Lewis River Hydroelectric Projects

FERC Project Nos. 935, 2071, 2111

Water Quality Management Plan

Prepared by

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July 2013

Table of Contents

Figures

Tables

Attachments

Abbreviations and Acronyms

ACC	Lewis River Aquatic Coordination Committee
ADA	Americans with Disabilities Act
ALP	Alternative Licensing Procedure
AST	Above-ground Storage Tank
BMP	Best Management Practice
CAP	Corrective Action Plan
CWA	Clean Water Act
DO	Dissolved Oxygen
EPA	United States Environmental Protection Agency
ESA	Endangered Species Act
FERC	Federal Energy Regulatory Commission
HCC	Hydro Control Center
HPA	Hydraulic Project Approval
JARPA	*Joint Aquatic Resource Permit Applications*
MHWM	Mean High Water Mark
NMFS	National Marine Fisheries Service
NOI	Notice of Intent
NOT	Notice of Termination
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resource Conservation Service
OHWL	Ordinary High Water Line
PUD	Public Utility District
QA/QC	Quality Assurance/Quality Control
RMAP	Road Maintenance and Abandonment Plan

SPCC	Spill Prevention Control and Countermeasures
SOP	Standard Operating Procedures
SWPPP	Stormwater Pollution Prevention Plan
TDG	Total Dissolved Gas
TDGWQAP	Total Dissolved Gas Water Quality Attainment Plan
TP	Total Phosphorous
TWQAP	Temperature Water Quality Attainment Plan
USCOE	U.S. Army Corps of Engineers
USFS	U.S. Forest Service
USGS	U.S. Geological Survey
WAC	Washington Administrative Code
WDFW	Washington Department of Fish and Wildlife
WDOE	Washington Department of Ecology (aka Ecology)
WQAP	Water Quality Attainment Plan
WQMP	Water Quality Management Plan
WQPP	Water Quality Protection Plan

1.0 INTRODUCTION

PacifiCorp Energy owns and operates the Merwin, Yale, and Swift No. 1 Hydroelectric Projects (Projects) on the Lewis River in Cowlitz, Clark, and Skamania counties, Washington. As part of Project relicensing activities, PacifiCorp Energy applied for and received water quality certifications pursuant to Section 401 of the federal Clean Water Act and 173-201A of the Washington Administrative Code (WAC). The water quality certifications require a water quality management plan that collects the specific water quality monitoring and other plans required by the certifications. *See* Ecology Order No. 3678 (Merwin Certification) § 4.1(20); Ecology Order No. 3679 (Swift No. 1 Certification) § 4.1(19). This Water Quality Management Plan (WQMP) fulfills that requirement.

1.1 BACKGROUND

The Projects, owned and operated by PacifiCorp under licenses issued by the Federal Energy Regulatory Commission (FERC), include:

Merwin Hydroelectric Project, FERC No. 935

Yale Hydroelectric Project, FERC No. 2071

Swift No.1 Hydroelectric Project, FERC No. 2111

The Swift No. 2 Project is owned by Cowlitz PUD and operated under contract by PacifiCorp Energy at Cowlitz PUD's direction. The project is located between the Swift No. 1 and Yale Projects. Cowlitz PUD holds a separate FERC license for the Swift No. 2 Project (FERC No. 2213), which is subject to a separate Section 401 certification issued by Ecology (Ecology Order No. 3676). This WQMP does not address the Swift No. 2 Project or its operations, which are the responsibility of Cowlitz PUD.

Ecology issued Section 401 water quality certifications for each of the PacifiCorp Projects on October 9, 2006, in conjunction with FERC's relicensing of them. Ecology amended these certifications on December 21, 2007; January 17, 2008; October 3, 2008; and November 7, 2011. FERC issued new licenses for the Projects on June 26, 2008. The section 401 certification conditions, as amended by Ecology before the new licenses were issued, are expressly incorporated into the new FERC licenses. The November 7, 2011 amendments included revised water quality standards and other provisions of Chapter 173-201A WAC. The individual water quality plans included in this WQMP address the certifications, as amended.

1.1.1 Project Area

The Project area for the Lewis River Projects is shown in Figure 1.1-1. For the purposes of implementing this plan, PacifiCorp Energy defines the management area as the head of Swift Reservoir (the Lewis River within the project influence) downstream to the confluence of the Lewis River with the Columbia River. This area includes 59 river miles of the mainstem Lewis River, of which approximately 36.5 miles are reservoirs related to the Projects.

1.1.2 Discussion of Applicable Water Quality Standards

Washington water quality standards are promulgated in WAC 173-201A (WDOE 2006). The standards designate all waters within the Project area for the following beneficial uses:

Water supply (domestic, industrial, agricultural, and stock watering)
Commerce and navigation
Salmonid spawning, rearing, and migration
Harvesting
Wildlife habitat
Primary contact recreation
Boating
Aesthetic values

In addition, all waters potentially influenced by the Project are designated as *Core Summer Salmonid Habitat*, except the Lewis River downstream of its confluence with Houghton Creek, which is designated for *Salmonid Spawning, Rearing, and Migration*. All waters potentially influenced by the Project are designated as extraordinary primary contact recreation except the Lewis River downstream of Merwin Dam. Finally, the Lewis River downstream of Merwin Dam to its confluence with Houghton Creek is designated for special protection of salmonid spawning and incubation. The special protection applies from September 1 through June 15 between Merwin Dam and approximately the river's confluence with Cedar Creek and applies from February 15 through June 15 downstream of Cedar Creek to Houghton Creek.

Based on these use designations, the following sections describe how Washington water quality standards for temperature, total dissolved gas (TDG), turbidity, dissolved oxygen, and pH, as well as oil spill prevention requirements, apply to the Projects. Unless otherwise noted, the water quality criteria presented are from WAC 173-201A (WDOE 2006), and the water quality data is from PacifiCorp and Cowlitz PUD (2004).

1.1.3 Water Temperature

Numeric water quality criteria are expressed as the rolling seven-day average of daily maximum temperatures for three days prior to and three days after each date ("7-DADMax").

In the Lewis River downstream of Merwin Dam to the river's confluence with Houghton Creek (located just upstream of Eagle Island at approximately river mile 11), the designated fish use is *Core Summer Salmonid Habitat.* The applicable temperature criterion for this designation is 16ºC as a 7-DADMax. In addition, the more stringent 13ºC criterion (as a 7-DADMax) for the protection of spawning and incubation applies seasonally to this reach. From Merwin Dam downstream to the river's confluence with Cedar Creek at approximately river mile 15, the 13ºC criterion applies from September 1 through June 15. From Cedar Creek to Houghton Creek, the 13ºC criterion applies from February 15 through June 15.

In the Swift No. 2 Canal and the Lewis River bypass reach, the applicable temperature criterion is the 16º C 7-DADMax criterion for *Core Summer Salmonid Habitat* (WAC 173-201A-200(1)(c), table 200(1)(c)).

When natural conditions exceed the applicable numeric criteria, human actions may not cumulatively increase the receiving water temperature by more than 0.3°C. as a 7-DADMax. When the background temperature of the water body is cooler than the applicable numeric criteria, incremental temperature increases from all non-point sources combined may not exceed 2.8°C. at any time.

With respect to stream segments potentially influenced by the Projects, temperatures within the Lewis River bypass reach and Swift No. 2 canal downstream from the Swift No. 1 project and Speelyai Creek are less than the applicable criterion of 16 ºC as a 7-DADMax (PacifiCorp and Cowlitz PUD 2012).

For the Lewis River downstream of Merwin Dam, the latest full dataset from 2012 measured a highest 7-DADMax Merwin tailrace temperature of just over 15º C. between September 1 and June 15, which exceeds the applicable 13º C. criterion, which became effective after the initial certification of the Projects. Between June 16 and August 31, when the 16 ºC criterion applies, the maximum measured 7-DADMax for the Merwin tailrace was about 13.5 ºC, which is well within the criterion. Because river temperatures exceed the newly applicable 13° C. criterion after September 1, Ecology amended Section 4.4(3) of the Merwin 401 Certification (Administrative Order Docket No. 8834) to require PacifiCorp to develop a Lewis River Temperature and Dissolved Oxygen Water Quality Attainment Plan (TDOWQAP) that presents a strategy for achieving compliance with temperature and dissolved oxygen water criteria in the Lewis River below Merwin Dam to the river's confluence with Houghton Creek.. The Lewis River TDOWQAP is provided as Attachment A of this plan.

The Merwin, Yale and Swift reservoirs, which have retention times of 44, 51, 120 days, respectively, are classified as 'lakes' and subject to WAC 173-201A-200(1)(c)(v) which states: *"For lakes, human actions considered cumulatively may not increase the 7-DADMax temperature more than 0.3ºC (0.54ºF) above natural conditions."* WAC 173-201A-200(1)(c)(v). Merwin dam has created artificial lake conditions over which the project has some control. In such circumstances, when it has been determined that the state standards are not attained, Ecology requires the Licensee to use all reasonable and feasible measures to achieve conditions that best protect the designated or characteristic uses for fish and shellfish within the reservoir" (See *e.g.*, Merwin Certification § 4.4(2) – Amendment 4). When it can be determined that a project is contributing to a water quality standards violation, the dam compliance schedule provision in Washington Administrative Code (WAC) Chapter 173-201A-510(5)(a)(ii), requires a water quality attainment plan to include "...identification of all reasonable and feasible improvements that could be used to meet standards, or if meeting the standards is not attainable, then to achieve the highest attainable level of improvement." Ecology has developed a guidance document related to this issue.

The only potential lake temperature criteria compliance issue identified in the 401 Certifications is temperature fluctuations in the Yale powerhouse tailrace, where it discharges into the upper end of Merwin reservoir (also referred to as Lake Merwin Canyon) (Yale Certification § 4.4(2)). The depth of the intakes for the Yale powerhouse results in water in the tailrace that is colder than ambient surface reservoir temperatures in Merwin reservoir during the summer months. Fluctuations in the flow from the tailrace caused by changing turbine operations creates substantial temperature fluctuations in the tailrace and small portions of the reservoir adjacent to the tailrace during June, July, and August, as the cold water drawn from Yale reservoir alternately displaces or is displaced by the warmer surface water of Merwin reservoir. As prescribed by Section 4.4.2 of the Yale 401 Certification (Order No. 3677), PacifiCorp has developed a Temperature Water Quality Attainment Plan (TWQAP) for the Lake

Merwin Canyon to evaluate and address, if necessary, these temperature fluctuations. The Lake Merwin Canyon TWQAP is provided as Attachment A of this plan.

1.1.4 Total Dissolved Gas

The Total Dissolved Gas (TDG) standard is to "not exceed 110 percent of saturation" for all use designations. WAC 173-201A-200(1)(f). This standard does not apply, however, whenever stream flows exceed the seven-day, 10-year frequency flood.

1.1.5 Turbine Related TDG

Based on relicensing studies (1994-2002), Ecology concluded that there were issues with turbine related TDG in the Swift and Yale tailraces. PacifiCorp worked with Ecology to develop a Corrective Action Plan in 2006 (Attachment C). PacifiCorp implemented the plan that same year and has worked to resolve elevated TDG at the two projects. The issue has been resolved through experimentation and the projects have been in compliance since about March 2010. Results and monitoring data have been reported to Ecology and FERC in the 2010 and 2011 Annual Reports.

1.1.6 Spill Related TDG

Spill-related TDG issues are known to occur at the Swift No. 1 and Merwin projects. However, observations of TDG during spill events at the Yale project have shown no effect on TDG levels. This is probably related to the spillway configuration that allows aeration and release of elevated gas levels before water reaches the Yale tailrace.

Swift No. 1

Spill at the Swift project has caused elevated TDG beyond 110% saturation, but all of the monitoring has been conducted during flows that exceed the 7Q10 high flow of 21,322 cfs. The TDG standard does not apply if inflows exceed 7Q10 flows. PacifiCorp will continue to monitor TDG during Swift spill events and will initiate a Spill TDG Water Quality Attainment Plan if TDG is elevated beyond 110% saturation during a spill event when in-flows are below 21,322 cfs, and in accordance with certification conditions 4.3(3) and 4.3(4).

Merwin

When spill flows exceed 5,000 cfs at Merwin dam, monitoring has repeatedly shown elevated TDG exceeding 110% saturation. A Spill TDG Water Quality Attainment Plan has been developed for Merwin and is included in Attachment D.

All of the current TDG monitoring for Merwin has been conducted under what is referred to as 'traditional forecasting,' which utilizes historical performance to determine when to spill. Following issuance of new licenses for the Lewis River projects, the FERC called for implementation of a High Runoff Procedure (HRP) for the Merwin project, which has as its foundation a computer-based forecasting tool. More specifically PacifiCorp has initiated use of a forecasting tool from the University of Washington (UW) known as 3Tier. The UW model is tailored to the specific geographic location of the Lewis River projects and is able to more accurately predict runoff as it relates to snowpack and pending storm fronts.

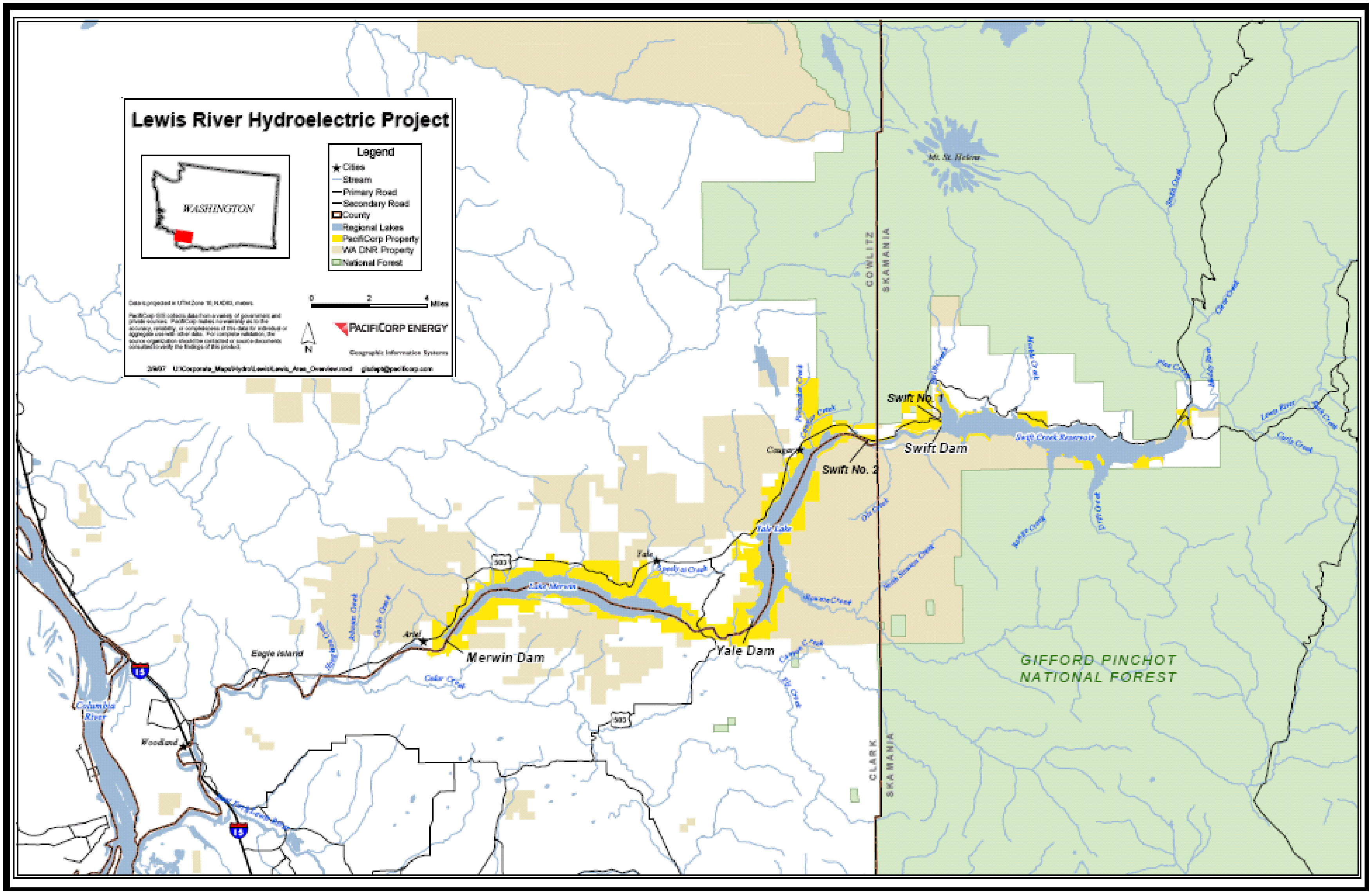

FIGURE 1.1-1. LEWIS RIVER HYDROELECTRIC PROJECT MAP.

A draft HRP has been prepared and is currently being reviewed by the FERC and the U.S. Army Corps of Engineers (USCOE). The HRP, a document (subject to FERC and FEMA approval) that outlines steps to be taken during a high runoff event, calls for spill pre-releases to dampen high flow event magnitudes in the future. This measure is designed to reduce the risk of flooding the lower Lewis River. How this affects the spill frequency and magnitude of Merwin spills is summarized in Attachment E. In short, the frequency of spills at Merwin for flows less than the 7Q10 flow of 32,884 cfs will likely increase from seventeen spills under the traditional forecasting method to about twenty-eight spills. The duration of such spills will likely increase as well from 922 hours per year to about 1059 hours per year. Overall this means an increase in the number and duration of events that could cause elevated TDG in the Merwin tailrace. Given the HRP, TDG levels are less manageable than under the traditional forecasting method. The attached Merwin Spill TDG Water Quality Attainment Plan (Attachment D), which proposes physical changes to the Merwin spillway, is expected to alleviate elevated TDG regardless of frequency or volume.

1.1.7 Dissolved Oxygen

Dissolved oxygen (DO) concentrations must equal or exceed 9.5 mg/L in waters designated *core summer salmonid habitat* and 8.0 mg/L in waters designated *salmonid spawning, rearing, and migration*. WAC 173-201A-200(1)(d). The Lewis River downstream of its confluence with Houghton Creek is designated *salmonid spawning, rearing, and migration* and is thereby subject to the 8.0 mg/l dissolved oxygen criterion. The Lewis River between Merwin Dam and Houghton Creek is designated *core summer salmonid habitat* and is subject to the 9.5 mg/l criterion. For the Project reservoirs, which the standards classify as "lakes," human activities may not decrease dissolved oxygen concentrations by more than 0.2 mg/l below "natural conditions." WAC 173-201A-200(1)(d)(ii). The dams have created artificial lake conditions over which the project has some control. In such circumstances, Ecology requires the Licensee to use all reasonable and feasible measures to achieve conditions that best protect the designated or characteristic uses for fish and shellfish within the reservoir." *See, e.g.*, Merwin Certification § 4.4(2) – Amendment 4. The only potential dissolved oxygen criteria compliance issue identified in the 401 Certifications is dissolved oxygen concentrations in the Lewis River downstream of Merwin Dam. Particularly during the autumn, dissolved oxygen concentrations may not meet the new, more stringent dissolved oxygen criterion applicable to this segment of the river. Accordingly, Section 4.4.3 of the Merwin 401 Certification (Administrative Order Docket No. 8834) requires that PacifiCorp develop a Temperature and Dissolved Oxygen Water Quality Attainment Plan (TDOWQAP) that presents a strategy for achieving compliance with temperature and dissolved oxygen water criteria in the Lewis River below Merwin Dam to the river's confluence with Houghton Creek. The Lewis River TDOWQAP is provided as Attachment A of this plan.

1.1.8 pH

The applicable pH criteria range for all use designations is 6.5 to 8.5. WAC 173-201A-200(1)(g). In addition, in waters designated *core summer salmonid habitat*, the human-caused variation in pH must be less than 0.2 within this range; in waters designated *salmonid spawning, rearing, and migration*, the human-caused variation must be less than 0.5 within this range. As described in section 1.0, above, waters that are designated *core summer* *salmonid habitat* are the reservoirs, the Lewis River downstream of Merwin Dam to the river's confluence with Houghton Creek, the Swift No. 2 Canal, Speelyai Creek, and the Lewis River bypass reach. The Lewis River downstream of Houghton Creek is designated for *salmonid spawning, rearing, and migration*.

Measurements for pH at the Projects were collected from May 1999 through April 2000 using a Hydrolab® field instrument. The pH data for the Projects are included in the appendix to Study WAQ-1 of the Water Quality Final Technical Report (PacifiCorp and Cowlitz PUD 2004). All measurements within waters influenced by the Project were within the range of 6.5 to 8.5, and there is no reason to believe that project operations can affect changes in pH. Therefore, the section 401 certifications for the Project do not require pH monitoring.

1.1.9 Turbidity

For all applicable use designations, the turbidity criterion is no more than a 5 nephelometric turbidity unit (NTU) increase over background when the background is 50 NTUs or less, and no more than a 10 percent increase over background when the background is more than 50 NTUs. WAC 173-201A-200(1)(e).

Turbidity levels at the upper watershed sites (tributaries upstream of the Projects) were generally low during the dry summer months (1-2 NTUs), and comparatively high during the rainy season from November through April. In general, turbidity levels at the lower watershed sites (Merwin reservoir inflow, near dam, tailrace, and Eagle Island) were similar to the upper watershed during the summer months (less than 2 NTUs). The winter and spring month turbidity levels were higher but only reached a maximum of about 4 NTUs.

In addition to monthly turbidity measurements, Ecology requested turbidity analyses prior to and following a drawdown of Merwin reservoir in October 2000. A 4-foot (1.2 m) drawdown, from 233 to 229 feet (71 to 70 m) occurred from October 6-10, 2000. Samples were collected at three reservoir locations (upper, mid-reservoir, and near the dam) and two depths (2- and 7.5-meters). Samples were also collected in the Merwin tailrace. Heavy rains (0.26 inch [0.6 cm]) were recorded at Merwin dam on October 9, and rain continued during sampling on October 10 (0.03 inch [0.07 cm]). Turbidity levels at all locations and depths were less than 2 NTUs on both dates.

1.1.10 Spill Prevention, Control and Countermeasures

PacifiCorp Energy has developed and implemented Oil Spill Prevention, Control and Countermeasure (SPCC) Plans for all three Projects. The SPCC Plans are consistent with the oil spill prevention and control requirements of the certifications. Oil spill prevention plan goals are as follows:

Minimize the likelihood that facility oil spills will occur,

Minimize the size and impacts of those facility oil spills which do occur,

Facilitate coordination of local, state, regional, tribal, and other prevention plans, Provide improved protection of waters and natural resources from oil spills, and

Emphasize that oil spill prevention is the top priority strategy for protecting Washington waters and natural resources from the impacts of oil spills.

These plans were updated in February 2013. Copies are available on a CD in the back sleeve of this document (see Attachment H).

2.0 PROJECT DESCRIPTIONS AND OPERATIONS SUMMARY

2.1 Merwin Project Description and Operations Summary

The Merwin hydroelectric project is owned and operated by PacifiCorp Energy. This project is the farthest downstream of the three Lewis River hydroelectric projects, located about 35 miles northeast of Portland, Oregon. Construction of the Merwin project began in 1929 and the first unit was completed in 1932. Two additional units were added to the project in 1949 and 1958. Merwin dam is located about 19 miles upstream from the confluence of the Lewis River with the Columbia River. The dam is a concrete arch structure with a total crest length of 1,300 feet and a maximum height of 314 feet. The dam consists of an arch section 752 feet in crest length, a 75-foot-long gravity thrust block, a 206-foot-long spillway section, a non-overflow gravity section 242 feet long, followed by a concrete core wall section 20 feet high and extending 25 feet into the bank. The spillway is equipped with four taintor gates that are 39 feet wide and 30 feet high, and one taintor gate that is 10 feet wide and 30 feet high. The taintor gates have been extended to an elevation of 240 feet-msl by adding 5-foot flashboards. Merwin reservoir, formed by Merwin dam, is about 14.5 miles long with a full pool surface area of about 4,000 acres. At full pool the reservoir has a gross storage capacity of 422,800 acre-feet. At minimum pool, the reservoir has an active storage capacity of 263,700 acre-feet.

The Merwin project consists of three penstocks from the dam to the powerhouse. A fourth penstock was originally constructed but is currently not utilized. Water is delivered to the three active penstocks via separate intakes. The intakes are relatively deep (about 178 feet below full pool) and include high-head intakes with design velocities ranging from 10 to 20 feet per second (fps). The capacity of the penstocks is different, with Units No. 1 and 2 capable of carrying 3,790 cfs, and Unit No. 3 capable of 3,890 cfs. The penstock inlet diameters and the minimum water surface elevation of Merwin reservoir allow the intake system to pass more than 150 percent of the existing plant hydraulic capacity.

The powerhouse contains three semi-outdoor generator units with an installed capacity of 45,000 kilowatts (kW) and one 1,000 kW house unit, for a total installed capacity of 136,000 kW. Two 115 kilovolt (kV) transmission lines serve the Merwin project. One line extends west from the Merwin substation about 15.9 miles to Kalama, Washington while the other line runs south from the Merwin substation for 26.7 miles to Battleground, Washington and then into Portland, Oregon.

Merwin operates as a re-regulating facility to meet minimum Lewis River flow and ramping requirements downstream of the project. The Merwin powerhouse discharges directly into the Lewis River. Merwin reservoir is normally maintained between elevations 235 feet-msl and 239.6 feet-msl (full pool). Reservoir operating levels are as follows:

- Full Pool 239.6 feet-msl

- Normal Minimum (summer) 235 feet-msl
- Minimum Operating 165 feet-msl
- Minimum of Record (December 1936) 166.7 feet-msl

There is no normal winter elevation. The reservoir typically is operated in the top five feet for recreation purposes during the summer and may be drawn down to a low of 165 feet-msl during non-recreation periods for special operations such as gate repairs or inspections (every five years). When natural inflows exceed power production requirements and reservoir storage space nears the prescribed minimum, spilling is initiated. The spillway is equipped with five spill gates that are operated in a sequential manner to reduce the potential for downstream dissolved gas supersaturation.

2.2 Yale Project Description and Operations Summary

The Yale project is owned and operated by PacifiCorp Energy. Construction of the Yale Project began in 1951 and was complete by 1953. The project is on the Lewis River about 15 miles upstream from the Merwin project (RM 34). Yale dam is a rolled earthfill embankment type dam with a crest length of 1,305 feet and a height of 323 feet above its lowest foundation point. The Saddle dam, an associated feature of the Yale project, is located ¼ mile north of Yale dam and is about 1,600 feet long and 40 feet high. The right abutment of Yale dam has a chute type spillway (with five 30- by 39-foot taintor gates) with a capacity of 120,000 cfs. Yale reservoir formed by Yale and Saddle dams, is about 10.5 miles long with a full pool surface area of about 3,800 acres. At full pool the reservoir has a gross storage capacity of 402,000 acre-feet. At minimum pool, the reservoir has an active storage capacity of 190,000 acre-feet.

The Yale project consists of two tunnels/penstocks from Yale dam to the powerhouse. Water is delivered to the tunnels/penstocks via a common intake that is located relatively deep (about 90 feet at full pool) and has high-head design velocities (10 to 20 fps). The maximum tunnel/penstock diameter is 18.5 feet, the minimum diameter is 16 feet, and they are capable of passing up to 4,880 cfs at velocities from 18.2 fps to 24.3 fps.

The Yale powerhouse is located at the base of the earth embankment on the left side of the former river channel and has two generators with a total installed capacity of 108,000 kW. The generator units were originally installed in 1952 and were rehabilitated coincident with generator rewinds in 1987 and 1988. In 1995, PacifiCorp Energy installed a new runner in Yale Unit No. 2, and a similar runner was installed in Unit No. 1 in 1996. These new runners increased Yale capacity to 134,000 kW. Yale Project power is transmitted to the Yale substation then 11.5 miles over a 115 kV transmission line (Merwin-Yale line) to a substation adjacent to the Merwin project.

The Yale powerhouse discharges directly into Merwin reservoir. The Yale project operators live near the powerhouse and are available for local control on short notice. Daily operation is controlled by the PacifiCorp Energy’s Hydro Control Center (HCC). Yale normally operates as a peaking project. This means that the project operates to provide energy during times of peak customer demand (load), usually from 6:00 a.m. to 10:00 p.m. During off-peak hours (10:00 p.m. to 6:00 a.m.), Yale powerhouse is usually shut down.

Yale reservoir is operated in coordination with Swift and Merwin reservoirs, following the Standard Operating Procedures (SOP) Manual (PacifiCorp 1985) to schedule system generation and provide for flood storage during periods of high runoff. When feasible, PacifiCorp Energy controls Yale reservoir elevation during the summer for recreation purposes. Yale Lake operating levels are as follows:

- Full Pool 490 feet-msl
- Normal Minimum Summer 480 feet-msl
- Minimum Operating 430 feet-msl (per USGS)
- Minimum of record (February 1957) 435.65 feet-msl

2.3 Swift No. 1 and No. 2 Projects

Swift No. 1 is the largest (240 mw) hydroelectric facility of the four Lewis River projects. When completed in 1958, the 512-foot high Swift dam was one of the tallest earth-fill dams in the world. Swift reservoir covers 4,600 acres and provides a wide variety of recreation opportunities. The Swift No. 1 powerhouse discharge enters a canal that takes it to the Swift No. 2 project (a 70-mw project). The Swift No. 2 canal and powerhouse are owned by the Public Utility District No. 1 of Cowlitz County (Cowlitz PUD) and operated by PacifiCorp Energy. After exiting Swift No. 2 turbines, the canal water enters the upper end of Yale Reservoir.

2.3.1 Swift No. 1 Project Description and Operational Summary

The Swift No. 1 project is owned and operated by PacifiCorp Energy. It is located on the Lewis River, 10.5 miles upstream from Yale dam. Construction of the Swift No. 1 project began in 1956 and was complete by 1958. The dam is an earthfill embankment type dam with a crest length of 2,100 feet and a height of 512 feet above its lowest foundation point. Its left abutment overflow spillway (with two 50- by 51-foot taintor gates) has a capacity of 120,000 cfs. The elevation at the top of the taintor gates is 1,001.6 feet-msl. Swift reservoir is about 11.5 miles long with a full pool surface area of 4,680 acres. At full pool the reservoir has a gross storage capacity of 755,500 acre-feet. At minimum pool, Swift reservoir has a capacity of about 447,000 acre-feet.

Water is delivered to the powerhouse through a system consisting of a tunnel, a surge tank, three branched outlets, and three penstocks. The intake is located relatively deep (878 feet-msl or 122 ft. below full pool) and has high-head intake design velocities (10 to 20 fps). The surge tank is located about 1,196 feet downstream of the tunnel intake and about 482 feet upstream of the powerhouse. This surge tank is a restricted orifice, non-overflow style, with a diameter of 55 feet and a top elevation of 1,035 feet-msl. Downstream of the surge tank, penstocks for each generating unit branch from the main tunnel. Each penstock is 13 feet in diameter and water velocities reach up to 23 fps at maximum turbine flows. Combined, the three penstocks are capable of passing a maximum of 9,120 cfs.

The Swift No. 1 powerhouse is operated by remote control from the Merwin Hydro Control Center. The powerhouse, located at the base of the dam on the left side of the former river channel, has three Francis-type generators with a total installed capacity of 240,000 kW. Swift No.1 power is transmitted to the nearby Swift substation, then 2.6-miles over a 230 kV line to the Swift No. 2 switchyard.

Swift reservoir is the largest and uppermost impoundment on the Lewis River. There is no flow regulation upstream of Swift reservoir; therefore, reservoir elevations and project operations can be significantly affected by natural inflows. Swift No. 1 is operated to provide peaking and load-following capabilities. The project operates in concert with the other Lewis River Projects to meet reservoir storage requirements, system load, minimum flows, and recreation needs. During the summer, PacifiCorp Energy typically maintains reservoir levels within 5 feet of full pool to meet recreation needs. However, reservoir elevations are influenced by factors such as minimum stream flow needs downstream of Merwin dam, inflows, system load, and flood control. Swift reservoir operating elevations are as follows:

- Full pool 1,000 feet-msl
- Normal summer minimum 990 feet-msl
- Minimum operating 878 feet-msl
- Minimum of record (May 1967) 884 feet-msl

The spillway is comprised of two radial gates with a hydraulic capacity of 120,000 cfs. The spillway discharges directly into the Lewis River bypass reach. Under normal operations the 2.7-mile-long bypass reach, which routes water to the Yale Reservoir, receives year–round flows from a siphon drain at the upper end of the Swift No. 2 power canal (Upper Release) and a downstream constructed side channel that receives water from a second drain in the power canal (Canal Drain or Lower Release) (Table 2.3.1). During a spill event the additional flows passed over the Swift No. 1 spillway discharge into the bypass reach.

Table 2.3.1. Minimum flow schedule for the Swift Bypass Reach.

