Wallowa Falls Hydroelectric Project
FERC Project No. P-308
Study Progress Report
(Draft Technical Report)

Water Resources

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December 2012

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For Public Review

Recommended Citation:

CH2M HILL. 2012. Study Progress Report (Draft Technical Report): Water Resources. Wallowa Falls Hydroelectric Project. FERC Project No. P-308. Prepared for PacifiCorp Energy, Portland, OR. Prepared by CH2M HILL, Inc., Portland, OR. December 2012.

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Acronyms and Abbreviations

°C	degrees Centigrade
°F	degrees Fahrenheit
7-DAD Max	7-day average of the daily maximum temperature
cfs	cubic feet per second
CWA	Federal Clean Water Act
DO	dissolved oxygen
FERC	Federal Energy Regulatory Commission
ft	feet
ft3	cubic feet
g	grams
ILP	Integrated Licensing Process
L	liter
m	Meter
mg	milligrams
mg/L	milligram per liter (equivalent to parts per million, or ppm)
mi	mile
msl	mean sea level (referring to elevation)
NA	not available or not applicable or not calculated because of three or fewer detections
NTU	nephelometric turbidity units
PAD	Pre-Application Document
ppm	parts per million
Project	Wallowa Falls Hydroelectric Project
TDG	total dissolved gas

1.0 INTRODUCTION

1.1 Purpose

This Water Resources Study Progress Report (Draft Technical Report) is related specifically to the Wallowa Falls Hydroelectric Project (Project) Water Resources Study—one of several resources studies that are being conducted by PacifiCorp Energy (PacifiCorp) to support the relicensing of the Project in accordance with the Federal Energy Regulatory Commission's (FERC's) Integrated Licensing Process (ILP). The Water Resources Study is being conducted by the PacifiCorp to address FERC regulations (18 Code of Federal Regulations [CFR] 4.51) for hydrology and water quality information related to the Project, and requirements of Section 401 of the Federal Clean Water Act (CWA) for information on water quality conditions related to the Project.

The Water Resources Study is being conducted according to the Water Resources Study Plan for the Project as contained in PacifiCorp's Revised Study Plans (PacifiCorp 2011a). The Water Resources Study Plan describes the purpose, objectives, approach, and methods for the evaluation of hydrologic and water quality resources in the Project area. The hydrology information being obtained in this study includes collection of flow data to support PacifiCorp's license application to FERC, including: (1) a quantification of available flows for Project operations; (2) ranges in flows and monthly flow duration curves; and (3) flow information to support analysis of instream flow needs for water quality and aquatic biota (18 CFR 5.18(b)).

The water quality information being obtained in this study includes collection of data as required by FERC regulations (18 CFR 5.18(b)) to support Project relicensing documentation. This required water quality information will be used to: (1) describe existing water quality conditions in the Project area; and (2) assess Project effects on water quality. The water quality information also will support certification that FERC will require from the Oregon Department of Environmental Quality (DEQ) that the Project meets applicable state water quality requirements pursuant to Section 401 of the Clean Water Act (hereafter referred to as "401 Certification").

1.2 Study Goal and Objectives

The goal of the study is to develop hydrology and water quality information to support: (1) a new FERC license application for continued future operation of the Project; and (2) 401 Certification from DEQ that the Project meets applicable state water quality requirements.

The study has two principal objectives:

1. Characterize and assess hydrology in the Project vicinity. This hydrologic information is needed to: (i) characterize flow conditions in the Project area and flow availability for Project operations; (ii) evaluate potential Project effects on flows and water quality (as related to flow); and (iii) support evaluation of flow effects and instream flow needs pertinent to aquatic biota (e.g., bull trout).

2. Monitor and evaluate key water quality parameters in the Project vicinity. The study will monitor and evaluate key water quality parameters that may be affected by Project facilities and operations, including those for which DEQ has established numeric or narrative water quality criteria and that are important to inform evaluation of water quality conditions for aquatic species (e.g., bull trout).

1.3 Background

The Project facilities are located along and adjacent to the East Fork and West Fork of the Wallowa River upstream of Wallowa Lake, near the town of Joseph, Oregon. The East Fork and West Fork of the Wallowa River are relatively pristine streams that originate in the Eagle Cap Wilderness Area in the Wallowa Mountains. The East Fork and West Fork join about 0.5 miles below the Project powerhouse tailrace, and the Wallowa River continues to flow north about 0.6 miles into Wallowa Lake (Figure 1.1).

1.3.1 Hydrologic Conditions in the Study Area

Elevations in the area range from 4,440 feet at Wallowa Lake to nearly 9,000 feet at the headwaters in the wilderness area. Temperature and precipitation vary considerably with elevation. Average annual precipitation increases from 22 inches in the town of Joseph (near the outlet of Wallowa Lake) to more than 60 inches in the mountainous headwaters areas. On average, precipitation increases approximately 5 inches with each 1,000-foot rise in elevation (Nowak and Kuchenbecker 2004). Precipitation occurs in the mountains throughout the year but falls primarily as winter snow. Generally, peak snow occurs in the area around March and April.

The East Fork and West Fork of the Wallowa River are snowmelt runoff streams. As such, snow acts as an important flow regulator or storage mechanism, holding a significant proportion of the precipitation in the area during the winter and releasing it later in the year as it melts. Peak runoff occurs in later spring to early summer, generally from May through mid-July, from melting snowpack. By late July, little of the snow is left in the Wallowa Mountains. Runoff recedes to low flows by late summer, usually August and September. Flows can again increase in fall in response to autumn rains, but lower flows generally persist from late fall through winter due to freezing conditions in the contributing high-elevation watershed areas, which result in little or no direct runoff during this time.

As explained in the PAD (PacifiCorp 2011b), available flow information for the Project area is largely confined to USGS streamflow data gathered data at two locations in the Project vicinity over a 58-year period from October 1924 through September 1983. The two historic USGS gages were located in the Project tailrace (USGS Station 13324500) and in the East Fork one quarter mile upstream of the confluence with the West Fork (USGS Station 13325000). The USGS also developed flow data for a third “reporting station” (USGS Station 13325001) that is a summation of data collected at the two gage sites. The data for the reporting station (USGS Station 13325001) represents the best data available characterizing the hydrology of the East Fork in the Project vicinity.

Based on the previous 58-year period of record, average monthly minimum flows in the East Fork ranged from 7.7 cubic feet-per-second (cfs) in March to 25.2 cfs in June, and average monthly maximum flows ranged from 14.6 in March to 142.2 cfs in June. Average mean monthly flows in the East Fork ranged from 11 cfs in February and March to 61 cfs in June. During the period of record, monthly flows met or exceeded 10 cfs 90 percent of the time, 14 cfs 50 percent of the time, and 45 cfs 10 percent of the time.

1.3.2 Water Quality Conditions in the Study Area

Overall water quality in the Wallowa River watershed is considered excellent, due to the relatively pristine location and physical characteristics of the watershed areas, most of which lies within the Eagle Cap Wilderness Area (Nowak and Kuchenbecker 2004).

Because the East Fork and West Fork are supplied by direct snowmelt runoff or groundwater baseflow, they are consistently relatively cold throughout the year. Available water temperature data for the Project area shows that the seven-day average of the maximum daily temperature (7-DAD Max) remains below about 8.0 degrees Celsius (°C) through June and after about mid-September (PacifiCorp 2011b). Even during the summer months of July and August, when air temperature and solar radiation are highest, available data shows that 7-DAD Max water temperatures remain below about 12.0°C, which is equivalent to the state temperature criteria for bull trout spawning and juvenile rearing use (OAR 340-041-0028(4)(f).

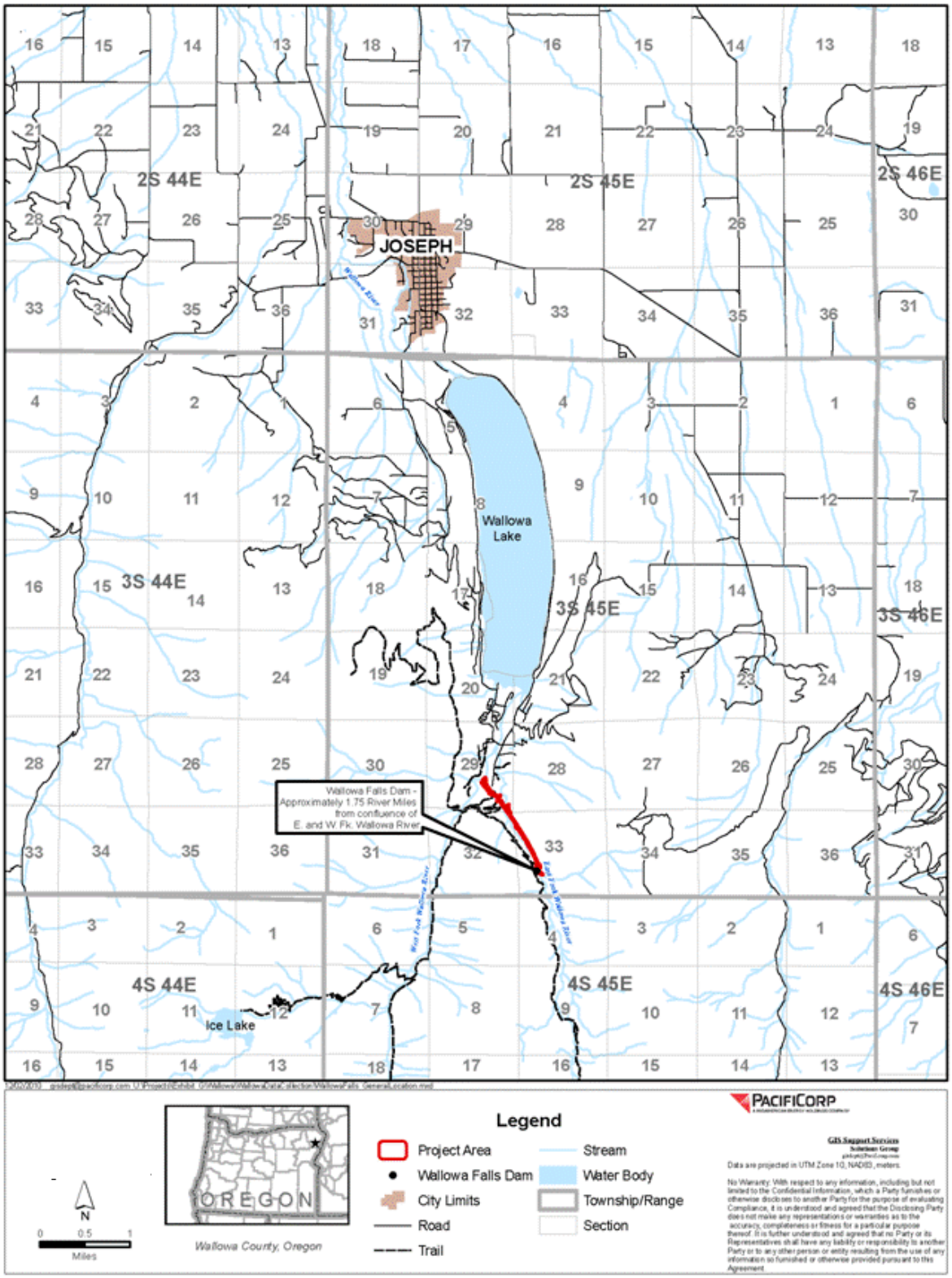
Other water quality data for the Project area is sparse. Dissolved oxygen sampling previously conducted by PacifiCorp showed dissolved oxygen concentrations of 8.9 to 9.1 milligrams per liter (mg/L) in samples taken in mid-summer in the East Fork upstream, within, and downstream of the Project forebay (Eddy 1985). These values indicate that dissolved oxygen was near 100 percent saturation, as expected, for the water temperature and elevation of sampling. Dissolved oxygen at saturation is expected given the turbulent and pristine nature of the streams in the area.

1.3.3 Project Nexus to Hydrology and Water Quality Conditions

Relative to hydrology, the primary Project nexus is the diversions of portions of the flow from the East Fork (and lesser diversions from Royal Purple Creek) for use at the Project powerhouse. As explained in the PAD (PacifiCorp 2011b), the Project is operated in run-of-the-river mode with no peaking or flood control capability. Because of the diversion of flows to the powerhouse, Project operation causes a reduction in downstream in-channel flows in the East Fork below the East Fork diversion dam. This portion of the East Fork is referred to as the “bypassed reach”.

During standard operation (which is done in a remotely-controlled automated mode), the minimum hydraulic capacity of the powerhouse is approximately 3 cfs and the maximum hydraulic capacity is 16 cfs. Thus, the total amount of flow diverted to the Project powerhouse ranges from 3 to 16 cfs. Recent records of powerhouse (turbine) discharge indicate that average monthly discharge (and, hence, amount diverted) ranged from a low of 9.6 cfs in February to a high of about 16 cfs in June.

Figure 1.1 Wallowa Falls Hydroelectric Project Location.



The current FERC license for the Project requires that flow releases are provided from the East Fork diversion dam to maintain a continuous minimum instream flow in the bypassed reach of the East Fork. The required minimum instream flow release is in the amount of 0.5 cfs or the natural inflow to the reservoir, whichever is less, as measured immediately downstream from the diversion dam. However, instream flows in the bypassed reach typically exceed the required minimum instream flow release for three reasons. First, the required minimum flow is released through a fixed pipe at the diversion dam, and measurements indicate that the pipe releases approximately 0.8 cfs, 0.3 cfs more than the required minimum flow. Second, natural accretion of flow on the order of a 1 to 2 cfs is assumed to occur in the bypassed reach based on limited measurements by PacifiCorp personnel during relatively low flow conditions. Third, during higher-flow times of the year (e.g., the snowmelt runoff period), flows arriving at the diversion dam from upstream are likely in excess of 16 cfs, which is the maximum hydraulic capacity of (and hence diversion to) the powerhouse. At these times, all flows in excess of 16 cfs remain within the bypassed reach. This can occur in many months, but is particularly prevalent in the months of May, June, and July.

Relative to water quality, the primary Project nexus also results from the diversions of portions of the flow from the East Fork (and to a lesser extent Royal Purple Creek) for use at the Project powerhouse. Project facilities and operations do not cause any direct discharge or load of water quality-related constituents to Project waters. However, the diversion of flow has the potential to affect physical flow conditions (e.g., flow quantity, depths, and velocities in the bypassed reach), which may in turn affect water quality parameters influenced by such conditions (such as, water temperature).

Also, under current operations, PacifiCorp flushes the forebay behind the East Fork diversion dam to reduce sediment build-up on an as-needed basis. The current FERC license restricts forebay flushing to the period of May 1 through August 30 of each year for the protection of kokanee eggs and sac fry in the gravel areas upstream of Wallowa Lake. Such flushing has the ability to increase suspended sediments and turbidity downstream of the diversion dam.

The nexus of the Project facilities and operations to key water quality parameters addressed by state standards and criteria (OAR 340-041) are summarized in Table 1-1. On the basis of Project nexus and the rationale as described in Table 1-1, this study is specifically focusing on the key water quality parameters of water temperature, dissolved oxygen, turbidity, and total dissolved gas (TDG). Further rationale and discussion of the focus on these particular parameters for this study are provided in the study methods section 2.0 below.

Table 1-1 Rationale for Sampling Conducted in this Study of Water Quality Parameters Addressed In Standards or Criteria Under Oregon Administrative Rules (OAR).

Parameter	Sampling Conducted?	Rationale	Applicable Standard
Numeric Criteria			
Water Temperature	Yes	Project facilities and operations do not cause any direct thermal discharge or load to Project waters. Project operations can affect physical flow conditions (e.g., flow quantity, depths, and velocities in the bypassed reach). Such effects have the potential to affect water temperature by increasing the amount of solar radiation entering the water. Analysis of these potential effects is warranted as water temperature is an important parameter for supporting cold-water biota (e.g., bull trout) in Project waters.	OAR 340-041-0028
Dissolved Oxygen	Yes	Project facilities and operations do not contribute any oxygen-demanding substances in Project waters. Project operations can affect physical flow conditions (e.g., flow quantity, depths, and velocities in the bypassed reach). Such effects are unlikely to affect DO, although verification is warranted as DO is an important parameter for supporting cold-water biota (e.g., bull trout) in Project waters.	OAR 340-041-0016(1)
Turbidity	Yes	Increases in turbidity are possible when water is spilled from the diversion dams due to maintenance flushing of the forebay. Turbidity will be monitored during such maintenance flushing.	OAR 340-041-0036
Total Dissolved Gas	Yes	Total dissolved gas (TDG) supersaturation can occur at hydropower facilities when large volumes of water are spilled from dams and entrain significant volumes of atmospheric gases. TDG supersaturation typically occurs only at larger mainstem dams where relatively deep reservoirs or non-turbulent river reaches offer less-effective gas dissipation than shallow, more turbulent river reaches that facilitate degassing. Therefore, TDG supersaturation is not expected for this Project, although verification is warranted as TDG is an important parameter for supporting cold-water biota (e.g., bull trout) in Project waters.	OAR 340-041-0031(2)
Nuisance Phytoplankton Growth	No	Project facilities and operations do not contribute to phytoplankton growth in Project waters. There are no Project-related discharges of nutrients or other conditions that would contribute to primary production.	OAR 340-041-0019
pH (Hydrogen Ion Concentration)	No	There are no Project-related discharges of nutrients or other conditions that contribute to primary production that could affect pH. Project facilities and operations do use or discharge any other substances to Project waters that could affect	OAR 340-041-0156(1)

Table 1-1 Rationale for Sampling Conducted in this Study of Water Quality Parameters Addressed In Standards or Criteria Under Oregon Administrative Rules (OAR).

Parameter	Sampling Conducted?	Rationale	Applicable Standard
		buffering capacity and pH.	
Total Dissolved Solids	No	Project facilities and operations do not discharge substances to Project waters that could affect total dissolved solids. The Project does not engage in irrigation or water reuse that could act to increase total dissolved solids.	OAR 340-041-0156(2)
Toxic Substances	No	Project facilities and operations do not discharge any potentially-toxic substances to Project waters.	OAR 340-041-0033
Bacteria	No	Project facilities and operations do not contribute to bacteria levels in Project waters. There are no Project-related discharges of raw or treated sewage or animal wastes into Project waters. Composting or vault type toilets are used at Project facilities.	OAR 340-041-0009
Narrative Criteria			
Biocriteria	Yes	This criterion clarifies that waters of the State must be of sufficient quality to support aquatic species without detrimental changes in the resident biological communities. Compliance with this criterion will be determined based on data obtained from water temperature, DO, and other monitoring as described above, as well as fisheries and macroinvertebrate data collected as part of the Aquatics Study Plan[a].	OAR 340-041-0011
Aesthetic Conditions	No	Project facilities and operations do not create or cause any known aesthetic conditions offensive to the human senses of sight, taste, smell, or touch. No sampling is necessary or proposed to address this criterion. Any potential for Project effects on aesthetic conditions would be related to turbidity, which can be inferred from data obtained from turbidity monitoring as described above. Other aspects of aesthetics and visual character related to Project facilities will be assessed under the Aesthetic and Visual Resources Study Plan[b].	OAR 340-041-0007(14)
Dissolved Gases	No	Project facilities and operations do not create or cause dissolved gases that produce objectionable odors or result in deleterious effects on designated beneficial uses. No sampling is necessary or proposed to address this criterion.	OAR 340-041-0031(1)
Tastes or Odors	No	Project facilities and operations do not create or cause taste or odors issues affecting water potability or fish consumption. No sampling is necessary or proposed to address this criterion.	OAR 340-041-0007(11)
Discoloration, Scum, Oily Sleek	No	Project facilities and operations do not create or cause objectionable discoloration, scum, oily sheens, or floating solids. No sampling is necessary or	OAR 340-041-0007(13)

Table 1-1 Rationale for Sampling Conducted in this Study of Water Quality Parameters Addressed In Standards or Criteria Under Oregon Administrative Rules (OAR).

Parameter	Sampling Conducted?	Rationale	Applicable Standard
		proposed to address this criterion.	
Bottom or Sludge Deposits	No	Project facilities and operations do not create or cause formation of appreciable bottom or sludge deposits or the formation of any organic or inorganic deposits deleterious to designated beneficial uses. No sampling is necessary or proposed to address this criterion.	OAR 340-041-0007(12)
Development of Fungi	No	Project facilities and operations do not create or cause the development of fungi or other growths having deleterious effects on designated beneficial uses. No sampling is necessary or proposed to address this criterion.	OAR 340-041-0007(10)
Radioisotopes	No	No radioisotopes are being added to the water by the Project, and there are no known naturally-occurring problems with radioisotopes.	OAR 340-041-0007(15)

[a] See the Aquatic Resources Study Progress Report (Draft Technical Report) for details on the approach and methods used for fisheries and macroinvertebrate data collection.

[b] See the Aesthetic and Visual Resources Study Progress Report (Draft Technical Report) for details on the approach and methods used to evaluate Project effects on aesthetic resources.

2.0 STUDY METHODS

2.1 Sampling Design

2.1.1 Study Parameters

The study is assessing five flow and water quality parameters at seven sampling sites in the vicinity of the Project over a one-year study period. During the year of the study, five flow and water quality parameters at seven sampling sites in the Project vicinity have been monitored. The five flow and water quality parameters and associated methods are summarized in Table 2-1.

Table 2-1 Parameters and Sampling Techniques for the Water Resources Study.

Parameters	Type	Sampling Technique
Flow	Continuous	Continuously recorded hourly values for the one-year period using stage gaging (at 5 sites).
Water temperature	Continuous	Continuously recorded hourly values for the one-year period using thermographs associated with flow dataloggers (at 4 flow gage sites).
Water temperature	Continuous	Continuously recorded hourly values for the one-year period using thermographs (at 3 additional water temperature sites).
Dissolved oxygen	Continuous	Continuously recorded hourly values for 72-hour periods in each of the months of August, September, and October (at 3 sites).
Total dissolved gas	Discrete	Grab samples taken twice daily on two consecutive days per month for June-September period using a TDG probe in the Project tailrace.
Turbidity	Continuous	The Water Resources Study Plan (PacifiCorp 2011a) called for continuously recorded hourly values for multi-day period that extended before, during, and after maintenance flushing using datasondes (at 3 sites). Such maintenance flushing sampling did not occur during the year as discussed further in section 3.5 of this report.

2.1.2 Study Area and Sampling Locations

The study area pertinent to the evaluation of hydrology and water quality includes the following waters:

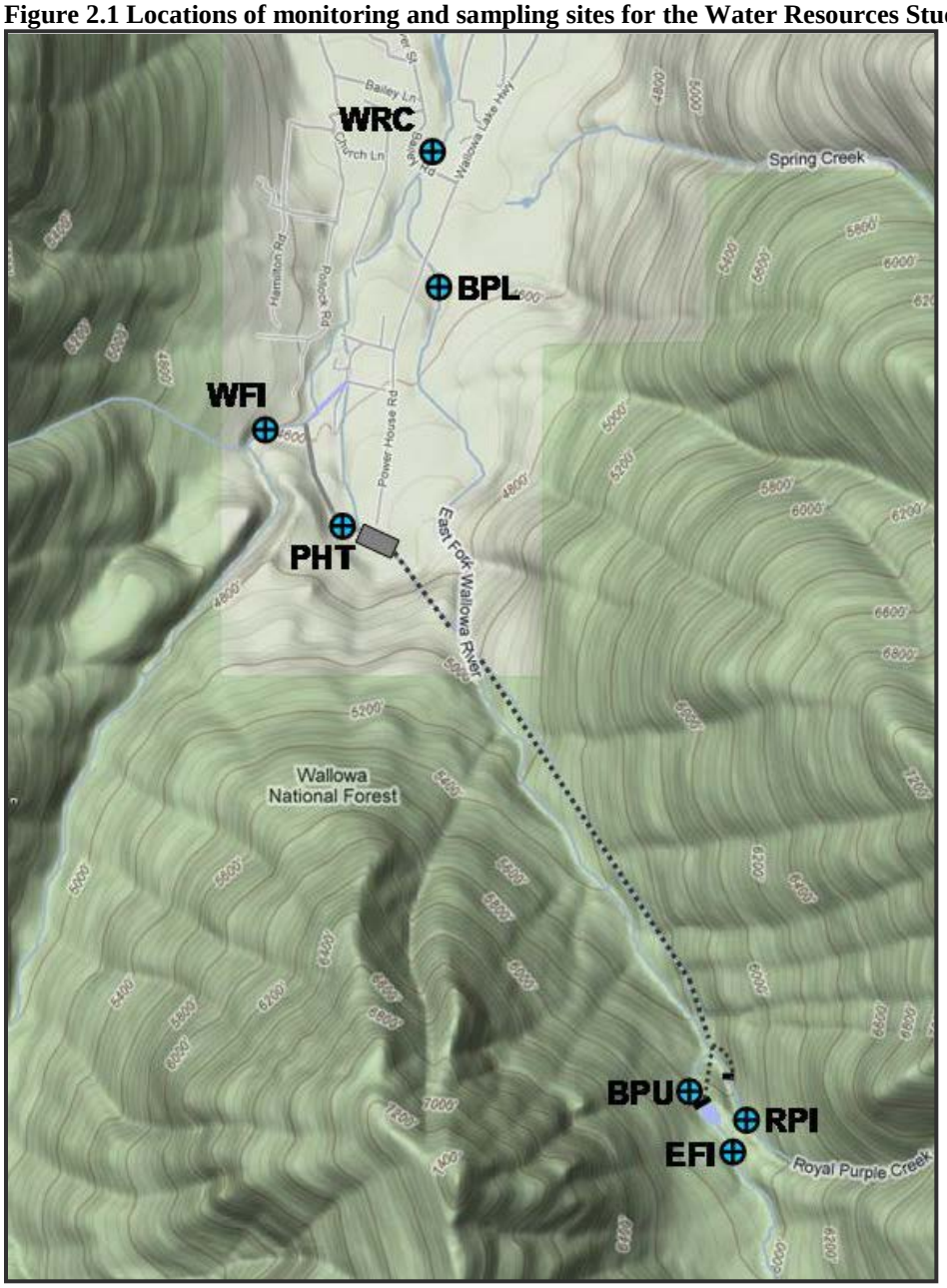
- East Fork Wallowa River and Royal Purple Creek inflows to Project diversions;
- East Fork Wallowa River bypassed reach;
- Project tailrace; and
- West Fork Wallowa River into which tailrace waters discharge.

The study includes seven monitoring and sampling sites. The seven sites are summarized in Table 2-2, and Figure 2.1 shows the locations of the sites. The sampling sites are chosen for their ability to represent conditions within the study area (as defined above) and to assess potential effects of Project facilities and operations on water quality.

Table 2-2 List of Sample Sites for the Water Resources Study

Sample Site	Associated Code
East Fork Wallowa River Inflow to Project Forebay	EFI
Royal Purple Creek Inflow to Project Diversion	RPI
East Fork Wallowa River Bypassed Reach – Upper End	BPU
East Fork Wallowa River Bypassed Reach – Lower End	BPL
Tailrace below Project Powerhouse	PHT
West Fork Wallowa River Upstream of Tailrace Discharge	WFI
Wallowa River Downstream of E.F. and W.F. Confluence	WRC

Figure 2.1 Locations of monitoring and sampling sites for the Water Resources Study.



2.1.3 Sampling Timing and Duration

Sampling timing and duration varies by parameter and sampling locations, as summarized in Table 2-3. They are five types of sampling timing and duration:

1. Continuous (hourly) sampling throughout the year of flow and water temperature (at flow gaging sites)

2. Continuous (hourly) sampling throughout the year of water temperature (at additional water temperature sites)

3. Continuous (hourly) sampling for three 72-hour periods in later August through October for dissolved oxygen

4. Discrete (twice daily) sampling for two-day periods each month from June to September for TDG

5. Continuous (hourly) sampling for multi-day period during forebay maintenance (for turbidity). Note: Such maintenance sampling of turbidity did not occur during the year as discussed further in section 3.5 of this report.

Table 2-3 List of Parameters, Sampling Events, and Sites for the Water Resources Study.

		Sampling Events							Sites						
Parameters	**Type**	**Seasonal: January**	**Seasonal: April**	**Monthly: June**	**Seasonal: July**	**Monthly: August**	**Monthly: September**	**Seasonal: October**	**EFI**	**RPI**	**BPU**	**BPL**	**PHT**	**WFI**	**WRC**
Flow	Continuous	▬	▬	▬	▬	▬	▬	▬	●	●	●	●	●		
Water temperature	Continuous	▬	▬	▬	▬	▬	▬	▬	●	●	●	●	●	●	●
Dissolved oxygen	Continuous					▬	▬	▬	●		●	●			
TDG	Discrete			▬	▬	▬	▬						●		
Turbidity	Continuous				*Not Conducted*				●			●	●		

2.2 Study Methodology

2.2.1 Hydrology

Flow gaging is being conducted at five sites, including sites EFI, RPI, BPU, BPL, and PHT as listed in Table 2-2 and shown in Figure 2.1. The EFI site represents the primary source of inflow to the Project. The RPI site is a secondary and relatively minor source of inflow to the Project. The BPU and BPL sites represent flows in the upper and lower ends

of the Project bypassed reach, respectively, where Project effects on flow are most prevalent due to diversions from the diversion dam to the powerhouse. The PHT site represents the discharge from the Project powerhouse.

Flow gaging is being conducted based on open-channel stage-discharge monitoring methods in which stage (that is, water level or water depth) in the channel at each site is continuously monitored. Stage data is subsequently converted to an estimate of corresponding streamflow based on relationships (or "ratings") between streamflow and stage that are developed for each site (e.g., Gordon et al. 2004, Rantz et al. 1982). Stage (i.e., water level) measurements are being recorded at hourly intervals over a one-year period at the four sites using an in-situ water level datalogger (e.g., Solinst Levelogger, various models), which includes a pressure transducer, temperature sensor, and internal datalogger.

To develop the stage-discharge ratings for each site, a series of at least three instantaneous flow measurements were made at or near the gage locations. These measurements were based on the area-velocity technique or volumetric measurements as appropriate for specific conditions at each site (e.g., NNPSMP 2008, Gordon et al. 2004, Rantz et al. 1982).

2.2.2 Water Quality

2.2.2.1 Water Temperature

Water temperature is being monitored at seven sites, including sites EFI, RPI, BPU, BPL, PHT, WFI, and WRC as listed in Table 2-2 and shown in Figure 2.1. These seven sites provide comprehensive spatial coverage of water temperature conditions upstream, within, and downstream of the Project area. Water temperature monitoring is occurring year-round, but the period of focus is from May to October, which is the portion of the year that includes: (1) presence of potentially-sensitive aquatic biota life stages (i.e., bull trout spawning and rearing; kokanee spawning); and (2) seasonally warmer meteorology and lower flow conditions, when potential Project effects on water temperatures, if present, are most likely to occur. While the period May to October is the focus, the water temperature collected for the other months provide additional background on ambient water temperatures during colder meteorological conditions.

Sites EFI, RPI, and WFI are representative of inflow water temperature conditions to waters in the Project vicinity. These inflow sites are being used to help characterize natural thermal conditions in the watershed upstream of Project facilities. These sites also are being used to compare with downstream sites to assess potential water temperature changes as flows travel through the Project area. Sites BPU and BPL are being used to characterize water temperature in the East Fork bypassed reach and to assess potential effects on water temperatures in the reach due to diversion of flows from the reach to the powerhouse. Site PHT is being used to characterize water temperature in flows discharged from the powerhouse and to assess potential effects due to diversion of flows through the powerhouse. Site WRC is being used to characterize water temperature in the Wallowa River below the confluence of the East Fork and West Fork and to assess

potential effects on the Project, if any, on water temperatures in the Wallowa River downstream of the Project area.

Water temperature data are being collected using continuously-recording water temperature sensors (i.e., thermographs) installed at each site as indicated in Table 2-3. At sites EFI, RPI, BPU, BPL, and PHT, thermographs consist of in-situ temperature sensors that are contained within water level dataloggers (e.g., Solinst Levelogger, various models) deployed at those sites for flow gaging (as described above in section 2.2.1). At sites WFI and WRC, thermographs consist of in-situ temperature dataloggers (e.g., Onset Tidbit UTBI-001). Temperature dataloggers are programmed to record temperature on an hourly basis, and have been downloaded during scheduled sampling visits to the field as indicated in Table 2-3.

2.2.2.2 Dissolved Oxygen

Project effects on dissolved oxygen are unlikely for reasons as discussed in Table 1-1. However, dissolved oxygen monitoring is being conducted to assess conditions in the East Fork bypassed reach for 72-hour periods in each of the months of August, September, and October. The East Fork bypassed reach is where Project operations have the most potential to affect physical flow conditions (e.g., flow quantity, depths, and velocities in the bypassed reach). Dissolved oxygen monitoring data are being used to verify that changes in physical flow conditions do not affect dissolved oxygen saturation. The monitoring period coincides with bull trout and kokanee spawning, and the associated application of the dissolved oxygen standard as indicated in Table 2-4.

Table 2-4 Assessment of Parameters Relative to Standards Compliance.

Parameters	Unit	Key Statistic	Associated Standard
Water temperature	°C	7-day average of the maximum daily water temperature (7-DAD Max)	Criteria in OAR 340-041-0028: May not exceed 12.0°C (53.6°F) in streams identified as having bull trout spawning and juvenile rearing use. "Natural Conditions Criteria" provides that where the natural thermal potential of all or a portion of a water body exceeds the biologically-based criteria (as above), the natural thermal potential temperatures supersede the biologically-based criteria, and are deemed to be the applicable criteria[a]. When temperatures are colder than the biologically-based criteria (as above), waters may not be warmed by more than 0.3°C (0.5°F) above the colder water ambient temperature[b]. This provision applies to all sources taken together at the point of maximum impact. Also, exceedance of the biologically-based criteria (as above) is not considered a violation during conditions of highest air temperatures (the 90th percentile value of annual maximum seven-day average maximum air temperatures) or lowest flows (less than the 7Q10 low flow conditions) [c].
Dissolved oxygen	mg/L	Individual values as recorded	Criteria in OAR 340-041-0016: DO may not be less than 11.0 mg/L when trout spawning through fry emergence occurs. However, if the minimum

Table 2-4 Assessment of Parameters Relative to Standards Compliance.

Parameters	Unit	Key Statistic	Associated Standard
			intergravel DO is 8.0 mg/L or greater, then the DO criterion is 9.0 mg/l. Where ambient pressure and temperature conditions preclude attainment of the 11.0 mg/l or 9.0 mg/L criteria, DO levels must not be less than 95% saturation DO may not be less than 8.0 mg/L as an absolute minimum. Where ambient pressure and temperature conditions preclude attainment of the 8.0 mg/L, DO levels must not be less than 90% saturation.
TDG	percent saturation	Individual values as recorded	Criteria in OAR 340-041-0031: TDG may not exceed 110 percent of saturation (% saturation) relative to atmospheric pressure at the point of sample collection, except when stream flow exceeds the 10-year, 7-day average flood. However, TDG may not exceed 105 % saturation in waters of less than two feet in depth.
Turbidity	NTU[d]	Individual sample values as recorded	Criteria in OAR 340-041-0036: No more than a 10% cumulative increase in natural stream turbidities may be allowed, as measured relative to a control point immediately upstream of the turbidity causing activity[e]. However, limited duration activities necessary to address an emergency or to accommodate essential activities and which cause the standard to be exceeded may be authorized provided all practicable turbidity control techniques have been applied and applicable approval has been granted.

[a] If necessary, the "natural thermal potential temperatures" will be determined using data from the EFI, RPI, and WFI sites (which represent inflow sites unaffected by the Project) adjusted as appropriate for downstream locations (e.g., using application of the Heat Source model).

[b] If necessary, the "colder water ambient temperature" will be determined using data from the EFI, RPI, and WFI sites (which represent inflow sites unaffected by the Project) adjusted as appropriate for downstream locations (e.g., using application of the Heat Source model).

[c] If necessary, these conditions will be determined based on locally-available air temperature and flow data.

[d] Nephelometric Turbidity Unit.

[e] Background turbidity will be determined using data from the EFI, RPI, and WFI sites, which represent inflow sites unaffected by the Project.

Dissolved oxygen are being monitored at three sites, including sites EFI, BPU, and BPL as listed in Table 2-2 and shown in Figure 2.1. Sites BPU and BPL are being used to characterize dissolved oxygen conditions in the East Fork bypassed reach and to assess potential effects on dissolved oxygen in the reach due to diversion of flows from the reach to the powerhouse. Site EFI is representative of inflow dissolved oxygen conditions to the East Fork bypassed reach. This inflow site is being used to help characterize dissolved oxygen background conditions upstream of the bypassed reach.