Lower Release	
At All Times	14 cfs
Upper Release	
December 8th – January 31st	51 cfs
February 1st – February 28th (see leap year provision)*	75 cfs
March 1st – May 31st	76 cfs
June 1st – September 23rd	54 cfs
September 24th – September 30th	55 cfs
October 1st – October 31st	61 cfs
November 1st – November 15th	76 cfs

November 16th – November 30th	56 cfs
December 1st – December 7th	51 cfs

*74 cfs released for the first 7 days in February in a leap year

2.3.2 Swift No. 2 Project Description and Operational Summary

The Swift No. 2 Project is owned by Cowlitz PUD and operated under contract by PacifiCorp Energy. As owner of the project, Cowlitz PUD is responsible to meet all regulatory obligations. As operator, PacifiCorp Energy operates the project as directed by Cowlitz PUD. This project is located between the Swift No. 1 and Yale projects, with the powerhouse about 3.2 miles downstream of the Swift No. 1 powerhouse. Construction of the Swift No. 2 project began in 1956 and was complete by 1958.

The Swift No. 2 power canal begins in the tailrace to the Swift No. 1 powerhouse. Tailrace water enters the 3.2-mile canal, which carries it to the powerhouse. An ungated spillway and discharge channel system prevents flows from exceeding the power canal hydraulic capacity and maintains maximum power canal levels. The power canal surface area is about 100 acres, it holds about 2,400 acre-feet of water. The maximum capacity of the power canal is 11,000 cfs.

Water from the power canal is delivered to the powerhouse via two penstocks (one for each generating unit). The powerhouse contains two Francis-type turbines, each rated at 35,000 kW. Swift No. 2 power is transmitted 0.9-miles over a 230 kV transmission line to the Swift No. 2 switchyard.

The Swift No. 2 project relies on water discharged from Swift No. 1 to a power canal that operationally links the two projects. The headwater level at Swift No. 2 is equal to the tailwater elevation at Swift No. 1 (minus a 1-foot hydraulic gradient). The maximum water level in the power canal is maintained at 604 feet-msl by a fixed crest wasteway that spills excess flow into the Swift bypass reach. The Swift No. 2 project provides peaking capabilities to both PacifiCorp Energy and the Cowlitz PUD. Canal operating elevations are: maximum pool- 604 feet-msl; Normal operating - 603 feet-msl; and, minimum pool - 601 feet-msl.

2.4 Fish Hatcheries

Three mitigation hatcheries (Lewis River, Merwin, and Speelyai) are part of PacifiCorp Energy's Lewis River FERC licenses. The hatcheries include settling ponds (for effluent treatment) that are regulated by Ecology and, as such, covered individually under National Pollutant Discharge Elimination System (NPDES) Waste Discharge Permits. Because the hatcheries are regulated through the NPDES permits, no 401 Certification conditions apply to the hatcheries.

3.0 WATER QUALITY ATTAINMENT, MONITORING AND REPORTING

The Washington Department of Ecology issued Clean Water Act Section 401 water quality certifications for each project on October 9, 2006. These certifications were amended on December 21, 2007, January 17, 2008, October 3, 2008, and November 7, 2011. To implement the Section 401 certification conditions and to meet conditions of the Lewis River Settlement Agreement, PacifiCorp Energy and the Cowlitz PUD have developed a Monitoring and Evaluation Plan that includes water quality monitoring requirements from the Section 401 certifications.

This section describes required monitoring efforts and water quality attainment plans (WQAPs) that address specific water quality issues associated with the Lewis River hydroelectric projects. The WQAPs include adaptive management provisions that are responsive to ongoing monitoring results and other new information, and a description of the annual reporting effort planned for the Projects.

Table 3.1.1 summarizes the monitoring requirements per the respective Section 401 Certifications. PacifiCorp has implemented monitoring and/or carried out the requirements summarized in this table. Results have been reported in PacifiCorp's ACC/TCC annual report that is conveyed to FERC. Ecology has received copies as well.

3.1 Water Quality Attainment Plans

To implement the Section 401 Certification requirements and address water quality issues, PacifiCorp Energy has included in the Attachment of this document the following water quality attainment and other plans:

Attachment A: Lewis River Temperature and Dissolved Oxygen Water Quality Attainment Plan, July 2013

Attachment B: Lake Merwin Canyon Water Quality Attainment Plan, July 2013

Attachment C: Yale and Swift No. 1 Turbine TDG Corrective Action Plan, January 2006

Attachment D: Merwin Spill Related TDG Quality Attainment Plan, July 2013

Attachment E: Spill Related Total Dissolved Gas Quality Assurance Project Plan, July 2013

Attachment F: Lewis River Water Quality Protection Plan, July 2013

Attachment G: In-Water Work Protection Plan (Routine Maintenance and Small Projects), July 2013

Attachment H: Lewis River SPCC Plans (CD sleeve attached), February 2013

Table 3.1.1. Summary of implementation and monitoring requirements of each project Section 401 Water Quality Certification.

	Total Dissolved Gas	Dissolved Oxygen	Temperature	Gravel Placement	Gravel Surveys	Fish rearing and spawning Surveys	Redd Surveys	Flow Monitoring	Spill	Construction Projects	Oil and Grease	Sumps	Transformer Deck	Oil tanks, transformers, and other oil tanks >100gal.	Fuel hoses, oil drums, oil & fuel transfer valves and fittings	Wash water	Pesticides
Merwin	Monitor turbine outlets to assure compliance with 110%. During spill, monitor just downstream of aeration zone. TDG must be <110% unless 32,884cfs inflows are exceeded. If TDG is exceeded with spill when inflow is <32,884cfs, then provide TDGWQAP wit	Monitor in forebay and tailrace, in September and October hourly.	Monitor in forebay at depths of 1, 5, 10, 20, 40, 60, 100, and 200 feet. May 1st through Oct. 31st hourly. Monitor tailrace hourly all year, not to exceed 16ºC (13ºC Sept. 1-June 15).	NA	NA	NA	NA	Monitor Lewis River below Merwin dam at USGS Ariel gage.	Calculate and report every change in spill gate openings during spill event	Provide Water Quality Protection Plan	Record amounts used of oil, grease, and hydraulic fluids.	Maintain oil sensors on the surface of the water in addition to sensors at the bottom of each pumping cycle.	Inspect containment area surfaces - must be impervious. Inspect deck drains.	Provide proper containment (largest single volume +15%). Provide external oil level gauges along with sign that explains the level readings.	Inspect fuel hoses, oil drums, oil or transfer valves and fittings for drips and leaks.	Contain and prevent discharge into waters of the State.	Use BMPs and obtain appropriate permits for application to waters of the State or adjacent to waters of the State.
Frequency/Duration	Ongoing if exceedences occur until 3 months after such exceedences are corrected.	Ongoing until DO is found to not go below 8 mg/l for a period of 5 consecutive years	Ongoing until tailrace temperature does not exceed 16ºC (13ºC Sept. 1-June 15) for five consecutive years.					Ongoing every 15 minutes for the term of the license.		Follow monitoring and BMPs identified in WQPP. Ongoing.	Weekly for the license term.	Inspect and test every 3 months. If oil is visible, call Emergency Management Division	Periodically inspect decks. Inspect drains daily during snow/ice conditions.	Immediate-ongoing	Regularly	Immediate-ongoing	Immediate-ongoing
Yale	Monitor turbine outlets to assure compliance with 110%. During spill, monitor just downstream of aeration zone. TDG must be <110% unless 27,088cfs inflows are exceeded. If TDG is exceeded with spill when inflow is <27,088cfs, then provide TDGWQAP wit	NA	Monitor in Forebay at depths of 1, 5, 10, 20, 40, 60, and 100 feet. May 1st through Oct. 31st hourly. Monitor tailrace, 15ft deep, hourly all year. Also profile of tailrace depth temp. Provide TWQ Attainment Plan for the canyon on Lake Merwin just dow	NA	NA	NA	NA	NA	Calculate and report every change in spill gate openings during spill event	Provide Water Quality Protection Plan	Record amounts used of oil, grease, and hydraulic fluids.	Maintain oil sensors on the surface of the water in addition to sensors at the bottom of each pumping cycle.	Inspect containment area surfaces - must be impervious. Inspect deck drains.	Provide proper containment (largest single volume +15%). Provide external oil level gauges along with sign that explains the level readings.	Inspect fuel hoses, oil drums, oil or transfer valves and fittings for drips and leaks.	Contain and prevent discharge into waters of the State.	Use BMPs and obtain appropriate permits for application to waters of the State or adjacent to waters of the State.
Frequency/Duration	Ongoing if exceedences occur until 3 months after such exceedences are corrected.		Ongoing until temp is shown to not increase the 7-DADMax temperature more than 0.3ºC (0.54ºF) above natural conditions. Occurs for five consecutive years. Tailrace temp./depth profile monitoring done until temp. fluctuations in tailrace/upper Lake Merwin							Follow monitoring and BMPs identified in WQPP. Ongoing.	Weekly for the license term.	Inspect and test every 3 months. If oil is visible, call Emergency Management Division	Periodically inspect decks. Inspect drains daily during snow/ice conditions.	Immediate-ongoing	Regularly	Immediate-ongoing	Immediate-ongoing
Swift No. 1	Monitor in Swift No. 1 forebay. Monitor turbine outlets to assure compliance with 110%. During spill, monitor just downstream of aeration zone. TDG must be <110% unless 21,322cfs inflows are exceeded. If TDG is exceeded with spill when inflow is <21,3	NA	Monitor Swift 1 forebay at 1, 5, 10, 20, 40, 60, 80, 120, and 145 ft. depths May 1st - Oct. 31st. Swift 1 tailrace canal at depth of 1 ft. hourly all year. Place 1 meter just upstream from Ole Creek mouth and 1 meter just downstream from Ole Creek mouth	Place 160 tons of gravel in bypass reach w/in 1 year of license issue during the first available work window following acquiring necessary permits.	Swift bypass reach; After 1st gravel augmentation. survey in Spring following 1st occurrence of spill 5000 cfs or greater. After 2nd gravel augmentation. Spring following first occurrence of spill of 5000cfs or greater. Following 3rd and 4th occurrence	Biological surveys of upper and lower flow channels.	Redd counts of both Swift bypass reach flow channels.	Upper flow channel will be monitored to follow instream flow regime within 55,200 ac-ft. (55,349 ac-ft. in leap year) as specified in the SA. Lower flow channel will be monitored to provide flow at 14cfs.	Calculate and report every change in spill gate openings during spill event	Provide Water Quality Protection Plan	Record amounts used of oil, grease, and hydraulic fluids.	Maintain oil sensors on the surface of the water in addition to sensors at the bottom of each pumping cycle.	Inspect containment area surfaces - must be impervious. Inspect deck drains.	Provide proper containment (largest single volume +15%). Provide external oil level gauges along with sign that explains the level readings.	Inspect fuel hoses, oil drums, oil or transfer valves and fittings for drips and leaks.	Contain and prevent discharge into waters of the State.	Use BMPs and obtain appropriate permits for application to waters of the State or adjacent to waters of the State.
Frequency/Duration	Ongoing if exceedences occur until 3 months after such exceedences are corrected. Spill monitoring ongoing unless TDG during spill is found to not exceed 110% during river flows <21,322cfs.		Swift forebay monitoring is ongoing until temp. behavior in the forebay of Swift 2, the upper and lower release points, and the bypass reach are understood. Monitoring in the Swift 1 tailrace and just below Ole Creek mouth are ongoing.	Augment depending on spill conditions as described in the 401 Cert	One time after first and second gravel augmentations. 1-3 times after 3rd and 4th occurrence of spill 5000 cfs or greater.	Survey both channels quarterly for 1 year after the first full year of operation. Survey quarterly for 1 year beginning in the 4th year after the first 4 years of operation of both channels. Surveys done quarterly for 1 year after each change in the comb	Ongoing once every 2 weeks from Oct. 1-Nov. 15 and from Feb. 1-May 31. Quarterly 1 year after reintroduction into Yale Lake. Quarterly following placement of upstream passage structures at Yale and Swift dams.	Upper flow channel and lower flow channel monitored every 15 minutes and recorded daily for term of license. Notify WDOE within 24 hours if flows are less than required.	Ongoing for life of license	Follow monitoring and BMPs identified in WQPP. Ongoing.	Weekly for the license term.	Inspect and test every 3 months. If oil is visible, call Emergency Management Division	Periodically inspect decks. Inspect drains daily during snow/ice conditions.	Immediate-ongoing	Regularly	Immediate-ongoing	Immediate-ongoing

3.1.1 Yale and Swift Turbine TDG Water Quality

The results from the PacifiCorp Energy water quality study (PacifiCorp and Cowlitz PUD 2004, WAQ 1) indicated that TDG levels in the Swift project tailrace represented project-related water quality problems. Additional studies (PacifiCorp and Cowlitz PUD 2004, WAQ 2 and 4) were conducted to address TDG compliance. The results of these studies are discussed in Attachment C along with the proposed correction measures including restricting air induction flow.

An assessment of the effects of restricting air induction on turbine cavitation was conducted by PacifiCorp Energy during the week of April 21, 2003. During that test period, the air induction vent was systematically blocked off and cavitation vibrations were measured with instrumentation. Results showed that vibration (and potential turbine damage) does not change with air restriction. Therefore, it appeared that restriction could occur as a measure to reduce TDG levels in the Yale and Swift No. 1 tailrace.

Given this information, PacifiCorp Energy automated the air vents at all three Swift No. 1 turbine units. Automation of the air vents is intended to control the volume of air entering the turbine units at certain generation levels. Generally, air inflow is restricted at lower generation levels and less restricted at higher generation levels.

Measures have been implemented to reduce TDG at the Yale and Swift No. 1 tailraces including installation of a Programmable Logic Control (PLC) and new valve actuators to control air entrainment in the draft tubes for each of the three turbines. More recent results are shown in Tables 3.1.2 and 3.1.3.

Table 3.1.2. Results of monitoring the Yale tailrace TDG - 2010 through 2012.

		Maximum monthly values for percent TDG in the Yale tailrace by month.										
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
2010	104.1	102.3	105.0	105.6	106.1	104.9	107.2	107.2	106.2	104.3	104.4	102.6
2011	101.1	103.9	103.6	105.6	106.9	106.1	104.8	109.0*	108.0	106.5	103.2	105.0
2012	105.9	105.9	108.2	109.0	108.1	108.4	108.1	108.9	108.2	107.9	106.4	109.0

*faulty TDG meter

Table 3.1.3. Results of monitoring the Swift No. 1 tailrace TDG - 2010 through 2012.

		Maximum monthly readings for percent TDG in the Swift tailrace by month.										
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
2010	104.3	108.9	106.3	109.5	109.4	109.9	108.8	108.0	109.1	106.8	102.7	104.3
2011	101.1	103.9	103.6	105.6	106.9	106.1	104.8	109.0*	108.0	106.5	103.2	105.0
2012	106.5	105.0	104.4	110.0	109.2	107.4	107.0	109.7	109.7	103.6	110.4	105.1

* Divers repositioned probe

Clearly the measures implemented at Yale and Swift No. 1 are working. PacifiCorp will continue to monitor the tailraces for TDG for at least two more years to illustrate the changes are permanent and effective.

3.2 Stream Flow Monitoring

Minimum stream flows, ramp rates and plateau operations were negotiated and agreed to by the Lewis River Settlement Agreement Parties (SA 6.1.5 and 6.2.4). Those requirements were subsequently incorporated into the Merwin and Swift No. 1 Section 401 Water Quality certifications (Table 3.2.1). The following describes how PacifiCorp Energy will implement and monitor the flow requirements for the Merwin and Swift No. 1 hydroelectric projects.

Methods and protocols for monitoring and reporting stream flow are included in the Lewis River Monitoring and Evaluation Plan (M&E Plan). The final M&E Plan is available on PacifiCorp's website (http://www.pacificorp.com/content/dam/pacificorp/doc/Energy_Sources/Hydro/Hydro_Licensing/Bear_River/2010_LR_ME_Plan.pdf). This plan was developed to evaluate all aspects of the implementation requirements, including flows, ramping and water quality. The final document was submitted to FERC on June 26, 2010.

3.2.1 Merwin Minimum Flows

Flow downstream of the Merwin project is measured at the Ariel gage (USGS No. 14220500). Readings are recorded every 15 minutes and summarized annually by the U.S. Geological Survey (USGS) – Surface water Flow Division. Ariel gage data can be queried on the USGS internet site for historic streamflow. Real-time flow information is also available.

Merwin project operators have a direct, instantaneous read-out of Ariel stage. The operators use this information to make fine adjustments to flows and ramp rates. Mean daily flow data from the USGS is used to provide a compliance report to FERC and Ecology as part of the ACC/TCC Annual Report. This annual report provides a description of Merwin project operations related to any excursions from the required flows, ramp rates and plateau operations.

3.2.2 Swift Bypass Minimum Flows

The Swift bypass channel has been modified (to improve habitat conditions) per the Lewis River Settlement Agreement. Water for the bypass is supplied from two different locations known as the Upper Release and the Canal Drain. Minimum stream flows for the Upper Release and Canal Drain were negotiated and agreed to by the Lewis River Settlement Agreement Parties. The Upper Release point is located close to the dam in the upper portion of the canal and the Canal Drain is located approximately one third the length of the canal downstream of the Swift No. 1 tailrace.

3.2.3 Upper Release Point

Water for the upper section of the Swift bypass reach originates from the Swift Canal at the Upper Release Point. Flows exit the canal through a 48-inch pipe into a manmade channel that joins the bypass reach at the spillway plunge pool. A flow meter is installed on the 48-inch pipe that provides digital flow information to the operator at Merwin Hydro Control Center. A valve controlling flow releases has an actuator that can be operated manually from HCC and can adjust flows through the 48-inch supply pipe. The actuator operates automatically to open and close the valve based on canal pool level to provide the correct flow to the bypass reach. Flow information can be accessed at any time through PacifiCorp Energy's database and can be queried to provide average daily flows for any given period. As described in the Monitoring and Evaluation Plan (PacifiCorp and Cowlitz PUD 2010), in the event that the flow release mechanism fails or the Canal elevation becomes too low to provide the required Upper Release flow amount, one of the spillgates at Swift No. 1 will open to provide the minimum flow until the Upper Release mechanism is back in service. Daily flows will be reported in PacifiCorp Energy's Annual ACC/TCC Report and distributed to Ecology.

3.2.4 Canal Drain Release Point

Water released from Swift Canal through the Lower Release point enters the Constructed Channel, which has received some habitat improvements prior to instituting the 14 cfs flow requirement. Water is supplied through a gate valve on a 30-inch diameter lined culvert to the upper plunge pool of the "Constructed Channel." This channel was modified (to improve habitat conditions) within the first year of the new FERC licenses per the Lewis River Settlement Agreement. Once the channel was completed, a permanent staff gage was installed near the outlet of the Canal Drain and rated for flow from the culvert at differing canal elevations. Once rated, the staff gage was intended to serve as a visual indicator of flow from the canal drain. The valve opening was set to provide 14 cfs at the lowest operating level of the canal. This method did not prove to be reliable so PacifiCorp installed a flow analyzer that records daily flow values and transmits the data to PacifiCorp's data storage system (called Process Integration or PI). Daily flows will be reported in PacifiCorp Energy's Annual ACC/TCC Report and distributed to Ecology.

Table 3.2.1. Summary of flow requirements for Merwin dam and the Swift Bypass Reach.

Minimum Flow Below Merwin Dam under New License	
Effective 6/25/2008	
July 31st - October 15th	1,200 cfs
October 16th - October 31st	2,500 cfs
November 1st - December 15th	4,200 cfs
December 16th - March 1st	2,000 cfs
March 2nd - March 15th	2,200 cfs
March 16th - March 30th	2,500 cfs
March 31st - June 30th	2,700 cfs
July 1st - July 10th	2,300 cfs
July 11th - July 20th	1,900 cfs
July 21st - July 30th	1,500 cfs

Swift Canal Releases under New License	
Lower Release	
At All Times	14 cfs
Upper Release	
December 8th - January 31st	51 cfs
February 1st - February 28th (see leap year prov.)+	75 cfs
March 1st - May 31st	76 cfs
June 1st - September 23rd	54 cfs
September 24th - September 30th	55 cfs
October 1st - October 31st	61 cfs
November 1st - November 15th	76 cfs
November 16th - November 30th	56 cfs
December 1st - December 7th	51 cfs

3.3 Adaptive Management Based on Monitoring Results

PacifiCorp Energy has gathered a great deal of water quality data over the past thirteen years which presents a good water quality baseline of project-influenced locations within the Lewis River Basin. The results indicate compliance with the majority of Washington State water quality criteria. To ensure continued compliance, PacifiCorp Energy will monitor select water quality parameters for Lewis River Basin locations potentially affected by Project operations as identified in Table 3.1.1. These select water quality parameters include water temperature, TDG (Swift No. 1 and Yale tailraces only), Dissolved Oxygen, flows and spill containment. Based on future water quality monitoring results, PacifiCorp Energy will evaluate corrective actions to maintain water quality standards. For example, if monitoring results indicate that a Project is not in compliance with State criteria, PacifiCorp Energy will notify Ecology and initiate actions (e.g., engineering or environmental studies) to determine the cause of the problem and develop corrective strategies (e.g., equipment or operational changes) to eliminate or mitigate the water quality issue. If appropriate, these measures will be incorporated into a WQAP and submitted to Ecology for approval.

Adaptive management efforts, developed in consultation with Ecology, will be addressed annually based on Ecology review of the annual water quality report.

3.4 Monitoring and Reporting

In addition to the routine monitoring requirements summarized in Table 3.1.1, Ecology has established water quality monitoring requirements for in-water work associated with the Lewis River Hydroelectric Projects. Per the Clean Water Act Section 401 Certifications issued for the Swift No. 1, Yale, and Merwin projects, the water quality parameters requiring monitoring during in-water construction work are dissolved oxygen and turbidity. Sections 1.1.7 and 1.1.9 of this plan address dissolved oxygen and turbidity monitoring requirements for maintaining compliance with the 401 Certifications.

For construction projects, the frequency and duration of turbidity and dissolved oxygen monitoring will be dependent on the proposed action and associated construction window. At a minimum, monitoring will occur once each day during construction in or adjacent to any water bodies within the project area that may be affected by construction. Two sampling locations are required during dissolved oxygen and turbidity monitoring; one upstream of the location where in-water construction is occurring (for ambient or baseline data) and another at the point of compliance as defined in Section 4.5.4 of the 401 Certifications and WAC 173-201A-200(1)(d)(e) and 201A-400. For all in-water work monitoring parameters, schedules, methods and quality assurance/quality control measures will be described in a project-specific In-Water Work Protection Plan. In-Water Work Protection Plans will be submitted to Ecology for review and approval in advance of all in-water construction.

PacifiCorp Energy will prepare an annual report that summarizes all routine water quality monitoring results, identifies water quality issues, and presents the status of WQAPs. The annual report will be submitted to Ecology and the Lewis River Aquatic Coordination Committee by the middle of April each year. If, upon review of the annual report, the need for adaptive management planning is indicated, consultations with Ecology to address water quality issues, modify monitoring protocols, plan adaptive management studies, etc. would begin during the third quarter of that calendar year (July - September).

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Attachment A

Lewis River Temperature and Dissolved Oxygen Water Quality Attainment Plan

Lewis River Hydroelectric Projects

FERC Project Nos. 935, 2071, 2111

Lewis River Temperature and Dissolved Oxygen Water Quality Attainment Plan

Prepared by

PacifiCorp Energy
A Division of PacifiCorp

July 2013

Table of Contents

Figures

1.0 INTRODUCTION

Temperature in the Merwin tailrace is closely associated with reservoir temperatures at the same depth as the turbine intakes (Figures 1.1-1 and 1.1-2). The temperature criterion for the river downstream of Merwin dam to approximately Cedar Creek is 13ºC as a 7-DADMax from September 1 through June 15 and 16ºC as a 7-DADMax from June 16 through August 31 (WDOE Special Insert 2006a).[1] Figures 1.1-1 and 1.1-2 show that the applicable temperature criterion is met for most of the year up until typically September 1, when the criterion changes and tailrace temperatures exceed the 13ºC 7-DADMax until approximately the end of October. During fall turnover, when the reservoir becomes isothermal, water temperature approaches 16ºC and dissolved oxygen is below 9.5 mg/l (Figure 1.1-3). Because of this condition, PacifiCorp Energy proposes the following temperature and dissolved oxygen water quality attainment plan to address Merwin tailrace temperatures in September and October.

This Temperature and dissolved oxygen Water Quality Attainment Plan (WQAP) includes:

(1) a proposal for a temperature and dissolved oxygen (DO) and model, developed by a qualified consultant to determine:

(a) the natural 7-DADMax temperatures and dissolved oxygen concentrations of the Lewis River immediately downstream of Merwin Dam during September through November;

(b) the Projects' contribution, if any, to any temperatures in excess of natural 7-DADMax temperatures or the 13º C, 7-DADMax criterion, whichever is greater; and,

(c) Projects' contribution, if any, to any dissolved oxygen 1-day minimum of less than 9.5 mg/l

(2) if the Projects contribute significantly to any temperatures in excess of natural temperatures or the 13º C, 7-DADMax criterion, whichever is greater, or any natural 7-DADMax dissolved oxygen or the 9.5 mg/l, 7-DADMax criterion, PacifiCorp will investigate and evaluate whether there are any reasonable and feasible improvements that could be made to the Projects in order to meet the two criteria. If there are not any reasonable or feasible measures that can be implemented, work to achieve any significant reduction in Project temperature contributions;

(3) if significant Project contributions to temperatures in excess of the temperature criterion or any greater natural temperatures cannot feasibly and reasonably be eliminated, a plan to develop the information necessary to support a site-specific temperature criterion pursuant to WAC 173-201A-430; and

(4) a schedule for completing these activities, including interim steps, not to exceed ten years.

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[1] From Cedar Creek downstream to Houghton Creek, the applicable criterion is 13º C. as a 7-DADMax from February 15 through June 15 and 16º C. as a 7-DADMax from June 16 through February 14.

1.1 Background

During relicensing studies for the Merwin project, temperatures in the Lewis River downstream of Merwin dam through early-November were shown to range between 5.3 ºC and 15 ºC, with the higher temperatures occurring in September and October. At report completion (April 2004), the temperature standard was 18 ºC. Since that time, and since the issuance of the Section 401 certifications, Ecology adopted a new aquatic life use numeric criteria and designated the Lewis River below Merwin dam as Core Summer Salmonid Habitat (16 ºC) and a supplemental spawning temperature criterion of 13 ºC from September 1 through June 15th.

A Water Quality Monitoring and Assessment Study (PacifiCorp 2001, WAQ 1) was conducted from May 1999 to April 2000 to determine current water conditions in areas associated with the Lewis River Projects. The primary objectives of the study were to assess effects on water quality that may be attributable to the Projects and to determine if the water quality in project-affected waters meets WDOE water quality standards. Various monitoring projects have been conducted during Merwin and Swift relicensing studies and periodically since 2004.

Water temperature stratification in the reservoir begins to form in May and continues until the end of September (Figure 1.1-1). Complete turnover occurred in 2010 by mid-October when the temperature was around 15ºC. Prior to late-July, temperatures at the intake depth (average 178 ft-msl) were less than 12ºC. During the fall turnover, reservoir temperature ranged from 12 to 16.5ºC consistently from surface to bottom. Note the Merwin intakes are on the bottom of the reservoir and capture the coldest reservoir water possible.

Since Merwin operates at a fairly constant flow, it is not likely that operations either upstream or at Merwin Dam have any significant short-term influence on temperature. Figure 1.1-2 displays the 7 day average maximum temperatures observed in 2010 during the September 1 to December 31 timeframe. After about November 16th, observed temperatures remained less than the 13ºC standard.

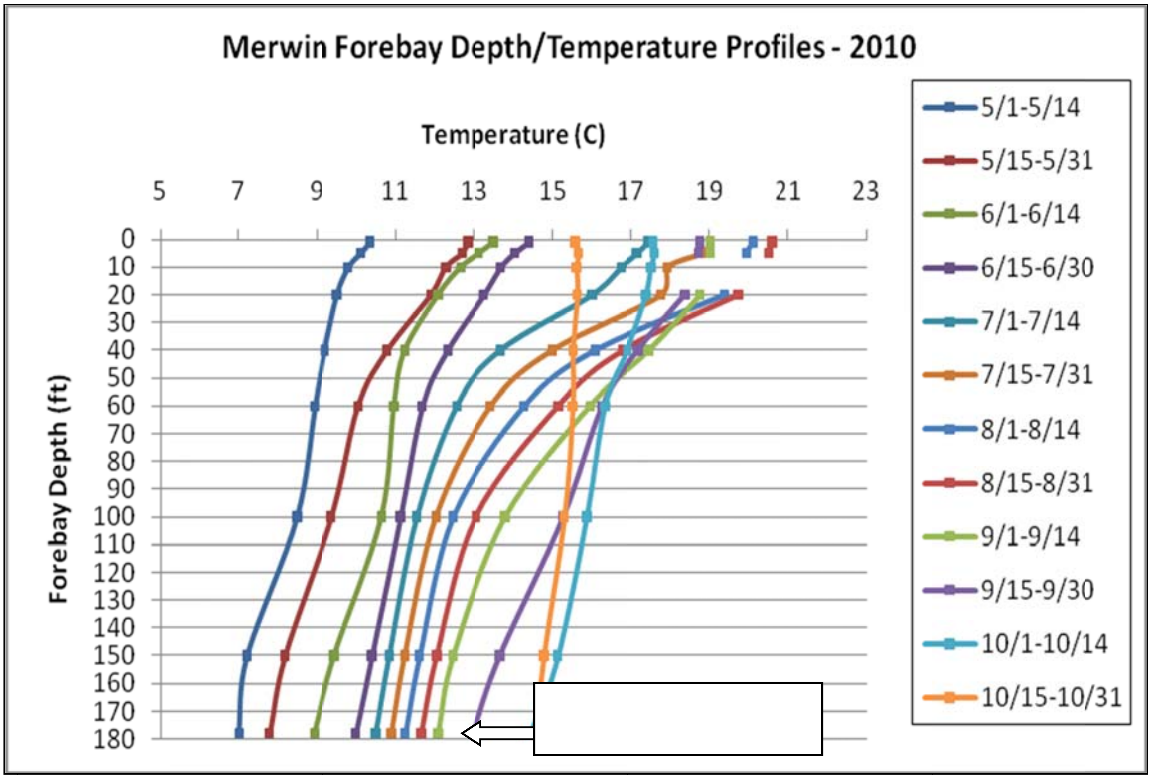


Figure 1.1-1. Profile of Merwin Reservoir forebay temperature for 2010.

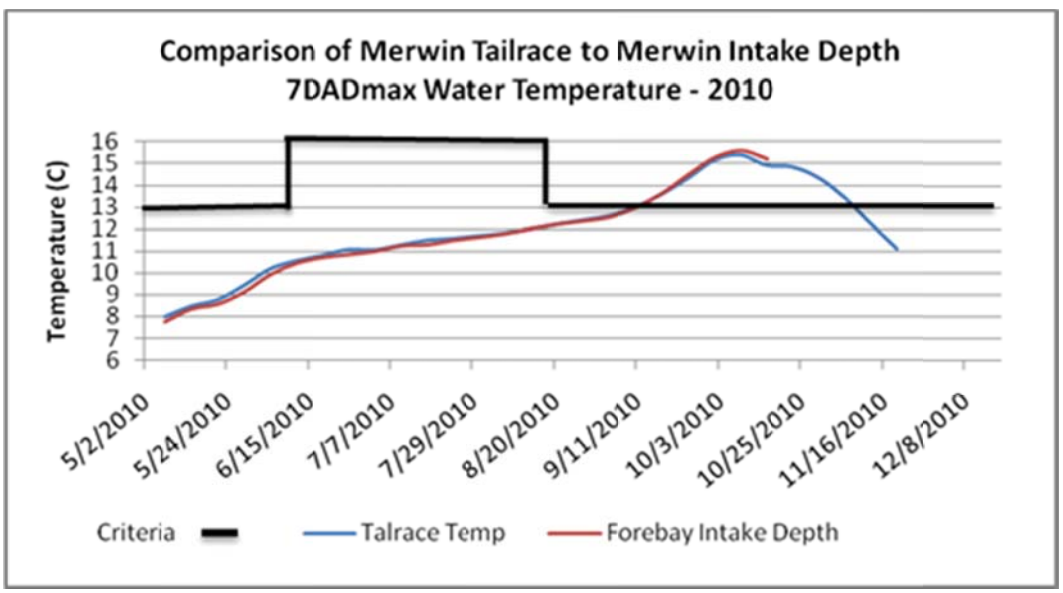


Figure 1.1-2. Merwin tailrace and intake water temperature, May-December 2010.

It is also apparent that the dissolved oxygen standard for the lower Lewis River is exceeded during the fall turnover time (Figure 1.1-3).