Continuously-recording water quality datasondes are being deployed for dissolved oxygen measurements at each of the sites. For dissolved oxygen data collection at sites EFI, BPU, and BPL, datasondes will include in-situ optical dissolved oxygen sensors (e.g., YSI Model 6920). These datasondes are being programmed to record sampled

values on an hourly basis, and are being downloaded at the conclusion of scheduled sampling periods as indicated in Table 2-3.

2.2.2.3 Total Dissolved Gas (TDG)

Project effects on TDG are unlikely for reasons as discussed in Table 1-1. However, a monthly TDG sampling schedule will be implemented to assess TDG conditions downstream of the Project powerhouse for the period of June through September to verify that air entrainment from the powerhouse does not cause TDG supersaturation.

TDG has been monitored at PHT as BPL as listed in Table 2-2 and shown in Figure 2.1 to characterize TDG in waters discharging from the powerhouse. TDG data was collected over a two-day period each month for June-September. Two discrete grab samples (morning and afternoon) were collected and recorded each day at site PHT using a monitoring instrument equipped with an in-situ TDG pressure transducer (e.g., Hydrolab Model MS-5 or DS-5).

2.2.2.4 Turbidity

The Water Resources Study Plan (PacifiCorp 2011a) called for continuously recorded hourly values for a multi-day period during maintenance of the forebay at the East Fork diversion dam (likely in July or August) when accumulated sediments in the forebay are released downstream. PacifiCorp may flush the Project forebay to reduce sediment build-up on an as-needed basis. Under the current license, forebay flushing is restricted to the period of May 1 through August 30 of each year for the protection of kokanee eggs and sac fry in the gravel areas upstream of Wallowa Lake.

The Water Resources Study Plan (PacifiCorp 2011a) called for turbidity to be monitored at three sites, including sites EFI, BPL and PHT (as listed in Table 2-2 and shown in Figure 2.1) using in-situ optical turbidity sensors (e.g., YSI Model 6920). Site EFI is representative of inflow turbidity conditions to the forebay, and would characterize background turbidity conditions upstream of the forebay. Site BPL would characterize turbidity concentrations in the East Fork that results from waters flushed from the forebay during the maintenance event. Site PHT would characterize turbidity concentrations in waters discharged from the powerhouse during the maintenance event.

As discussed further in section 3.5 of this report, routine forebay maintenance flushing did not occur during the year. Consequently, proposed turbidity sampling as described above did not occur in 2012.

2.3 Data Analysis

2.3.1 Analysis of Hydrology Data

For the gaged sites EFI, RPI, BPU, BPL, and PHT, mean daily and mean monthly flows were calculated from collected streamflow data values. Summary tables of the flow measurement data were produced, and included sample dates, times, locations, and results. Mean daily and mean monthly flows, and lowest and highest (peak) hourly flows

for each site were computed and tabulated. Mean daily flows for each site were graphed for assessment and discussion of trends (as presented in section 3.1 of this report).

Although not presented in the Study Progress Report (Draft Technical Report), the record of mean daily flows for site EFI will be extended, if possible, to provide a longer hydrologic period of record using correlation to records of daily flows from similar USGS gages data elsewhere in the region, an approach known as a basin transfer method (Sanborn and Bledsoe 2006, Gordon et al. 2004, Riggs 1973). The extended record of mean daily flows for site EFI will be used to characterize the flows measured during this one-year study in context within the range of historic flow conditions. The extended record of mean daily flows for site EFI also are being used to calculate flow duration statistics by month (Gordon et al. 2004, USGS 2001). Resulting monthly flow duration curves will relate flow values to the percent of time those values have been met or exceeded, which are useful for assessing flow availability for Project generation and instream flows. This extended hydrologic information will be provided as part of the Water Resources Final Technical Report that PacifiCorp plans to issue in June 2013.

2.3.2 Analysis of Water Quality Data

Tables of the water quality data were produced, including sample dates, times, locations, and results for inclusion as appendices to this report. Appendixes containing data are attached, including water temperature data (Appendix B), dissolved oxygen data (Appendix C), and TDG data (Appendix D). Minimum, mean, and maximum values, and other key water quality statistics were computed, including those listed in Table 2-4. Summary tables and graphs were compiled for assessment and discussion of water quality conditions and trends as presented in sections 3.2 (water temperature), 3.3 (dissolved oxygen), and 3.4 (TDG).

For water temperature, the hourly data at the sites were used to compute summary statistics, including the minimum, mean, and maximum temperatures recorded for each day at each site, and the 7-day average of the daily maximum temperature (7 DAD Max). The 7 DAD Max is the arithmetic average of seven consecutive daily maximum temperature measurements. The 7 DAD Max for any individual day is calculated by averaging that day's daily maximum temperature with the daily maximum temperatures of the 3 days prior to, and the 3 days after, that date. As summarized previously in Table 2-4, the 7 DAD Max is a statistic described in the State of Oregon's water quality standards to assess water temperature protection of State waters based on salmon and trout (salmonid) use categories (OAR 340-041-0028).

This Study Progress Report (Draft Technical Report) does not include a specific assessment of compliance of the study parameters relative to State of Oregon water quality standards as summarized in Table 2-4. Pending acquisition of remaining data and additional analysis of the data, that assessment will be provided as part of the Water Resources Final Technical Report that PacifiCorp plans to issue in June 2013.

3.0 RESULTS

Results of the data collection for the Water Resources Study during 2012 are presented in the following sections by parameter.

3.1 Hydrology Data

3.1.1 Summary of Data Completeness

Completeness is the percentage of valid results obtained compared to the total number of planned hourly measurements to be taken at the gage sites for flow. Completeness is ideally 100 percent, but the actual completeness can be less than 100 percent if data cannot be obtained or is eliminated due to logistics, equipment, or analytical issues.

During the 2012 study period from January 1 to date, data collection completeness of 100 percent was successfully achieved at four of the five gage sites: EFI, BPU, BPL, and PHT (Table 3-1). Furthermore, PacifiCorp commenced hydrology data collection prior to the start of the 2012 study period on January 1 in an effort to obtain data for the complete Water Year 2012 (WY 2012), which covers the months of October 2011 through September 2012. Data collection completeness of 100 percent was also achieved for WY 2012 at sites BPU and PHT, 95 percent at site EFI, and 83 percent at site BPL (Table 3-1).

Data collection completeness was less successful at gage site RPI, including 35 percent for WY 2012 and 43 percent the 2012 study period from January 1 to date. However, data collection at site RPI was 100 percent during the summer lower-flow months (Table 3-1). Prior to May, the levelogger and staff gage at site RPI were located just upstream of the small weir that serves as the intake diversion point at this site. The small weir was subject to accumulation of debris that affected the water levels over the levelogger. Subsequently, the levelogger and staff gage at site RPI were moved upstream approximately 10-20 feet, above the influence of the intake.

The RPI site is a secondary and relatively minor source of inflow to the Project. Continuous flow gaging at the RPI site was proposed as part of the Water Resources Study Plan for the Project (PacifiCorp 2011a). However, the Water Resources Study Plan emphasized that accurate and reliable flow gaging at the RPI site may prove infeasible or incomplete due to constraints posed by the site's small channel and flow levels. The Water Resources Study Plan for the Project (PacifiCorp 2011a) describes other techniques that may be used for estimating flows at the RPI site using correlation to the EFI gage (or other gages in the area), or through hydrologic modeling. This additional hydrologic information for site RPI will be provided as part of the Water Resources Final Technical Report that PacifiCorp plans to issue in June 2013.

Table 3-1 Completeness of Hydrology Data Collection by Study Site for the Months of the Water Year 2012 and Calendar Year 2012 (to Date).

			Percent of Hours Data Collected by Study Site				
Period	**Days**	**Hours**	**EFI**	**RPI**	**BPU**	**BPL**	**PHT**
By Month							
October	31	744	40	0	100	0	100
November	30	720	100	0	100	1	100
December	31	744	100	0	100	100	100
January	31	744	100	0	100	100	100
February	29	696	100	0	100	100	100
March	31	744	100	0	100	100	100
April	30	720	100	0	100	100	100
May	31	744	100	5	100	100	100
June	30	720	100	99	100	100	100
July	31	744	100	100	100	100	100
August	31	744	100	100	100	100	100
September	30	720	100	100	100	100	100
By Year							
Water Year	366	8784	95	34	100	83	100
Calendar Year	274	6576	100	45	100	100	100

3.1.2 Annual and Mean Monthly Flows

The hourly flow data at the gage sites was used to compute average monthly flows and the annual average flow for WY 2010 at the gage sites (Table 3-2). The overall average annual flow for WY 2010 at the gage sites was 21.1, 1.8, 10.9, 19.5, and 10.5 cfs, respectively, at sites EFI, RPI, BPU, BPL, and PHT (Table 3-2).

For comparison purposes, the records of average monthly flows were obtained for the two historic USGS gages in the Project tailrace (USGS Station 13324500) and in the East Fork just upstream of the confluence with the West Fork (USGS Station 13325000) for the 58-year period from October 1924 through September 1983. The USGS also developed flow data for a third "reporting station" (USGS Station 13325001), which is a summation of data collected at the two gage sites. The data for the reporting station (USGS Station 13325001) represents the best data available characterizing the historic hydrologic conditions in the Project vicinity. These records were used to compute the 10, 50, and 90 percent exceedance levels[1] of average monthly flows and the overall average annual flow at these historic gages (Table 3-3).

[1] The 10 percent exceedance level is the flow level that is equaled or exceeded by 10 percent of the monthly average flow values in the period of record. For example, a 10 percent exceedance level of 15 cfs in February means that, for a 50-year record, 5 of the monthly average flow values for February in the historic record equaled or exceeded 15 cfs and the other 45 values were less than 15 cfs. Likewise, the 90 percent exceedance level is the flow level that is equaled or

Table 3-2 Average Monthly Flow (cfs) by Study Site During Water Year 2012.

	Average Monthly Flow (cfs) by Study Site				
Month	**EFI**	**RPI**	**BPU**	**BPL**	**PHT**
October	15.6	NA	3.8	NA	13.8
November	14.9	NA	1.9	NA	13.7
December	14.8	NA	1.6	21.1	12.3
January	12.2	NA	6.5	24.0	5.3
February	10.8	NA	3.2	10.8	8.6
March	10.0	NA	1.3	6.6	10.5
April	17.0	NA	5.6	11.1	10.7
May	30.3	0.8	16.4	22.4	12.6
June	51.9	1.0	36.9	47.6	12.8
July	41.5	2.1	33.2	33.7	9.6
August	16.7	2.0	11.1	9.9	9.0
September	13.9	2.2	9.8	8.4	7.6
Average	21.1	1.8	10.9	19.5	10.5

Table 3-3 Average Monthly Flow (cfs) by Percent Exceedance Levels for Historic USGS Gage in the Project Vicinity.

	Project Tailrace plus East Fork (USGS Station 13325001)			Project Tailrace (USGS Station 13324500)			East Fork (USGS Station 13325000)		
Month	**10%**	**50%**	**90%**	**10%**	**50%**	**90%**	**10%**	**50%**	**90%**
October	19.6	14.8	11.1	13.2	8.7	6.3	9.3	4.9	2.8
November	17.9	14.1	10.6	12.6	8.8	6.5	8.3	4.4	2.1
December	16.5	12.7	10.4	12.1	8.7	5.4	7.0	3.8	1.6
January	14.4	11.6	9.6	11.0	8.3	6.4	6.2	2.8	1.4
February	13.8	11.3	8.9	11.3	8.0	6.3	4.8	2.5	1.0
March	13.3	10.9	8.5	11.0	7.6	5.7	4.8	2.6	0.9
April	17.0	13.6	10.3	10.5	7.7	5.8	9.3	4.7	2.6
May	47.9	27.4	21.0	13.6	8.6	6.5	35.7	18.7	12.2
June	88.3	56.3	38.1	14.8	9.3	6.7	73.9	44.8	27.2
July	73.5	42.7	21.3	14.5	9.2	5.8	66.8	30.7	9.9
August	29.5	20.4	12.9	13.1	9.3	6.6	17.7	8.5	4.1
September	19.6	16.4	11.7	13.9	9.5	6.9	10.7	5.3	2.6
Average	30.9	21.0	14.5	12.6	8.6	6.2	21.2	11.1	5.7

exceeded by 90 percent of the monthly average flow values in the period of record. The 50 percent exceedance level is the median of the monthly average flow values in the period of record.

Comparison of average monthly flows for WY 2010 at the gage sites (Table 3-2) with the 10, 50, and 90 percent exceedance levels of average monthly flows at the historic USGS gages (Table 3-3) can be used to estimate whether flow conditions for WY 2010 were near normal (if comparable to the median or 50-percent historic value), significantly above average or "wet" (if near to the 10-percent historic value), or significantly below average or "dry" (if near to the 90-percent historic value). Such comparisons indicate that inflows to the Project at the EFI site were normal in most months, expect for March and September that were dry by comparison and April that was wet by comparison. Comparisons indicate that flows further downstream in the bypassed reach at site BPL were normal in the spring and summer months (i.e., May through September), but were wet by comparison in the winter months, particularly in December and January when average monthly flows were higher than any recorded previously at the historic USGS gages for those months. As described further in section 3.1.3.3 below, these wet winter conditions were the result of substantial peak flows caused at lower elevations by rain-on-snow events that were recorded at the lower elevation BPL site during WY 2012.

The above comparisons assume that the previous 58-year period of record at the historic USGS gages from October 1924 through September 1983 is representative of current hydrologic conditions (i.e., no systematic shift in conditions has occurred since). This may or may not be the case depending on the extent to which climate change may be affecting trends in hydrologic conditions in the Project area. The potential effects of climate change on hydrologic conditions in the Project area will be further assessed in the Water Resources Final Technical Report that PacifiCorp plans to issue in June 2013.

3.1.3 Hourly and Average Daily Flow Rates

The hourly flow data at the gage sites were used to compute average daily flows at the gage sites (by averaging the 24 hourly values for each day). Hydrographs of average daily flows during WY 2012 are shown in Figure 3.1 for the Project forebay inflow sites EFI and RPI, and powerhouse diversion PHT. Hydrographs of average daily flows during WY 2012 are shown in Figure 3.2 for the upper bypassed reach site BPU and lower bypassed reach site BPL.

3.1.3.1 Inflow Conditions

The hydrograph of average daily flows during WY 2012 for the inflow site EFI (Figure 3.1) indicates a snowmelt-dominated hydrograph with a distinct period of peak flows from May to August coincident with seasonal warming and snowmelt runoff. The peak flow period extends well into mid-summer because the contributing watershed area to site EFI includes high elevation areas to nearly 9,000 feet in the headwaters of the Eagle Cap Wilderness Area. The relatively high elevation watershed area represented at site EFI likely accounts for the lack of late fall or winter peak flows caused at lower elevations by rain-on-snow events, such as occurred at the lower elevation BPL site (Figure 3.2) as described further in section 3.1.3.3 below.

As expected, the magnitude of average daily flows for the inflow site RPI is minor in comparison to site EFI. The trend of average daily flows for the inflow site RPI did not

show a similar high peak runoff mode during June and July as site EFI. It is likely that site RPI also exhibits a snowmelt-dominated hydrograph, but which probably occurs earlier because the drainage area to site RPI is much smaller and covers a lesser range of elevations.

Figure 3.1 Hydrographs of Average Daily Flows During WY 2012 for Sites EFI, RPI, and PHT.