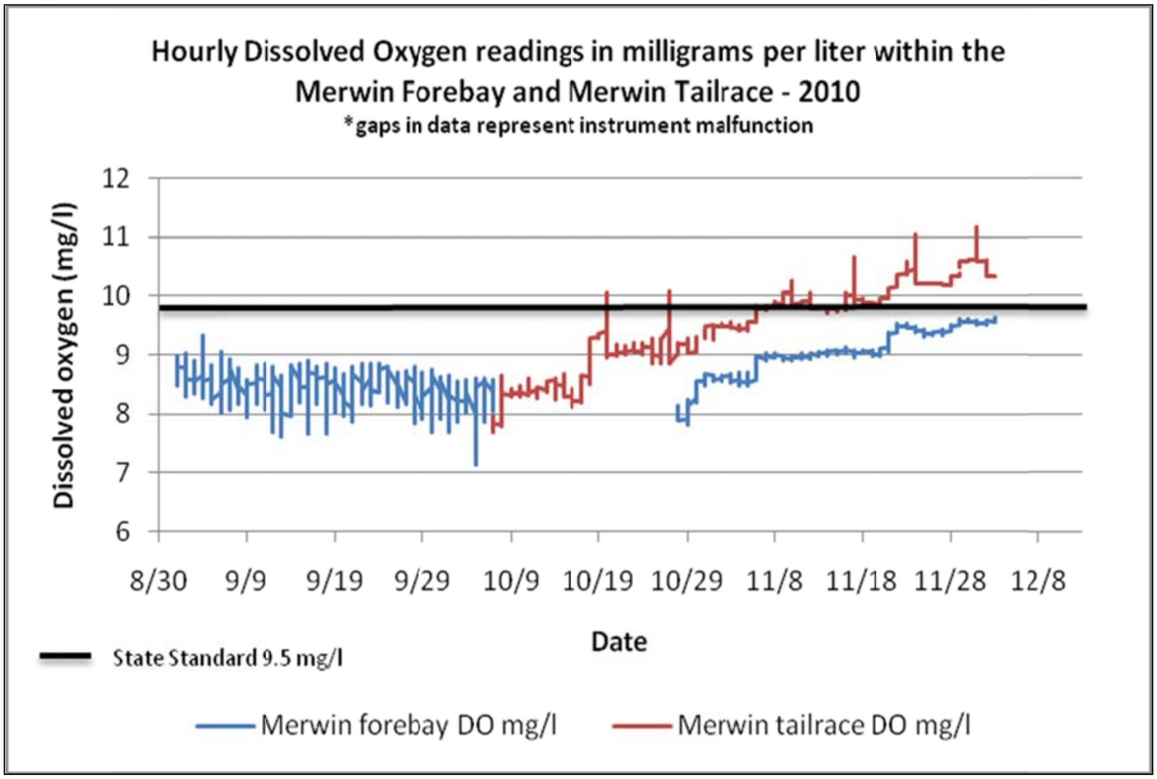


Figure 1.1-3. Hourly 2010 dissolved oxygen in the Merwin forebay and tailrace shown with the 9.5 mg/l standard.

PacifiCorp will work with a qualified consultant to develop a formal modeling plan for Ecology to review. The schedule is to be determined by Ecology.

Attachment B

Lake Merwin Canyon Water Quality Attainment Plan

Merwin Hydroelectric Project

FERC Project No. 935

LAKE MERWIN CANYON WATER QUALITY ATTAINMENT PLAN

Prepared by

PACIFICORP ENERGY
A DIVISION OF PACIFICORP

July 2013

Table of Contents

Figures

1.0 INTRODUCTION

1.1 BACKGROUND

A water temperature study that included the Lake Merwin Canyon (Yale powerhouse tailrace) was conducted during the Yale relicensing process. The results were provided in the Yale hydroelectric project final technical report (PacifiCorp 1999). The study found Yale tailrace temperatures were somewhat dependent on Yale generation. When the project was at full generation, tailrace temperatures were nearly the same as the Yale Lake hypolimnion. In this operating scenario during the summer months, warm Merwin reservoir surface waters are displaced from the Yale tailrace by cold water coming through the Yale turbine discharge during Yale powerhouse generation. The result is observed as tailrace cooling when the project is running and tailrace warming when the project is shut down. This on/off cycle is fairly common in the dry, hot summer months and causes a large swing in the Yale tailrace water temperature. Sometimes water temperatures fluctuate as much as 10°C. A follow-up detailed study measured water temperatures near the surface (3 m) and near the bottom of the tailrace (20 m). During this study in August 1998 and in contrast with previous work, both surface and bottom temperatures remained cool. The study concluded that Yale project operations have a direct influence on water temperature in the Yale tailrace but that other additional factors such as turbine cooling-water discharge and ground seepage were also having an influence.

A more recent monitoring effort, required by the Yale 401 Certification, recorded similar temperature effects from Yale operations similar to the August 1998 study. Temperature stratification was observed in the Yale reservoir forebay for the entire data gathering time-frame, May 2, – October 31, 2011 (Figure 1.0-1). The forebay from the surface to a depth of 100 feet was isothermal for October. The coldest temperature recorded during the analysis was 9.5°C at 100 feet deep and was observed in May. The warmest temperature was just over 20°C at the reservoir surface during August.

The Yale tailrace/forebay intake depth 7DADmax temperature graphs are depicted in Figure 1.0-2. The tailrace water temperature is comparable to the forebay intake depth temperature when operations are stable. During times when the units are offline or motoring the tailrace temperature deviates from the intake depth due to Merwin Reservoir water backing up into the tailrace and turbine cooling water being discharged near the Datasonde® probe. This condition results in no correlation between the tailrace temperature and forebay intake depth temperature during either times of project motoring or non-operation.

Temperature perturbations in the Yale tailrace were generally described in previous studies as occurring during the period from April through November 15th. On a broad scale, each time turbines are shut-down, water temperatures drop with the magnitude of temperature reduction dependent on how much generation was reduced and for how long. On a smaller scale, motoring with one unit (operation of a turbine using system power for the purposes of keeping the unit ready for instant response) has a dramatic positive effect on temperature.

This was probably the effect observed in previous water quality monitoring efforts but the temperature increases were not correlated to motoring operations – instead, advancing Merwin surface water was believed to be the cause for temperature fluctuations. Two units motoring can have as much effect on temperature increases as generation.

The change in water temperature conditions related to turbine operation were not the same as observed in previous studies. Water temperature increased as much as 5°C when the two Yale turbines were activated.

2.0 TEMPERATURE WATER QUALITY ATTAINMENT PLAN

Because of the above described conditions, the Section 401 certification (Section 4.4(2)) requires development of a Temperature Water Quality Attainment Plan (TWQAP) for the Lake Merwin Canyon to evaluate and, if necessary, address these temperature fluctuations. The purpose of the plan is to "identify and maintain the highest attainable water quality conditions to provide a temperature fluctuation regime that are reasonable and feasible to achieve and will best protect the cold-water biota." Washington Department of Ecology identified six steps for PacifiCorp Energy to incorporate into the plan that would lead toward an adaptive process for evaluating feasible, technical, and operational changes to improve water temperature for cold-water biota. The steps are:

- identify the canyon's species of fish and macroinvertebrates (identified to the lowest practical taxonomic level) and determine where they are found in the water column at different life stages and different times of day;
- evaluate the temperature requirements of those organisms that use the upper water column;
- evaluate the effects of the project-related temperature fluctuations on these organisms;
- if necessary to protect the most sensitive beneficial uses, identify the target temperatures in the canyon which will protect the organisms in the upper water column and/or the benthos;
- if necessary to protect the most sensitive beneficial uses, identify all reasonable and feasible methods to ensure that the water temperature fluctuation regime in the canyon remains below levels which would harm the aquatic biota or limit the potential healthy cold water habitat; and,
- identify adaptive management strategies to further improve the temperature fluctuation regime for cold-water biota in the event that target temperatures are not achieved.

In addition, PacifiCorp Energy will provide additional spatial analysis of temperature effects by taking localized measurements during the sampling periods.

2.1 Study Area

The Yale tailrace is located at the upper end of Merwin reservoir at approximately RM 35 in Section 32 of Township 6N and Range 4E. As stated earlier, the Merwin reservoir backs up to the toe of Yale dam when Merwin reservoir is full.

The study area will be divided into four zones (Figure 4.0-1). Zone 1 is the Yale tailrace proper that covers the area from the toe of the dam to the upstream edge of the spillway. Zone 3 is the area just upstream of the boat barrier (also the mouth of Canyon Creek) up to Zone 2 which is exactly half-way between Zones 1 and 3. Zones 2 and 3 are approximately 1800 ft. long. Zone 4 extends downstream 1,800 feet from the boat barrier. Zone 4 is influenced by Canyon Creek while the other zones are not. The distance from the toe of Yale dam to the lowermost point of Zone 4 is approximately 5,900 ft.

Figure 2.1-1. Profile of Yale forebay temperatures for May-Oct. 2010.

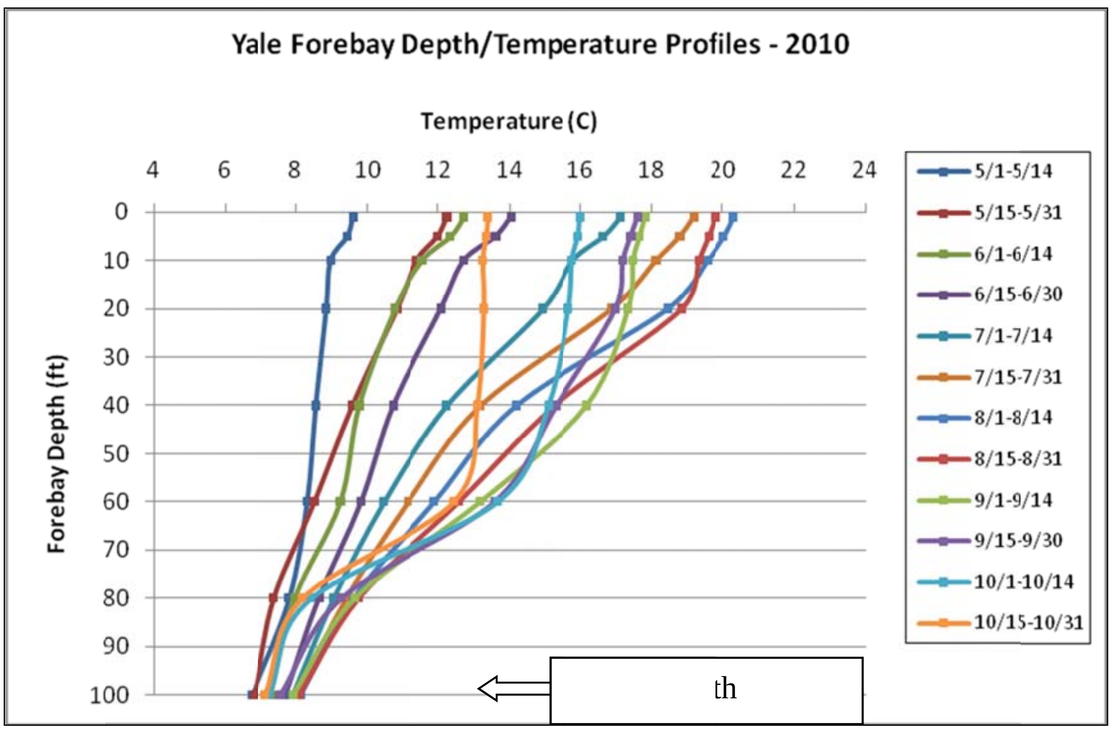
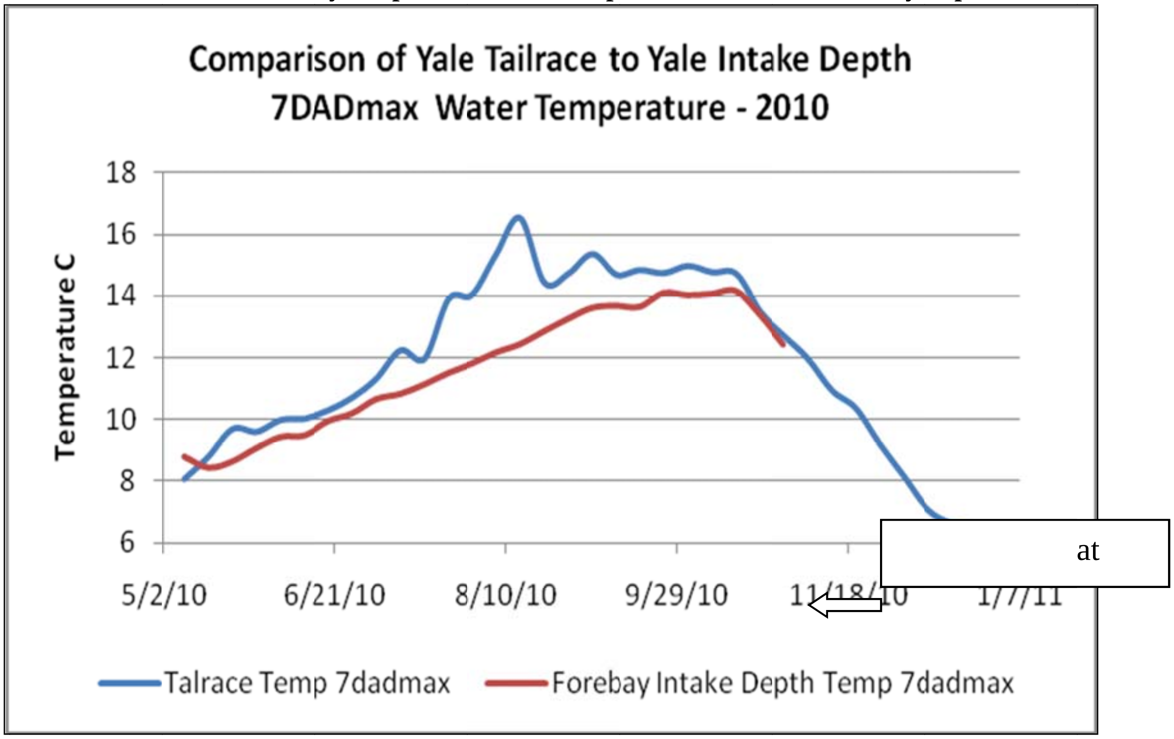


Figure 2.1-2. Yale tailrace and forebay temperatures at the depth of the Yale intake, May-Sept. 2010.



3.0 TEMPERATURE ASSESSMENT

Water entering the tailrace through Yale theoretically comes from the Yale Lake 90-foot water column at the surface down to the bottom of the intakes which is 400 ft-msl. The bulk of the water, though, is thought to come from the bottom 15 to 45 feet of the intake tower (Figure 3.0-1).

The four Yale tailrace zones will allow for assessment of temperature effects from Yale operations (Figure 4.0-1). In order to obtain a better sense of the temperature fluctuations in the Yale tailrace and canyon, one vertical profiling temperature string of thermisters will be deployed in each of the four zones. The recorders will be situated in the center of each zone with the exception of Zone 1 where the recorder will need to be placed in an area that will not be subject to damage by the turbine discharge. With temperature recorders placed in this manner, it will be possible to determine vertical temperature differences and longitudinal profiles throughout the length of the sampling area. This should provide a means to determine the origin of higher temperatures, whether it's the Yale forebay or the Merwin reservoir surface waters that influence the temperature regime in the tailrace. Temperature will be recorded hourly using Ryan Tidbits®. Hourly turbine operations and hourly Merwin reservoir surface elevations will also be retained for analysis purposes.

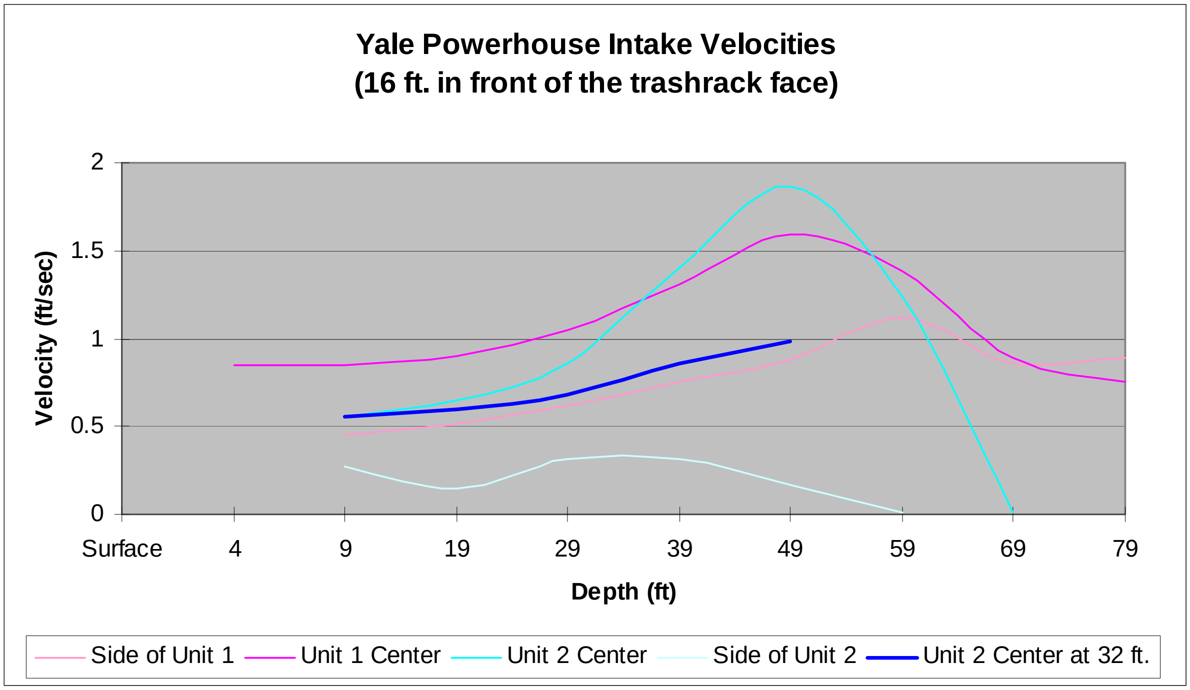


Figure 3.0-1. Water velocity in front of the Yale intake at various depths.

4.0 BIOTIC COMMUNITY ASSESSMENT

The purpose of this step in the evaluation is to identify the species of fish and macroinvertebrates present in the canyon downstream of the Yale powerhouse. Species will be identified to the lowest practical taxonomic level and, if possible, investigators will determine, from the literature, where the various species are usually found in the water column at different life stages and at different times of day.

4.1 Fish Biota

PacifiCorp Energy will initiate a fish sampling plan that will assess the fish assemblage in the Yale tailrace area from the turbine discharge pool down to and including Zone 4. If the water elevation is less than the depth of the Merwin reservoir epilimnion (approximately 219 ft-msl) then fish will not be sampled in Zone four. The thought is that any fish from Zone four downstream are occupying, and accustomed to, the epilimnion temperatures.

Sampling will occur on a bi-weekly basis from May 1st through October 31st and will be focused on the period when temperature fluctuations are a function of Yale operations. Relative abundance of fish species will be assessed using custom-made vertical gill nets set at 15-minute intervals. Captured fish will be held in an aerated water tank until they are evaluated. Every attempt will be made to safely remove fish from the nets and return them quickly to the water away from the netting area. Species and length will be recorded. The vertical nets will allow investigators to gain a better understanding of where fish can be found within the water column. For the more passive species, the shoreline will be electrofished for two hours in daylight and two hours in darkness coinciding with the gill net sets on a bi-weekly basis in coordination with power operations in Zone 1. Electrofishing will sample the shorelines down to the effective depth which is approximately 8 feet. All fish captured will be held in an aerated water tank,

identified to the lowest practical taxonomic level, measured for length, and released to an area away from the electrofishing operation.

4.2 Aquatic Macroinvertebrates

Aquatic macroinvertebrates will be assessed in the four zones using a Ponar® dredge. Eight benthic samples will be collected in each zone. Four samples will come from near shore collections and four from deep water collections. The samples will be washed in graduated sieves to remove sediment. Organisms present will be identified to the nearest practical taxonomic level. The location of each benthic collection will be recorded using a global positioning unit and noted on a map of the study area.

4.3 Evaluation of Temperature Requirements of Existing Organisms

Information was collected from the literature on the common temperature ranges for each organism expected to be found in the Yale tailrace/canyon along with a tolerance (or lethal) limit. Figure 4.0-3 displays temperature information collected prior to this study for expected organisms in the Yale tailrace. This information will need verification during the proposed study to confirm species present. Water temperature will be collected at each sample site. Once actual organisms have been collected and analyzed, the information will be updated in a similar format as Figure 4.0-3. Actual data and cited resource are listed in Table A-1 in the Appendix.

Figure 4.0-2. Aerial Photo of Yale tailrace and canyon showing the four sampling zones.

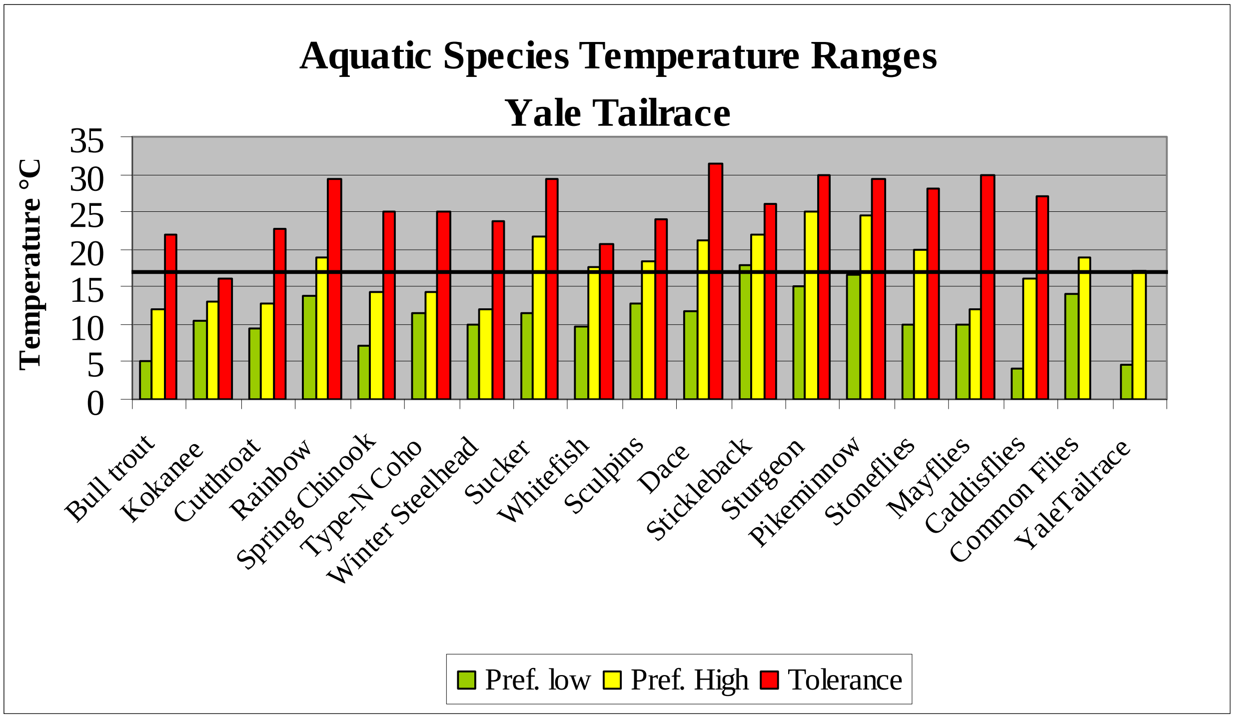


Figure 4.0-3. Example of possible biota present in the Yale tailrace and their temperature tolerances.

4.4 Evaluation of Temperature Effects on Existing Organisms

Based on available information in the scientific literature database and field observations, temperature information and aquatic biota presence will be evaluated in terms of the following:

1) Location of each taxon found in the four tailrace zones laterally and longitudinally and at what depths;
2) Temperatures found in the areas associated with each taxon;
3) The different temperature regimes observed at the various life stages of each taxon;
4) The observed temperatures and effect of turbine operation; and,
5) Likely effects of temperature on each life stage of each taxon.

4.5 Identification of Target Temperatures that will Benefit Existing Organisms

Once the existing organisms living in the Yale tailrace study area are located and captured, temperature measurements will be taken to determine the conditions where they reside. Through existing literature, reported ranges will be compared with observed temperatures to determine any effects of *in situ* temperature that provide benefits and detriment to each taxon. These benefits will be identified and provided in the report.

5.0 REASONABLE AND FEASIBLE ALTERNATIVES TO PROTECT ORGANISMS SENSITIVE TO PROJECT RELATED TEMPERATURE FLUCTUATIONS

For those situations where detrimental effects are occurring (and that are related to project operations) with a particular taxon, potential methods to address the effects will be evaluated to achieve conditions that best protect the cold-water biota. In the case where there are conflicting effects among cold-water biota, PacifiCorp Energy will consult with WDOE as to the most reasonable path to pursue.

6.0 COMPLIANCE SCHEDULE

If reasonable and feasible measures are identified, PacifiCorp Energy will work with WDOE to determine an implementation schedule.

Attachment C

Yale and Swift No. 1 Turbine Total Dissolved Gas (TDG) Corrective Action Plan

Table of Contents

No table of contents entries found.

PROPOSED CORRECTIVE MEASURES

FOR

MITIGATING DISSOLVED GASES IN TAILWATERS

North Fork Lewis River, Washington

Swift No. 1 – FERC Project No. 2111
Yale – FERC Project No. 2071
Merwin – FERC Project No. 935
Owned by PacifiCorp

and

Swift No. 2 – FERC Project No. 2213
Owned by Public Utility District No. 1 of Cowlitz County, Washington

Prepared for the
Washington Department of Ecology

by

Erik Lesko
PacifiCorp, Hydro Compliance

January 2006

Table of Contents

Introduction

This report is intended to provide (1) a description and analysis of existing data, and (2) propose specific corrective measures at projects that have the potential to exceed state water quality limits for total dissolved gases (TDG). Data and results contained in this report are derived principally from studies denoted as WAQ 2, WAQ 4 and WAQ 5 presented in PacifiCorp's and Cowlitz County PUD's Final Technical Report (PacifiCorp and Cowlitz PUD 2004). Additional data sources include internal and external memos, internal data files and PacifiCorp's Process Integration (PI) software platform which provides real-time data logging at all project facilities.

1.1 Background

Beginning with the Yale licensing process in 1995, PacifiCorp began testing the relationship between tailwater TDG saturation and powerhouse operations. Results from these tests confirmed that the turbine air vents used at some projects are responsible for elevated TDG in project tailwaters. These studies also indicated that at projects with elevated TDG, an inverse relationship exists between TDG in the tailwaters and turbine water discharge (or generation). That is, at lower turbine discharge levels, TDG is typically higher and gradually declines as the unit discharge increases.

The purpose of each turbine air vent is to draw atmospheric air into the units to equalize negative pressure (i.e., vacuum) that develops primarily below the runner assembly and draft tube. This equalization is necessary to reduce potentially destructive cavitation (formation of air bubbles), which reduces turbine efficiency and can cause premature wear (or possibly failure) of the turbine runner.

Once it was understood that the air vents (specifically the air drawn into the units) were at times causing excessive TDG, PacifiCorp began tests that restricted the amount of air entering the units via the air vents. The primary method was to cap the air vent and monitor tailwater TDG throughout the generation range of each unit. These tests were conducted at the Yale and Swift No. 1 projects. Results from these tests led to the rationale for corrective measures presented in Section 4.0.

General Project Descriptions

This section provides relevant summary statistics in regards to hydraulic and turbine configuration. This information is helpful in understanding the main hydraulic differences of each project and how those differences may influence TDG in project tailwaters. Table 2.0.1 provides those statistics that mainly have an effect on pressure within the turbine, which directly affects the ability of the projects to dissolve gas into solution. For example, Swift No. 1 with a net head of 390 feet, translates into a pressure differential of nearly 12 atmospheres (390/34 = 11.47) above ambient barometric pressure. Therefore, Swift No. 1 has a high potential to dissolve gases into solution.

Table 2.0.1. Summary statistics for Merwin, Yale, Swift No. 1 and Swift No. 2 hydroelectric projects. Source: PacifiCorp and Cowlitz PUD, 2000

	Plant			
Statistic	Merwin	Yale	Swift No. 1	Swift No. 2
Service Year	1932	1953	1958	1958
Turbine Type	Francis	Francis	Francis	Francis
Full Pool Elevation (ft, msl)	240	490	1000	602
Total Generation, mw (per unit)	135 (45)	134 (67)	240 (80)	70 (35)
Intake Depth* (ft)	180	82	146	49
Intake Diameter (ft)	15.6	18.6	25.0	16.0
Dam Height (ft)	314	323	512	Na
Net Head (ft)	181	240	390	117
Runner Elevation (bottom, ft, msl)	58	234	602	472
Tailwater Elevation (normal, ft, msl)	48	240	602	485

*Intake Depth is center line of intake opening at full pool

2.1 Air-Intake System

The air intake system for each of PacifiCorp's facilities is not unique, and each unit employs basically the same configuration. Each turbine unit has its own separate system composed of an outside air vent and a 4-inch (6-inch at Yale) steel pipe that directs vacuum air flow into the headcover of the turbine. Air is drawn into the turbine due to a pressure drop created by water flowing through the turbine. This pressure drop is most evident below the runner at the top end of the draft tube, thus, most of the air is drawn to this location and available to be dissolved into the water. The volume of air entering the units varies based on water volume and velocity through the units. Generally, higher flow volumes produce higher air flow volumes (i.e., positive relationship). However, this relationship is not linear, and does not hold true when the units reach 80 to 90 percent of generation capacity. At this level, the air volume to generation is an inverse relationship.

Originally, the valve design incorporated into each of these systems did regulate air flow. Air flow regulation was accomplished by a cam located near the headcover of each unit. This cam controlled air flow based on wicket gate position via a pneumatic valve. Typically, the air vent would be open at smaller wicket gate positions, and then gradually close at larger wicket gate positions. However, the rate at which air flow was regulated differed slightly for each unit depending on the particular hydraulics and efficiency range for each unit. Prior to PacifiCorp's modification to these air intake systems, it was found that, in most cases, the pneumatic valves were either leaking or broken and consequently blocked fully open. Through testing, PacifiCorp repaired this problem. The results of these tests and air valve modifications are discussed in further detail below.

Cowlitz PUD installed new runners at Swift No. 2 in 2005. The new runners perform like the old runners in the fact that both runners can introduce air into the system to protect against cavitation. Air can be introduced by opening up a vent near the runner, but this has not been historically used. The manufacturer of the new turbines has performed computational fluid dynamic review of the runners and concludes that the runners should be free of cavitation throughout the entire guaranteed range of operation, from full gate at maximum head, to full gate at minimum head.

TDG Monitoring Results (under unmodified air flow conditions)

Data presented in this section are represented as correlations between TDG and generation. These illustrations are based on operations that do not have any modification to the air intake system. That is, the air vents were fully open throughout the testing. Therefore, the data presented here are intended as a baseline from which corrective measures can be developed and monitored.

Data collection methods are explained fully in the Final Technical Report (PacifiCorp and Cowlitz PUD 2004). Generally, all data were collected with Common Sensing TBO-DL6 meters. Meters were suspended from the ‘catwalk’ or railing present at all facilities. All meters were weighted to provide consistent depth from fluctuating turbine discharges. Meters were submerged at least 10 feet to prevent air bubble formation on the sensor membranes (compensation depth).

Swift No. 1 Hydroelectric Project

Figures 3.1-1 through 3.1-3 illustrate the relationship between TDG and generation (mw). Each unit was tested individually and without influence from operations at the other units. The air vent was fully open at the time these data were collected. Therefore, the units were able to freely draw as much atmospheric air as needed.

Strong inverse relationships are present for each unit. Additionally, the slope of each trend line is nearly identical. For all units, the maximum saturation was slightly above 130 percent. As generation increases, TDG levels decrease, and at full generation the levels of saturation stabilize between 100 and 105 percent for all units.

For all units, the generation level needed to achieve 110 percent saturation is generally about 55 megawatts. That is, at levels below 55 megawatts, TDG tends to exceed 110 percent saturation, and at levels higher than 55 megawatts, TDG tends to be less than 110 percent saturation.

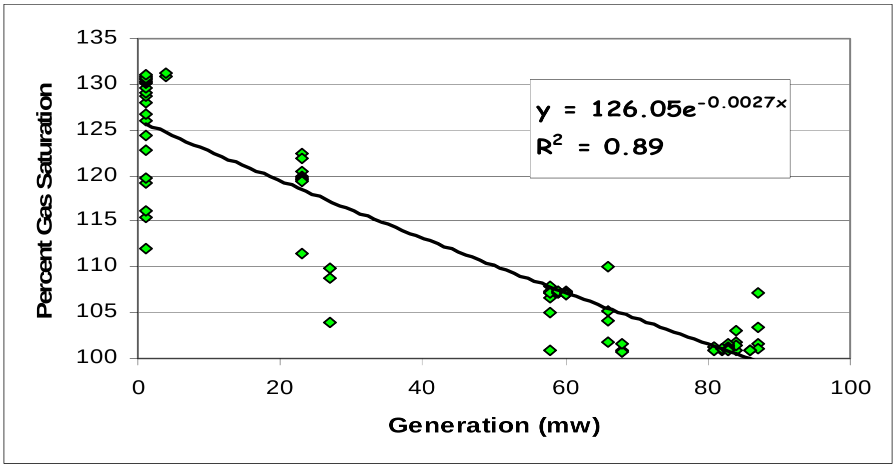


Figure 3.1-1. Relationship between generation and percent gas saturation at Swift No. 1 for Unit No. 11, September 1999.

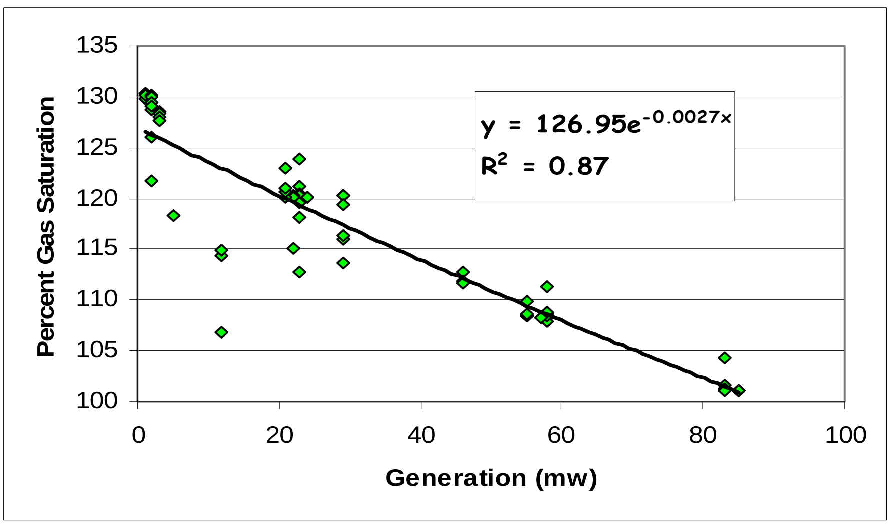


Figure 3.1-2. Relationship between generation and percent gas saturation at Swift No. 1 for Unit No. 12, September 1999.

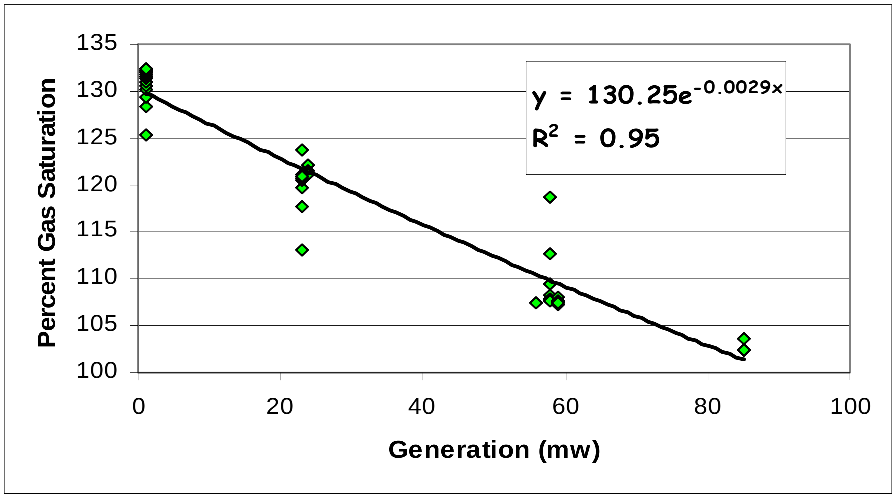


Figure 3.1-3. Relationship between generation and percent gas saturation at Swift No. 1 for Unit No. 13, September 1999.

3.2 Swift No. 2 Hydroelectric Project

The relationship between TDG and generation at Swift No. 2 is unique from the other Lewis River hydroelectric project. It is unique in that it does not appear that generation has a substantial effect on tailrace gas saturation. The relationship appears to be random with no perceptible trend at any generation level (Figure 3.2-1).

In 1999, PacifiCorp measured the intake saturation versus what was measured in the tailrace. This relationship is not only very strong, but it is evident that the major influence on TDG levels at Swift No. 2 tailrace are derived from the water entering the powerhouse and not from the units themselves (Figure 3.2-2).

These data were collected from the original design and construction at the Swift No. 2 development. The project has recently been rebuilt and these tests should be redone to confirm that design changes or turbine configurations continue to have no effect on tailrace TDG. Figure 3.2-1 illustrates the relationship between gas saturation and generation; Figure 3.2-2 shows the relationship between forebay (at intake depth) and tailwater TDG levels.

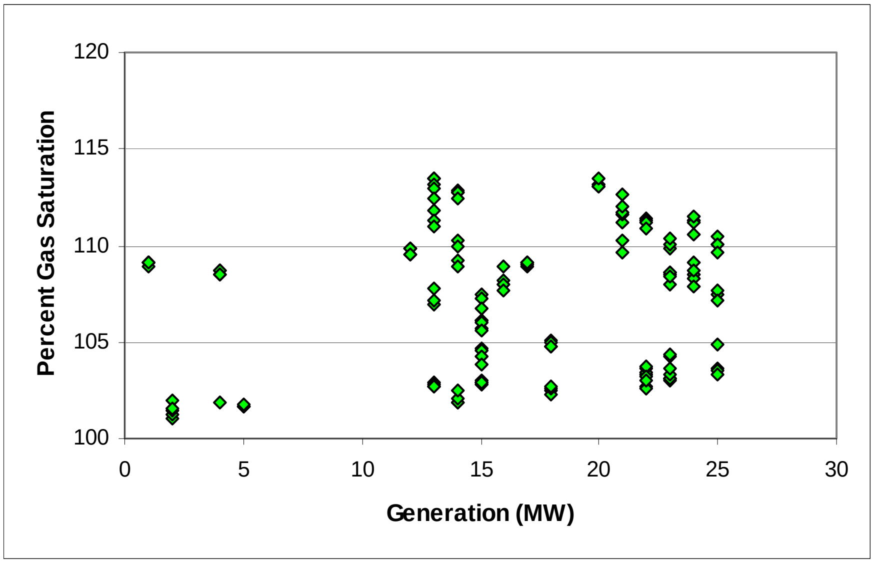


Figure 3.2-1. Relationship between generation and percent gas saturation at Swift No. 2 for Unit No. 21, September 1999.

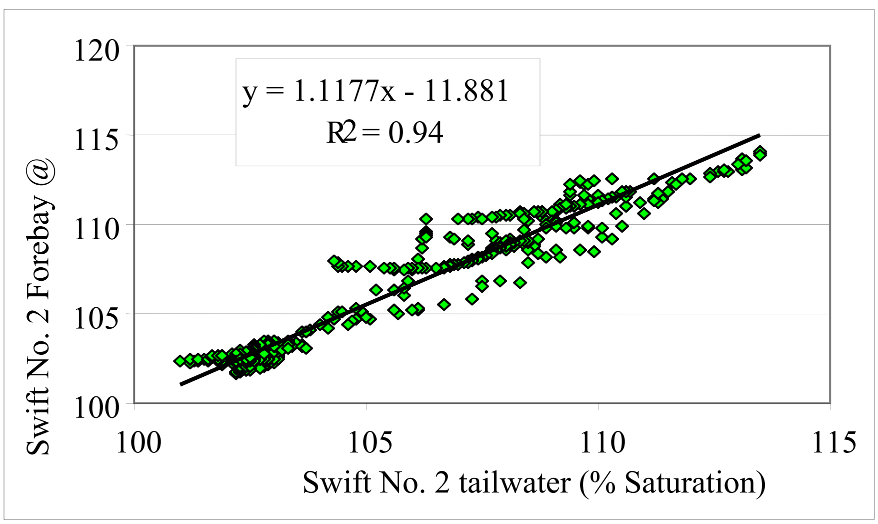


Figure 3.2-2. Relationship between forebay percent gas saturation and tailwater percent gas saturation at Swift No. 2, September 15-20, 1999.

Yale Hydroelectric Project

The Yale project licensing studies presented the first monitoring results for TDG in relation to the air admission system. Like the Swift No. 1 project, the air valves at Yale were always open (i.e., stuck open or inoperable) and the units were able to draw as much atmospheric air as needed. The relationship depicted in Figure 3.3-1 is similar to that collected for Swift No. 1 in that percent saturation exceeds 110 percent at generation levels less than 55 megawatts. At generation higher than 55 megawatts, percent saturation slowly decreases and stabilizes at 105 to 106 percent saturation.

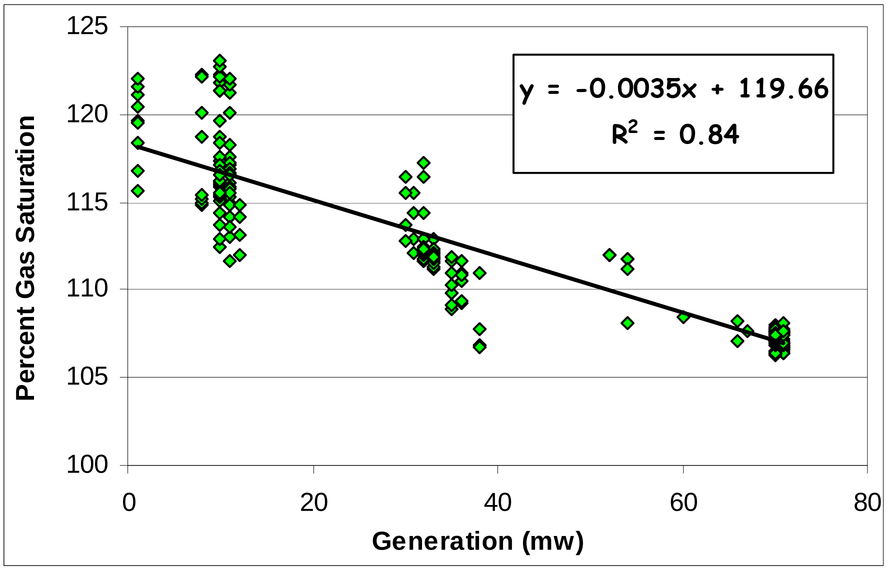


Figure 3.3-1. Relationship between generation and percent gas saturation (n=259) at Yale for Unit No. 2, July, 1996.

Merwin Hydroelectric Project

Existing data show that percent saturation rarely exceeds 110 percent saturation through turbine operation at Merwin. These patterns were primarily collected by PacifiCorp in the years 1987-1989. Additionally, monitoring studies in 2000 continued to show that TDG remains below state limits (Figure 3.4-1). The reasons for this are not well understood, however, a memo written by Mike Bonoff and PacifiCorp in 2002 provide some possible explanations as to why percent saturation does not appear to be as sensitive to turbine operation at Merwin when compared to the other projects.

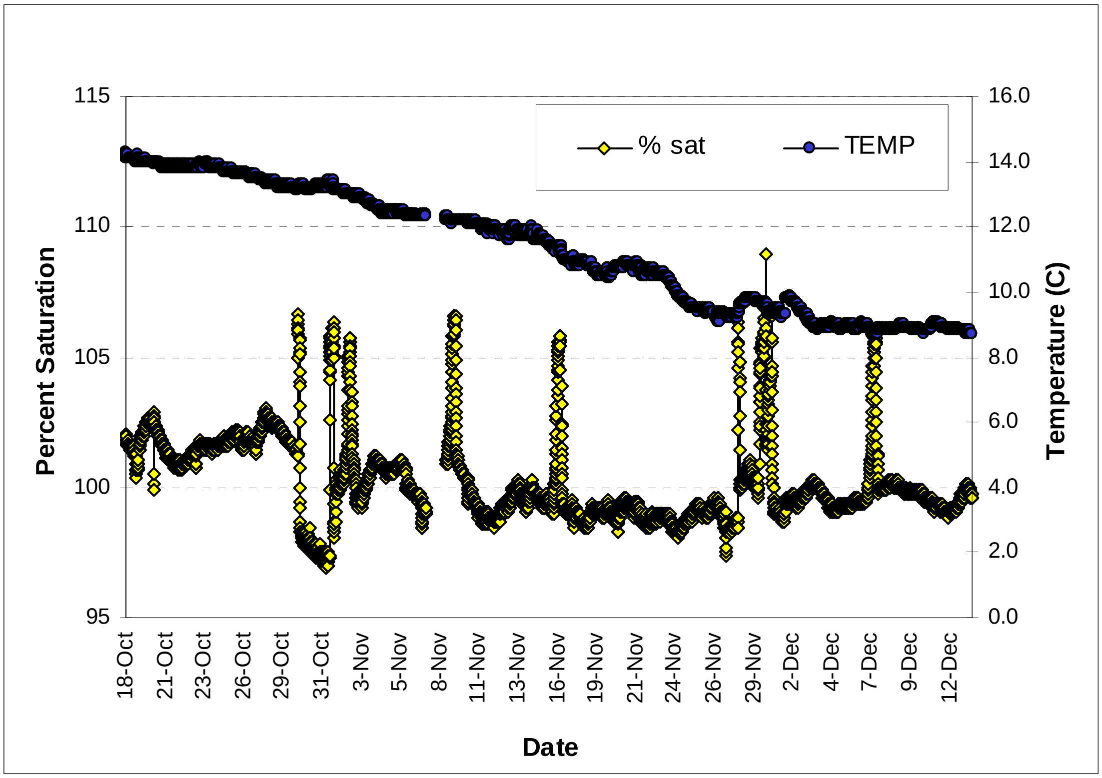


Figure 3.4-1. Percent saturation and temperature monitored in the Merwin tailrace between October 18 and December 13, 2000 (10 min intervals).

Corrective Measures

Measures contained in this section are directed towards the Swift No. 1 and Yale hydroelectric projects. Existing data for Swift No. 2 and Merwin projects continue to show that TDG is either unrelated to the operation at the project (Swift No. 2), or that project operations do not appear to over saturate tailwaters in excess of state limits (Merwin).

For Swift No. 1 and Yale, corrective measures are directed towards the turbine air admission system, which is the principal cause of elevated dissolved gases. Control of the air admission system is both effective and easily accomplished through automation. However, air flow control must be precise and accurate to prevent excessive cavitation and potential damage to the units. Precision is controlled automatically by the existing control automated systems and thus does not present a problem. Accuracy, however, is accomplished through field testing and data interpretation, therefore, corrective measures provided in this report are subject to modification in the future. An important consideration to note is that once air flow is restricted, the units are forced to operate in conditions for which they were not designed. Therefore, we must continue to monitor both TDG and cavitation levels to ensure that air flow restrictions are not causing excessive wear or damage to the units.

Swift No. 1 Hydroelectric Project

Under unrestricted conditions, the air flow into the turbine units is substantial (Figure 4.1-1). Small changes to the air valve can cause dramatic changes to air flow into the turbine. It is also evident that this relationship is not linear, which makes predicting the effect of air valve changes on air flow and resulting TDG more difficult.

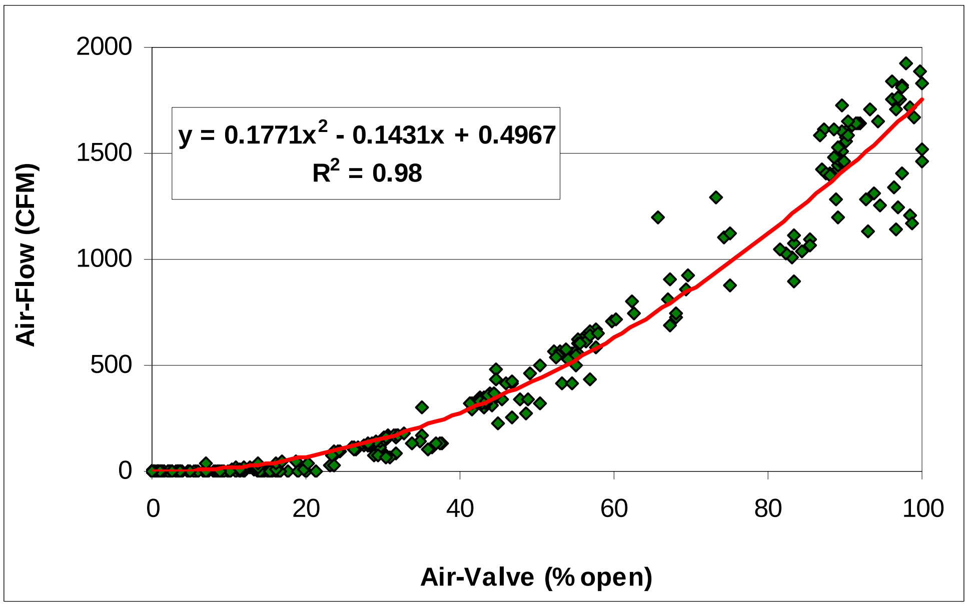


Figure 4.1-1. Air flow of atmospheric air entrained by Swift Unit No. 13 at a constant 50 megawatts across the operating range of the air valve

Currently, the air valve modulates in a reverse direction within a specified wicket gate position range. Specifically, as the wicket gates opens past 40 percent, the air valve slowly closes and at a wicket gate position of 70 percent the air valve is completely closed and remains closed through full gate opening. This relationship is as follows:

Wicket Gate Position	0…………….40………….70…..………100
Valve	│----OPEN---│---RAMP---│-CLOSED-│

The amount of air entering the unit under this scenario is shown in Figure 4.1-2.

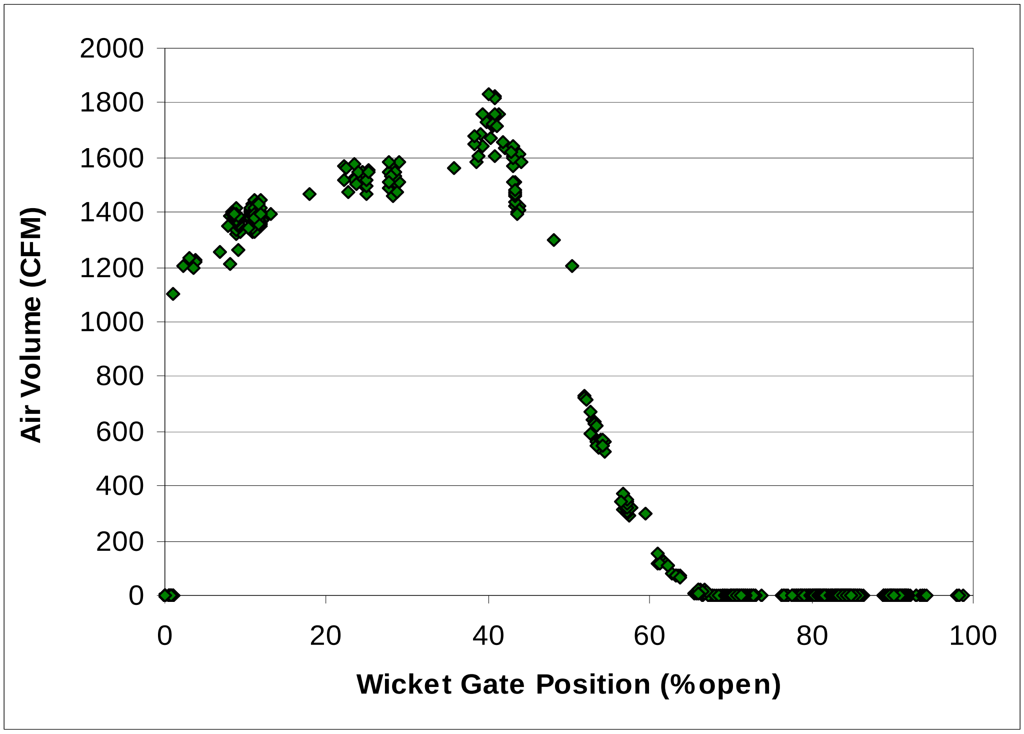


Figure 4.1-2. Current air flow volume entering a swift turbine for all wicket gate positions

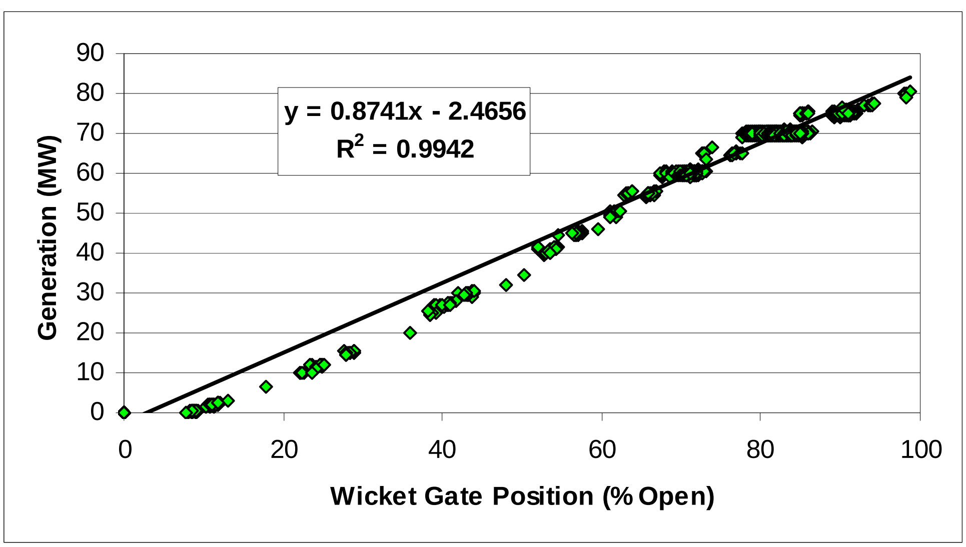


Figure 4.1-3. Relationship between wicket gate position and generation at Swift No. 1

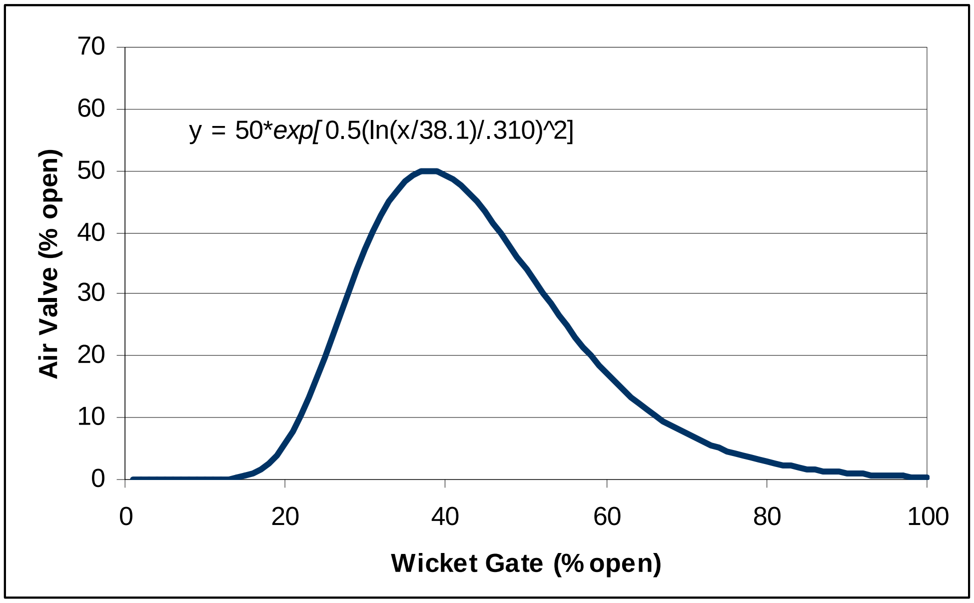


Figure 4.1-4. Proposed operation of the air valve using wicket gate position as the independent variable

The curve proposed in Figure 4.1-4 is designed to limit TDG production at the lower generation levels (or wicket gate positions) and then allow some air entrainment in the mid-generation levels. The amount of air entering the unit is then gradually decreased as the unit ramps up to peak efficiency. The most critical range within the curve will be between 20 and 40 percent wicket gate positions. This is the range in which cavitation potential is greatest and will need to be monitored closely to ensure that the curve represents the best balance between cavitation and control of TDG in the tailrace.

Given this proposed air valve operation, the ability of TDG to exceed 110 percent is substantially reduced – although not eliminated. Based on previous evaluations it does not appear possible to entirely eliminate saturation levels above 110 percent. Prior studies have indicated that cavitation levels become significant at generation levels between 20 and 40 megawatts. Cavitation and inherent "rough' zones are characteristics of all Francis turbines. These zones are typically between wicket gate position of 20 to 30 percent. Because of these characteristics, the turbines do not operate continuously at these levels; thus, the potential for TDG saturation is reduced.

Once the proposed air valve modifications are in place at Swift No. 1 (as shown in Figure 4.1-4), monitoring data will be collected and the proposed curve may be modified as necessary and with consultation with WDOE to determine the appropriate balance between cavitation and gas saturation in the tailwaters. [Note: as if 2012 the modifications were installed and working to prevent exceedences]

Yale Hydroelectric Project

Measures to control TDG at Yale were initiated in 1996 after new runners were installed at the plant. In 2005, automated controls upgrades were installed which accomplish the same control of the air vent as described earlier. Figure 4.2-1 provides hourly TDG data collected during the month of November, 2005. When comparing these data to data collected prior to air vent modification (Figure 3.3-1) it is evident that at lower generation levels, TDG is dramatically reduced. Like Swift No. 1, the risk of elevated TDG is not eliminated, but substantially reduced due to the limitations placed on the air vent. Furthermore, it is unusual for the units to operate for sustained periods in the 20-30 megawatt range as this is both inefficient and substantial cavitation is to be expected.

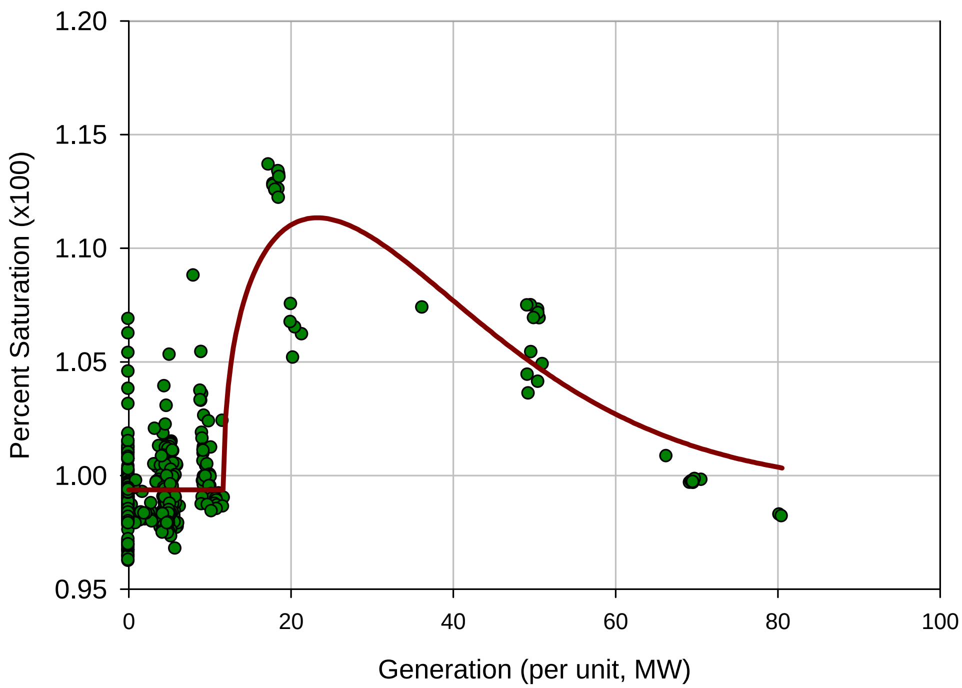


Figure 4.2-1. Relationship between generation and percent gas saturation measured in the tailwaters at Yale powerhouse during November, 2005.

Flushing Flow Operations at Yale

Background

The presence of turbine induced total dissolved gas (TDG) is well documented in the Yale project tailwaters. Corrective measures to mitigate excessive TDG in the Yale tailrace were initiated in 1996. These measures involved restrictions to the air volume normally entering the turbine during operation and appear to effectively mitigate excessive TDG. However, recent TDG monitoring results indicate highly variable TDG levels in the tailwaters while the unit(s) is motoring. While motoring, tailrace TDG ranges between 100 and 120 percent of saturation and appears to show a cumulative response. That is, TDG gradually and continually rises as the unit(s) continues to motor.

In November of 2005, PacifiCorp deployed an air depression (blow down) system to allow more efficient motoring of the units. The system is designed to increase air pressure within the turbine and draft tube of each unit. This pressure effectively lowers the elevation of the water normally present in the draft tube and runner assembly. By depressing the water elevation below the runner assembly, the turbine is allowed to motor without the resistance of water, and thus, requires less energy.

The Effect of the Air Depression System on Tailrace TDG

It is suspected that the air depression system is contributing to tailrace TDG. This assumption is based on elevated air pressure created by the blowdown system and normal wicket gate leakage. The reasons for this assumption are described below

It is not known how much water leaks through the wicket gates during motoring. However, any water that does leak through is subjected to increased air pressure while the air depression system is active. The (recommended) air pressure required to sufficiently lower the water level (off the runner) within the draft tube is approximately 4 PSI (207 mmHg), which is equal to about 9.25 feet of hydrostatic water pressure.

Water that passes through areas of increased air pressure will always dissolve air into solution as the dissolved gas pressure in the water strives to equilibrate with ambient air pressure. The ability of the air to dissolve into solution is facilitated by increasing the surface area of the water (e.g., a spray or mist of water has more surface area that a sharp stream of water). Water leaking through the wicket gates passes through with substantial hydrostatic pressure. Leakage water also passes through the runner and then falls off the runner into the receiving water of the draft tube. This scenario provides optimal surface area of the water and gases are dissolved into solution and reach equilibrium pressures immediately. That is, the pressure of the dissolved gas in solution equals the ambient air pressure within the turbine. Therefore, the leakage water falling into the draft tube water is fully saturated to the ambient pressure within the turbine.

Given the recommended 4 PSI (207 mmHg) of air pressure added to the turbine from the air depression system and ambient barometric pressure of 1 atmosphere (760 mmHg), water falling off the runner has a dissolved gas pressure of 967 mmHg. In the Yale turbine this would be considered 100 percent of saturation; however, in the Yale tailrace this value equates to 127 percent of saturation (assuming ambient barometric pressure of 1 atmosphere)! This relationship between added pressure within the turbine and its potential effect on tailrace TDG is provided in Table 4.2.2.1.

Table 4.2.1.1. The effect of additive air pressure on percent gas saturation of water (assuming full saturation) which is then subjected to standard barometric pressure of 1 atmosphere.

Additive Air Pressure in the Yale turbine attributed to the air depression system (PSI)	Resulting Gas Saturation in the Yale tailrace (at 1 Atmosphere)
2	113 %
3	120 %
4	127 %

Magnitude and duration of flushing event

A flushing event must be of enough magnitude and duration to substantially dilute the over-saturated water present in the tailrace. The water that combines with the saturated water must have low saturation and upon termination of the flushing event the units cannot ramp down slowly, but rather a steep ramp down should be followed to reduce the excess water saturation that is known to occur between the 20 and 50 mw range (per unit). This rapid ramp-down is critical if the units are again to be used for motoring.

The duration and magnitude of the flushing event is estimated to require displacement of 1.2 million cubic feet of water. For example, if we assume that a unit will operate at 2,000 cubic feet per second flow rate, then the unit would need to operate for 10 minutes to achieve this displacement, at a minimum.

Frequency of flushing events

TDG continues to rise over time when either one or both units are motoring. When the units are sitting idle and not operating, TDG tends to remain constant. To determine how this relationship will affect operations, we need to determine the rate at which TDG rises in the tailrace while motoring one or two units.

Programming of flushing events

The Flushing Mode is active only when the Unit is in Motoring and when the TDG saturation level has exceeded the setpoint of 108 percent. Once Flushing Mode is active, the Unit is taken out of Motor Mode and ramped up to a preset generation setpoint of 5 MW. A Flushing indicator in the HMI screen will be blinking to inform the Operator that the Unit is in Flushing Mode. A Timer will be activated to provide the Flushing duration. The Timer starts when the Unit is in Flushing Mode and when the generator’s output has reached the setpoint.

Flushing Mode is done when the Timer is done timing or when the TDG level has dropped below setpoint of 104 percent saturation. The PLC will activate the Flushing function when the following conditions have been met:

1. Generator is in Motor Mode.
2. Flushing function is turned ON.
3. TDG level is above setpoint.

When Motoring Mode is first selected, the Unit will either go directly to motoring or to flushing depending on the TDG level. If one Unit is already in Flushing Mode, putting the second Unit in Motor Mode will cause it to go to Flushing Mode immediately. The MW setpoint will be the same for both units.