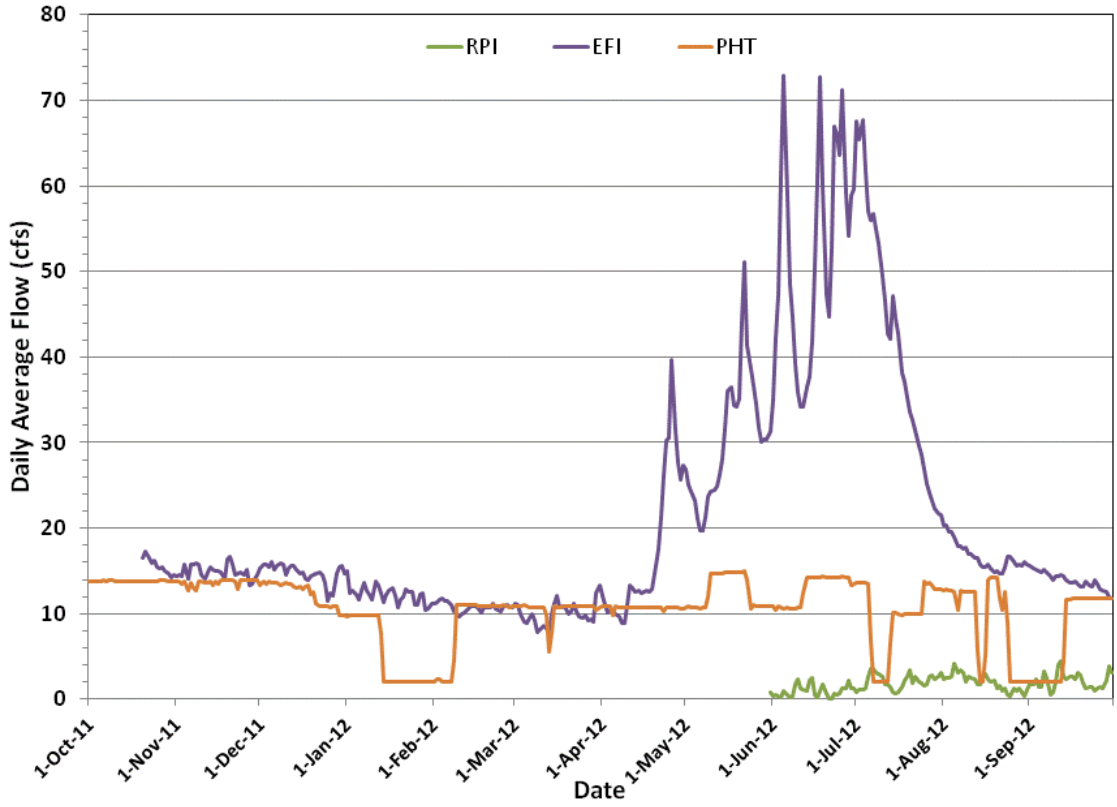
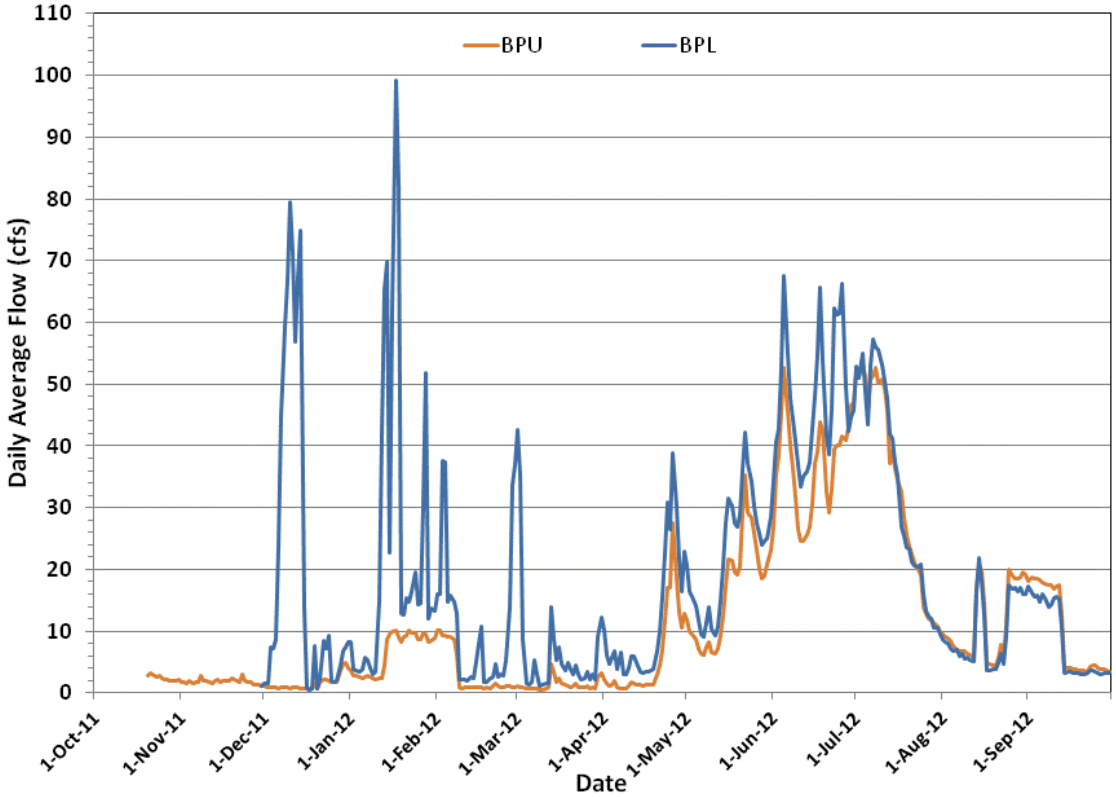


Figure 3.2 Hydrographs of Average Daily Flows During WY 2012 for Sites BPU and BPL.



3.1.3.2 Flow-Related Powerhouse Operations

The hydrograph of average daily flows during WY 2012 for site PHT is directly indicative of flow-related powerhouse operations (Figure 3.1). As expected, the PHT flows were relatively uniform throughout much of year at flow levels between about 10 and 14 cfs, with a few relatively short periods of negligible flow when powerhouse operations were stopped for maintenance purposes (for example, see the mid-January to early-February period of reduced PHT flows in Figure 3.1). The overall average annual flow for WY 2010 at the PHT site was 10.5 cfs, with average monthly flows that ranged from 5.3 cfs in January to 13.8 cfs in October (Table 3-2).

The flow values observed at site PHT during WY 2012 corresponded with (i.e., were within) standard operations at the Project powerhouse. As discussed in section 1.3.3, during standard operation (which is done in a remotely-controlled automated mode), the minimum hydraulic capacity of the powerhouse is approximately 3 cfs and the maximum hydraulic capacity is 16 cfs. Thus, the total amount of flow diverted to the Project powerhouse ranges from 3 to 16 cfs.

3.1.3.3 Flow Conditions in the Bypassed Reach

The bypassed reach includes the East Fork downstream of the forebay dam to the confluence with the Wallowa River, which is characterized in this study by site BPU at the upper end of the reach (located just below the Project diversion dam) and site BPL at

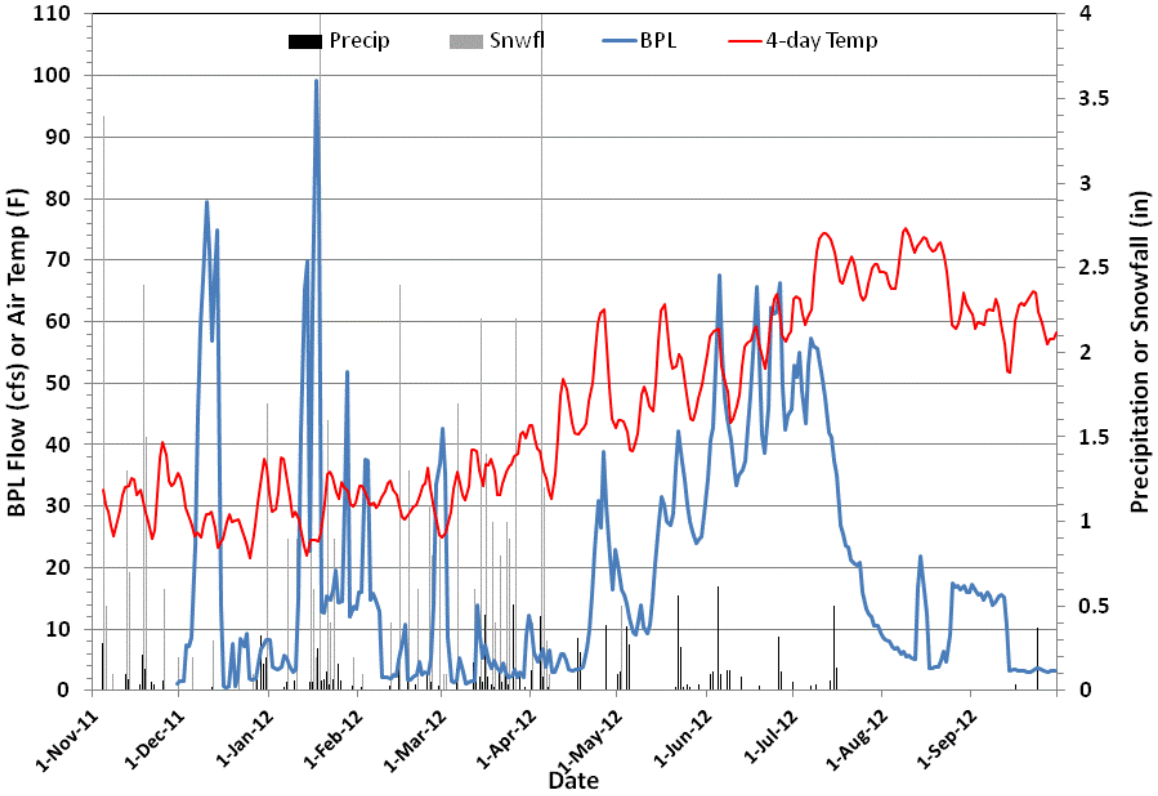
the lower end of the reach (located about 800 ft upstream of the confluence with the Wallowa River).

The hydrograph of average daily flows during WY 2012 for site BPU at the upper end of the reach (Figure 3.2) shows a distinct snowmelt-dominated period of peak flows from May to August coincident with seasonal warming and snowmelt runoff. As expected, the hydrograph for site BPU closely tracks the inflow hydrograph for site EFI, but with flows offset (lessened) by the amount of flow diverted to the Project powerhouse (as indicated by the hydrograph for site PHT in Figure 3.1).

The hydrograph of average daily flows during WY 2012 for site BPL at the lower end of the reach (Figure 3.2) also shows the snowmelt-dominated period of peak flows from May to August. However, in contrast to site BPU, the hydrograph for site BPL shows distinct late fall and winter peak flows that were likely caused by rain-on-snow runoff from the lower elevation drainage area to the bypassed reach that lies between the upper and lower sites. The BPU site is located at an elevation of about 6,040 ft and the BPL site is located at an elevation of about 4,023 ft.

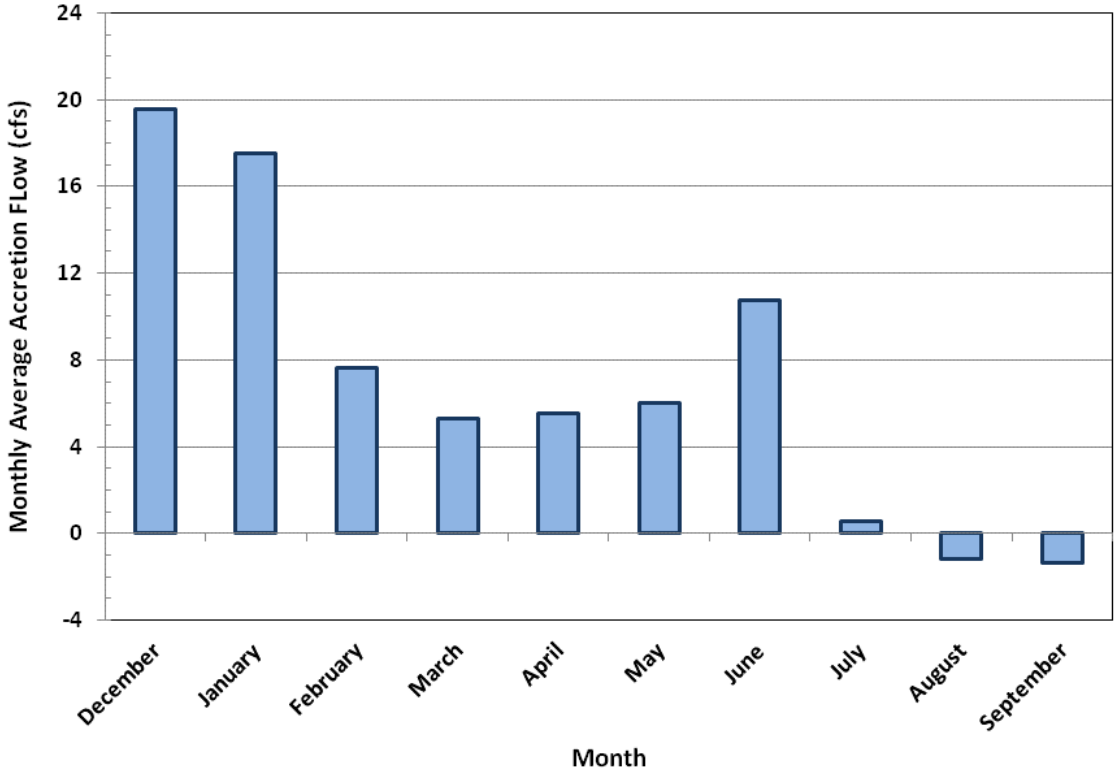
Evidence for rain-on-snow runoff activity during late fall and winter peak is presented in Figure 3.3 by overlaying on the hydrograph for site BPL the concurrent precipitation, snowfall, and air temperatures measured at the Joseph Ranger Station (Western Regional Climate Center Station 354329). This graphical comparison suggests that peak runoff events during this period correspond to temporary warming fronts (reaching relatively warm wintertime average air temperatures of 8°C) combined with rain. These warming fronts were preceded by episodes of snowfall accumulation that had occurred at the elevation of the lower gage site BPL.

Figure 3.3 Hydrograph of Average Daily Flows During WY 2012 for Site BPL with Concurrent Precipitation, Snowfall, and Air Temperatures Measured at the Joseph Ranger Station (Western Regional Climate Center Station 354329).



The differences in flows between the BPU and BPL sites were used to estimate accretion of flow in the bypassed reach. The differences in average monthly flows between the two sites are shown in Figure 3.4. These estimates suggest that accretion of flow in the reach varies by time of year and runoff conditions. During the fall, winter, and spring periods of more active watershed runoff events from rain storms, rain-on-snow, or snowmelt, accretion is appreciable (typically 5 cfs or greater) and can be substantial (e.g., nearly 20 cfs on average in December). By contrast, during the dry late summer period, accretion is low or absent. The negative values estimated for August and September suggest that a net flow loss may have occurred in the East Fork bypassed reach during the dry late summer period in WY 2012.

Figure 3.4 Estimated Accretion in the East Fork Bypassed Reach Based on the Differences in Average Monthly Flows During WY 2012 Between Site BPU and BPL.

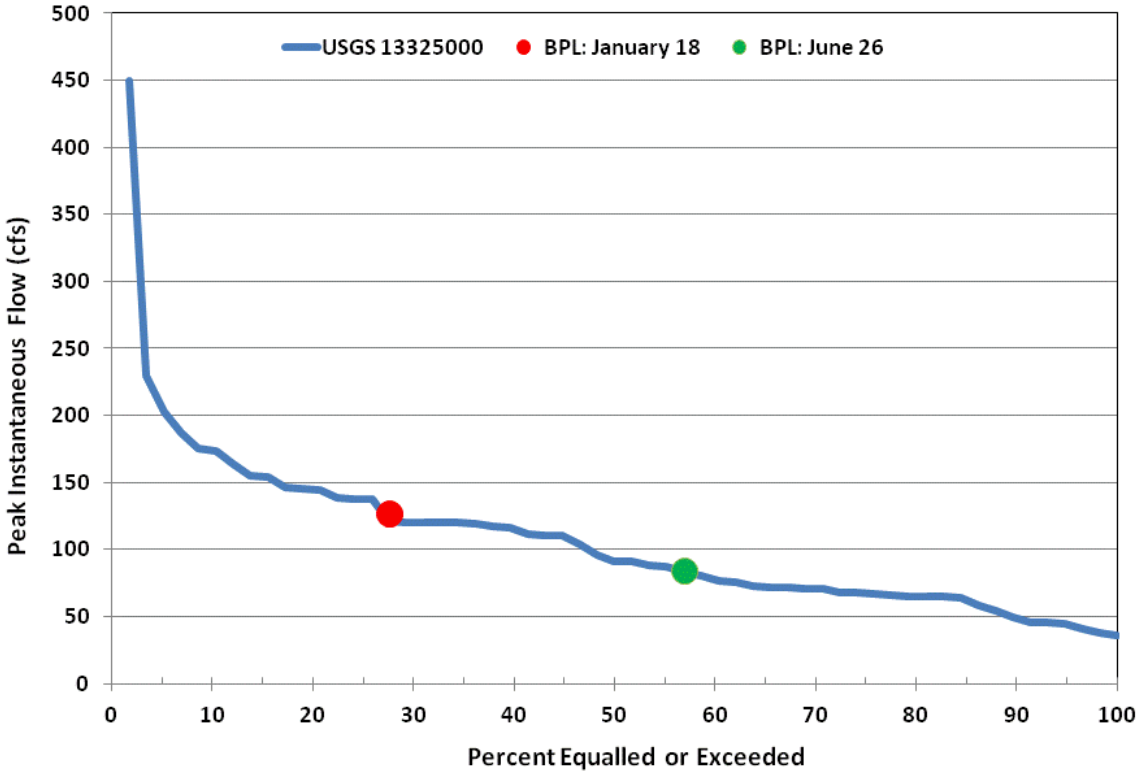


3.1.4 Annual Peak Flow Conditions

The highest instantaneous (hourly) peak flow value recorded at the study sites during WY 2012 was 127 cfs at site BPL on January 18. This occurred at the peak of one of the winter rain-on-snow runoff events. The highest instantaneous (hourly) peak flow value recorded during the spring snowmelt runoff period was 84 cfs at site BPL on June 26.

These two highest instantaneous (hourly) peak flow values are shown in Figure 3.5 on the exceedance curve of the peak flow series for the 58-year period of record (from 1924 to 1984) at USGS Station 13325000 in the East Fork. Nearly all of the peak flows over the 58-year period of record at USGS Station 13325000 occurred during spring. For example, the four highest instantaneous peak flow value recorded in the East Fork were 450 cfs in July 1937, 230 cfs in June 1948, 203 cfs in June 1927, and 187 cfs in July 1975. The January 18 peak flow of 127 cfs during WY 2012 is equivalent to about the 30 percent-exceedance peak flow from the historic record, and the June 26 peak flow of 84 cfs is equivalent to about the 60 percent-exceedance peak flow from the historic record.

Figure 3.5 Highest Instantaneous (Hourly) Peak Flow Values During WY 2012 on the Exceedance Curve of the Peak Flow Series for the 58-year Period of Record (from 1924 to 1984) at USGS Station 13325000 in the East Fork.



3.1.5 Daily Flow Duration Curves by Month

Flow duration curves, by month, at the gage sites will be completed for inclusion in the Water Resources Final Technical Report that PacifiCorp plans to issue in June 2013. These curves will be used to characterize the percent of days for a particular month that a given flow has been equaled or exceeded.

3.2 Water Temperature

3.2.1 Summary of Data Completeness

During the 2012 study period from January 1 to date, data collection completeness of 100 percent was successfully achieved at four of the five water temperature monitoring sites: EFI, BPU, BPL, and PHT (Table 3-4). PacifiCorp commenced some water temperature monitoring prior to the start of the 2012 study period so that considerable data collection also occurred at these sites during the fall months in 2011 (Table 3-4).

Data collection was less complete at sites RPI, WFI, and WRC. Activation of water temperature monitoring equipment at these sites occurred in April at sites WFI and WRC, and May at site RPI. However, data collection at these sites was 100 percent during the summer lower-flow months (Table 3-1), when water temperatures is of most interest.

Table 3-4 Completeness of Water Temperature Data Collection by Study Site During the 2012 Study Period (to Date).