PacifiCorp is currently testing the effectiveness of flushing flows at Yale. After tests have confirmed that the flushing flows are effective at reducing TDG during motoring operations we anticipate similar procedures to be implemented at the Swift No. 1 project.

Monitoring Procedures

PacifiCorp currently has permanent TDG monitoring stations in the tailwaters of both the Yale and Swift No. 1 projects. These stations provide real-time data acquisition that is logged at specified intervals. These data are retrieved using PacifiCorp's Process Integration software platform. Because TDG data are viewed in real-time in off site locations, equipment malfunction can be identified and repaired quickly. Water quality parameters that can be collected or calculated include:

- Water Temperature (C)
- Average Hourly Project Outflow (cfs)
- Total Pressure (mm Hg)
- Barometric Pressure (mm Hg)
- Percent Gas Saturation

For both Swift No. 1 and Yale, PacifiCorp proposes to collect each of these parameters on an hourly basis. The purpose of collecting these data is to confirm (or disprove) that the proposed operation of the air vent is successful in mitigating TDG in the tailwaters. Once the proposed air vent operation is confirmed, it is anticipated that TDG monitoring will no longer require continuous monitoring, but rather seasonal monitoring efforts focusing on periods when water temperature is warmest and the potential for supersaturation is greatest.

6.0 Quality Control and Accuracy

Hydrolab® Minisonde MS5 sonde units will be deployed within fixed monitoring stations at Swift No. 1 and Yale.

During any continuous monitoring at Swift No. 1 and Yale, meters will be serviced every two months. More frequent servicing will be conducted if during data review (to be done on a weekly basis) erroneous data including data drift are observed. Erroneous data are defined as percent saturation in excess of 150 percent or less than 90 percent of barometric pressure. Data drift is defined as a continuous (slow) trend characterized by unresponsive measurements despite changes in generation or wicket gate positions. This unresponsiveness must continue for at least 4 hours during operational changes to indicate that service is needed on the unit(s).

Servicing will include the following:
Inspection of probe body and sensor membrane
Cleaning, inspection, greasing and replacement (if necessary) of all 'O' ring seals and electrical connections
In situ checks of deployed instrument with additional meter (Yale only)
In situ checks of barometric pressure transducer, calibration if necessary.
Replacement of TDG sensor membrane if erroneous data are observed or every 6 months.

Sensor membranes that exhibit erroneous data will be discarded. Membranes that are exchanged at the 6 month interval will be cleaned and redeployed in a subsequent servicing.

No calibration of the TDG probes will be performed. Rather, if erroneous data are identified as defined in this section, the membrane will simply be replaced. This eliminates field calibration error. If upon replacement of new sensor membrane erroneous data are still observed, the unit will be taken out of service and be repaired and certified by the manufacturer prior to redeployment.

7.0 Literature Cited

PacifiCorp and Cowlitz PUD. 2004. Licensee's Final Technical Studies Status Report for the Lewis River Hydroelectric Projects. Portland, OR and Longview, WA. April 2004.

PacifiCorp and Cowlitz PUD, 2000. Final Initial Information Package (IIP). Prepared by EA Engineering, Science and Technology and Harza Engineering Company, March 2000.

Attachment D

Merwin Spill Related Total Dissolved Gas Quality Attainment Plan

Merwin Hydroelectric Project

FERC Project No. 935

Spill-related Total Dissolved Gas Water Quality Attainment Plan DRAFT

Prepared for the Washington Department of Ecology

PACIFICORP ENERGY
A DIVISION OF PACIFICORP

July, 2013

Table of Contents

List of Tables

List of Figures

1.0 Introduction

1.1 Background

PacifiCorp received the Merwin hydroelectric project 401 water quality Certification/Order No. 3678 (Merwin 401) from Washington Department of Ecology (WDOE) on October 9, 2006. This certification was amended on December 21, 2007, January 17, 2008, and October 3, 2008. A fourth amendment is pending as of this plan completion. In addition, the 401 certification as amended through January 17, 2008 is incorporated into the Federal Energy Regulatory Commission (FERC) Merwin Project License dated June 26, 2008. A map of the project area is shown in Figure 1.

Since issuance of the 401 certificates, PacifiCorp has monitored the Merwin, Yale, and Swift No. 1 project spill for the purpose of documenting total dissolved gas (TDG) percent saturation during any spill event.

On December 13, 2010, the Lewis River experienced a high flow event that reached 31,997 cubic-feet-per-second (cfs) inflow at Merwin dam (Table 1). While this was not a particularly unusual winter flow, the event resulted in the Merwin Project spilling nearly 9,000 cfs (daily average = 4,425 cfs) for approximately 12 hours (Figure 2). The resultant total dissolved gas (TDG) levels exceeded 110 percent criterion for part of the spill period. According to procedures defined in the Merwin 401 Certification, TDG monitoring continued for 48 hours following the termination of spill. Neither the Yale project nor the Swift project spilled during this period. Further information on this event is provided in Table 1 below and the ACC/TCC 2010 Annual Report.

2.0 General Merwin Project Description

The Merwin Project, the oldest and most downstream of the Lewis River Projects, includes a 313-foot-high concrete arch dam extending 1,252 feet across the Lewis River. Deepwater inlets lead to three short penstocks with a total capacity of 11,470 cfs, which enter the powerhouse immediately downstream of the dam. The plant has a nameplate capacity of 136 megawatts (MW). Power from the project is carried by three 115-kilovolt (kV) primary transmission lines 1,000 feet to the Merwin substation. Flows in excess of powerhouse capacity are controlled by five taintor gates situated above the 206-foot-long spillway. The project impounds the 14.5-mile-long Lake Merwin, with a surface area of about 4,000 acres at full pool. Merwin's 263,700 acre-feet of useable storage is managed for the purposes of power generation, flood management, recreation, and downstream fish habitat enhancement. Figure 3 is an aerial photo of the project and spillway. Other details are shown in Table 2.

Table 1: Hourly spill and TDG data related to the December 2010 Merwin spill event.

DATE	SPILL	TDG	INFLOW
	(cfs)	% SAT	(cfs)
12/13/10 22:00	0	101.07	24763.8
12/13/10 23:00	66.3	101.21	22182.1
12/14/10 0:00	4484.5	109.57	22734.3
12/14/10 1:00	8083.5	113.58	20426.3
12/14/10 2:00	8782.3	114.09	31977.3
12/14/10 3:00	8918.5	114.78	23689.5
12/14/10 4:00	8917.8	114.75	25228.6
12/14/10 5:00	8976.9	114.61	23718.2
12/14/10 6:00	8968.7	115.03	24851.9
12/14/10 7:00	8960.6	114.77	23183.1
12/14/10 8:00	8921.5	114.75	23862.8
12/14/10 9:00	8889.7	114.46	23063.5
12/14/10 10:00	4519	108.82	22224.7
12/14/10 11:00	4715.4	109.63	21905.9
12/14/10 12:00	4666.7	109.35	22911.8
12/14/10 13:00	0	109.61	22774.8

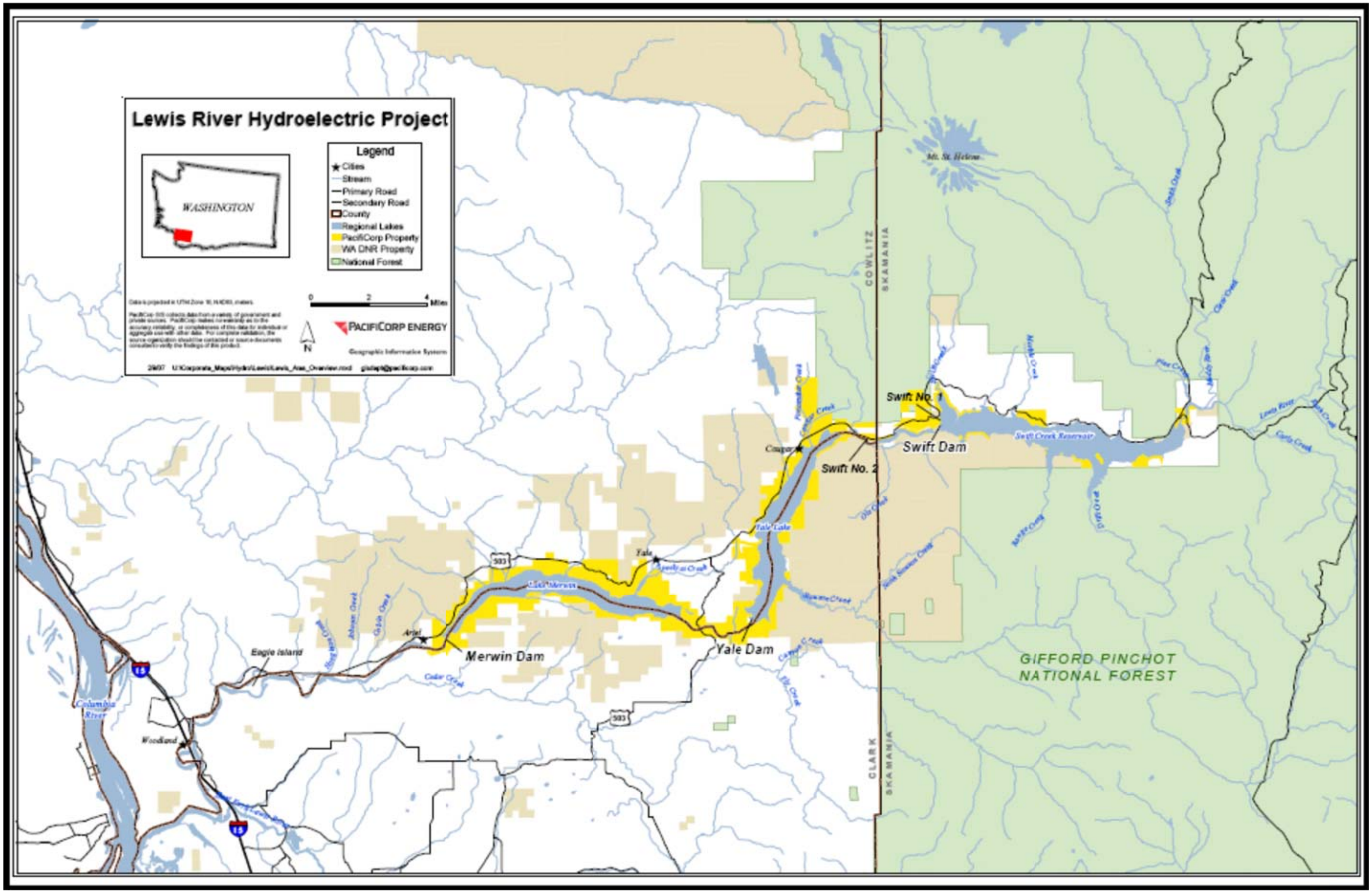


Figure 1: Area map of PacifiCorp's Lewis River hydroelectric project.

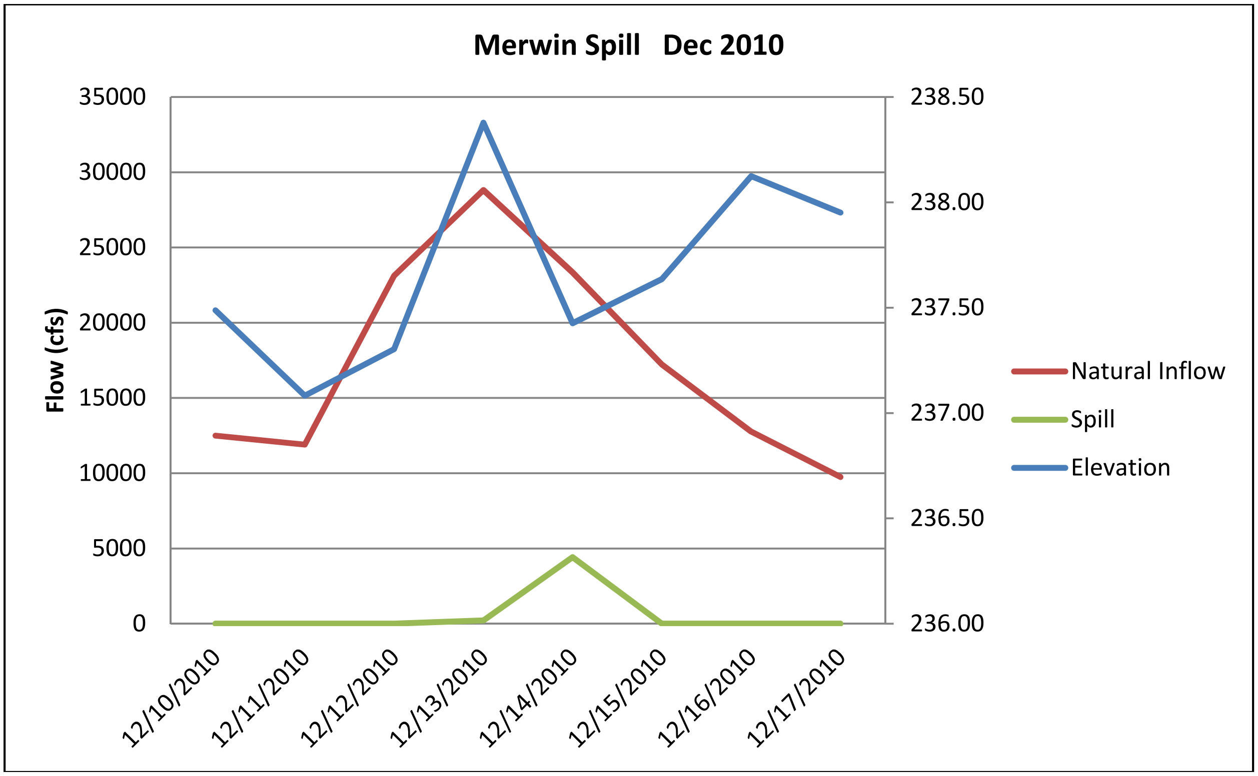


Figure 2: Daily average data for the December 2010 spill event at Merwin dam.

Figure 3: Aerial photo of Merwin dam and spillway.

Table 2: Summary statistics for the Merwin hydroelectric project.
Source: PacifiCorp and Cowlitz PUD (2000).

Statistic	
In-Service Year	1932
Turbine Type	Vertical Francis
Full Pool Elevation (ft-msl)	239.6
Total Generation, mw (per unit)	135 (45)
Intake Depth* (ft-msl)	179.6
Intake Diameter (ft)	15.5
Dam Height (ft)	314
Net Head (ft)	181
Runner Elevation (bottom, ft-msl)	58
Tailwater Elevation (normal, ft-msl)	48

*Intake Depth is center line of intake opening at full pool

2.2 Lewis River Project Operations

As the downstream facility, Merwin operates as a re-regulation reservoir for the upstream Lewis River Projects, providing FERC-required minimum instream flows and ramping rates for the lower Lewis River. The Merwin Project, together with the Swift No. 1 Project and the Yale Project, is also operated to meet FERC and Federal Emergency Management Agency (FEMA) requirements for flood management. Per Article 302 of the Merwin FERC license, these requirements call for minimum storage withdrawal beginning by September 20 and reaching at least 70,000 acre-feet by November 1 of each year. PacifiCorp must retain storage space through April 1 and is permitted to gradually refill by April 30 of the following year. Reservoir storage must adhere to the following schedule:

Date	Minimum Storage Space (Acre-feet)
September 20	0
October 10	35,000
November 1-April 1	70,000
April 15	35,000
April 30	0

Minimum flow releases under the FERC license range from 1,200 to 4,200 cfs, depending on the season, while downramping rates are limited to 2 inches per hour when flow releases downstream of Merwin dam are less than 8,000 cfs. Upramping is limited to 1.5 feet per hour. Stream ramping conditions do not apply when the project is experiencing a high flow event, the reservoirs are near the flood control storage capacity, and inflows exceed Merwin turbine capacity of 11,400 cfs. The reservoir is maintained at a fairly constant level during the recreation season but may fluctuate between elevations 229 feet above mean sea level (msl) (normal minimum summer pool) and 239.6 feet msl (full pool). Due to its large size, Lake Merwin experiences only minimal hourly fluctuations in response to peaking operations at the upstream Yale Project. The pattern of releases from the Merwin Project varies seasonally, with median monthly values ranging from 1,300 cfs in August to 8,000 cfs in December. During periods of high runoff, the Merwin facility spills water in volumes ranging from a few thousand cfs in moderate high-runoff events to as much as 80,000 cfs or more during severe floods.

When a spill event occurs the established procedure for Merwin is to open the middle spill gate (gate No. 3) followed by the two gates on either side of gate No. 3 (gates No. 2 and No. 4) and subsequently gates No. 1 and No. 5. This procedure was shown in the early 1980s to reduce dissolved gases (source material unavailable) but is not clearly documented. In addition, during those spill tests in the early 1980s it was clear that spills less than 5,000 cfs did not create TDG levels that exceeded the 110% Washington Department of Ecology standard. Figure 4 shows Merwin in spill mode with gate Nos. 2, 3, and 4 opened.

Figure 5 is an example of how spill exits the Merwin spillway and inundates the access bridge with spray. The bridge is for operational personnel only and is not accessible to the general public. At some point above 25,000 cfs spill, the bridge is closed to all access for safety reasons due to visibility.

2.4 Description Lewis River Operations during High Run-off

During a high run-off event, PacifiCorp uses the procedure described in 4.3.4(a) of the Merwin 401 Certification for planning purposes. This procedure relies on an event-by-event evaluation of existing snow pack, reservoir storage, turbine unit availability, expected weather conditions, and direction from the U.S. Army Corps of Engineers (USCOE) Reservoir Control Center. In other words it is a manual process that relies on the historical record to forecast inflow to Merwin.

The principal objective of the high runoff procedure (HRP) described in section 4.3.4(a) of the Merwin 401 Certification is to use inflow forecasts and a corresponding amount of total project storage at Swift, Yale and Merwin reservoirs to provide the most effective reduction of high flow downstream of Merwin. Specific operational rules are employed to ensure that the high runoff control storage is effectively used in a consistent, pre-defined manner.

In the high runoff season, frequent forecasts of the peak and volume of natural flow are made and compared to total available project storage. Based on this comparison, a discharge at Merwin is recommended to maintain the required project storage to the extent possible. In general, when forecasted inflows are in danger of encroaching upon the required storage, discharges at Merwin in excess of turbine hydraulic capacity (11,400 cfs) will be recommended. When forecasted inflows are not in danger of encroaching upon flood storage, operations are considered normal and the project is scheduled as usual by PacifiCorp's Operations Scheduling Group.

2.4.1 Lewis River High Runoff Procedure

As required by Section 12.8 of the Lewis River Settlement Agreement (SA 12.8) and Article 302 of the FERC licenses, PacifiCorp is required to develop a new High Runoff Procedure (HRP). This procedure has been drafted and is currently under review by the FERC. One feature of the

HRP is to initiate spill pre-releases (discussed later) and to shorten the flood management period by two weeks on each end of the required flood management period depending on snowpack conditions. These operating rules are intended to decrease the frequency and magnitude of high flow releases compared to those used in the past. The HRP will be implemented when approved by the FERC.

When the HRP is implemented, there will likely be more occurrences of longer duration spill of less than 32,000 cfs at Merwin dam and the other two upstream dams (Table 3) and fewer shorter duration spills of more than 32,000 cfs. The change in spill frequency and duration is a function of the HRP protocol but is not a direct result of the new modeling tools. The basic rule in the HRP is this: if the Merwin inflow hydrograph is rising and likely to reach 60,000 cfs or more, then Merwin dam will pre-release flow via spill beginning at 25,000 cfs and increasing to no more than 40,000 cfs. Conditions will be evaluated every six hours to determine next steps in spill releases or if spill needs to exceed 40,000 cfs.

PacifiCorp is using a forecasting tool created by the University of Washington called '3-Tier Forecasting Model' which is tuned into the historical weather patterns, geographic features of Lewis River Basin. The model tracks the storms specifically headed for the Lewis River and projects the 'behavior' of each storm. Since 2003, PacifiCorp has increasingly relied on this tool since the predicative accuracy has been very close to observed conditions. The Lewis River Water Quality Management Plan (PacifiCorp 2011) describes the HRP in more detail. It is expected that, by implementing the HRP there will likely be at least nine additional annual spill events in the 11,300 cfs to 32,000 cfs range.

Table 3: Number and duration (total hours) of spills projected with the traditional forecasting method versus the 3-Tier forecasting tool.

Forecast method	Inflow up to 11,300 cfs	11,300 cfs – 16,000 cfs	16,001 cfs – 25,000 cfs	25,001 cfs – 32,000 cfs	>32,001 cfs
Traditional	0 events	11 (456 hrs.)	5 (453 hrs.)	0 (0 hrs.)	5 (77 hrs.)
3-Tier	0 events	16 (609 hrs.)	9 (401 hrs.)	2 (36 hrs.)	3 (26 hrs.)

2.5 Flood Frequency at Merwin Dam

Table 4 summarizes significant high flows as recorded at the USGS gage (No. 14220500) at Ariel, Washington just downstream of Merwin Dam since 1933. As Table 4 indicates, streamflows exceeding 50,000 cfs have occurred eleven times since Merwin began operation in 1932. When Merwin initiated operations in 1932, the Merwin powerhouse only had one turbine with a hydraulic capacity of 3,790 cfs and remained that way until 1949 and 1953 when units 2 and 3 were installed, respectively. The addition of units 2 and 3 increased Merwin's hydraulic capacity to 11,470 cfs.

The Yale Project was completed in 1953 and the Swift No. 1 project began operating in 1958. Once all three storage projects were fully operational in 1958, the capability to manage higher flows was enhanced.

Figure 4: Merwin dam during spill with gates 2, 3 and 4 open (date unknown).

For the period from 1958 to present when all three dams were in operation, only four spills have occurred at Merwin dam that were greater than 50,000 cfs. In addition, there have not been any streamflows recorded at the Ariel gage greater than 50,000 cfs since February 1996. The highest flow observed post-1996 occurred on January 31, 2003 when Ariel gage measured 49,300 cfs. A record of all spill events of any magnitude for all three hydro projects is included as Attachment A.

Table 4: Historic peak streamflows greater than 50,000 cfs as measured at Ariel Gage.

Date	Peak Flow (cfs)	Approximate Spill (cfs)
December 22, 1933	129,000	125,210
December 30, 1937	61,500	57,710
November 23, 1942	57,600	53,810
December 13, 1946	67,300	63,510
November 20, 1962	75,500	64,110
December 13, 1966	50,500	39,100
January , 5, 1974	59,600	48,200
December 4, 1975	64,500	53,100
December 2, 1977	71,900	60,500
December 26, 1980	53,700	42,300
February 8, 1996	86,400	75,000

Figure 5: Merwin spill as it exits and oversprays the access bridge.

PacifiCorp operates the Lewis River dams from the perspective that it is better to store water for future use than spill. This is evident in data shown in attached spill record where Merwin had only 22 significant spills (greater than 5,000 cfs) in the past 21 years. Of those spills, sixteen were 7Q10 events. In other words, Merwin spills, for the most part, because the inflows were greater than or nearly equal to the seven-day, ten-year frequency flood of 32,884 cfs. Many other spill events can be attributed to providing make-up water when one or more of the Merwin turbine units trip. The practice of a spill release during unit trips was formalized in 1993 so there have been many small spills that have occurred since then to maintain river levels and prevent fish stranding downstream of Merwin Dam.

2.6 Details of the December 2010 High Flow Event

The conditions and events leading up to the December 2010 high flow event are provided in detail within the ACC/TCC 2010 Annual Report.

Figure 6 illustrates the Merwin Lake elevation as recorded before and after the December 2010 spill. Even though reservoir managers were prepared for an average storm occurrence for the January time of year, available storage at the upstream projects was not adequate to manage this event and prevent spill. Spill gate Nos. 2 and 4 were used during this event because gate No. 3 had a damaged seal (discussed later).

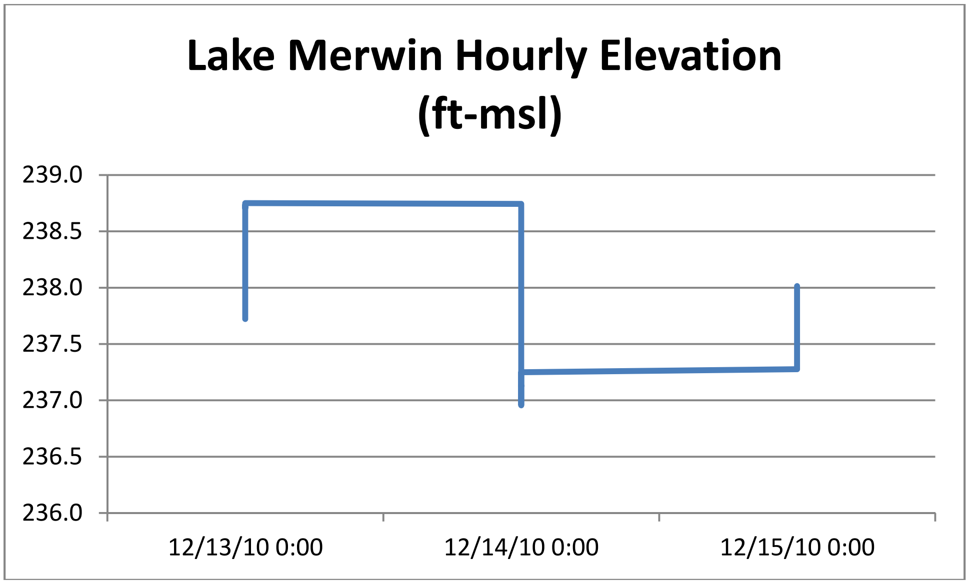


Figure 6: Hourly Merwin reservoir elevations during the December 2010 high flow event.

As in the past, spills less than 5,000 cfs did not exceed the 110 percent TDG standard (Figure 7). Raw hourly data is provided in Attachment B.

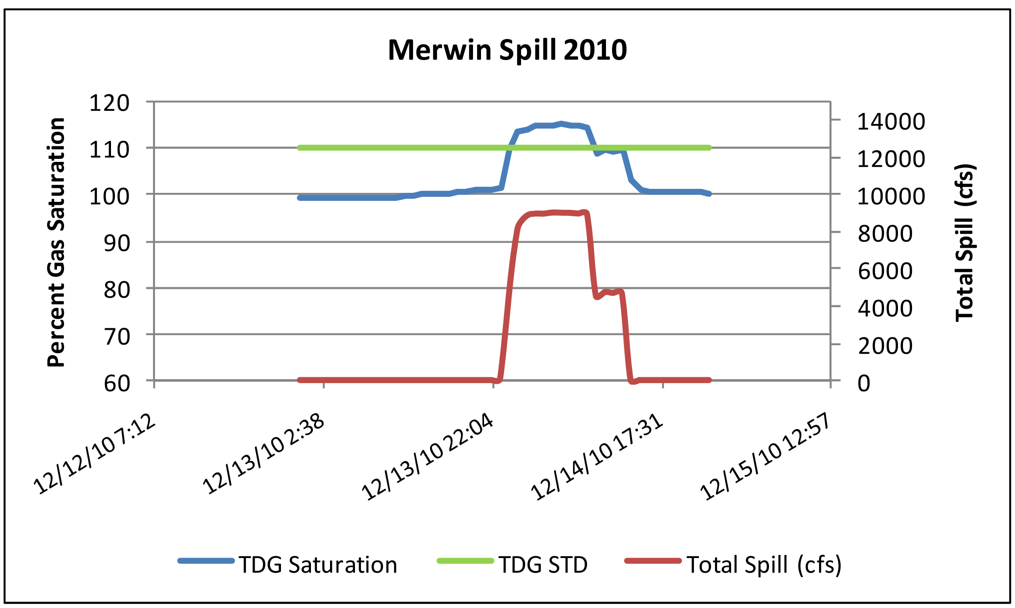


Figure 7: Hourly spill and TDG levels downstream of Merwin dam during the December 2010 high flow event. The green line indicates the 110% TDG standard.

In order to be consistent with WDOE's standard reporting criteria, TDG occurrences for the December 2010 event are summarized as the twelve highest consecutive hourly readings with corresponding natural inflows for Merwin in Table 5 (see Attachment C - memo from Chris

Maynard-WDOE, 4/2/2008). This follows Table 200(1)(f) in the 'Water Quality Standards for Surface Waters of the State of Washington-Chapter 173-201A WAC' which lists the TDG criterion as "Total dissolved gas shall not exceed 110 percent of saturation at any point of the sample collection". The narrative accompanying that table at 200(1)(f)(ii) states that TDG is "measured as an average of the twelve highest consecutive hourly readings in any one day, relative to atmospheric pressure." Using this method of reporting, it is evident that the Merwin project had daily TDG exceedance on December 14th.

Table 5: Merwin twelve highest consecutive hourly inflows and TDG for December 2010.

Date	Twelve Highest consecutive hourly TDG	Twelve Highest consecutive hourly natural inflow
12/11/2010	99%	13,498cfs
12/12/2010	99%	27,776cfs
12/13/2010	101%	31,977cfs
12/14/2010	113%	24,605cfs
12/15/2010	101%	20,327cfs
12/16/2010	101%	15,533cfs

3.0 Evaluation of Potential Operational Improvements to Reduce TDG

The following section evaluates operational or physical improvements that could be implemented at Merwin and Swift dams. PacifiCorp used several criteria to evaluate each alternative. These criteria include:

1) The potential to effectively reduce TDG;
2) The effect on each project's ability to pass the Probable Maximum Flood (PMF);
3) Constructability;
4) Operation and maintenance challenges;
5) Dam safety;
6) Effects on fish passing through the spillway; and,
7) Cost to implement.

3.1 Potential Merwin Dam Improvements

Since it is apparent that TDG is not exceeded at spills less than 5,000 cfs and exempt when flows are higher than 32,884 cfs and since the Merwin Project has a hydraulic capacity of 11,400 cfs, PacifiCorp considered alternatives that would effectively alleviate elevated TDG for spills between 5,000 cfs and 21,484 cfs (32,884cfs *minus* 11,400 cfs). However, PacifiCorp is not excluding the effects on higher spill flows from the evaluation. Several alternatives were considered that fell under two categories: 1) Operational Alternatives and 2) Structural Alternatives.

Of those alternatives, five possible solutions emerged that could potentially reduce TDG downstream of Merwin during a spill event. These are:

1) Repair gate No. 3 and re-establish the spill gate operational protocol [Structural/Operational];
2) Manage Merwin Reservoir to a lower elevation in the high flow period (Nov. 1 to April 15) [Operational];
3) Alter the spill pattern to spill sooner and longer in order to keep spill amount less than 5,000 cfs [Operational]; and,
4) Modify the spillway to increase turbulence and aerate the spill waters (e.g. diffuser blocks) [Structural].

3.1.1 Implement Spill Gate Opening Protocol

Based on the results of spill tests conducted in the early 1980's PacifiCorp has anecdotal evidence that operating the spillgates in the previously described sequence of gate Nos. 3, then 2 and 4, then 5 and 1 reduced the incidence of elevation TDG. Spillgate No. 3 currently has a faulty seal creating a situation of significant gate leakage after the gate is operated. PacifiCorp provided the FERC with a plan to repair the seal on the Merwin gate No. 3. Construction maintenance planning is underway but may be delayed until such time that the repairs can coincide with FERC-required Merwin spill gate full-open testing. This work will require a significant reservoir level change (pool elevation reduction by 25 feet) to accomplish the spillway gate tests and to complete the replacement of the seal. Regardless, the No. 3 spillgate will be operated with or without the new gate seal until such time as it can be repaired. PacifiCorp will resume operating the spillgates in the previously described sequence of gate Nos. 3, then 2 and 4, then 5 and 1. Since there is not any clear documentation for the effectiveness of this sequence, PacifiCorp proposes to conduct some tests of this spill sequence over several high flow events and spill magnitudes to determine whether or not this procedure truly works as a measure to reduce TDG. The methods for addressing the effectiveness of spill gate sequence in controlling TDG are detailed in the attached Quality Assurance Project Plan (QAPP).

3.1.2 Manage Merwin Reservoir to a Lower Elevation

This measure involves maintaining Merwin reservoir levels to lower elevations than previously managed. PacifiCorp typically manages its reservoirs with more flood storage (i.e. at lower elevations) than is required by FERC. This is because the company tries to prevent any spill since this is considered wasting generation. There are concerns for lowering the reservoir too much including the inability to fill the reservoirs for the spring recreation season, and turbines cannot run efficiently at low head (lower elevations levels) and would use more water for the same megawatt generation.

Typically, PacifiCorp maintains the bulk of its flood storage in the Swift reservoir because it has the greatest storage capacity compared to the Yale and Merwin reservoirs and allows operations to capture a higher volume of water during high flow events. Swift reservoir has about 412,000 ac-ft of usable storage while Merwin has about 251,000 ac-ft. Yale is even smaller in size than Merwin with about 185,000 ac-ft of usable storage.

Shifting the bulk of available storage to Merwin reservoir would likely result in maintaining the upper reservoirs at higher elevations. During a high flow event, since water could not be captured in the upper reservoirs, it would have to be spilled past the upper dams. Not only does this represent a large negative impact to generation but it could exacerbate TDG issues at Swift dam in addition to those at Merwin dam.

3.1.3 Alter the Spill Pattern to Spill Sooner and Longer

Altering the spill pattern to spill sooner and longer than in the past is already an element of the proposed High Runoff Procedures (HRP) being reviewed by the USCOE as per the Lewis River Settlement Agreement. These episodes of spill are known as “pre-releases” in the proposed HRP. However, the purpose of the change to the old procedures is to reduce potential damage to life, limb and property downstream of Merwin Dam, particularly in and around Woodland, Washington. The pre-releases proposed in the draft procedures range from 15,000 cfs to 25,000 cfs.

Pre-releases at flow levels low enough to avoid TDG issues are not possible since forecasting technology is only accurate two or three days ahead of an event. For instance, releasing 5,000 cfs for 2-3 days prior to the event would not provide enough available storage to capture an event to mitigate downstream releases to non-damaging levels. Also, the long-term average natural inflows to Merwin during the flood season are 6,058 cfs for November, 8,222 cfs for December, 7,464 cfs for January and 6,897 cfs for February which complicates PacifiCorp's ability to effectively manage pre-spills that are less than 5,000 cfs. Alternatively, pre-releases at higher flow levels (total flow at Ariel >40,000 cfs) could potentially cause unnecessary property damage downstream. This alternative would require inflow predictions that could be as long as a week ahead of a storm depending on the storm's magnitude. This conundrum essentially renders this TDG management alternative impossible to achieve with the current forecasting technologies that are available to PacifiCorp.

3.1.4 Modify the Spillway to Increase Turbulence and Reduce Spill Energy

This action is described and detailed in the attached Quality Assurance Project Plan (QAPP).

3.1.5 Estimated Costs and Implementation Schedule for Merwin

For the operational changes to the Merwin project some internal costs for analysis and restructuring of operational protocols are anticipated. Depending on the selected measure, review and approval of a correction measure could involve between one month and six months. For example, altering spill releases would involve discussion with local Emergency Management Officials and the USCOE and, depending on the interaction with flood management, the Federal Emergency Management Agency (FEMA). This level of coordination would require considerably more internal involvement and costs.

A spillway modification at Merwin would likely require about 1.5 years to complete design and to obtain the appropriate permits. An additional year would be needed to construct the approved spillway modification. This project would likely cost over $2 million to complete.

Based on this analysis, PacifiCorp's preferred alternative is to re-implement and test the spill gate protocol. If this operational change does not eliminate TDG exceedences, then PacifiCorp would initiate modeling and analysis of the cost and effectiveness of spill dissipation structures.

4.0 Implementation Timeline for Operational Adjustments

4.1 Merwin Spill Gate Protocol

PacifiCorp anticipates re-establishing the Merwin spillgate protocol during the ensuing spill event will likely occur in the Fall 2011 or Winter 2012. As with previous spill monitoring, a Hydrolab® TDG datasonde unit will be deployed near the Ariel gage station. Spill amounts and associated TDG will be recorded for the spill event. When the storm passes and flows begin to recede, the spillgates will be closed in the reverse order so that Gate No. 3 will be the last to close and a direct spill-TDG effect can be observed. If this monitoring proves inconclusive, PacifiCorp will attempt to monitor spill with an alternate spillgate procedure. This alternative will depend on the previous observations and consultation with WDOE staff.

This process will be repeated with each spill event until PacifiCorp and WDOE staffs are satisfied with the results and can make an informed decision as to the effectiveness of this measure.

5.0 Schedule to Complete Construction Measures

The following are PacifiCorp's preferred options to prevent TDG exceedences as they relate to spills. The Quality Assurance Project Plan (Attachment E) provides a timeline for these options. At the present time, the entire process is projected to start with a request for proposals (RFP) in July 2012 and completion of construction by January 15, 2015. This schedule is subject to revision depending on approvals and spill gate testing.

5.1 Merwin Spillway Modification

If it is determined that the spillgate protocol does not effectively reduce TDG at Merwin, then PacifiCorp will evaluate modification of the Merwin spillway. If the evaluation shows that modification of the spillway is an effective and appropriate means of achieving the TDG criterion without other adverse environmental, safety, or other effects, PacifiCorp will, with the approval of Ecology and after obtaining other necessary approvals, construct the modification. It is anticipated to take approximately 2.5 to 3 years to complete a modification. If a spillway modification does not prove to be an effective and appropriate means of achieving the TDG criterion, PacifiCorp will submit a modified Water Quality Attainment Plan to Ecology for approval.

6.0 Monitoring Plan

6.1 Monitoring Schedule and Protocol

Prior to the flood management season (November 1 to March 15), all TDG metering equipment will be fully serviced and prepared for deployment. In the instance where access is difficult and requires time and safety measures, the monitoring probes will be deployed near the beginning of the flood management season and serviced every six weeks (replace batteries and clean probes). This would apply to Swift dam which requires a spill gate tag-out as the probe is placed in very low- to no-traffic areas. The Merwin monitoring location, on the other hand, receives a lot of boat traffic and some shore anglers so deployment and removal will occur with each potential storm/spill event to avoid vandalism and theft.

For monitoring at Merwin, once a potential high flow event is identified using forecasting tools, a Hydrolab® MiniSonde MS5 will be deployed in the Lewis River downstream of the dam in deep water near the Ariel gage in advance of the storm. When spill is initiated at Merwin, PacifiCorp will notify WDOE as soon as practical and will monitor throughout the high flow event. After spill termination, the monitoring unit will remain in place for the subsequent 48 hours and then be removed from the river and the data downloaded. The MiniSonde probes will then be inspected for unusual wear or other damage. PacifiCorp staff will obtain pertinent Merwin operational data (i.e. spill gate opening, turbine operation, estimate of natural inflow) to accompany the TDG data and will forward this information to WDOE as soon as it is downloaded and assembled in a spreadsheet. This process will be repeated as often as spill occurs until WDOE is satisfied that excess TDG has been abated.

7.0 Literature Cited

PacifiCorp and Cowlitz PUD, 2000. Final Initial Information Package (IIP). Prepared by EA Engineering, Science and Technology and Harza Engineering Company, March 2000.

PacifiCorp and Cowlitz PUD. 2004. Licensee's Final Technical Studies Status Report for the Lewis River Hydroelectric Projects. Portland, OR and Longview, WA. April 2004.

ATTACHMENT A

LEWIS RIVER PROJECT SPILL FREQUENCY AND MAGNITUDE SINCE 1990

Frequency and magnitude of spills (average cfs/day) at the Lewis River projects from January 1990 through April 2011. Each spill event is separated by a blank row. Bold numbers represent 7Q10 events. 7Q10 inflows= 32,884 cfs for Merwin, 27,088 cfs for Yale and 21,322 cfs for Swift.

Date	**Merwin Spill (cfs)**	**Merwin Inflow (cfs)**	**Yale Spill (cfs)**	**Yale Inflow (cfs)**	**Swift Spill (cfs)**	**Swift Inflow (cfs)**
1/8/1990						
1/9/1990	**6913**	**56400**		**47800**		
1/10/1990	**27220**	**37244**	**6398**	**29586**		
1/11/1990	**20192**	**18051**	**24540**	**14434**		
1/12/1990	**1311**	**12714**	**13729**	**11129**		
11/24/1990	**611**	**35783**	**532**	**30550**	359	11006
11/25/1990	**22845**	**36213**	**16885**	**16253**	13803	16799
11/26/1990	**10817**	**16353**	**8463**	**11520**	10433	13831
11/27/1990	**2263**	**12742**	**7660**	**9008**	5603	10462
11/28/1990			**7537**	**8011**	1138	6841
11/29/1990			**2639**	**6894**		
2/20/1991			1219	13491		
2/21/1991			1072	9397		
11/1/1991	354	1213	51	791		
1/30/1992	615	17090	1813	12923		
1/31/1992	1369	14977	1313	11699		
2/3/1992	165	8365				
12/26/1994	**521**	**20341**	**444**	**27657**		
12/27/1994	**14866**	**34078**	**10655**	**19451**		
12/28/1994	**11297**	**22418**	**100034**	**12679**		
12/29/1994	**4997**	**14426**	**3355**	**9464**		
1/30/1995					**0**	**21847**
1/31/1995	537	**31781**	**1047**	**26297**	**1383**	**19702**
2/1/1995	5055	**29997**	**5740**	**17877**	**4978**	**17196**
2/2/1995	8685	**20203**	**4533**	**12548**	**2651**	**12574**
2/3/1995	2374	**14045**				
2/5/1995			515	7065		
2/6/1995			2053	6311		
2/7/1995			2050	5774		
2/8/1995			897	5471		

Date	Merwin Spill (cfs)	Merwin Inflow (cfs)	Yale Spill (cfs)	Yale Inflow (cfs)	Swift Spill (cfs)	Swift Inflow (cfs)
2/18/1995			**685**	**33506**		
2/19/1995	**7532**	**43496**	**8904**	**22741**		
2/20/1995	**13068**	**27559**	**7475**	**13941**		
2/21/1995	**6182**	**16927**	**3276**	**10184**		
2/22/1995			**1048**	**7772**		
2/23/1995			**1050**	**7222**		
2/24/1995			**394**	**6462**		
11/11/1995	5214	32873	6827	14177		
11/12/1995	5285	18303	7254	13366		
11/13/1995			4426	10472		
11/14/1995			3589	8492		
11/15/1995			4294	7704		
11/16/1995			638	6899		
11/25/1995	**890**	**17326**				
11/26/1995	**0**	**15236**				
11/27/1995	**5565**	**18011**	**6972**	**30981**		
11/28/1995	**20727**	**39696**	**19254**	**39117**		
11/29/1995	**28015**	**49152**	**21909**	**32359**		
11/30/1995	**31270**	**41499**	**24988**	**27718**	**14270**	19937
12/1/1995	**30063**	**35177**	**24531**	**19880**	**23225**	**32517**
12/2/1995	**13124**	**23175**	**10822**	**14578**	**14695**	**24207**
12/3/1995	**4668**	**17120**	**8280**	**13136**	**7995**	**18009**
12/4/1995	**1888**	**15105**	**3103**	**10243**	**1624**	**10473**
12/12/1995	4884	18025	7212	18033	4865	12691
12/13/1995	5090	12377	18841	18493	9695	19954
12/14/1995	14438	22038	13736	15008	4611	16191
12/15/1995	5858	18118	7642	10801		
12/16/1995			5128	8189		
12/17/1995			4859	6926		
12/18/1995			4949	5806		
12/19/1995			4240	5667		
12/20/1995			2022	5186		
1/7/1996	1013	24058	964	17575		
1/8/1996	3401	21252	3041	12849		
1/15/1996	100	13711				

Date	Merwin Spill (cfs)	Merwin Inflow (cfs)	Yale Spill (cfs)	Yale Inflow (cfs)	Swift Spill (cfs)	Swift Inflow (cfs)
1/19/1996			932	7302		
1/20/1996			3190	6846		
1/21/1996			3185	5651		
1/22/1996			3153	5382		
1/23/1996			1203	4809		
2/6/1996						**31241**
2/7/1996	**3574**	**56665**	**3033**	**75657**		**36489**
2/8/1996	**44114**	**96488**	**34418**	**42667**	**28989**	**32766**
2/9/1996	**51084**	**56723**	**39747**	**18467**	**44711**	**48792**
2/10/1996	**24882**	**24203**	**20600**	**11429**	**16088**	**22758**
2/11/1996	**10707**	**14856**	**10466**	**8647**	**4467**	**11375**
2/12/1996	**5863**	**11107**	**8751**	**7684**	**844**	**7076**
2/13/1996	**1368**	**9461**	**2298**	**7203**		
2/19/1996	1747	17154	1557	12364		
2/20/1996	4561	13819	3992	10001		
2/28/1996	27	4629				
4/23/1996	2512	21455	2044	21633		
4/24/1996	3689	25276	3246	14826		
4/25/1996	952	18095	3605	11444	710	9114
4/26/1996	2673	13935	3739	9172	1065	1065
4/27/1996	669	11212	2665	7783		
4/28/1996			931	6799		
4/29/1996			103	5826		
5/8/1996			2350	2869		
9/19/1996	3000	4296				
12/29/1996	**9830**	**28545**				
12/30/1996	**3874**	**27807**	**857**	**28308**		**21951**
12/31/1996	**7771**	**32535**	**5268**	**38682**		**21457**
1/1/1997	**13281**	**42017**	**12509**	**31397**	**12193**	**24711**
1/2/1997	**14425**	**34206**	**14549**	**23028**	**15941**	**29031**
1/3/1997	**6889**	**24958**	**8052**	**14309**	**5395**	**16600**
2/13/1997			1945	4936		

Date	Merwin Spill (cfs)	Merwin Inflow (cfs)	Yale Spill (cfs)	Yale Inflow (cfs)	Swift Spill (cfs)	Swift Inflow (cfs)
2/14/1997			1239	5523		
7/15/1998	22	1234				
1/25/1998	**1833**	**30952**				
1/26/1998	**8719**	**35372**				
1/27/1998	**2000**	**20298**				
11/25/1998				**29171**		
11/26/1998			**667**	**15843**		
11/27/1998			**1833**	**10837**		
12/28/1998	**8779**	**37995**	**3066**	**27928**		
12/29/1998	**14774**	**38572**	**5527**	**22289**		
12/30/1998	**20245**	**31941**	**4567**	**13841**	2358	11436
12/31/1998	**8606**	**19802**	**5000**	**12204**	4049	12694
1/1/1999	**5075**	**14101**	**4356**	**8514**	337	7511
1/2/1999			**2200**	**6727**		
1/3/1999			**1700**	**5560**		
1/7/1999			650	2434		
1/8/1999			1010	2236		
1/9/1999			1010	2881		
1/10/1999			800	3226		
5/4/1999	292	9980				
6/6/1999	175	6791				
10/20/1999	500	910				
11/25/1999	**2573**	**52710**	**1795**	**31837**		
11/26/1999	**8087**	**40357**	**4151**	**15336**		
11/27/1999	**154**	**19380**				
11/28/1999	**1085**	**12016**				
12/3/1999	779	12800				
12/13/1999	1538	13207				
12/14/1999	5306	12184	1707	15932		
12/15/1999	15185	24990	7135	19895		
12/16/1999	13002	29082	6858	16923		

Date	Merwin Spill (cfs)	Merwin Inflow (cfs)	Yale Spill (cfs)	Yale Inflow (cfs)	Swift Spill (cfs)	Swift Inflow (cfs)
12/17/1999	6883	22707	1282	20106		
12/18/1999	11269	25695	3600	12723		
12/19/1999	5074	16530	2475	10055		
12/20/1999	2075	12731				
12/31/1999	73	3853				
1/1/2000	36	4154				
5/15/2000					35*	4431
5/16/2000					84	4746
5/17/2000					140	4419
5/18/2000					247	4847
5/19/2000					188	4906
6/12/2000	487	14534	367	8040		
6/13/2000	429	10569	275	6595		
12/16/2001	445	14534				
12/17/2001	1669	10563				
3/27/2002					490**	3254
3/28/2002					500	3156
4/4/2002					604	3800
4/5/2002					500	4519
5/1/2002	867	6200				
6/30/2002					623***	1120
7/1/2002					2543	4768
11/6/2002	288	931				
1/26/2003	**191**	**26644**				
1/27/2003	**1781**	**18140**				
1/28/2003	**2117**	**12026**				
1/29/2003	**4000**	**10403**				
1/30/2003	**4000**	**14552**	**2550**	**42053**		**28302**
1/31/2003	**26345**	**56759**	**15481**	**30467**	**4095**	**14178**
2/1/2003	**33785**	**36381**	**28736**	**14857**	**12689**	**23145**
2/2/2003	**8708**	**18210**	**6813**	**9833**	**1374**	**9472**
2/3/2003	**2423**	**13157**	**2920**	**7492**		

Date	Merwin Spill (cfs)	Merwin Inflow (cfs)	Yale Spill (cfs)	Yale Inflow (cfs)	Swift Spill (cfs)	Swift Inflow (cfs)
2/4/2003	**16**	**9645**				
3/12/2003	214	16792				
3/13/2003	919	21683				
9/28/2003					65	532
9/29/2003					100	652
9/30/2003					100	568
10/1/2003					100	568
10/2/2003					100	611
10/3/2003					100	569
10/4/2003					100	569
10/5/2003					100	612
10/6/2003					100	698
10/7/2003					100	827
10/8/2003					100	763
10/9/2003					100	764
10/10/2003					46	818
8/30/2004	169	2203				
10/22/2004	1371	5016				
10/23/2004	42	4566				
10/27/2004	354	3802				
1/17/2005	315	9055				
1/18/2005	1661	31207				
9/24/2005					32	526
9/25/2005					50	501
9/26/2005					50	523
9/27/2005					50	502
9/28/2005					50	567
9/29/2005					50	1214
9/30/2005					50	1064
10/1/2005					50	807
10/2/2005					50	742
10/3/2005					50	678
10/4/2005					50	592
10/5/2005					50	527
10/6/2005					50	636

Date	Merwin Spill (cfs)	Merwin Inflow (cfs)	Yale Spill (cfs)	Yale Inflow (cfs)	Swift Spill (cfs)	Swift Inflow (cfs)
10/7/2005					50	678
10/8/2005					50	750
10/9/2005					50	589
10/10/2005					50	715
10/11/2005					20	608
1/9/2006	**5040**	**21012**	**3488**	**36302**		
1/10/2006	**13745**	**43349**	**7700**	**31940**		**24949**
1/11/2006	**17427**	**38083**	**7700**	**20693**		**15379**
1/12/2006	**18021**	**25726**	**7700**	**21153**		**14773**
1/13/2006	**18250**	**26280**	**7700**	**16914**	**170**	**11679**
1/14/2006	**11865**	**20647**	**6033**	**11831**	**864**	**9919**
1/15/2006	**3792**	**14910**	**2700**	**10082**		
1/16/2006	**6521**	**12920**	**2700**	**14372**		
1/17/2006	**3229**	**18857**	**2700**	**11437**		
1/18/2006	**4100**	**15152**	**2700**	**9453**		
1/19/2006	**3543**	**12403**	**2025**	**9785**		
1/30/2006	3855	21046				
1/31/2006	1298	15812				
2/1/2006	488	14282				
6/3/2006			1975	4589		
6/4/2006			3183	5004		
11/5/2006	**2771**	**9810**	**2708**	**43064**		
11/6/2006	**22383**	**55468**	**6237**	**52577**		
11/7/2006	**24189**	**64896**	**8145**	**21198**		
11/8/2006	**10902**	**25743**	**5829**	**12787**		
11/9/2006	**5116**	**15384**	**2850**	**11201**		
11/10/2006	**4292**	**13636**	**2604**	**10600**		
11/11/2006	**3354**	**12770**	**2937**	**11259**		
11/12/2006	**2640**	**13923**	**3200**	**12799**		
11/13/2006	**5745**	**16099**	**3200**	**9924**		
11/14/2006	**4663**	**12364**	**2750**	**9610**		
11/15/2006	**1208**	**11936**	**417**	**12088**		
12/12/2006	850	11537				
12/13/2006	48	17793				
12/14/2006	1708	25485				
12/15/2006	1000	29135				

Date	Merwin Spill (cfs)	Merwin Inflow (cfs)	Yale Spill (cfs)	Yale Inflow (cfs)	Swift Spill (cfs)	Swift Inflow (cfs)
4/10/2007	112+	6225				
12/3/2007	**2583**	**38356**				
12/4/2007	**5639**	**42541**				
11/12/2008	4092	32577				
11/13/2008	7363	26174				
11/14/2008	1500	11566				
1/1/2009	1875	12590				
1/2/2009	1383	13578				
1/6/2009	**7954**	**12109**		**34994**		
1/7/2009	**24054**	**48864**	**5000**	**38470**		**21682**
1/8/2009	**21954**	**49801**	**5875**	**18866**	**5150**	**9740**
1/9/2009	**9608**	24172	**2458**	**12556**	**12554**	**10904**
1/10/2009	**3791**	15007	**0**	**9152**	**13817**	**14470**
1/11/2009	**2959**	12005	**1688**	**8509**	**8400**	**8324**
1/12/2009					**7817**	**8932**
1/13/2009					**4992**	**9601**
4/19/2009	492	5807				
1/2/2010	216	11915				
1/5/2010	168	14582				
1/6/2010	390	12940				
3/2/2010	620	4748				
12/13/2010	208	28822				
12/14/2010	4425	23342				
1/16/2011	**19009**	**46850**	**4244**	**37881**		
1/17/2011	**19011**	**43161**	**6806**	**37881**		
1/18/2011	**3130**	24510	**6920**	**21733**		
1/19/2011	**1638**	14832	**1736**	**13331**		
1/20/2011	**123**	11021	**1001**	**9676**		
1/21/2011			**534**	**8713**		
3/16/2011					391	7909

Date	**Merwin Spill (cfs)**	**Merwin Inflow (cfs)**	**Yale Spill (cfs)**	**Yale Inflow (cfs)**	**Swift Spill (cfs)**	**Swift Inflow (cfs)**
3/18/2011					297	5575
4/3/2011			3599.7	8918		
4/4/2011			4228.6	9284		
4/5/2011			2022.7	8772		

+Merwin dropped load

*- Flow releases for instream flow study

**- Flow releases for fish behavior study

***- Emergency spill due to canal failure

ATTACHMENT B

HOURLY RAW DATA FOR THE DECEMBER 13, 2010 SPILL EVENT

Date:Time	Natural Inflow (cfs)	TDG %	Spill (cfs)
12/13/10 15:00	24646	100.13	0.0
12/13/10 16:00	25517	100.27	0.0
12/13/10 17:00	25630	100.27	0.0
12/13/10 18:00	24437	100.53	0.0
12/13/10 19:00	25372	100.67	0.0
12/13/10 20:00	23154	100.80	0.0
12/13/10 21:00	24420	100.94	0.0
12/13/10 22:00	24764	101.07	0.0
12/13/10 23:00	22182	101.21	66.3
12/14/10 0:00	22734	109.57	4484.5
12/14/10 1:00	20426	113.58	8083.5
12/14/10 2:00	31977	114.09	8782.3
12/14/10 3:00	23689	114.78	8918.5
12/14/10 4:00	25229	114.75	8917.8
12/14/10 5:00	23718	114.61	8976.9
12/14/10 6:00	24852	115.03	8968.7
12/14/10 7:00	23183	114.77	8960.6
12/14/10 8:00	23863	114.75	8921.5
12/14/10 9:00	23064	114.46	8889.7
12/14/10 10:00	22225	108.82	4519.0
12/14/10 11:00	21906	109.63	4715.4
12/14/10 12:00	22912	109.35	4666.7
12/14/10 13:00	22775	109.61	4653.6
12/14/10 14:00	18182	103.33	0.0
12/14/10 15:00	22448	100.93	0.0
12/14/10 16:00	20808	100.67	0.0
12/14/10 17:00	19468	100.67	0.0
12/14/10 18:00	23010	100.53	0.0
12/14/10 19:00	20649	100.66	0.0
12/14/10 20:00	20101	100.53	0.0
12/14/10 21:00	21698	100.53	0.0
12/14/10 22:00	19573	100.40	0.0
12/14/10 23:00	19072	100.26	0.0

ATTACHMENT C

APRIL 2007 CHRIS MAYNARD MEMO

April 2, 2008

TO: Columbia and Snake River Dam Spill Operators

FROM: Chris Maynard, Hydropower Coordinator, Washington State Department of Ecology

RE: Method for averaging 12 consecutive daily average high TDG readings in any one day

I have been asked to clarify how Ecology expects operators to measure TDG during fish passage spill on the Columbia and Snake Rivers.

Washington's previous 1997 total dissolved gas (TDG) Water Quality Standards (WQS) for fish spill on the Snake and Columbia Rivers required TDG measurements to be taken at least hourly and the 12 highest measurements averaged over the course of a day. A day was assumed to be a 24 hours period although the start and end time were never clearly defined. The operators averaged measurements and reported based on a calendar day, starting at 12:a.m. and ending at 12 am. The term 'day' did not need to be defined because averaging any high TDG from midnight to midnight captured all high TDG readings. Often the high readings for tailraces would occur during the early hours after midnight and in the evening hours with a period of lower readings in between during the day. This is because fish spill often occurs more at night.

The revised 2006 Washington WQS require measuring the average of the 12 highest *consecutive* hours in any one day. This is because at 120% TDG or less, studies have shown that aquatic organisms experience the most TDG harm from consecutive exposure, not intermittent exposure throughout a 24 hour period. High TDG and corresponding spills tend to occur during consecutive blocks of time. Measuring midnight to midnight breaks up the consecutive period of nightly high TDG.

<u>Beginning during the 2008 spill season, the operators should use the following method to average and report the 12 consecutive hourly high TDG reading in a day:</u>

Method: Use a rolling average to measure 12 consecutive hours. The highest 12 hour average in 24 hours is reported on the calendar day (ending at midnight) of the final measurement.

- The first averaging period of each calendar day begins with the first hourly measurement at 1:00 a.m. This hour is averaged with the previous day's last 11 hourly measurements.
- Each subsequent hourly measure is averaged with the previous 11 hours until there are 24 averages for the day.
- From the 24 hour averages, the highest average is reported for the calendar day.
- Round 12 hour average to nearest whole number.

> *Rationale for the rolling average:* The standards say "in any one day", but a day need not be a calendar day. Defining a day as starting at a set hour (like midnight) and ending 24 hours later leaves only twelve 12-hour blocks to average within 24 hours. If a period ends at midnight, night spill TDG measurements would be cut off during the middle of the night and the consecutive readings of the highest spill period would not be averaged since the period from 12 midnight on would not be counted with the previous day. So a rolling 12-hour average makes the most sense. This method best captures consecutive hours of high TDG not only below dams that spill at night, but also for dams that vary their hours of spill from nighttime. It also captures consecutive forebay reading which measure TDG from the upstream dam hours later..

The accompanying table shows an example of how the TDG should be tracked and averaged as a rolling average. It shows what hours will be reported for a day: the highlighted green and blue hours are those that are averaged each hour to report as May 19th. The first period evaluated for May 19th reporting begins with the first hour's measurements of the day. Since the previous 12 hour measurements are needed for a consecutive average, eleven of those hours (in the first highlighted column) will necessarily occur on May 18th. The next hour's measurement is then evaluated with the eleven hours previous, and so on through the day until the last measurement at midnight. There are now twenty-four averaging periods, and the highest average (ending at 2: a.m. May 19th) is chosen to report for May 19th.

Cc: Agnes Lut, ODEQ
Margaret Filardo, FPC
WQT
Pat Irle, Ecology
Marcie Mangold, Ecology

Attachment E

Spill Related Total Dissolved Gas Quality Assurance Project Plan

Quality Assurance Project Plan for the Merwin Project Spillway Modification Plan

July, 2013

Prepared by
Frank Shrier
PacifiCorp Energy

Prepared for
Department of Ecology
Environmental Assessment Program

Quality Assurance Project Plan
for the
Merwin Project Spillway Modification Plan
July, 2013

Approval Signatures:

____ Date: __________________
Bruce Barbour, WA Dept. of Ecology, Water Quality Inspector

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1.0 Background

Study Area and Surroundings

A general description of the Merwin project is provided below. While the Yale and Swift No. 1 projects are integral to the Lewis River hydroproject, description of those projects is not included but, where appropriate, this document describes the Yale and Swift projects' function in the high flow event of December 2010.

2.0 Logistical Problem

Water spilled from Merwin dam exits the spillway and plunges into the deep tailwaters of the dam. This plunging action entrains dissolved gases and creates elevated levels of TDG that exceed the state standard of 110 percent when spill is greater than 5,000 cfs.

On December 13, 2010, the Merwin project experienced high inflows that were just 900 cfs less than a 7Q10 event and, consequently went into spill. The conditions and events leading up to the December 2010 high flow event are provided in detail within the ACC/TCC Annual Report.

Even though reservoir managers were prepared for an average storm occurrence for the January time of year, available storage at the upstream projects was not adequate to manage this event and prevent spill at Merwin. As in the past, spills less than 5,000 cfs did not exceed the 110 percent TDG standard (Figure 4).

In order to be consistent with WDOE's standard reporting criteria, TDG occurrences for the December 2010 event are summarized as the twelve highest consecutive hourly readings with corresponding natural inflows for Merwin in Table 4 (see Merwin Spill TDG Attainment Plan Attachment C - memo from Chris Maynard-WDOE, 4/2/2008). This follows the example Table 200(1)(f) in the 'Water Quality Standards for Surface Waters of the State of Washington-Chapter 173-201A WAC' which lists the TDG criterion as "Total dissolved gas shall not exceed 110 percent of saturation at any point of the sample collection". The narrative accompanying that table at 200(1)(f)(ii) states that TDG is "measured as an average of the twelve highest consecutive hourly readings in any one day, relative to atmospheric pressure." Considering this, it is evident that the Merwin project had daily TDG exceedences on December 14thth.

3.0 Goals

The primary goal of this project is to achieve successful compliance with the State TDG criteria of 110% or less total dissolved gas in the Lewis River downstream of Merwin dam. We plan to accomplish this by meeting the following objectives:

1) Determine and implement the best spill gate opening sequence at Merwin dam that results in the lowest total dissolved gas reading;

2) Manage Merwin Reservoir to a Lower Elevation to enable additional storage and reduce spill frequency;
3) Alter the spill pattern to spill sooner and longer; and,
4) Modify the spillway to increase turbulence and reduce spill energy.

These actions are described in detail in the Merwin Spill TDG Water Quality Attainment Plan. In terms of sampling design and protocols, only items 1 and 4 are addressed in this plan.

4.0 Sampling Process Design

The following describes the two action items that require monitoring to determine effectiveness in reducing spill TDG.

Test the Spill Gate Protocol

The Merwin gates are numbered 1 through 5 starting at the right abutment with Gate No.1 being the 10-foot-wide “trash” gate. When spill is initiated, Merwin Gate No. 3 should be opened first, up to a flow of 3,000 cfs, then followed by Gate No. 2 for a total flow of up to 6,000 cfs, then followed by Gate No. 4 for a total flow of up to 10,000 cfs. The total flow through the three gates will then be increased up to 30,000 cfs while maintaining the flow through each gate within 3,000 cfs of the other two gates. If additional flow release is necessary, the three gates will be opened more or less equally. Gate No. 5 will be opened after gate Nos. 2, 3, 4 are fully open or are out of the water. Gate No. 1 will be opened after Gates 2 through 5 are fully open.

This protocol has not been followed recently because the seal on spill gate No. 3 is broken and will not reseal, if opened, without the help of divers. The seal is scheduled to be repaired and, once that is accomplished, the protocol will be resumed and tested. Once the first spill event has occurred, PacifiCorp will evaluate the data and relate TDG to the conditions at the spillway. Gate number and opening (expressed as “percent opened”) will be recorded during the event for later analysis. This test procedure will take place with at least three spill events that differ by magnitude and duration. Following the first spill event, gate sequence or gate opening may be adjusted if there appears to be significant changes in TDG with certain conditions. Test results will be reported to WDOE within 30 days of termination of spill and a conference call will be scheduled to discuss the findings and to determine the next steps. For each test, total dissolved gas will be measured with the same HydroLab miniSonde® instrumentation in the same location.

Modify the Spillway to Increase Turbulence and Reduce Spill Energy

Total Dissolved Gas is a well known issue when spill occurs at many hydroelectric and flood control dams. Much of the readily available research is for spillways with full stilling basins utilizing submerged tailwater. There are several possible physical changes that could be implemented at Merwin dam (Figure 5). Merwin dam has a straight drop end basin, similar to the action of a natural waterfall Figure 6). There are several notable studies on other nonfederal dams being conducted currently or recently completed (e.g. Boundary dam - WA, Lake Chelan - WA). Most proposed modifications involve adding some type of dissipater to the overfall area. These can take the form of a full width flip bucket (Figure 7), or flow splitters and diffuser blocks, etc. (Figure 8). Another possible modification includes roughening the surface of the spillway face or apron to induce turbulence into the flow (Figure 9). Spillway roughening could look similar to the current Yale Spillway. These options have been demonstrated to reduce gas entrainment by reducing the plunging effect of the overfall through redirection or energy dissipation and aeration of flow to reduce the efficiency of the air entrainment mechanism.

The study area is the Merwin powerhouse tailrace downstream to the USGS Ariel gage station (No. 14220500) approximately one-quarter mile downstream of the dam. Data collection is constrained by the occurrence of spills especially when spill gate protocol testing is in effect. Construction of the spillway roughness start-up is dependent on development of a physical model to test the hydraulics.