			Percent of Hours Data Collected by Study Site						
Period	**Days**	**Hours**	**EFI**	**RPI**	**BPU**	**BPL**	**PHT**	**WFI**	**WRC**
By Month									
October	31	744	40	0	100	0	0	0	0
November	30	720	100	0	100	1	10	0	0
December	31	744	100	0	100	100	100	0	0
January	31	744	100	0	100	100	100	0	0
February	29	696	100	0	100	100	100	0	0
March	31	744	100	0	100	100	100	0	0
April	30	720	100	0	100	100	100	64	64
May	31	744	100	5	100	100	100	100	100
June	30	720	100	99	100	100	100	100	100
July	31	744	100	100	100	100	100	100	100
August	31	744	100	100	100	100	100	100	100
September	30	720	100	100	100	100	100	100	100
By Year									
Water Year	366	8784	95	34	100	83	83	39	39
Calendar Year	274	6576	100	45	100	100	100	52	52

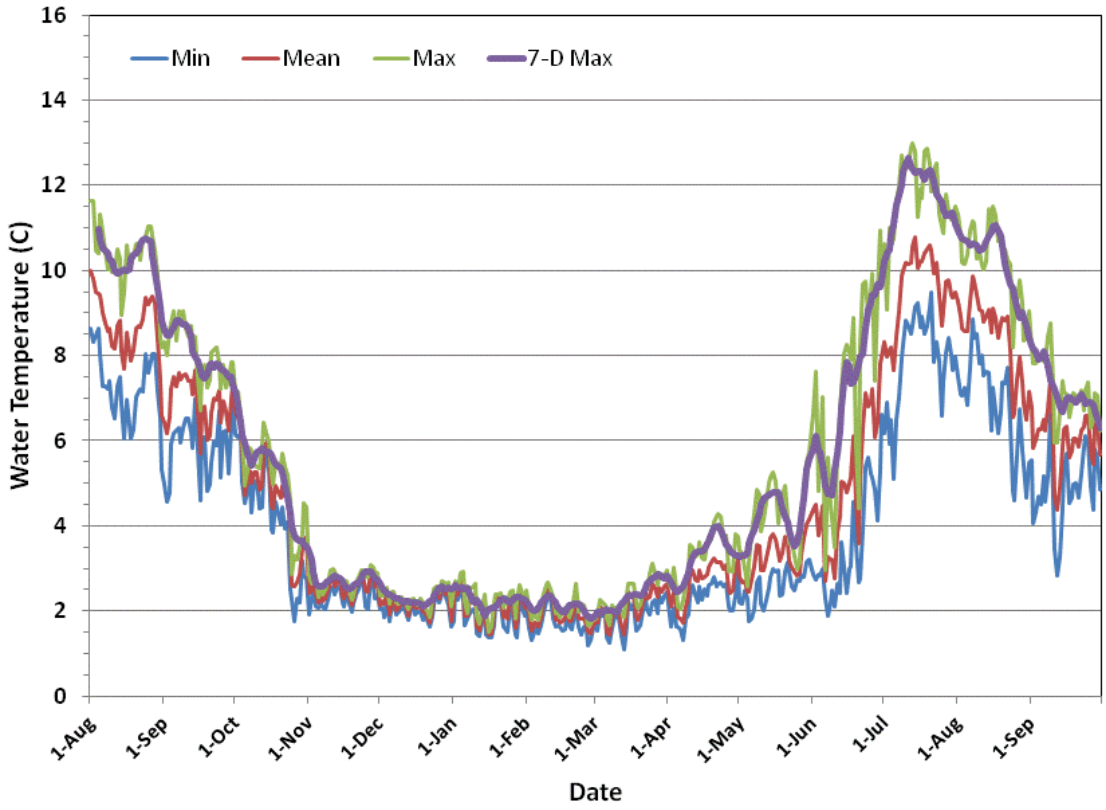
3.2.2 Water Temperature Hourly Data and Summary Statistics

The hourly water temperature data at the sites were used to compute summary statistics, including the minimum, mean, and maximum temperatures recorded for each day at each site, and the 7-day average of the daily maximum temperature (7-DAD Max). The 7-DAD Max is the arithmetic average of seven consecutive daily maximum temperature measurements. The 7-DAD Max for any individual day is calculated by averaging that day's daily maximum temperature with the daily maximum temperatures of the 3 days prior to, and the 3 days after, that date. As summarized previously in Table 2-4, the 7-DAD Max is a statistic described in the State of Oregon's water quality standards to assess water temperature protection of State waters based on salmon and trout (salmonid) use categories (OAR 340-041-0028). The temperature data as presented below will be further assessed relative to the state water quality standard in the Water Resources Final Technical Report that PacifiCorp plans to issue in June 2013. Appendix B includes the hourly water temperature data and the daily summary statistics based on the hourly water temperature data.

3.2.3 Annual and Seasonal Water Temperature Trends

As indicated above in Table 3-4, site BPU has the longest record of water temperature data collected during the study. Therefore, as shown in Figure 3.6, the results from site BPU offers the most complete picture of the overall annual and seasonal trends of water temperature in the study area. As expected, this overall annual trend of water temperature conditions indicates distinctive seasonal trends with warmest temperatures in summer and coldest temperatures in winter in the Project area.

Figure 3.6 Daily Minimum, Mean, Maximum, and 7-DAD Max Water Temperature Values at Site BPU During August 2011 Through September 2012.



As expected, the warmest temperatures of the year occur in July and August. The peak 7-DAD Max water temperature shown in Figure 3.6 for site BPU was 12.6°C, which occurred over the 7-day period centered on July 10. The peak 7-DAD Max water temperatures for other sites in the East Fork included 12.9°C, 12.4°C, and 13.9°C at sites EFI, RPI, and BPL over 7-day periods centered on July 21, 10, and 20, respectively. The peak 7-DAD Max water temperatures the WFI and WRC sites were 15.0°C and 14.2°C, respectively, over 7-day periods centered on August 9.

Minimum water temperatures ranged from about 1.0 to 3.0 °C from January to early March, and were similar among the sites. Daily water temperature ranges were greatest during summer (up to around 12°C) and least during winter (about 2°C), which match the timing in summer and winter, respectively, of the largest and smallest daily ranges in air temperatures and solar radiation.

The observed water temperatures conditions at the study sites are indicative of an overall cold thermal regime in the streams of the Project area. For example, of the five thermal classifications (i.e., cold, cold-cool, cool, cool-warm, and warm) for temperate streams in the U.S. and Canada developed by Chu et al. (2009), the coldest (i.e., "cold") classification includes locations that have daily maximum water temperatures of 15.9°C or less. Based on the data obtained in this study, all of the study sites fall within this "cold" classification.

The overall cold thermal regime in the streams of the Project area is driven primarily by the high-elevation location and associated climatic influence. Carr (2003) determined that location in the watershed and climatic influence, from both maximum and minimum air temperature, are dominant factors with respect to water temperatures patterns of stream in northeastern Oregon. Carr (2003) showed that elevation, through its association with reach location in the watershed and attendant time of thermal energy exposure, is strongly correlated with the daily maximum stream temperature.

Elevation is expected to have a direct effect of on the rate of stream heating, particularly in mountain landscapes, because the lapse rate of air temperature with elevation and orographic lifting of air parcels cause greater condensation and precipitation at high elevations (Isaak and Hubert 2001). Elevation change, through adiabatic heating processes, is known to express a linear relationship with air temperature. The adiabatic rate of heating and cooling typically ranges between 2°C and 3.5°C of air temperature change per 1,000 feet of elevation (Satterlund and Adams 1992).

The overall cold thermal regime in the streams of the Project area could also be affected by watershed aspect, which is thought to influence stream temperatures on the premise that orientation relative to the path of the sun will alter the amount and intensity of sunlight that a stream receives (Isaak and Hubert 2001). As such, streams within the northern hemisphere that have northerly aspects are generally believed to be coldest. Both the East Fork and West Fork drainages in the Project area have roughly northerly aspects.

3.2.4 Annual Peak Water Temperatures

The highest instantaneous (hourly) peak water temperature values recorded at the study sites during the 2012 study period (in descending order) were 15.8°C at site WFI on August 7, 15.1°C at site WRC on August 6, 14.3°C at site BPL on July 18, 13.3°C at site EFI on July 18, 13.0°C at site BPU on July 13, and 12.9°C at site RPI on July 9. These dates all coincided with days of air temperature conditions that were among the warmest of the year (e.g., daytime maximum air temperature at or above 32°C and nighttime minimum air temperature at or above 13°C as recorded at Joseph State Airport).

3.2.5 Water Temperature Conditions by Location

3.2.5.1 Inflow Water Temperature Conditions

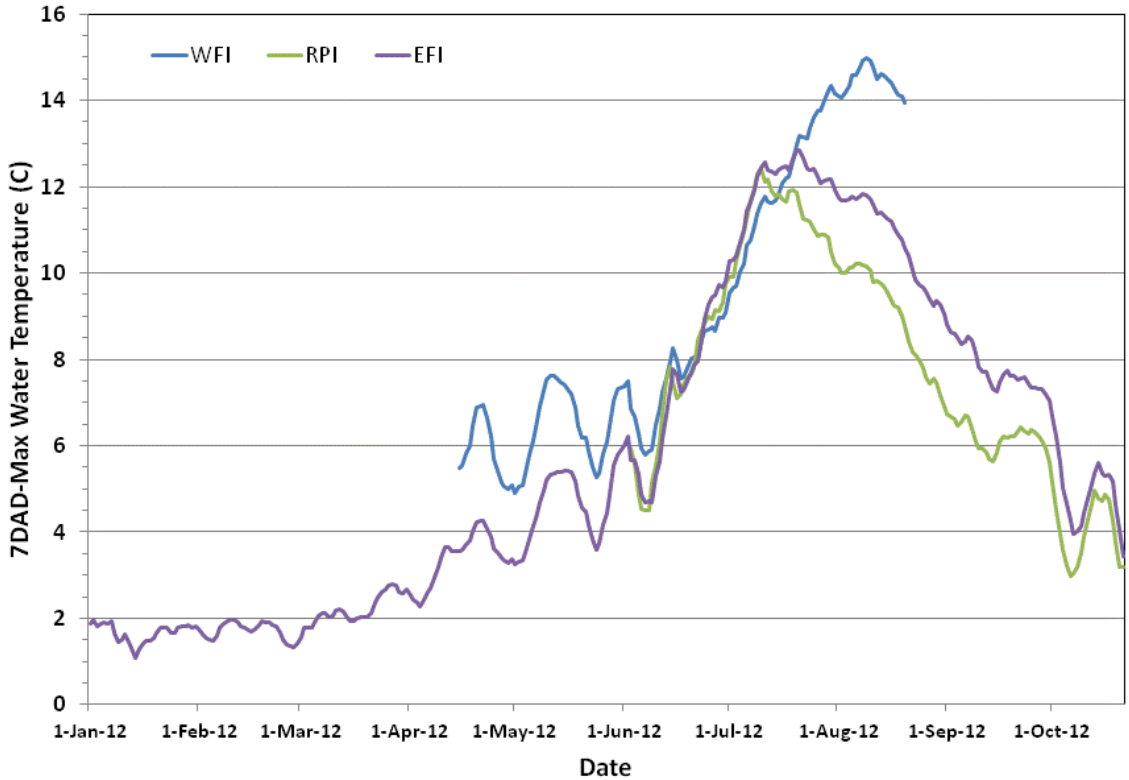
The trends in 7-DAD Max water temperature values at sites EFI, RPI, and WFI during the 2012 study period are shown in Figure 3.7. Each of these sites represents upstream

conditions outside the potential influence of the Project. Sites EFI and RPI represent inflow water temperature conditions to the Project forebay in the East Fork drainage, and site WFI represents water temperature conditions in the West Fork upstream of the confluence of the Project tailrace and the East Fork bypassed reach.

Site WFI shows the higher maximum temperatures of all study sites during summer. It is likely that the higher 7-DAD Max water temperature values at WFI are the result of a larger watershed area draining to the WFI site compared to the drainage areas to sites EFI and RPI. The larger drainage area to site WFI means that site WFI has comparatively lower mean elevation, lower average gradient, greater stream width, and longer stream reach length than occur at sites EFI and RPI. As described above, the relative rate of stream heating is expected to increase as elevation decreases. In addition, in a mechanistic sense, greater stream width and longer stream reach length allow for a greater magnitude and duration of solar input to waters as they flow downstream (Isaak and Hubert 2001).

By contrast, site RPI shows the coolest temperatures of all sites during summer, and the reasons for cooler conditions at site RPI are likely because of conditions opposite to site WFI as described above. Royal Purple Creek is a relatively small, high-gradient stream. It is likely that lower 7-DAD Max water temperature values at RPI are the result of higher average gradient, much lesser stream width, and short stream reach length, which results in lesser rate of heating from solar input and air temperatures than at sites EFI and WFI.

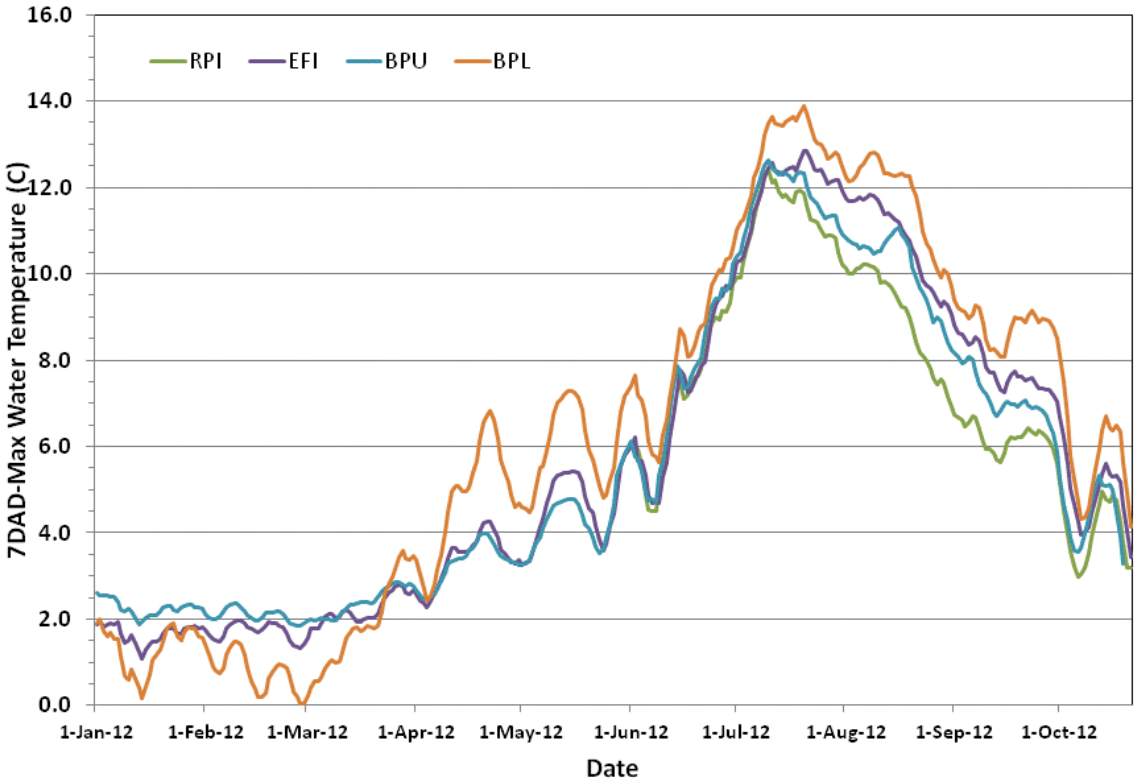
Figure 3.7 7-DAD Max Water Temperature Values at Sites WFI, EFI, and RPI During the 2012 Study Period.



3.2.5.2 Water Temperature Conditions in the Bypassed Reach

Figure 3.8 shows the trends in 7-DAD Max water temperature values at the bypassed reach sites BPU (at the upper end of the reach below the Project diversion dam) and BPL (at the lower end of the reach above the confluence with the Wallowa River). The 7-DAD Max water temperature trends for the upstream inflow sites EFI and RPI are also included in Figure 3.8 to provide direct comparisons of bypassed reach and inflow temperature conditions.

Figure 3.8 7-DAD Max Water Temperature Values at Sites EFI, RPI, BPU, and BPL During the 2012 Study Period.



The trend in 7-DAD Max water temperature values at site BPU closely follows the trend in values at site EFI, which is not surprising given the short distance separating these two sites and their equivalent elevations (see Figure 2.1). Although the trends are close, the 7-DAD Max water temperature values at site BPU are consistently slightly cooler than at upstream site EFI throughout much of the summer. Given that site BPU is downstream of site EFI, it is reasonable to expect that, if anything, the opposite should be the case—that is, the 7-DAD Max water temperature values at site BPU would be consistently slightly warmer than at upstream site EFI. The minor cooling between EFI and BPU may be the result of possible insulating effects of the water volume in the forebay and/or the addition of cooler RPI inflows that occur between the EFI and BPU sites.

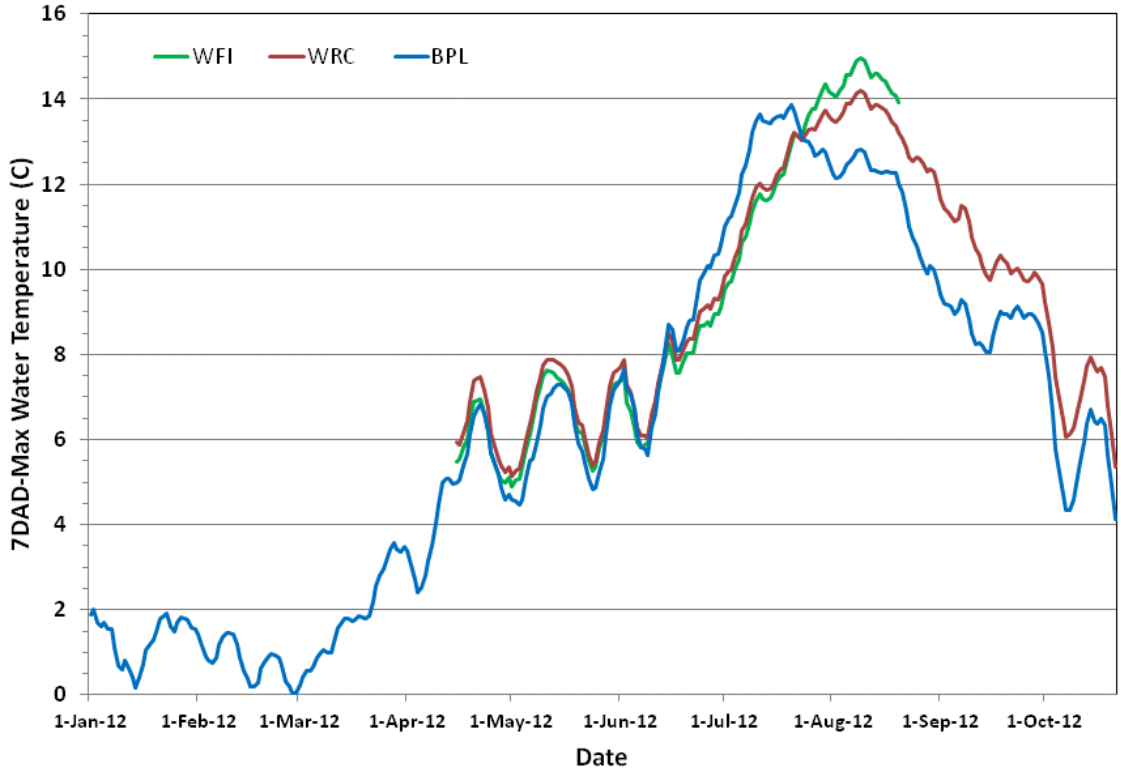
The comparison of water temperature trends between the BPU and BPL sites indicates that flows are consistently warmer at BPL from spring through summer. The warming of flows as they travel downstream in the bypassed reach, particularly during summer, is

reasonable to expect given that the gradient of the reach drops from about 5,800 to 4,600 ft in elevation between the two sites. As discussed in section 3.2.3 above, elevation is expected to have a direct effect of on the rate of stream heating, particularly in mountain landscapes, because of the adiabatic lapse rate, which can result in heating of air temperatures by about 3.5°C per 1,000 feet drop in elevation (Isaak and Hubert 2001, Satterlund and Adams 1992). The additional reach length between sites (about 2 mi) also increases the time that flows can be exposed to solar radiation and air temperatures during the day. Pending acquisition of remaining data and additional analysis of the data, additional assessment of potential Project-related effects on water temperatures in the bypassed reach will be provided as part of the Water Resources Final Technical Report that PacifiCorp plans to issue in June 2013.

3.2.5.3 Water Temperature Conditions in the Adjacent Wallowa River

The trends in 7-DAD Max water temperature values at sites WFI, WRC, and BPL during the 2012 study period are compared in Figure 3.9. Shown together, the graphs in Figure 3.9 allow comparison of water temperature trends in the West Fork and Wallowa River above (as represented by site WFI) and below (as represented by site WRC) the potential influence of the Project (as represented by site BPL).

Figure 3.9 7-DAD Max Water Temperature Values at Sites WFI, WRC, and BPL During the 2012 Study Period.



The overall trends in 7-DAD Max water temperature values at these three sites are similar, except during summer, when values reach maximum level earlier at site BPL (i.e., in July versus August) and then gradually decline in later summer and fall at consistently cooler levels than at sites WFI and WRC. The reasons for these differences

at site BPL are likely the same as described in section 3.2.5.1 above in comparing sites EFI and WFI—that is, the relative rate of stream heating in the West Fork watershed is greater, particularly during summer, because of its larger watershed area (and comparatively lower mean elevation, lower average gradient, greater stream width, and longer stream reach length than occurs at the East Fork sites).

The trend in 7-DAD Max water temperature values at site WRC closely follows the trend in values at site WFI, although the values at site WRC are consistently slightly cooler that at upstream site EFI during the peak summer warming period. As observed at site BPU (see section 3.2.5.2 above), the opposite should perhaps be expected—that is, the 7-DAD Max water temperature values at the downstream site WRC would be consistently slightly warmer that at upstream site WFI. It is likely that the minor cooling between WFI and WRC is the result of the addition of cooler BPL and Project forebay return inflows occurring between the WFI and WRC sites.

3.3 Dissolved Oxygen

3.3.1 Summary of Data Completeness

As described in section 2.1 above, the Water Resources Study Plan (PacifiCorp 2011a) continuous hourly sampling of dissolved oxygen for 72-hour periods in each of the months of August, September, and October 2012 at sites EFI, BPU, and BPL. For the August sampling event, data collection completeness of 100 percent was achieved at sites BPU and BPL. Due to sampling equipment malfunction, data collection was not completed at site EFI.

For the September sampling event, data collection completeness of 100 percent was achieved at all three sites. For the October sampling event, data collection was still underway as of the production of this report. Therefore, data for the October event are not included in this report, but will be included and discussed in the Water Resources Final Technical Report that PacifiCorp plans to issue in June 2013. Appendix C presents the hourly dissolved oxygen data for the 72-hour sampling periods in August and September.

3.3.2 Dissolved Oxygen Conditions

3.3.2.1 August 2012 Sampling Event

The dissolved oxygen measurements (in mg/L and percent-saturation) at sites BPU and BPL during the 72-hour sampling event of August 2012 are shown in Figures 3.10 and 3.11. The data indicate that dissolved oxygen during the sampling event of August 2012 were near full saturation (100 percent) throughout the sampling period at concentrations between about 9 and 10 mg/L. A daily pattern in dissolved oxygen concentration is evident, whereby higher concentrations occurred at around 6 to 8 A.M. and lower concentrations at around 3 to 5 P.M. This pattern coincides with the daily pattern in water temperature, which is the key factor controlling how much dissolved oxygen content water can hold. Temperature inversely controls the solubility of oxygen in water—as temperature increases, oxygen is less soluble.

Figure 3.10 Dissolved Oxygen Measurements (in mg/L and percent-saturation) at Site BPU During the 72-hour Sampling Event of August 2012.

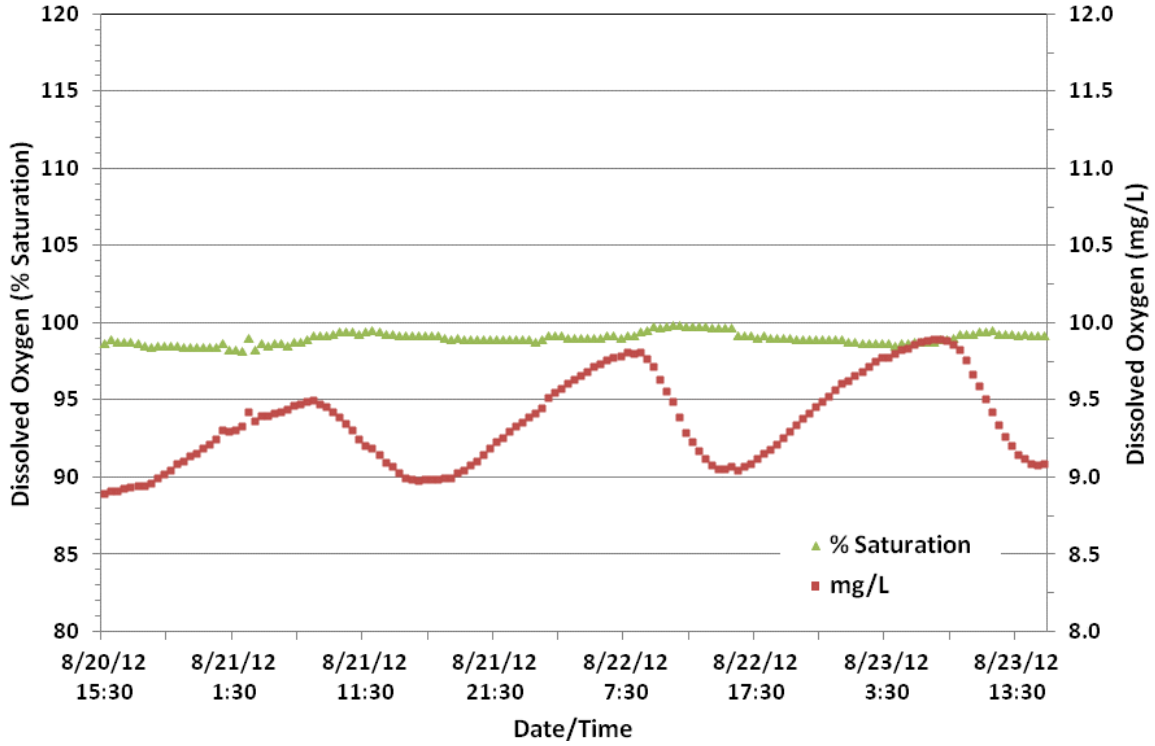
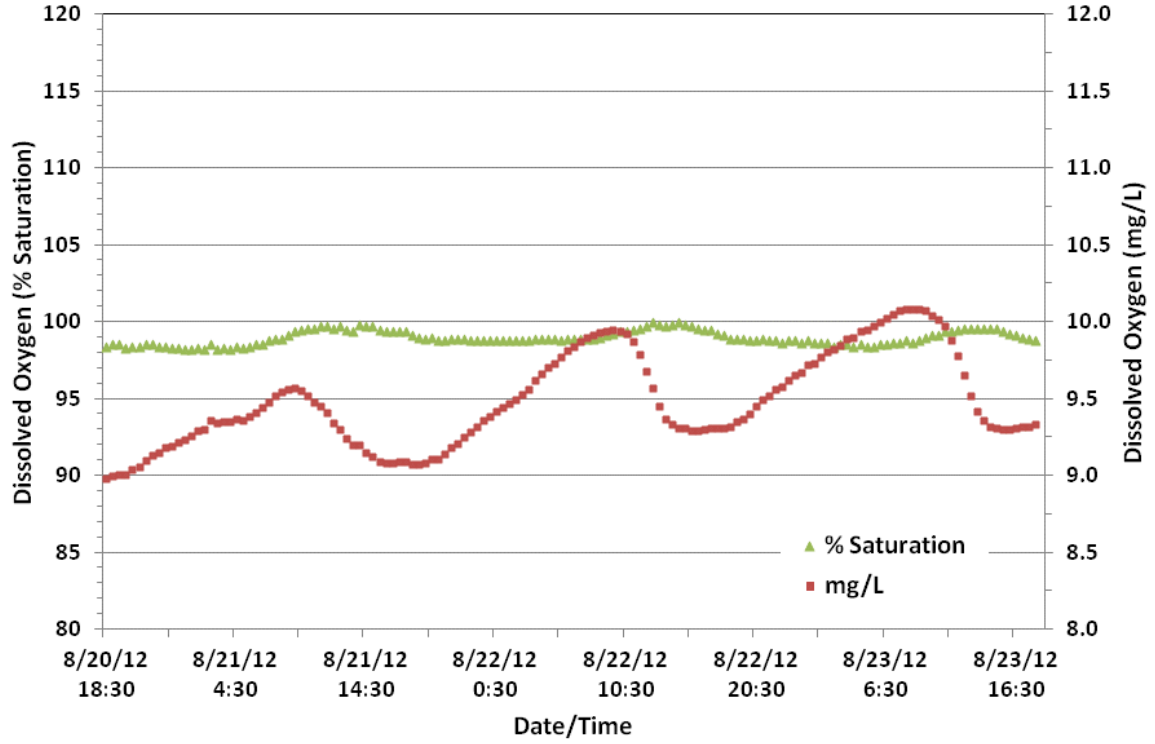


Figure 3.11 Dissolved Oxygen Measurements (in mg/L and percent-saturation) at Site BPL During the 72-hour Sampling Event of August 2012.



Other important factors that influence dissolved oxygen include altitude, salinity, and stream structure. As atmospheric pressure increases due to elevation changes, oxygen solubility increases. As discussed further below, the relatively high elevation of the Project area is an important factor in interpreting the results of the dissolved oxygen data collected for this study. Stream structure also influences dissolved oxygen concentrations. Atmospheric oxygen becomes mixed into a stream at turbulent, shallow riffles, resulting in increased dissolved oxygen levels. Because of the high-gradient, turbulent nature of the streams in the Project area, it is expected that dissolved oxygen should be effectively maintained at full saturation (100 percent) at all times as a result of such turbulent mixing. Salinity also reduces the solubility of oxygen in water. However, because the streams in the Project area are very dilute with minimal salinity values, this factor can be disregarded in this case.

The biological processes of photosynthesis and respiration also affect dissolved oxygen concentrations in streams. As aquatic plants photosynthesize, they give off dissolved oxygen during daylight hours, and respiration from aquatic vegetation, microorganisms, and algae consume oxygen throughout the day and night. However, the streams in the Project area have low nutrient and aquatic plant productivity. As a result, little if any "signals" from these biological processes are expected in the trends of the dissolved oxygen observed in this study.

3.3.2.2 September 2012 Sampling Event

The dissolved oxygen measurements (in mg/L and percent-saturation) at sites EFI, BPU, and BPL during the 72-hour sampling event of August 2012 are shown in Figures 3.12 to 3.14. Like the trends observed in August, dissolved oxygen measurements at sites BPU and BPL were near full saturation (100 percent) throughout the September sampling event. Concentrations at sites BPU and BPL maintained levels between about 9.5 and 10.3 mg/L. Dissolved oxygen measurements at site EFI actually exceeded 100 percent saturation—levels were consistently about 110 percent saturation, and concentrations between about 10.5 and 11.5 mg/L, throughout the September sampling event. The reasons for consistently higher dissolved oxygen measurements at site EFI are not known at this time, but will be further assessed with the addition of data from the October sampling event in the Water Resources Final Technical Report that PacifiCorp plans to issue in June 2013.

Figure 3.12 Dissolved Oxygen Measurements (in mg/L and percent-saturation) at Site EFI During the 72-hour Sampling Event of September 2012.

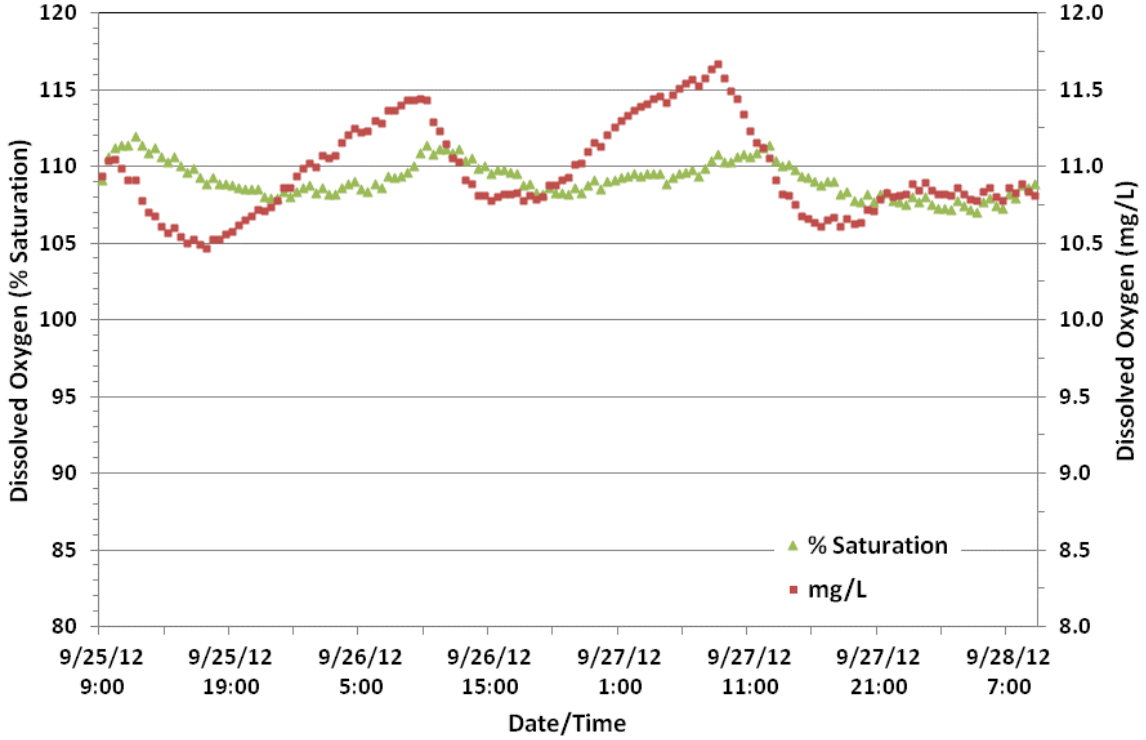


Figure 3.13 Dissolved Oxygen Measurements (in mg/L and percent-saturation) at Site BPU During the 72-hour Sampling Event of September 2012.