5.0 Measurement Procedures

For each action, a continuously recording Hydrolab MiniSonde® will be placed *in situ* in the deep part of the Lewis River channel adjacent to the Ariel gage. Prior to placement, each instrument will be calibrated according to manufacturer's recommendations (see next Section). The instrument will be placed 24-hours prior to an anticipated spill. Once spill has terminated, the Hydrolab Minisonde® will be removed 48-hours after termination of spill by a PacifiCorp Aquatic Scientist and downloaded. Preliminary results will be reported to Ecology as soon as practical. The instrument will be set to record every 15 minutes and be reported in 1-hour intervals along with river flow (cfs), temperature (°C), barometric pressure (mmHg) and total dissolved gas (% saturation).

Quality Control and Accuracy of Measuring Tools

Servicing of monitoring equipment will include the following:

- Inspection of probe body and sensor membrane
- Cleaning, inspection, greasing and replacement (if necessary) of all O-ring seals and electrical connections
- *In situ* checks of barometric pressure transducer, calibration if necessary.
- Replacement of TDG sensor membrane if erroneous data are observed or every 6 months.

Sensor membranes that exhibit erroneous data will be discarded. Membranes that are exchanged at the six month interval will be cleaned and redeployed in a subsequent servicing.

No calibration of the TDG probes will be performed. Rather, if erroneous data are identified as defined in this section, the membrane will simply be replaced. This eliminates field calibration error. If upon replacement of new sensor membrane erroneous data are still observed, the unit will be taken out of service and be repaired and certified by the manufacturer prior to redeployment.

6.0 Data Management Procedures

Data will be downloaded in the field to a Panasonic ToughBook® laptop. Upon returning to the office, a PacifiCorp Aquatic Scientist will transfer the data into an EXCEL® file on a desktop computer at the Merwin Hydro Control Center. Once data is validated, it will be shared with Ecology's Water Quality Inspector. All data, field notes, and analysis will be made available to Ecology upon request.

7.0 Audits and Reports

Other than data sharing that will occur during each test procedure, PacifiCorp staff will prepare an annual report on activities and findings to Ecology by mid-April of each year. The report will include:

- A map of the sampling locations;
- Discussion of the data analysis;
- A summary table of the data and any relevant field notes; and,
- Evaluation of the findings and recommendations for further action.

8.0 Data Verification and Validation

PacifiCorp staff will follow manufacturer recommendations for calibration of the field instruments. Calibration will occur each time an instrument is deployed for data collection. Prior to deployment and after instrument is downloaded, PacifiCorp staff will have a second instrument on site to validate the readings on the *in situ* instrument. All data and pertinent information will be stored electronically on a desktop computer with back-up on a portable flash drive.

9.0 Data Quality (Usability) Assessment

Table 5 lists the TDG instrumentation that will be used to measure total dissolved gas in the Lewis River at the Ariel gage. The instrumentation will be calibrated after each spill episode to insure the most accurate measurement.

Figures

Figure 1. Aerial photo of Merwin dam and spillway

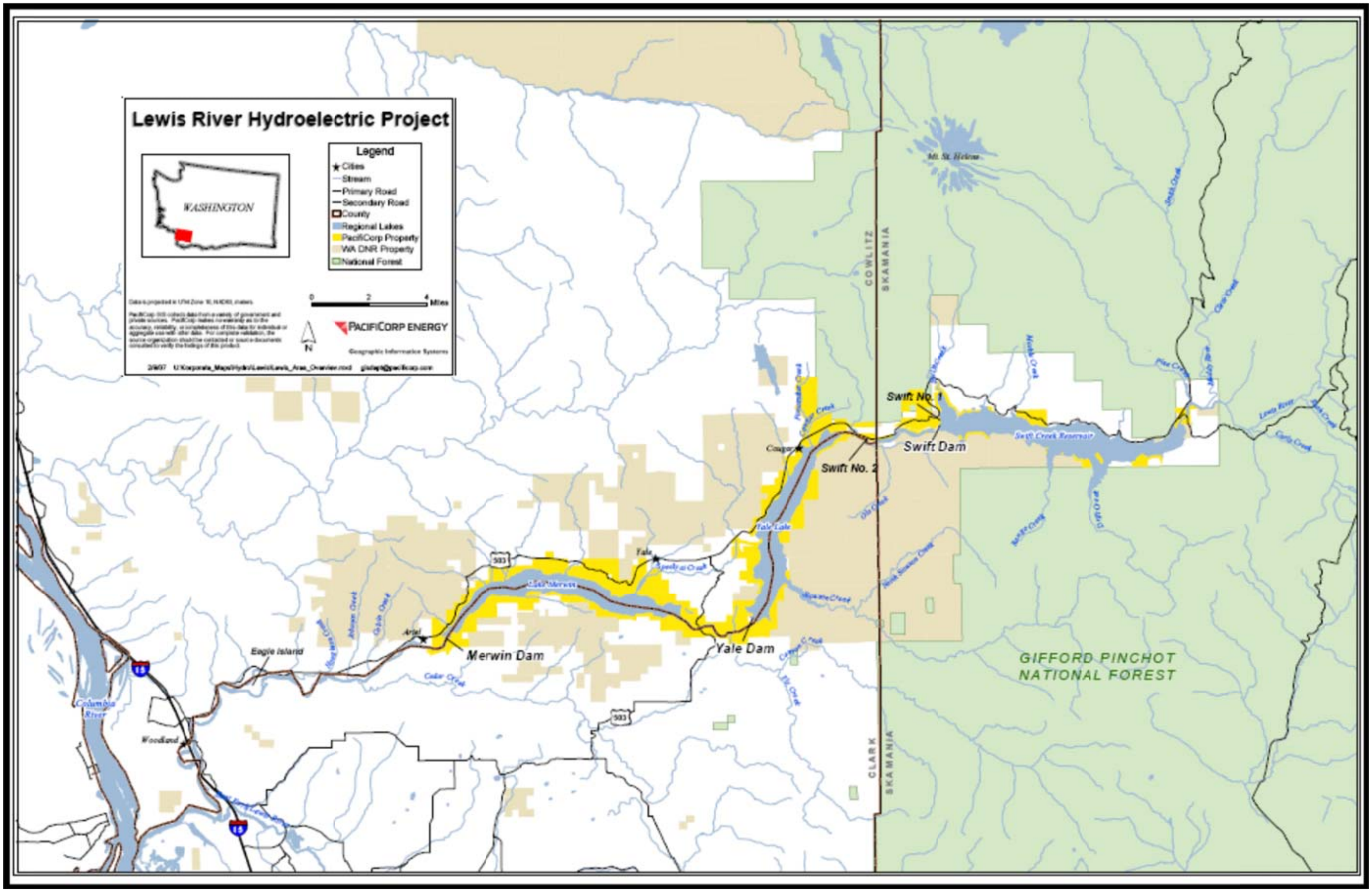


Figure 2. Area map of PacifiCorp's Lewis River hydroelectric project.

Figure 3. Merwin dam during spill with gates 2, 3 and 4 open (date unknown).

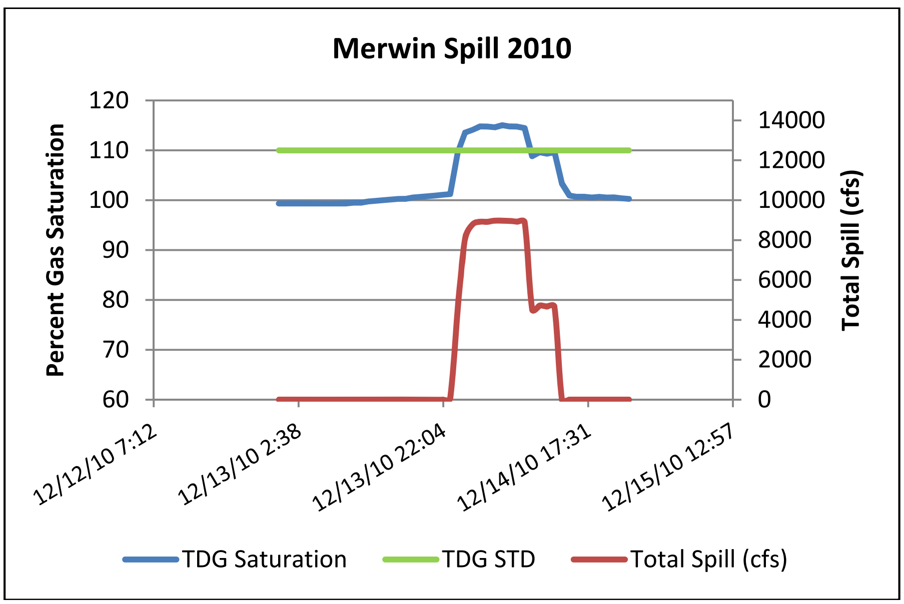


Figure 4. Hourly spill and TDG levels downstream of Merwin dam during the December 2010 high flow event.

The green line indicates the 110% TDG standard.

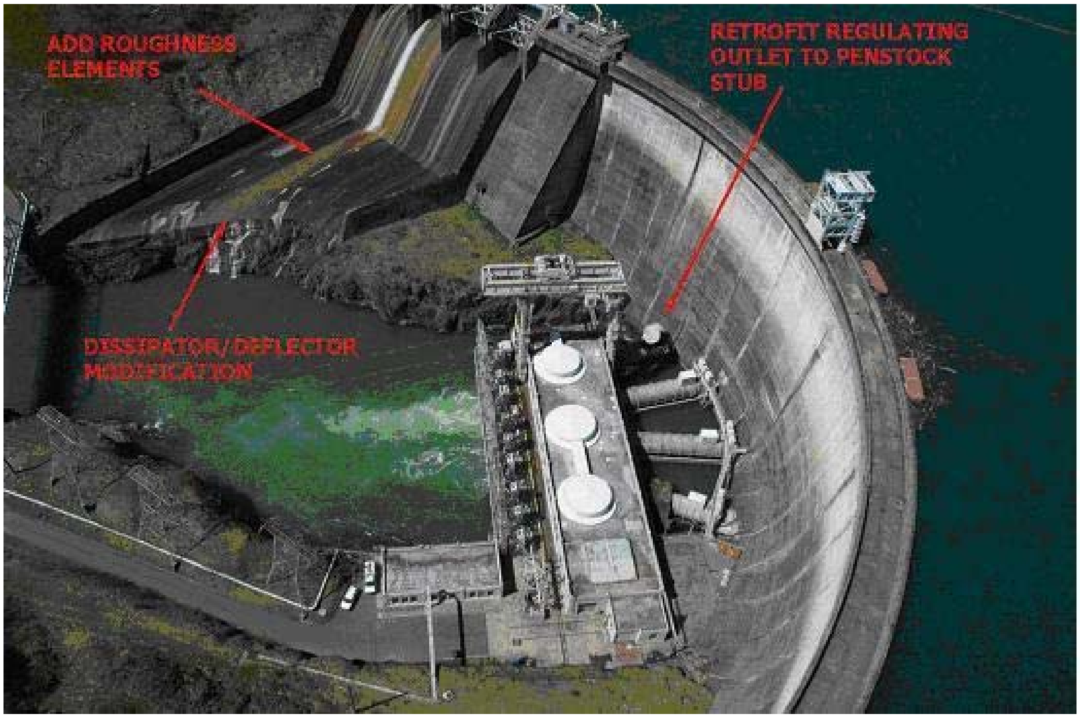


Figure 5. Approximate location of potential physical improvements to Merwin dam for TDG abatement.

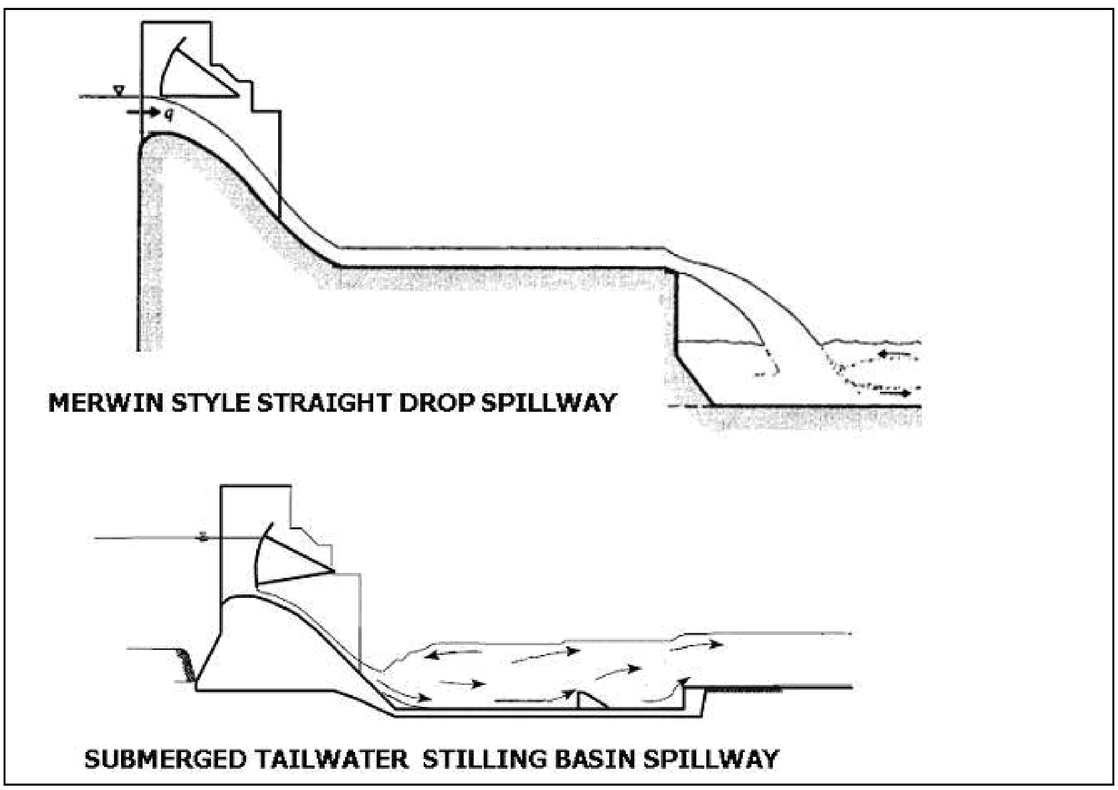


Figure 6. A generalized Merwin spillway configuration and a typical stilling basin spillway configuration.

Figure 7. Full flip lip bucket-type spillway.

Figure 8. Flow splitter/diffuser block type spillway.

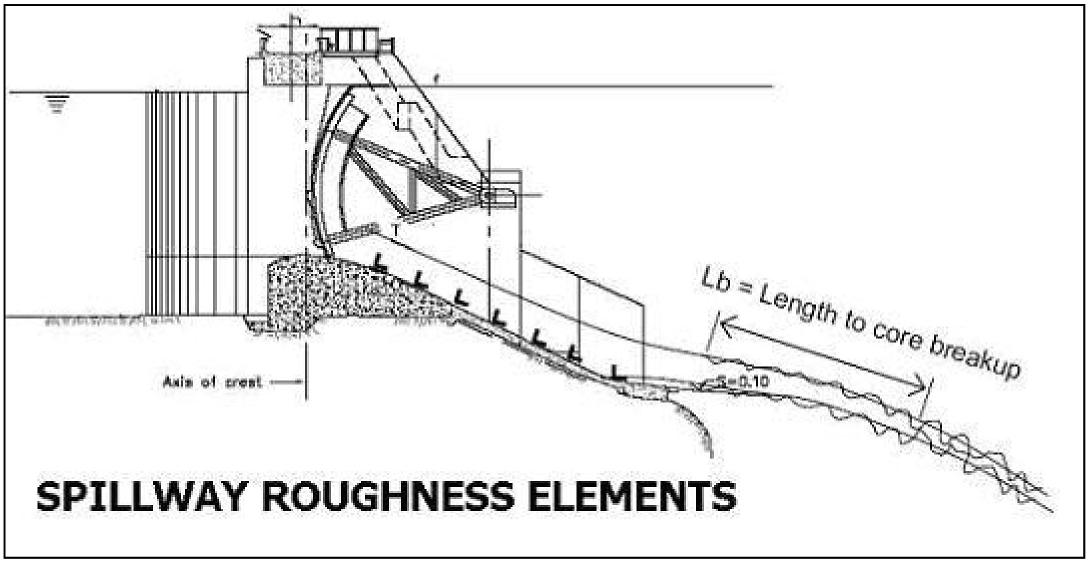


Figure 9. Example of a spillway roughness design.

Tables

Table 1. Summary statistics for the Merwin hydroelectric project. Source: PacifiCorp and Cowlitz PUD (2000).

Statistic	
In-Service Year	1932
Turbine Type	Vertical Francis
Full Pool Elevation (ft-msl)	239.6
Total Generation, mW (per unit)	135 (45)
Intake Depth* (ft-msl)	179.6
Intake Diameter (ft)	15.5
Dam Height (ft)	314
Net Head (ft)	181
Runner Elevation (bottom, ft-msl)	58
Tailwater Elevation (normal, ft-msl)	48

*Intake Depth is center line of intake opening at full pool

Table 2. Number and duration (total hours) of spills projected with the traditional forecasting method versus the 3-Tier Forecasting tool.

Forecast method	Inflow up to 11,300 cfs	11,300 cfs – 25,000 cfs	25,001 cfs – 32,000 cfs	32,001 cfs – 40,000 cfs	>40,000 cfs
Traditional	0 events	11 (456 hrs.)	5 (453 hrs.)	0 (0 hrs.)	5 (77 hrs.)
3-Tier	0 events	16 (609 hrs.)	9 (401 hrs.)	2 (36 hrs.)	3 (26 hrs.)

Table 3. Historic peak stream flows greater than 50,000 cfs as measured at Ariel Gage.

Date	Peak Flow (cfs)	Approximate Spill (cfs)
December 22, 1933	129,000	125,210
December 30, 1937	61,500	57,710
November 23, 1942	57,600	53,810
December 13, 1946	67,300	63,510
November 20, 1962	75,500	64,110
December 13, 1966	50,500	39,100
January , 5, 1974	59,600	48,200
December 4, 1975	64,500	53,100
December 2, 1977	71,900	60,500
December 26, 1980	53,700	42,300
February 8, 1996	86,400	75,000

Table 4. Merwin twelve highest consecutive hourly inflows and TDG for December 2010.

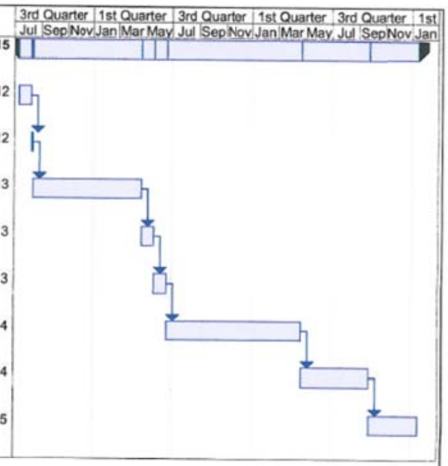
Date	Twelve Highest consecutive hourly TDG	Twelve Highest consecutive hourly natural inflow
12/11/2010	99%	13,498cfs
12/12/2010	99%	27,776cfs
12/13/2010	101%	31,977cfs
12/14/2010	113%	24,605cfs
12/15/2010	101%	20,327cfs
12/16/2010	101%	15,533cfs

Table 5. Instrumentation and precision levels used to measure TDG downstream of Merwin.

Parameter	Instrumentation	Precision Relative Standard Deviation (RSD)	Bias (deviation from true value)	Required Reporting Limits
Total Dissolved Gas (TDG	Hydrolab Mini DataSonde®	± 1.5 mmHg	NA	400-1400 mmHg

Table 6. Implementation schedule (as needed) for project improvements to reduce spill-related total dissolved gas at the Merwin and Swift hydroelectric projects.

ID	Task Name	Duration	Start	Finish
2	**Spillway Roughness**	**656 days**	**Thu 7/12/12**	**Thu 1/15/15**
3	RFP	21 days	Thu 7/12/12	Thu 8/9/12
4	Contract Tendered	2 days	Fri 8/10/12	Mon 8/13/12
5	Modeling Studies	180 days	Tue 8/14/12	Mon 4/22/13
6	Design RFP	21 days	Tue 4/23/13	Tue 5/21/13
7	Design Contract Tendered	21 days	Wed 5/22/13	Wed 6/19/13
8	Begin Design	220 days	Thu 6/20/13	Wed 4/23/14
9	Permitting	110 days	Thu 4/24/14	Wed 9/24/14
10	Construction	81 days	Thu 9/25/14	Thu 1/15/15



Project: ReleasePondProject Schedul
Date: Wed 6/8/11

Task | Progress | Milestone | Summary | Rolled Up Task | Rolled Up Milestone | Rolled Up Progress | Split | External Tasks | Project Summary | Group By Summary | Deadline

Page 1

Attachment F

Lewis River Water Quality Protection Plan

Lewis River Hydroelectric Projects

FERC Project No. 935, 2071, 2111, 2213

LEWIS RIVER WATER QUALITY PROTECTION PLAN

Prepared for the Washington Department of Ecology

PACIFICORP ENERGY
A DIVISION OF PACIFICORP

June 2013

Table of Contents

1.0 STORMWATER POLLUTION PREVENTION COMPLIANCE PLAN

Each of the Lewis River hydroelectric projects' 401 Water Quality Certifications calls for the preparation of a Water Quality Protection Plan (WQPP). Within the WQPP, the content must include a Construction Stormwater Pollution Prevention Plan and an Inwater Work Protection Plan. These two plans are included in the following subsections.

This section provides PacifiCorp Energy's stormwater management program for the Lewis River Hydroelectric Project area. The following provides a template for developing project specific Construction SWPPPs for projects that disturb one or more acres of land, as well as, stormwater management practices for existing facilities associated with the Lewis River Hydroelectric Project.

The following sections outline Construction SWPPP requirements, identify when PacifiCorp Energy will implement the Construction SWPPP and summarize the stormwater Best Management Practices (BMPs) for construction activities as well as the operation of existing facilities.

2.0 PROJECTS REQUIRING CONSTRUCTION SWPPP COVERAGE

PacifiCorp Energy will develop and implement a project-specific SWPPP for all projects requiring coverage under the WDOE Construction Stormwater General Permit. PacifiCorp Energy will request permit coverage for all construction projects expected to disturb one or more acres of land through clearing, grading, excavating, or fill-material stockpiling. It is anticipated that most projects, greater than one acre within the Project area, will have the potential for stormwater to run off the site during construction and into surface waters or conveyance systems, reaching surface waters regulated by the U.S Army Corps of Engineers (USACE) and the WDOE.

A Construction SWPPP will be developed for each applicable construction project. The SWPPP will describe the construction practices, stabilization techniques and structural BMPs that will be implemented during construction to prevent erosion and minimize sediment transport. The appropriate physical implementation elements provided in BMPs will be installed, inspected, maintained, and repaired as needed to assure continued design performance. The Construction SWPPP will also detail procedures for conducting and documenting site inspections.

The Construction SWPPP is considered a stand-alone document that will be located at the construction site and be readily accessible for construction or inspection personnel. Pertinent construction drawings will be kept on the construction site at all times. As site work progresses, the plan will be modified to reflect changing site conditions. Changes to the Construction SWPPP are subject to the rules for plan modification by the local permitting authority.

2.1 Project Filing Procedures

To obtain coverage under the WDOE Construction Stormwater General Permit, PacifiCorp Energy will submit a project-specific Notice of Intent (NOI) at least 60 days prior to the start of construction. A NOI form is available on WDOE's web site. Road maintenance and construction activities, including culvert maintenance, replacement or installation on existing roads conducted under the State Road Maintenance and Abandonment Plan (RMAP) or new road construction under a the Forest Practices Application are exempt from state and federal regulatory procedures other than Washington Forest Practices Act requirements. Therefore, a Construction SWPPP will not be developed for these projects. For clarification, PacifiCorp Energy is operating under the assumption that any culvert replacement project (RMAP required or not) that is initiated for the benefit of erosion-prevention/fish habitat improvement would be permitted the same way. This type of in-water work would be regulated under the Hydraulic Project Approval Permit process administered by Washington Department of Fish and Wildlife and would follow BMPs as stipulated for each individual project.

2.2 Construction SWPPP Outline

The Construction SWPPP will include two components; a Narrative (Section 4.1.3.1) and Construction Drawings (Section 4.1.3.2). A construction SWPPP checklist prepared by WDOE is presented in A-4.

2.2.1 Narrative Section

Project Description. Describe the nature and purpose of the construction project. Include: the total size of the area; any increase in existing impervious area; the total area to be disturbed by clearing; grading, excavation or other construction activities including off-site borrow and fill areas; and, grading cut and fill volumes.

Existing Site Conditions. Discuss pre-construction site conditions including existing topography, drainage, and vegetation. Include descriptions of any structures or development on the site including impervious surface areas.

Soil Characteristics. Document local soil properties such as surface and subsurface runoff characteristics, percent organic matter, effective depth, depth to impermeable layer, depth to seasonal groundwater table, permeability, shrink-swell potential, texture, settleability and erodibility. This information may be obtained either from published literature (Natural Resource Conservation Service (NRCS) soil surveys), or a qualified soil professional or engineer.

Critical Areas. Describe critical areas on or adjacent to the site. These areas may include steep slopes, streams, floodplains, lakes, wetlands, sole source aquifers, geologic hazard areas, etc. Identify any critical areas within and up to ¼ mile away from the site that receive runoff from the construction site. Discuss any special requirements for working in, or near, these areas.

Adjacent Areas. Describe areas adjacent to the site that might be affected by the construction project. These areas may include streams, lakes, wetlands, residential areas, and roads. Describe the drainage leading downstream from the site to the receiving body of water.

Precipitation Records. Determine the average monthly rainfall and rainfall intensity for the required design storm events. Utilize rainfall records to determine the method of analysis for a compatible BMP design.

Potential Erosion Problem Areas. Identify and describe areas that have potential erosion problems such as denuded or exposed soil, or steep slopes.

Twelve (12) Elements. Discuss how the Construction SWPPP addresses each of the 12 required elements (discussed further in Section 4.1.1.4.). Include the type and location of BMPs used to satisfy each element. If an element is not applicable to the project, provide justification for its exemption.

Construction Schedule and Phasing. Describe the sequence and timing of construction activities. Identify the construction schedule. If the schedule extends into the wet season describe what activities will continue and how the transport of sediment from the construction site to receiving waters will be prevented.

Financial/Ownership Responsibilities. Discuss ownership and obligations for the project. Include bond forms and other evidence of financial responsibility for environmental liabilities associated with construction activities.

Engineering Calculations. Attach any calculations performed for sediment ponds, diversions and waterway designs, as well as runoff and stormwater detention design (if applicable). Engineering calculations must bear the signature and stamp of an engineer licensed in the State of Washington.

Erosion Control Specialist. Identify a State of Washington Certified Erosion Control Specialist for the projects. Include their contact information.

2.2.2 Construction Drawings

The SWPPP drawings will identify and illustrate the project area and describe where and when BMPs will be installed, the expected BMP performance, and actions to be taken if the BMP performance goals are not attained. The drawings will include the following components:

Vicinity Map. Identify the location of the construction site, adjacent roads and receiving waters.

Site Map. Include a legal description of the property boundaries, or show property lines, including distances. Indicate north in relation to the site. Identify existing structures and/or roads, if present. Identify soil types, soil boundaries and erosion characteristics, drainages, ground cover, critical and adjacent areas. Include a contour interval of 1 to 5 feet depending upon the site slope.

Drainage/Conveyance Systems. Locate and mark existing drainage swales and patterns on the drawings. Show both temporary and permanent conveyance system structures.

Structural BMPs. Identify the locations of stormwater source control structures including ponds and infiltration systems. Identify all major structural BMPs for the control of erosion or other pollutants. This could include concrete wash-out areas, oil/water separators, biofilters and settling basins. Include the dimensions for each structure, material specifications, stabilization techniques, and all specific BMP sizing, spacing, or schematic drawings to describe proper installation.

Monitoring Locations. Identify water quality sampling locations (if required).

2.3 Key Elements and Recommended BMPs

As noted above, the narrative elements of the SWPPP include 12 key elements, as required by WDOE. Exemption of any element from the Construction SWPPP must be justified in the SWPPP narrative (e.g. based on unique site conditions).

A list of stormwater management BMPs that may be applicable to projects within the Lewis River Hydroelectric Project area are provided below. Not all of the BMPs may be required for every project. The BMP identification codes are referenced from the State of Washington Department of Ecology Stormwater Management Manual for Western Washington, Volumes II through IV (Stormwater Manual).

2.3.1 Element #1 – Preserve Vegetation and Mark Clearing Limits

Prior to beginning land disturbance activities, all clearing limits, sensitive areas and associated buffers, and vegetation to be preserved within the construction area will be clearly marked in the field and on the plan drawings. Plastic, metal or stake fence may be used to mark the clearing limits. Recommended BMPs include:

Preserving Natural Vegetation (C101);
Buffer zones (C102);
High visibility plastic or metal fence (C103); and
Stake and wire fence (C104).

2.3.2 Element #2 – Establish Construction Access

Access and exit for construction vehicles will be limited to one route, if possible. Two routes for linear projects such as roadways are allowed for ease in maneuvering large equipment. Access points should be stabilized to minimize tracking of sediment onto public roadways. Sediment tracked off-site onto a public roadway will be removed from the road surface by shoveling or pickup sweeping and transported to a controlled sediment disposal area. Street washing is allowed only after sediment is removed by sweeping. Recommended BMPs include:

Stabilized construction entrance (C105);
Wheel wash (C106); and
Construction road/parking area stabilization (C107).

2.3.3 Element #3 – Control Flow Rates

Properties and waterways downstream from construction sites will be protected from erosional sediment due to increases in volume, velocity, and peak flow rate of stormwater runoff.

Recommended BMPs include:

Sediment trap (C240); and
Temporary sediment pond (C241).

2.3.4 Element #4 – Install Sediment Controls

Stormwater will be passed through a sediment pond, trap, filter or other similar measure before it leaves the site or enters a drain inlet. Recommended BMPs include:

Straw bale barrier (C230);
Brush barrier (C231);
Gravel filter berm (C232);
Silt fence (C233);
Vegetation strip (C234);
Straw wattles (C235);
Sediment trap (C240);
Temporary sediment pond (C241);
Construction stormwater chemical treatment (C250); and
Construction stormwater filtration (C251).

2.3.5 Element #5 – Stabilize Soils

All exposed and undisturbed soil will be stabilized by BMPs from rain impact, flowing water, and wind. No soil will remain exposed and un-worked for more than two (2) days from October 1 through April 30. No soil will remain exposed and un-worked for more than seven (7) days from May 1 to September 30, including soils at final grade. Soil stockpiles must be stabilized from erosion and located away from storm drain inlets, waterways and drainage channels when possible. Recommended BMPs include:

Temporary and permanent seeding (C120);
Mulching (C121);
Nets and blanket (C122);
Plastic covering (C123);
Sodding (C124);
Topsoiling (C125);
Polyacrylamide for soil erosion protection (C126);
Surface roughening (C130);
Gradient terraces (C131);
Dust control (C140); and
Small project construction stormwater pollution prevention (C180).

2.3.6 Element #6 – Protect Slopes

Design and construct slopes to minimize erosion. Consider soil types and erosion potential. Recommended BMPs include:

Temporary and permanent seeding (C120),
Surface roughening (C130);
Gradient terraces (C131);
Interceptor dike and swale (C200);
Grass-lined channels (C201);
Pipe slope drains (C204);
Subsurface drains (C205);
Level spreader (C206);
Check dams (C207); and
Triangular silt dike (C208).

2.3.7 Element #7 – Protect Drain Inlets

Storm drain inlets installed during construction will be protected from runoff entering the conveyance system without filtering, or will be treated to remove sediment. Sediment and street wash will not enter storm drains of approach roads without adequate sediment treatment. Inlets should be inspected weekly and daily during storm events and cleaned or replaced when at 1/3rd of its available capacity. Recommended BMPs include:

Storm drain inlet protection (C220).

2.3.8 Element #8 – Stabilize Channels and Outlets

All temporary on-site conveyance channels will be designed, constructed and stabilized to prevent erosion from expected peak flows. Recommended BMPs include:

Channel lining (C202); and
Outlet protection (C209).

2.3.9 Element #9 – Control Pollutants

Prevent chemicals and other pollutants from impacting stormwater. This includes waste materials and demolition debris. Recommended BMPs include:

Concrete handling (C151); and
Saw-cutting and surface pollution prevention (C152).

2.3.10 Element #10 – Control De-Watering

Water derived from foundation, vault or trench de-watering activities will be discharged into a controlled conveyance system prior to discharge to a sediment trap or pond. Non-turbid de-watering water derived from well-point groundwater can be discharged to state surface and tributary waters provided the flow does not cause erosion or flooding of receiving waters. These clean waters will not be routed through stormwater sediment ponds.