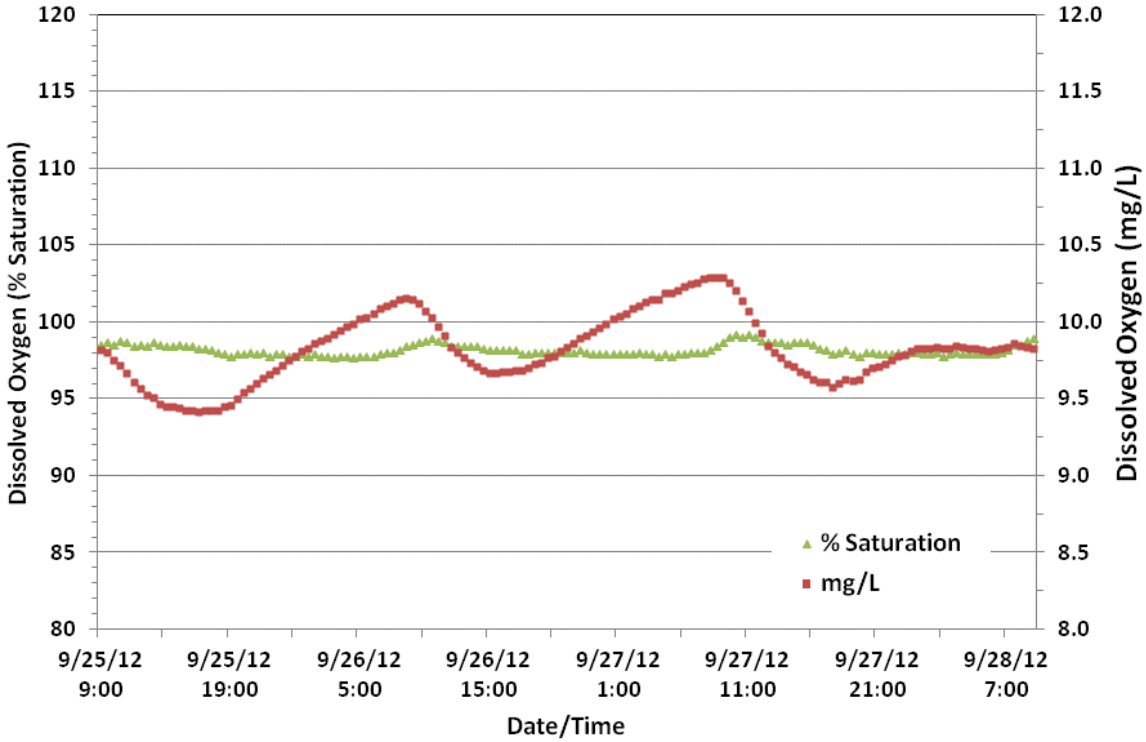
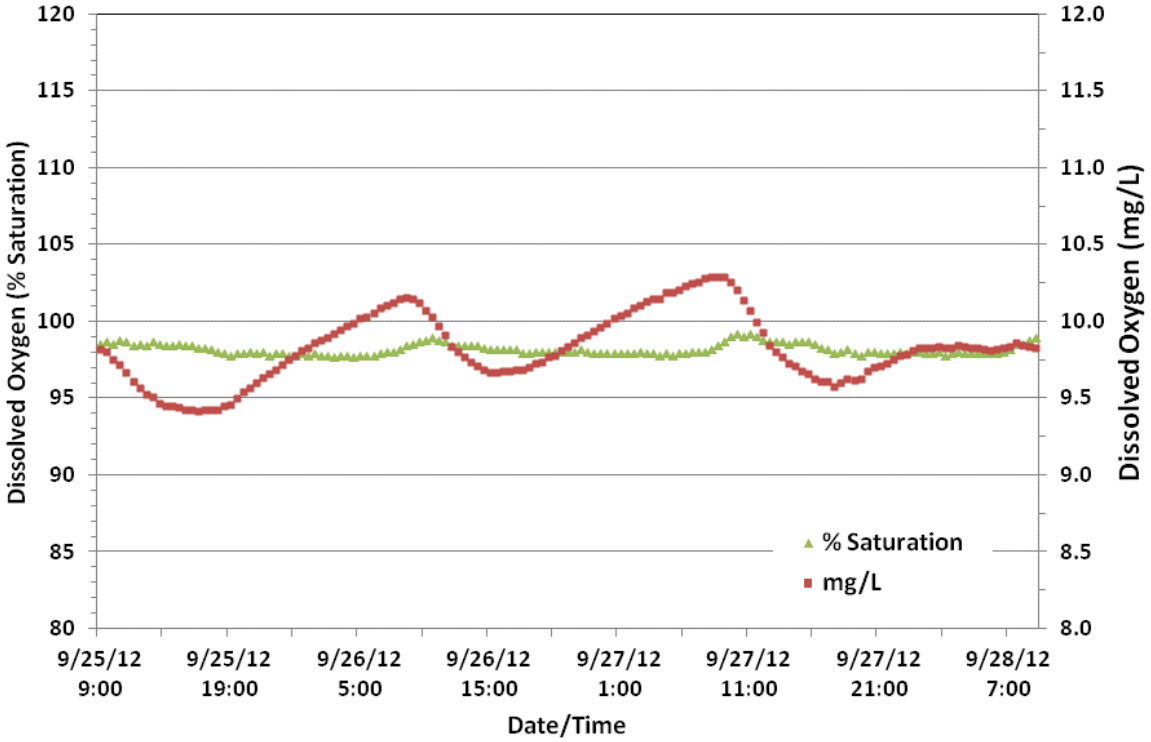


Figure 3.14 Dissolved Oxygen Measurements (in mg/L and percent-saturation) at Site BPL During the 72-hour Sampling Event of September 2012.



3.3.2.3 Effects of Project Area Elevations on Dissolved Oxygen

As indicated above, the relatively high elevation of the Project area is an important factor in interpreting the results of the dissolved oxygen data collected for this study. There is a direct relationship between atmospheric pressure and dissolved oxygen—at higher elevations, where air pressure decreases relative to sea level, the relative oxygen solubility decreases. As shown in Figure 3.15, water can hold higher concentrations of dissolved oxygen at sea level than at higher elevations. For example, at a water temperature of 11°C, the 100 percent saturated dissolved oxygen level is achieved at a concentration of 11.3 mg/L in water at sea level, compared to 9.5 mg/L at an elevation of 4600 ft (at the BPL site) and 9.1 mg/L at an elevation of 5800 ft (at the BPU site). Thus, it is important to account for elevation effects when interpreting the dissolved oxygen conditions in the Project area. For example, Figure 3.16 shows the August and September data for site BPU relative to saturation levels that specifically correspond to the BPU site elevation. Such elevation-related effects will be further assessed with upcoming availability of data from the October sampling event and discussed relative to the state water quality standard in the Water Resources Final Technical Report that PacifiCorp plans to issue in June 2013.

Figure 3.15 The Relationships at Differing Elevation Levels of Dissolved Oxygen Concentration and Water Temperature Equal to 100 Percent Saturation.

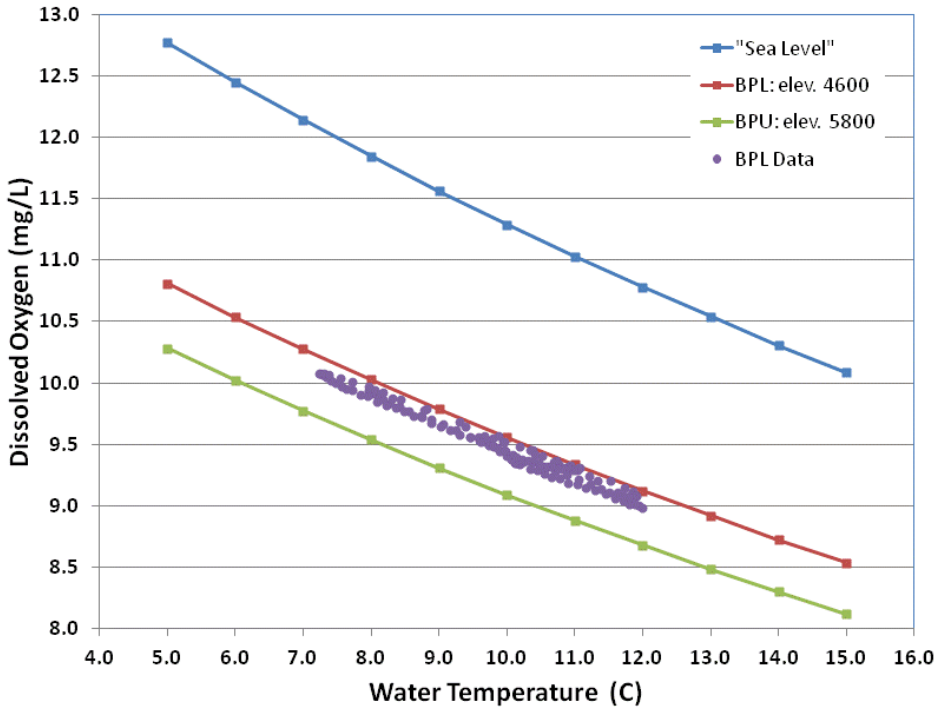
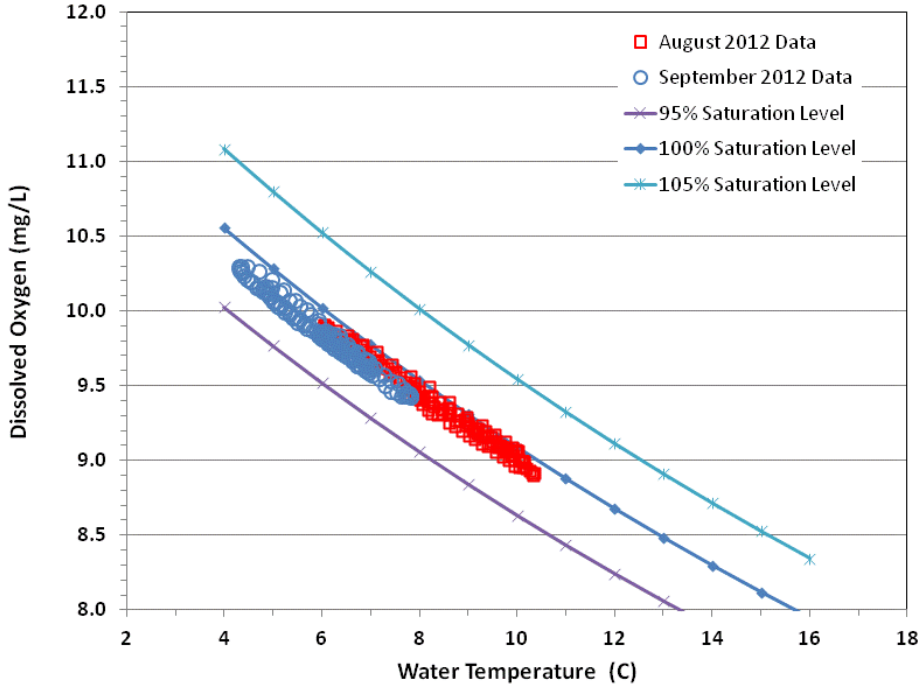


Figure 3.16 Example of the Relationship at Site BPU of Dissolved Oxygen Concentration and Water Temperature Equal to 95, 100, and 105 Percent Saturation Levels.



3.4 Total Dissolved Gas

3.4.1 Summary of Data Completeness

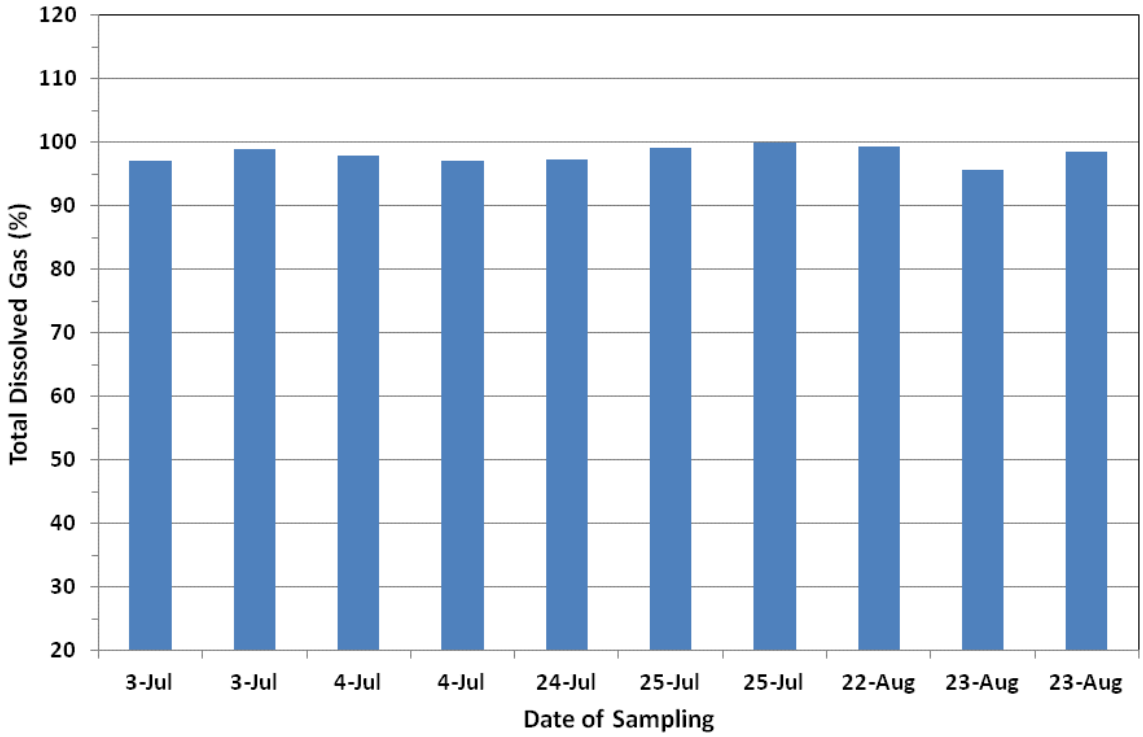
As described in section 2.1 above, discrete TDG measurements were taken twice daily on two consecutive days per month for June-September period in the Project tailrace. Data collection completeness of 100 percent was achieved at the tailrace site as planned for the June-September period. Appendix D presents the TDG data collected for this study.

3.4.2 Total Dissolved Gas Conditions

TDG measurements were made in the powerhouse tailrace to demonstrate that TDG supersaturation (i.e., TDG saturation greater than 110 percent) from potential turbine air entrainment is not a concern. Although air entrainment through turbines can lead to gas supersaturation, the situation is not common and increased gas pressure from this cause is usually not substantial (WDOE 2004).

The TDG measurements (in percent-saturation) at the powerhouse tailrace site are shown in Figure 3.17. The TDG measurements were all at or near 100 percent saturation (i.e., average of 98 percent saturation; range 96 to 100 percent saturation). As expected, these values indicate that TDG is not supersaturated, but instead is at near-saturation conditions. These data will be further assessed relative to the state water quality standard in the Water Resources Final Technical Report that PacifiCorp plans to issue in June 2013.

Figure 3.17 TDG Measurements Taken Twice Daily on Two Consecutive Days per Month for June-September Period in the Project Tailrace.



3.5 Turbidity

Routine forebay maintenance flushing did not occur during 2012. Consequently, turbidity sampling as proposed under the Water Resources Revised Study Plan (PacifiCorp 2011a) did not occur in 2012.

In 2011, PacifiCorp initiated discussions with the U.S. Fish and Wildlife Service (USFWS), U.S. Army Corps of Engineers (USACE) and DEQ regarding necessary permitting and consultation for future forebay flushing under the current FERC license. In 2012, field activities (outside of the Water Resources Study reported herein) were conducted to support these anticipated permitting needs. These activities included a volumetric survey and sediment sampling in the forebay, and additional substrate characterization and water sampling in the bypassed reach. The status and results of these 2012 activities are discussed in PacifiCorp (2012).

4.0 CONCLUSIONS AND RECOMMENDATIONS

4.1 Summary of Conclusions

This Water Resources Study Progress Report (Draft Technical Report) presents the results of flow, water temperature, dissolved oxygen, and TDG monitoring during 2012 to characterize hydrology and water quality conditions in the Project area. As expected and as previously documented (e.g., Nowak and Kuchenbecker 2004), the data collected in 2012 confirm that overall water quality in the streams in the Project area is excellent, due to the relatively pristine location and physical characteristics of the watershed areas, most of which lie within the Eagle Cap Wilderness Area.

4.1.1 Flow

The overall average annual flow for WY 2010 at the five gaged study sites was 21.1, 19.5, 10.9, 10.5, and 1.8 cfs, respectively, at sites EFI, BPL, BPU, PHT, and RPI. Flows at the EFI site were normal in most months compared to the available 58-year historic data (1924 through 1983) from nearby USGS gages. The exceptions were March and September, which were dry by comparison, and April, which was wet by comparison. Flows further downstream in the bypassed reach at site BPL were normal in the spring and summer months (i.e., May through September), but were wet by comparison in the winter months, particularly in December and January when average monthly flows were higher than any recorded previously in the available 58-year historic data. As described in section 3.1.3.3 above, these wet winter conditions were the result of substantial peak flows caused at lower elevations by rain-on-snow events that were recorded at the lower elevation BPL site during WY 2012.

Flows at site PHT, indicative of flow-related powerhouse operations, were relatively uniform throughout much of year at flow levels between about 10 and 14 cfs, with a few relatively short periods of negligible flow when powerhouse operations were stopped for maintenance purposes. Average monthly flows at the PHT site ranged from 5.3 cfs in January to 13.8 cfs in October, which corresponded to (i.e., were within) standard operations at the Project powerhouse. The maximum hydraulic capacity of the powerhouse is 16 cfs, and the total amount of flow diverted to the Project powerhouse typically ranges from 3 to 16 cfs (PacifiCorp 2011b).

The differences in flows between the BPU and BPL sites were used to estimate accretion of flow in the Project bypassed reach. These estimates indicate that accretion of flow in the reach varies by time of year and runoff conditions. During the fall, winter, and spring periods of more active watershed runoff events from rain storms, rain-on-snow, or snowmelt, accretion is appreciable (typically 5 cfs or greater) and at times substantial (e.g., nearly 20 cfs on average in December). By contrast, during the dry late summer period, estimates suggested that accretion was low or absent.

4.1.2 Water Temperature

The observed water temperatures conditions at the study sites are indicative of an overall cold thermal regime in the streams of the Project area. For example, the peak 7-DAD

Max water temperatures for the study sites were 15.0°C, 14.2°C, 13.9°C, 12.9°C, and 12.4°C at sites WFI, WRC, BPL, EFI, and RPI occurring in mid-summer. Minimum water temperatures ranged from about 1.0 to 3.0 °C in mid-winter, and were similar among the sites. Of the five thermal classifications (i.e., cold, cold-cool, cool, cool-warm, and warm) for temperate streams in the U.S. and Canada developed by Chu et al. (2009), the coldest (i.e., "cold") classification includes locations that have daily maximum water temperatures of 15.9°C or less. Based on the data obtained in this study, all of the study sites fall within this "cold" classification.

The overall cold thermal regime in the streams of the Project area is driven primarily by the high-elevation location and associated climatic influence. Carr (2003) determined that location in the watershed and climatic influence, from both maximum and minimum air temperature, are dominant factors with respect to water temperatures patterns of stream in northeastern Oregon. Carr (2003) showed that elevation, through its association with reach location in the watershed and attendant time of thermal energy exposure, is strongly correlated with the daily maximum stream temperature. The northerly aspects of the watersheds in the Project area probably also influence the colder thermal conditions.

Based on comparison of the main inflow sites (sites EFI and WFI), the water temperatures in the East Fork are generally cooler than the West Fork during summer. The data suggest that the cooler water temperatures in the East Fork are the result of a smaller watershed area draining to the EFI site compared to the WFI site. The larger drainage area to the WFI has comparatively lower mean elevation, lower average gradient, greater stream width, and longer stream reach length in the West Fork, which are factors that act to cause a relatively higher rate of stream heating as waters flow downstream (Isaak and Hubert 2001).

The comparison of water temperature trends between the BPU and BPL sites indicates that flows are consistently warmer at BPL from spring through summer. The warming of flows as they travel downstream in the bypassed reach, particularly during summer, is reasonable to expect given that the gradient of the reach drops from about 5,800 to 4,600 ft in elevation between the two sites. As discussed in section 3.2.3 above, elevation is expected to have a direct effect of on the rate of stream heating, particularly in mountain landscapes, because of the adiabatic lapse rate, which can result in heating of air temperatures by about 3.5°C per 1,000 feet drop in elevation (Isaak and Hubert 2001, Satterlund and Adams 1992). The additional reach length between sites (about 2 mi) also increases the time that flows can be exposed to solar radiation and air temperatures during the day.