2.3.11 Element #11 – Maintain BMPs

All temporary and permanent erosion and sediment control structures called-for in the BMPs will be maintained and repaired as needed for continued performance. Maintenance and repair will be conducted in accordance with BMP specifications. Temporary structures called-for in the BMPs will be removed within 30 days after final site stabilization or after the structure called-for in the BMPs is no longer required. Trapped sediment and disturbed soil resulting from the removal of the structure called-for in the BMPs will be either removed or permanently stabilized.

2.3.12 Element #12 – Manage the Project

Construction projects will be phased to prevent soil erosion and the transport of sediment from the site during construction activities. Other project management considerations include seasonal work limitations, coordination with utilities and other contractors, inspection monitoring, and maintaining and updating the construction SWPPP.

2.3.13 Element #13 – Terminating the Construction Stormwater Permit

PacifiCorp Energy will terminate the Construction Stormwater Permit at the completion of the project and after the construction site has undergone final stabilization. The most current Notice of Termination (NOT) form will be downloaded from the WDOE website.

3.0 STORMWATER MANAGEMENT AT EXISTING FACILITIES

PacifiCorp Energy's existing facilities on the Lewis River include three hydropower dams, three fish hatcheries, and numerous day-use areas, boat ramps, and campgrounds. Stormwater management at these facilities was reviewed and evaluated from the standpoint of requirements of the Stormwater Manual. The following sections document present site conditions, site-specific pollutant source areas and potential pollutants, and evaluation of existing BMPs at each facility in the Lewis River Hydroelectric Project area. In addition to PacifiCorp Energy's facilities, PacifiCorp Energy will be the applicant for construction permits on the Washington State-owned Lewis River Hatchery. PacifiCorp Energy will be responsible for implementing and maintaining BMPs during construction.

3.1 Merwin Dam Complex

The Merwin Dam Complex consists of an office building, a fleet vehicle maintenance yard, the Merwin Fish Hatchery, and a day-use park. Stormwater may come into contact with the Merwin dam's powerhouse building, electrical transformers and equipment, fish trap, and the surrounding paved access and parking areas. In general, the housekeeping practices across the site, pollution prevention procedures and facility design are sufficient to minimize likelihood of stormwater quality impacts.

Drainage from the roof drains, downspouts, the dam deck and surface drainage from the spillway structure and paved areas discharges to the river. Stormwater accumulating around the powerhouse, intake substation, and emergency generator buildings is directed into drains that discharge into the Lewis River. The roof drains discharge into the tailrace through the main powerhouse drain pipe. There are no stormwater controls on top of the dam; all drainage flows down the concrete face of the structure to the river.

Environmental procedures minimize likelihood of stormwater impacts from normal operating practices. The facility has a current spill prevention, control and countermeasure plan (SPCC). The procedures and practices incorporated into the plan are consistent with BMPs for *Spills of Oil and Hazardous Substances* listed within the Stormwater Manual. Herbicide is applied to control knotweed and scotch broom in grassy areas above the dam. All application is done in accordance with herbicide label requirements. These practices are consistent with the BMPs listed in the Manual for *Landscaping, Lawn and Vegetation Management*.

A bridge spanning the Lewis River connects the powerhouse and dam area to the maintenance yard. Stormwater from the bridge discharges directly to the Lewis River. Stormwater from the paved road servicing the dam drains to natural vegetated areas and infiltrates to the soil. At the time this report was prepared, the bridge was observed with peeling paint, which has been identified by PacifiCorp Energy as containing lead. PacifiCorp Energy has plans to remove the lead-based paint and re-paint the bridge in calendar year 2009. The waste material from the project will be contained and properly disposed.

The Merwin maintenance facility includes a fabrication shop, a 7-bay vehicle and material storage building, a waste management building, a 6-bay vehicle and equipment parking structure, a vehicle and equipment re-fueling area, and a vehicle wash bay. Stormwater has potential to come into contact with materials stored outside such as steel pipe and sheet metal, masonry brick and heavy equipment.

The areas surrounding the buildings are primarily paved, with areas of lawn, gravel, and natural vegetation located behind the buildings and along the roadways. Stormwater runoff from the roof drains and downspouts is discharged directly to the surface soils for infiltration in these naturally vegetated areas. The paved area is sloped to the south toward the naturally vegetated area between the maintenance area and the Lewis River. Stormwater sheet flow from the paved area drains and infiltrates into the natural area. It is unlikely that the sheet flow from the asphalt would reach or enter the river.

Floor drains in the fabrication and vehicle storage buildings have been capped to prevent spills or releases inside the buildings from entering the stormwater system.

The refueling area includes one diesel and one gasoline underground storage tank. The fueling area is covered to prevent direct contact with precipitation. The fueling area is located on a slight slope that would direct releases of petroleum hydrocarbons down-gradient to the natural area between the maintenance area and the river. The facility has a current SPCC plan that identifies procedures and controls to prevent discharges of petroleum during transfer and fueling operations. Stormwater management practices are generally consistent with the BMP for *Fueling at Dedicated Stations* presented in the Manual.

The vehicle wash area is used infrequently to clean PacifiCorp Energy fleet vehicles. It is not used for degreasing or cleaning equipment. The wash station is comprised of a sloped and curbed concrete area large enough to catch spray and runoff from washing activities. A grit separator has been installed to receive washwater, and allows for the settlement of larger particles carried by the wash water. A subsurface vault with a 3-baffle separator receives the water from the grit separator, allowing for further settlement of suspended solids, and oil/water separation. Water is either retained within the vault or allowed to discharge to the surface soil of the natural area that separates the developed portion of the site from the river.

Best Management Practices (BMPs) for *Washing and Steam Cleaning Vehicles/Equipment/Building Structures* allows for washwater to be discharged to the ground after proper treatment in accordance with *Ecology guidance WQ-95-056, "Vehicle and Equipment Washwater Discharges," June 1995.* Discharge to ground is allowed provided the effluent will not cause violation of the Washington State groundwater quality standards. The system is considered adequate based on its current use.

WDOE, in its administrative code BMPs, recommends that the system design include a control valve on the discharge from the system to isolate spills or releases and prevent discharge. The system at the Merwin site does not have a control valve. PacifiCorp Energy will install a control valve on the discharge from the grit separator at the Merwin vehicle wash area.

3.2 Yale Dam

Yale is a large earthfill dam. Stormwater at the Yale Dam area may come into contact with the powerhouse building, electrical transformers and equipment, and a paved access road and parking areas. Stormwater drainage from the dam, intake structures and powerhouse is discharged directly into either the intake or the reservoir. Site drainage surrounding the spillway structure is also discharged either onto the spillway or into the reservoir. Floor drains located in the back-up generator building on Yale Dam at the spillway structure discharge directly onto the surrounding riprap. Discharge from these drains infiltrates into the ground or leaches into the Lewis River. Stormwater drainage from the transformer deck is directed into a buried oil-water separator. Discharge from the oil-water separator exits through an oil stop-valve and into the tailrace.

PacifiCorp Energy maintains a current SPCC plan that identifies procedures and controls to prevent discharges of petroleum products from the site (Attached in back page sleeve). Based on the age of the facility, lead-based paint covered with new lead free paint could be present on the powerhouse building. Any future painting activities that include scraping will require sampling for lead and the proper removal and disposal of the paint chip material. Any lead paint waste will be contained and properly managed.

3.3 Swift Dam

Swift Dam is a large earthen dam. Stormwater at the dam may come into contact with the powerhouse building, concrete-pad mounted electrical transformers, and paved access and parking areas. The dam is approximately 1-mile from the highway and is accessed via a paved road. Stormwater runoff from this access road is discharged to grass-covered canal banks and natural vegetation areas.

Site drainage and surface runoff from the dam, spillway structure and intake structure is discharged directly into the Swift Reservoir, or the Lewis River. Stormwater drainage from roof drains is collected and diverted around the powerhouse to the tailrace. Stormwater from the concrete transformer deck, which overhangs the tailrace, is directed by curbing to drains and piped via gravity to a buried oil/water separator equipped with an oil stop-valve prior to discharge to the tailrace. Groundwater is diverted around the north side of the dam and discharged into the tailrace. PacifiCorp Energy maintains a current SPCC plan that identifies procedures and controls to prevent discharges of petroleum products from the site.

3.4 Merwin Fish Hatchery

The Merwin Fish Hatchery was built in 1993 and is comprised of a large multi-use building that includes four employee residences, an office, a 2-bay vehicle and equipment storage garage, a laboratory and egg incubation room. The hatchery also includes numerous rearing ponds, raceways and holding ponds. A 3-bay garage and surrounding gravel parking and equipment storage area is located to the southeast of the main hatchery operation. Stormwater from the roof drains of the 3-bay garage infiltrates into the soil surrounding the structure.

The main hatchery area is paved. Stormwater runoff is collected in drains around the facility and piped to an outfall located southeast of the facility near the 3-bay garage. The outfall discharges into a natural area and a creek that eventually drains to the Lewis River. Seepage from beneath the raceways, rearing ponds, and holding ponds is also collected in these pipes and is discharged through the outfall. Effluent from the fish hatchery flows into a two-pond series detention facility and this effluent is piped to the fish trap at the base of Merwin dam and is covered under the existing NPDES permit.

Hatchery activities with potential for impacts to stormwater include the use of chemicals for controlling water quality in the raceways. Bulk chemical containers are stored in secondary containment. An above-ground storage tank (AST) containing gasoline fuel for vehicles is located on the north side of the site. This tank is a dual-walled concrete tank. BMPs are consistent with the *Storage of Liquid, Food Waste, or Dangerous Containers* recommendations.

3.5 Speelyai Fish Hatchery

The Speelyai Fish Hatchery is comprised of a multi-use building that includes the hatchery office, a laboratory and egg incubation room, and numerous rearing ponds, raceways and holding ponds. Three employee houses, a small chemical storage building, and a shop are located on the northern portion of the site. The entire site is paved and stormwater runoff flows via inlet drains and/or sheet flows toward the reservoir where it is discharged. An existing NPDES permit addresses the effluent from the fish hatchery that enters a detention pond and outfalls to the Merwin reservoir. Stormwater is not incorporated in the NPDES permit.

A newly constructed hazardous materials storage building houses the chemicals used on-site which include iodine and formaldehyde. When adult salmon are present, iodine is slowly released into the holding ponds from a 55-gallon drum stored next to the rearing pond in a secondary containment structure. Bulk chemical containers are stored in secondary containment. An AST containing gasoline fuel for vehicles is located on the north side of the site. This tank is a dual-walled concrete tank. These practices are consistent with the BMPs for *Storage of Liquid, Food Waste, or Dangerous Waste Containers* presented in the Manual.

3.6 Lewis River Fish Hatchery

The Lewis River Hatchery is owned and operated by the State of Washington for the benefit of the Lewis River Hydroelectric Project mitigation. The hatchery is comprised of a multi-use building that includes the hatchery office, a laboratory and egg incubation room, an adult collection ladder and holding pond with spawning area, and numerous rearing ponds, raceways and holding ponds. Four employee houses, a drive-in freezer, 3-bay garage, and a shop are also located on the site. The entire site is paved and stormwater runoff flows via inlet drains and/or sheet flows toward into the Lewis River. An existing NPDES permit addresses the effluent from the fish hatchery that is pumped to a detention pond on the hill above the hatchery and outfalls to the Lewis River. Stormwater is not incorporated in the NPDES permit. There are three dual-walled concrete ASTs on the site used to store fuel for hatchery vehicles and emergency back-up generators for the pumping stations.

3.7 Public Recreation Facilities

3.7.1 <u>Overnight Campgrounds</u>

Several overnight and extended stay campgrounds are connected with the day-use areas and boat ramps. These areas include the Cresap Bay, Cougar, Beaver Bay, and Swift Forest campgrounds. In general, these campgrounds are set back from the water's edge and include natural vegetation, asphalt-paved roads, parking areas, and designated campsites. Covered domestic trash dumpsters, washout water and sink disposal areas are provided. Recreational vehicle (RV) waste disposal dump stations are provided at Beaver Bay, and Swift Forest Campgrounds and the Yale Park Day-use area. These dump stations are not located near the water and it is unlikely that stormwater impacts them. The waste disposal areas are comprised of natural vegetation and contain only small areas of impervious surfaces, which is consistent with the BMP recommendations listed in the Manual for Landscaping, Lawn and Vegetation Management.

3.7.2 <u>Day-Use Areas</u>

Several day-use areas including Merwin Park, Cresap Bay Park, Saddle Dam Park, Yale Park, Cougar Park, Beaver Bay Park, Speelyai Park, and Swift Forest Camp Park provide areas for picnicking along the reservoir shoreline. These areas are well maintained and are typically level, covered in grass and have pavement, grass or gravel parking areas. Pesticides and fertilizers are not used on the grass. Covered picnic areas drain stormwater to the soil. Paved areas are not typically near the waters edge, limiting sediment from reaching the reservoirs. Drains are not used in these areas and dumpsters are covered to limit the mixing of solid waste and stormwater. These day-use areas include natural vegetation and contain limited impervious surfaces. The design of the facilities and practices are consistent with the BMPs recommendations listed in the Manual for *Landscaping, Lawn and Vegetation Management*.

Unlike the other day-use areas, the Cresap Bay Park has a paved parking area with stormwater drains. In the paved area, two drains convey stormwater to the reservoir from dropped inlets which allowed for sediments to settle out of suspension. The presence of dropped inlets combined with good housekeeping of the parking area is consistent with good environmental practices and it is unlikely that an increased amount of sediment is reaching the river from this area.

3.7.3 Boat Ramps

Boat ramps are provided along the Lewis River at nearly all of the PacifiCorp Energy facilities including the Merwin Fishing Access boat ramp, Cresap Bay Park, Speelyai Park, Saddle Dam Park, Yale Park, Cougar Campground, Beaver Bay Campground, and Swift Forest Campground. In addition the Lower Lewis River Fishing access sites (Island Boat ramp, Cedar Creek boat ramp, and Lewis River Fish Hatchery boat ramps) are owned by the State of Washington and maintained by PacifiCorp Energy. The ramps are primarily concrete construction, which greatly reduces shoreline erosion and the potential introduction of suspended sediments. Posted signs prohibit gasoline refueling activities on the ramp or near the water's edge. This practice helps control the possible migration of hazardous materials from combining with stormwater and reaching the river.

Lower Lewis River fishing access sites are equipped with accessible vault toilets. Single-vault toilets have been installed at Johnson Creek and Merwin Hatchery River Access Sites. They are Americans with Disabilities Act (ADA) accessible with a footprint of 8 feet by 15 feet. Each unit has a 1,000 gallon tank which can accommodate up to 15,000 uses. A double vault toilet has been installed at Island River Access Site. It is ADA accessible and has an 11 feet by 16 feet footprint. It has two 1,000 gallon tanks which collectively can accommodate up to 30,000 uses. PacifiCorp contracts have the vaults pumped at least once a year or more depending on use. A double-vault will also be installed at Lewis River Hatchery Access Site.

Parking areas are level and commonly covered in asphalt pavement, grass or gravel to limit runoff to the river. In the areas where the parking areas are paved there are no drains, and sheet flows convey stormwater to grass covered areas for infiltration. Covered dumpsters in the boat ramp and day-use areas are designed to prevent stormwater from mixing with solid wastes.

The Island Ramp, Lewis River Hatchery boat ramp and the Cedar Creek boat ramp day-use areas consists of gravel parking areas and concrete boat ramps. The Merwin Fishing Access boat ramp has a paved approach with a gravel launch area and a gravel parking area. There are no BMPs in the Manual that directly address gravel boat ramps and there was no evidence of erosion. Observation will occur during future storm events to evaluate if sediment is transported by stormwater from the parking area or ramp to the river.

3.8 Other Areas

3.8.1 Swift Warehouse

The Swift Warehouse is located downstream of the Swift No. 1 Dam Area and is accessed by a gravel road. The area is used for the storage of wood, miscellaneous items, and snow removal equipment. The 4-bay garage building is located approximately 650 feet north of the Swift canal and all stormwater from roof drains infiltrate to the surface soil. The area consists of natural vegetation and contains limited impervious surfaces. The area is sprayed with herbicides as necessary to treat invasive plant species using backpack-applied foliar treatments. Herbicide applications follow the PacifiCorp Energy invasive species management plan included in the Wildlife Habitat Management Plan. These maintenance areas are occasionally treated with pre-emergent herbicides to maintain a weed-free gravel area around the warehouse. The practices at the Swift Warehouse are consistent with the BMPs identified in the Manual for *Landscaping, Lawn and Vegetation Management*.

3.8.2 Yale Warehouse

The Yale Warehouse is located southwest of the Yale Dam, accessed by a secondary gravel road leaving from the main Yale Dam road. The area is used for the storage of wood, miscellaneous items, and equipment. A warehouse building, several connex boxes, and a refueling area are present at this site. All stormwater from roof drains infiltrates to the surface soil. The refueling area includes one gasoline underground storage tank. The fueling area is covered to prevent direct contact with precipitation. The area consists of natural vegetation and contains limited impervious surfaces. The area is sprayed with herbicides as necessary to treat invasive plant species using backpack-applied foliar treatments. Herbicide applications follow the PacifiCorp Energy invasive species management plan included in the Wildlife Habitat Management Plan. These maintenance areas are occasionally treated with pre-emergent herbicides to maintain a weed free gravel area around the warehouse. The practices at the Yale Warehouse are consistent with the BMPs identified in the Manual for *Landscaping, Lawn and Vegetation Management*.

3.8.2 Swift Forest Campground Wood Collection Area

PacifiCorp Energy has a Hydraulic Project Approval (HPA) Permit (# 00000G 3203-2) from the State of Washington to allow for the removal of wood debris from the reservoirs. The majority of wood debris removal is conducted at Swift Reservoir but can occur at all three reservoirs. Debris removal practices currently being utilized involve the collection of floating woody debris within booms and removal of the debris to haul-out areas. Wood and other woody debris is removed from the water with a grapple-type head on an excavator or crane equipped with a clam-shell bucket. Collected logs are either incorporated in fish and wildlife habitat restoration projects or sold if all habitat project needs have been met. Unused smaller logs and small woody debris are disposed of annually either by burning or chipping for commercial fuel.

A large pile of annually removed wood debris is located near the boat ramp within the Swift Forest Campground on the reservoir's edge. An approximately ½ acre area is fenced off from public access to allow for temporary log storage and provide a contained working area for log removal.

All woody debris removal and collection follows the requirements of the existing HPA for this work. Contract specifications require the contractor completing the work to keep equipment in good working order and free of oil leaks. Steel drums containing spill clean-up equipment (absorbent pads, booms, etc.) are kept onsite during wood removal operations.

4.0 IN-WATER WORK PROTECTION PLAN

In compliance with requirements of Section 4.5(2)(b) of the Section 401 Water Quality Certifications for the Lewis River Projects, PacifiCorp Energy will prepare a project-specific In-Water Work Protection Plan (IWWPP) for all in-water construction actions. The purpose of the IWWPP is to provide a summary of Best Management Practices (BMPs) and control measures for in-water work activities associated with yet-to-be constructed projects. In addition, the

IWWPP addresses regulatory terms and conditions regarding in-water work for activities stipulated in the Federal Energy Regulatory Commission licenses for the Lewis River Hydroelectric Projects.

The following IWWPP template has been developed to provide a framework for the future development of project-specific IWWPPs. Project-specific IWWPPs will be prepared and submitted to Ecology for review and approval prior to all permitted in-water work activities.

4.1 Types of Projects Requiring In-Water Work

Operation of the Lewis River Hydroelectric Projects and associated infrastructure and facilities results in a variety of different projects that require in-water work. These projects could occur in the Lewis River or its tributaries, or in project reservoirs (Merwin, Swift No. 1, and Yale). Examples of major projects requiring in-water work and implementation of an IWWPP include repairs or modifications to major fish enhancement structures such as the Merwin Dam Fish Trap and the Swift Dam Juvenile Fish Collection System, as well as work required to repair and maintain dam forebays, and spillways, and recreational facilities, such as boat ramps. In short, any construction or maintenance activity requiring work below full pool elevation of project reservoirs, or below the ordinary high water line (OHWL) of any regulated waterway requires the development of an IWWPP[1].

[1] Debris cleanup below the OHWL of project reservoirs is covered under PacifiCorp Energy's blanket HPA and would not in itself require an IWWPP.

Attachment G
In-Water Work Protection Plan
(Routine Maintenance and Small Projects)

Lewis River Hydroelectric Projects

FERC Project No. 935, 2071, 2111, 2213

LEWIS RIVER IN-WATER WORK PROTECTION PLAN

Routine Maintenance and Small Projects

PACIFICORP ENERGY
A DIVISION OF PACIFICORP

July 2013

Table of Contents

1.0 INTRODUCTION

In compliance with requirements of Section 4.5(2)(b) of the Section 401 Water Quality Certifications for the Lewis River Projects, PacifiCorp Energy will prepare a project-specific In-Water Work Protection Plan (IWWPP) for all in-water construction actions. The purpose of the IWWPP is to provide a summary of Best Management Practices (BMPs) and control measures for in-water work activities associated with yet-to-be constructed projects. In addition, the IWWPP addresses regulatory terms and conditions regarding in-water work for activities stipulated in the Federal Energy Regulatory Commission licenses for the Lewis River Hydroelectric Projects.

The following IWWPP template has been developed to provide a framework for the future development of project-specific IWWPPs. Project-specific IWWPPs will be prepared and submitted to Ecology for review and approval prior to all permitted in-water work activities.

1.1 Project Description

The purpose of this In-Water Work Protection Plan (IWWPP) is to address the requirements of Section 4.5.2(b) of the Section 401 Water Quality Certification/Orders issued by the Washington Department of Ecology (WDOE) for the Federal Energy Regulatory Commission (FERC) relicensing of the Merwin Hydroelectric Project (FERC No. 935), Yale Hydroelectric Project (FERC No. 2071) and Swift No. 1 Hydroelectric Project (FERC No. 2111).

This IWWPP addresses regulatory terms and conditions and outlines the management measures for the protection of water resources during in-water work activities. This IWWPP covers routine maintenance and small project activities that involve in-water work within the FERC project boundaries of the Lewis River hydroelectric projects.

The responsible party for this project is:

PacifiCorp Energy (owner)
825 NE Multnomah Street, Suite 1500
Portland Oregon 97232

Project Manager: PacifiCorp Engineering
Phone: TBD by assignment

Compliance Lead: Briana Weatherly
Phone: (503) 813-7039
Briana.weatherly@pacificorp.com

1.2 Species Present

Federally threatened listed species that are present in the Lewis River include:

- Bull trout (*Salvelinus confluentus*)

- Chinook (*Oncorhynchus tshawytscha)*
- Coho (*O. kisutch)*
- Steelhead trout *(O. mykiss)*
- Chum (*O. keta*)

Non-listed fish species that are present in the Lewis River include:

- Cutthroat trout (*Oncorhynchus clarki*)
- Kokanee (*Oncorhynchus nerka*)
- Rainbow trout (*Oncorhynchus mykiss*)
- Mountain whitefish (*Prosopium williamsoni*)
- Largescale sucker (*Catostomus macrocheilus*)
- Other resident fish

2.0 IN-WATER WORK

2.1 Best Management Practices (BMPs)

In an effort to minimize and/or eliminate adverse impacts on water quality and aquatic habitat, Best Management Practices (BMPs) implemented during in-water work activities will include:

- ***Timing of In-Water Work***: Work below the bankfull elevation (ordinary high water mark [OHWM]) will be conducted during:
  - The in-water work window of **July 16 – August 15** for the North Fork of the Lewis River (WRIA 27.0334)–Merwin Dam to lower falls and all tributaries as specified by the Washington Department of Fish and Wildlife (WDFW) (Gold and Fish Rule, April 2, 2009); or
  - As specified in a Hydraulic Project Approval (HPA) issued by the WDFW.
- ***Cessation of Work***: Construction project activities will cease under high flow/flood conditions. All materials, equipment, and fuel must be removed if flooding of the area is expected to occur within 24 hours.
- ***Fish Screens***: All water intakes used for a construction project, including pumps used to isolate an in-water work area, will have a fish screen installed, operated, and maintained according to National Marine Fisheries Service (NMFS) fish screen criteria.
- ***Fish Passage***:

  Fish passage is not associated with this project.

  OR

  Passage must be provided for any adult or juvenile salmonid species present in the Project area during construction, unless otherwise approved in writing by NMFS, and maintained after construction for the life of the Project. Passage will be designed in accordance with NMFS' "Anadromous Salmonid Passage Facility Guidelines and Criteria" (finalized in 2008). Upstream passage is required during construction if it previously existed.

- **Capture and Release**.

  Fish Capture and Release is not associated with this project.

  OR

  Before and intermittently during pumping to isolate an in-water work area, attempt to capture and release fish from the isolated area using trapping, seining, electrofishing, or other methods as are prudent to minimize risk of injury. The entire capture and release operation will be conducted or supervised by a fishery biologist experienced with work area isolation and competent to ensure the safe handling of all Endangered Species Act (ESA) listed fish. The work will comply with the requirements in the National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS) biological opinions and PacifiCorp's State Scientific Collection Permit issued by WDFW.

- **Invasive Species Protections:** Measures will be performed to prevent introduction of invasive species in accordance with regulations governing aquatic invasive species as described in Appendix 1.

- ***Existing Permits***: Activities associated with habitat enhancement and erosion control measures must meet or exceed BMPs and other performance standards contained in the applicable state and federal permits for this project.

- ***Erosion and Sediment Control:*** If ground disturbing activities impact one acre or greater, a Construction Stormwater General National Pollutant Discharge Elimination System (NPDES) Permit will be obtained from the WDOE and a Stormwater Pollution Prevention Plan (SWPPP) will be prepared.

  Appropriate BMPs to prevent erosion and sedimentation, and identify, reduce, eliminate or prevent stormwater contamination and water pollution from construction activity will be implemented. The Stormwater Management Manual for Western Washington (Manual), Volume 1-V (WDOE 2005) can be referenced for applicable BMPs. The following recommended Source Control BMPs can be referenced in detail in Volume II of the Manual (WDOE 2005).

  - Preserve natural vegetation (BMP C101)
  - Establish one stabilized construction entrance and exit (BMP C105)
  - Install appropriate sediment controls (e.g. Straw bale barriers (BMP C230) and Silt filter fences (BMP C233))
  - Stabilize disturbed soils and protect slopes (e.g. Temporary and permanent seeding (BMP C120), Dust control (BMP C140), Straw bale barriers (BMP C230) or Silt filter fences (BMP C233)
  - Control pollutants (e.g. Concrete handling (BMP C151) and spill prevention)
  - Control dewatering activities

  - Maintain BMPs throughout the project

- ***Work Practices:*** During construction, all necessary measures shall be taken to minimize the disturbance of waters of the state and existing riparian or wetland vegetation.
  - All construction debris shall be properly disposed of on land so that the debris cannot enter the waterway or cause quality degradation of state waters. Retention areas, swales or impoundments will be used to prevent discharge of water from construction staging areas.
  - In the event of a discharge of oil, fuel or chemicals into state waters or onto land with a potential for entry into state waters, immediately begin and complete containment and clean-up efforts, taking precedence over normal work. **Immediately notify the National Response Center at (800) 424-8802 and the State of Washington at (800) 258-5990.** Clean-up shall include proper disposal of any spilled material and used clean-up materials.
  - Do not use emulsifiers or dispersants in water of the state without prior approval from the WDOE Southwest Regional office.
  - PacifiCorp shall ensure that any fill materials that are placed for the proposed habitat improvements in any water of the state do not contain toxic materials in toxic amounts.
  - All vehicles on site will be monitored for leaks and receive regular preventive maintenance to reduce the chance of leakage.
  - Petroleum products will be stored in tightly sealed containers which are clearly labeled.
  - Materials and equipment necessary for spill cleanup will be kept on site and readily available.
  - Concrete trucks will not be allowed to wash out or discharge surplus concrete or drum wash water on the site.

3.0 MONITORING

Site monitoring of BMPs will be conducted by the onsite construction crew or PacifiCorp employees. One individual from the construction crew will be assigned to ensure that proper BMPs are implemented on site and that if site circumstances or characteristics change; BMPs will be changed to meet the needs of the site activities. This individual will also be responsible for maintaining site BMPs and to ensure their effectiveness.

Per the Clean Water Act Section 401 Certifications/Orders issued for the Swift No. 1, Yale, and Merwin projects, the water quality parameters requiring monitoring during in-water work are turbidity and dissolved oxygen. As specified in the Certification/Orders, dissolved oxygen and turbidity monitoring will occur at least once each day during construction in or adjacent to any water bodies within the project area that may be affected by construction. Water quality compliance points will be determined based on the following parameters:

- For waters up to 10 cubic feet per second (cfs) flow at the time of construction, the point of compliance shall be 100 feet downstream from the activity that may cause a turbidity exceedance.
- For water above 10 cfs to 100 cfs flow at the time of construction, the point of compliance shall be 200 feet downstream from the activity that may cause a turbidity exceedance.
- For waters above 100 cfs flow at the time of construction, the point of compliance shall be 300 feet downstream from the activity that may cause a turbidity exceedence.

The following state water quality standards apply to all in-water work activities:

Use Category	**Turbidity – Percent Saturation** (WAC 173-201A-200(e))	**Dissolved Oxygen (DO) – Lowest 1-Day Minimum** (WAC 173-201A-200(d))
Char Spawning and rearing	Turbidity shall not exceed: • 5 nephelometric turbidity units (NTU) over background when the background is 50 NTU or less; or • A 10 percent increase in turbidity when the background turbidity is more than 50 NTU.	DO concentrations must equal or exceed 9.5 mg/L.
Core Summer Salmonid Habitat	Same as above.	DO concentrations must equal or exceed 9.5 mg/L.
Salmonid Spawning, Rearing and Migration	Same as above.	DO concentrations must equal or exceed 8.0 mg/L.
Salmonid Rearing and Migration ONLY	Turbidity shall not exceed: • 10 NTU over background when the background is 50 NTU or less; or • A 20 percent increase in turbidity when the background turbidity is more than 50 NTU.	DO concentrations must equal or exceed 6.5 mg/L.

3.1 Quality Control and Accuracy

The extent of QA/QC measures will be a function of the complexity and duration of in-water work, but may involve the following:

- Instrument servicing, which may include:
  - Inspection of probe body and sensor membrane
  - Cleaning, inspection, greasing, and replacement (if necessary) of all ‘O’ ring seals and electrical connections

  - Replacement of DO sensor membrane if erroneous data are observed or every 6 months.
- Instrument Calibration Forms (to document instrument accuracy)
- Standardized field data sheets
- Duplicate field measurements (to document field variability and precision)
- Blank and/or audit samples (field checks on accuracy).

3.2 Reporting

The results of in-water construction turbidity and DO monitoring will be provided to the Washington Department of Ecology upon request.

Any work that is found out of compliance with the provisions set forth in the 401 Water Quality Certification/Orders, or conditions that result in distressed, dying or dead fish, or any discharge of oil, fuel, or chemicals into state waters, or onto land with a potential for entry into state water, or exceedance of an applicable water quality criteria is prohibited. If these conditions occur, the following steps shall be immediately taken:

- Cease operations at the location of the violation to the extent such operations may reasonably be causing or contributing to the problem.
- Assess the cause of the water quality problem and take appropriate measures to correct the problem and/or prevent further environmental damage.
- Notify the Ecology 401 Project Manager of the failure to comply.
- Oil or chemical spill events shall be reported immediately to Ecology’s 24-Hour Spill Response Team at (800) 258-5990 within 24 hours. Other non-compliance events shall be reported to Ecology’s Federal Permit Manager at (800) 424-8802.
- A detailed written report shall be submitted to Ecology as requested. The report should describe the nature of the event, corrective action taken and/or planned, steps to be taken to prevent a recurrence, results of any samples taken, and any other pertinent information.

4.0 REFERENCES

Washington State Department of Ecology. 2006. Yale Hydroelectric Project (FERC No. 2071) 401 Certification/Order No. 3678. October 9, 2006.

Amended Orders No. 5000. December 21, 2007; Amended Order No. 5329. January 17, 2008; and Amended Order No. 5743. October 3, 2008. Amended Order No. 8834, November 7, 2011.

Washington State Department of Ecology. 2006. Yale Hydroelectric Project (FERC No. 2071) 401 Certification/Order No. 3677. October 9, 2006.

Amended Orders No. 4999. December 21, 2007; Amended Order No. 5328. January 17, 2008; and Amended Order No. 5972. October 3, 2008. Amended Order No. 8833, November 7, 2011.

Washington State Department of Ecology. 2006. Swift No. 1 Hydroelectric Project (FERC No. 2071) 401 Certification/Order No. 3679. October 9, 2006.

Amended Orders No. 5001. December 21, 2007; Amended Order No. 5330. January 17, 2008; and Amended Order No. 5974. October 3, 2008. Amended Order No. 8831, November 7, 2011.

Attachment H
Lewis River SPCC Plans