4.1.3 Dissolved Oxygen

Dissolved oxygen was at or near full saturation (100 percent) in all measurements at each of the sites during the sampling events of August and September 2012 at concentrations between about 9.0 and 11.5 mg/L. As discussed in section 3.3.2.3 above, the relatively high elevation of the Project area is an important factor in interpreting the results of the dissolved oxygen data collected for this study. There is a direct relationship between atmospheric pressure and dissolved oxygen—at higher elevations, where air pressure

decreases relative to sea level, the relative oxygen solubility decreases. Elevation-related effects will be further assessed with pending data from the October sampling event in the Water Resources Final Technical Report that PacifiCorp plans to issue in June 2013.

4.1.4 Total Dissolved Gas

The TDG measurements (in percent-saturation) at the powerhouse tailrace site were all at or near 100 percent saturation. These values indicate that TDG supersaturation (i.e., TDG saturation greater than 110 percent) from potential turbine air entrainment is not a concern at the Project powerhouse. Although air entrainment through turbines can lead to gas supersaturation, the situation is not common and increased gas pressure from this cause is usually not substantial.

4.2 Recommendations

Pending acquisition of remaining 2012 data and additional analysis of the data, assessment of potential Project-related effects on hydrology and water quality will be provided in the Water Resources Final Technical Report that PacifiCorp plans to issue in June 2013. The Water Resources Final Technical Report also will include a specific assessment of compliance of the study parameters relative to State of Oregon water quality standards as summarized in Table 2-4. No actions or adjustments regarding the Water Resources Study, including additional data collection in 2013, are recommended at this time.

5.0 REFERENCES

Carr, C. 2003. The Influence of Environmental and Physical Factors on the Thermal Patterns of Headwater Streams. Master of Science Thesis, Rangeland Resources, Oregon State University. 168 pp.

Chu, C., N. Jones, A. Piggott, and J. Buttle. 2009. Evaluation of a Simple Method to Classify the Thermal Characteristics of Streams Using a Nomogram of Daily Maximum Air and Water Temperatures. North American Journal of Fisheries Management 29:1605-1619.

Eddy, B. 1985. Letter from Bruce Eddy (PacifiCorp) to Glen Carter (Oregon Department of Environmental Quality) on dissolved oxygen sampling for the Wallowa Falls Hydroelectric Project. August 7, 1985. 2 pages.

Gordon, N.D., T.A. McMahon, B.L. Finlayson, C. J. Gippel, and R.J. Nathan. 2004. Stream Hydrology: An Introduction for Ecologists, 2nd Edition. John Wiley and Sons Publishers. June 2004.

Isaak, D. and W. Hubert. 2001. A Hypothesis About Factors That Affect Maximum Summer Stream Temperatures Across Montane Landscapes. Journal of the American Water Resources Association 37 (2), 351-366.

Maloney, S., A. Tiedemann, D. Higgins, T. Quigley, and D. Marx. 1999. Influence of stream characteristics and grazing intensity on stream temperatures in eastern Oregon. Gen. Tech. Rep. PNW-GTR-459. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 19 p.

NNPSMP. 2008. Surface Water Flow Measurement for Water Quality Monitoring Project. National Nonpoint Source Monitoring Program. Tech Notes 3. March 2008.

Nowak, M.C. and L. Kuchenbecker. 2004. Grande Ronde Subbasin Plan. Prepared for the Northwest Power and Conservation Council. Prepared by Cat Tracks Wildlife Consulting and the Grande Ronde Model Watershed Program. May 28, 2004.

PacifiCorp. 2011a. Revised Study Plan—Water Resources. Wallowa Falls Hydroelectric Project, FERC Project No. 308. Prepared by PacifiCorp Energy, Hydro Resources. December 2011.

PacifiCorp. 2011b. Pre-Application Document (PAD) for PacifiCorp's Wallowa Falls Hydroelectric Project, FERC Project No. 308. Prepared by PacifiCorp Energy. Submitted to Federal Energy Regulatory Commission. February 23, 2011.

PacifiCorp. 2012. Technical Memorandum. Wallowa Falls Hydroelectric Project Sediment and Substrate Characterization. Prepared for the U.S. Fish and Wildlife Service, La Grande Fish and Wildlife Office, La Grande, Oregon. Prepared by PacifiCorp Energy, Portland, Oregon. November 20, 2012.

Rantz, S.E., and others. 1982. Measurement and computation of streamflow—Volume 1. Measurement of stage and discharge—Volume 2. Computation of discharge: U.S. Geological Survey Water-Supply Paper 2175, 631 p.

Riggs, H.C. 1973. Regional Analyses of Streamflow Characteristics. U.S. Geological Survey, Techniques of Water-Resources Investigations, Book 4, Chapter B3.

Sanborn, S.C., and B.P. Bledsoe. 2006. Predicting streamflow regime metrics for ungauged streams in Colorado, Washington, and Oregon. Journal of Hydrology. Volume 325, Issues 1-4, 30 June 2006, Pages 241-261.

Satterlund, D.R. and P.W. Adams. 1992. Wildland watershed management. 2nd ed. John Wiley & Sons Inc. New York.

USGS. 2001. US Geological Survey, 2001. Methods for Estimating Flood Magnitude and Frequency in Washington, 2001. U.S. Geological Survey Fact Sheet 016-01.

Washington Department of Ecology (WDOE). 2004. Water Quality Certifications for Existing Hydropower Dams: Preliminary Guidance Manual. Pub. No. 04-10-022. Olympia WA.

Appendix A
Hydrology Data

Table A-1. Daily Average Flow (cfs) at Gage Sites During Water Year 2012. Wallowa Falls Hydroelectric Project Water Resources Study.

Date	Royal Purple Inflow (RPI)	East Fork Inflow (EFI)	Bypassed Reach: Upper (BPU)	Bypassed Reach: Lower (BPL)	Powerhouse Tailrace (PHT)
10/1/2011			3.8		13.8
10/2/2011			3.7		13.8
10/3/2011			3.4		13.8
10/4/2011			3.9		13.8
10/5/2011			4.8		13.8
10/6/2011			4.8		13.9
10/7/2011			5.6		13.8
10/8/2011			4.8		13.9
10/9/2011			4.4		13.9
10/10/2011			6.2		13.8
10/11/2011			8.0		13.8
10/12/2011			4.8		13.8
10/13/2011			4.5		13.8
10/14/2011			4.6		13.8
10/15/2011			4.4		13.7
10/16/2011			4.7		13.7
10/17/2011			4.2		13.8
10/18/2011			3.8		13.8
10/19/2011			3.7		13.8
10/20/2011		16.6	3.5		13.8
10/21/2011		17.3	3.9		13.7
10/22/2011		16.6	3.6		13.7
10/23/2011		15.9	3.2		13.7
10/24/2011		16.2	3.4		13.7
10/25/2011		15.4	2.9		13.8
10/26/2011		15.3	2.6		13.9
10/27/2011		15.5	2.8		13.9
10/28/2011		15.0	2.6		13.9
10/29/2011		14.7	2.7		13.8
10/30/2011		14.3	2.7		13.8
10/31/2011		14.6	2.9		13.8
11/1/2011		14.4	2.2		13.8
11/2/2011		14.5	2.1		13.7
11/3/2011		14.4	2.1		13.4
11/4/2011		15.7	2.5		13.7
11/5/2011		14.1	1.6		12.7
11/6/2011		15.8	1.7		13.7
11/7/2011		15.7	1.8		13.1
11/8/2011		15.9	2.8		12.7
11/9/2011		15.7	1.9		13.7
11/10/2011		14.5	2.0		13.7
11/11/2011		14.1	1.8		13.7
11/12/2011		14.8	1.6		13.6

Table A-1. Daily Average Flow (cfs) at Gage Sites During Water Year 2012. Wallowa Falls Hydroelectric Project Water Resources Study.

Date	Royal Purple Inflow (RPI)	East Fork Inflow (EFI)	Bypassed Reach: Upper (BPU)	Bypassed Reach: Lower (BPL)	Powerhouse Tailrace (PHT)
11/13/2011		15.4	1.9		13.7
11/14/2011		15.2	2.2		13.3
11/15/2011		15.0	1.8		13.8
11/16/2011		15.1	1.9		13.4
11/17/2011		14.8	2.0		14.0
11/18/2011		14.0	2.0		14.0
11/19/2011		16.4	2.3		14.0
11/20/2011		16.7	2.2		14.0
11/21/2011		15.8	1.9		14.0
11/22/2011		14.6	1.7		13.7
11/23/2011		14.7	3.0		12.9
11/24/2011		14.8	1.9		14.0
11/25/2011		14.5	1.7		13.9
11/26/2011		15.2	1.7		14.0
11/27/2011		13.3	1.3		13.9
11/28/2011		13.5	1.2		13.9
11/29/2011		14.1	1.4		13.9
11/30/2011		14.5	1.2	1.2	13.9
12/1/2011		15.3	1.2	1.5	13.4
12/2/2011		15.7	1.0	1.6	13.8
12/3/2011		15.7	1.0	7.4	13.5
12/4/2011		15.5	0.9	7.2	13.8
12/5/2011		16.1	0.9	8.8	13.6
12/6/2011		15.2	0.8	23.5	13.7
12/7/2011		15.6	0.8	44.7	13.6
12/8/2011		15.9	0.9	59.2	13.4
12/9/2011		15.7	0.9	66.9	13.5
12/10/2011		14.6	0.8	79.5	13.6
12/11/2011		15.3	0.8	71.4	13.5
12/12/2011		15.6	0.9	56.8	13.4
12/13/2011		15.6	0.9	67.2	13.1
12/14/2011		15.1	0.8	75.0	13.0
12/15/2011		14.8	0.8	13.7	13.2
12/16/2011		14.9	0.8	0.6	12.9
12/17/2011		14.0	0.7	0.6	13.1
12/18/2011		13.9	0.7	0.7	13.3
12/19/2011		14.4	1.6	7.6	12.2
12/20/2011		14.5	0.8	0.6	12.5
12/21/2011		14.6	1.7	2.1	11.2
12/22/2011		14.8	2.2	8.6	10.8
12/23/2011		14.5	2.2	7.2	10.9
12/24/2011		13.6	2.0	9.3	10.9
12/25/2011		11.5	1.7	1.9	10.9

Table A-1. Daily Average Flow (cfs) at Gage Sites During Water Year 2012. Wallowa Falls Hydroelectric Project Water Resources Study.

Date	Royal Purple Inflow (RPI)	East Fork Inflow (EFI)	Bypassed Reach: Upper (BPU)	Bypassed Reach: Lower (BPL)	Powerhouse Tailrace (PHT)
12/26/2011		12.3	1.7	1.8	10.8
12/27/2011		12.1	1.7	1.9	10.8
12/28/2011		14.7	3.6	4.5	10.8
12/29/2011		15.4	4.6	6.8	9.9
12/30/2011		15.6	4.9	7.5	9.8
12/31/2011		14.8	4.1	8.3	9.8
1/1/2012		14.9	3.7	8.3	9.7
1/2/2012		12.4	2.8	3.8	9.8
1/3/2012		12.6	2.8	3.6	9.8
1/4/2012		12.2	2.5	3.5	9.9
1/5/2012		11.6	2.4	3.8	9.8
1/6/2012		12.7	2.7	5.8	9.8
1/7/2012		13.6	2.8	5.4	9.8
1/8/2012		12.8	2.5	4.1	9.8
1/9/2012		12.3	2.3	3.1	9.8
1/10/2012		11.7	2.1	3.5	9.8
1/11/2012		13.7	2.3	15.0	9.9
1/12/2012		13.3	2.4	42.0	9.9
1/13/2012		12.5	4.6	65.1	7.6
1/14/2012		11.4	8.7	69.9	2.1
1/15/2012		12.2	9.5	22.8	2.1
1/16/2012		12.7	9.9	61.9	2.1
1/17/2012		13.0	10.1	99.2	2.1
1/18/2012		12.1	9.1	82.1	2.1
1/19/2012		10.7	8.3	13.0	2.1
1/20/2012		11.7	9.0	12.7	2.1
1/21/2012		11.9	9.2	15.5	2.1
1/22/2012		12.9	10.1	14.8	2.1
1/23/2012		12.5	9.8	16.3	2.1
1/24/2012		12.6	9.7	19.5	2.1
1/25/2012		11.1	8.6	14.4	2.1
1/26/2012		11.0	8.7	14.5	2.1
1/27/2012		12.3	9.7	30.2	2.1
1/28/2012		12.4	9.5	51.8	2.1
1/29/2012		10.5	8.3	12.0	2.1
1/30/2012		10.6	8.4	13.7	2.1
1/31/2012		11.2	8.9	13.2	2.1
2/1/2012		11.2	10.2	16.1	2.1
2/2/2012		11.4	10.1	15.9	2.3
2/3/2012		11.7	9.2	37.6	2.4
2/4/2012		11.7	9.3	37.4	2.1
2/5/2012		11.5	9.1	14.8	2.1
2/6/2012		11.5	9.1	15.7	2.1

Table A-1. Daily Average Flow (cfs) at Gage Sites During Water Year 2012. Wallowa Falls Hydroelectric Project Water Resources Study.

Date	Royal Purple Inflow (RPI)	East Fork Inflow (EFI)	Bypassed Reach: Upper (BPU)	Bypassed Reach: Lower (BPL)	Powerhouse Tailrace (PHT)
2/7/2012		11.1	8.8	14.8	2.1
2/8/2012		10.3	6.1	12.9	4.5
2/9/2012		9.9	0.9	2.2	11.1
2/10/2012		9.7	0.8	2.1	11.0
2/11/2012		9.9	0.9	2.2	11.0
2/12/2012		10.1	0.9	1.9	11.0
2/13/2012		10.6	0.9	2.6	11.0
2/14/2012		10.8	0.9	2.4	11.0
2/15/2012		10.9	0.9	5.0	11.0
2/16/2012		10.9	0.8	8.1	11.0
2/17/2012		10.5	0.8	10.7	10.9
2/18/2012		10.1	0.8	1.7	10.9
2/19/2012		10.7	0.9	1.8	10.9
2/20/2012		10.8	0.8	2.5	10.9
2/21/2012		10.7	1.1	2.6	10.9
2/22/2012		11.1	1.6	4.6	11.0
2/23/2012		10.6	1.1	2.6	11.0
2/24/2012		10.4	1.0	3.0	10.9
2/25/2012		10.3	0.9	2.8	10.9
2/26/2012		10.9	1.1	5.4	11.0
2/27/2012		11.0	1.0	13.9	10.9
2/28/2012		10.8	0.9	33.7	10.8
2/29/2012		10.8	1.0	36.9	10.9
3/1/2012		11.2	1.0	42.5	10.9
3/2/2012		11.0	1.0	35.3	10.9
3/3/2012		9.9	0.8	8.6	10.9
3/4/2012		9.1	0.7	1.5	11.0
3/5/2012		8.9	0.7	1.3	10.9
3/6/2012		9.6	0.7	1.8	10.7
3/7/2012		9.9	0.8	5.3	10.8
3/8/2012		9.2	0.7	3.0	10.7
3/9/2012		7.9	0.5	1.2	10.8
3/10/2012		8.1	0.6	1.3	10.8
3/11/2012		8.5	0.6	1.6	10.7
3/12/2012		8.4	0.9	1.6	9.8
3/13/2012		7.8	4.7	13.9	5.5
3/14/2012		10.0	3.5	8.8	7.7
3/15/2012		11.2	1.8	5.3	10.9
3/16/2012		12.2	2.5	7.5	10.8
3/17/2012		10.7	1.5	4.6	10.8
3/18/2012		10.9	1.4	3.6	10.9
3/19/2012		10.5	1.2	4.9	10.8
3/20/2012		10.0	1.0	3.9	10.9

Table A-1. Daily Average Flow (cfs) at Gage Sites During Water Year 2012. Wallowa Falls Hydroelectric Project Water Resources Study.

Date	Royal Purple Inflow (RPI)	East Fork Inflow (EFI)	Bypassed Reach: Upper (BPU)	Bypassed Reach: Lower (BPL)	Powerhouse Tailrace (PHT)
3/21/2012		10.3	1.2	3.0	10.9
3/22/2012		11.1	1.5	4.6	10.8
3/23/2012		10.3	1.0	2.9	10.9
3/24/2012		9.7	0.8	2.1	10.9
3/25/2012		9.5	0.9	2.4	10.8
3/26/2012		9.7	1.1	3.5	10.8
3/27/2012		9.2	0.8	2.2	10.9
3/28/2012		9.3	0.8	3.1	10.8
3/29/2012		9.1	0.7	2.2	10.9
3/30/2012		12.5	2.7	9.0	10.4
3/31/2012		13.3	3.3	12.1	10.7
4/1/2012		12.1	2.2	10.2	10.8
4/2/2012		11.0	1.5	6.2	10.8
4/3/2012		10.2	1.2	4.7	10.8
4/4/2012		10.4	1.3	5.7	10.8
4/5/2012		10.3	2.0	6.8	9.9
4/6/2012		10.0	0.9	3.9	10.8
4/7/2012		9.6	0.8	6.6	10.8
4/8/2012		8.9	0.7	3.0	10.7
4/9/2012		8.9	0.7	3.1	10.7
4/10/2012		11.0	1.2	4.0	10.8
4/11/2012		13.3	1.7	5.9	10.7
4/12/2012		12.9	1.5	6.0	10.7
4/13/2012		12.5	1.3	4.8	10.7
4/14/2012		12.7	1.3	3.4	10.8
4/15/2012		12.3	1.2	3.2	10.7
4/16/2012		12.5	1.3	3.4	10.7
4/17/2012		12.7	1.3	3.5	10.7
4/18/2012		12.6	1.3	3.6	10.7
4/19/2012		12.9	1.4	3.8	10.8
4/20/2012		15.6	3.0	6.7	10.8
4/21/2012		17.6	4.5	10.0	10.8
4/22/2012		21.2	7.0	15.5	10.7
4/23/2012		26.1	11.8	22.7	10.3
4/24/2012		30.3	17.0	30.8	10.8
4/25/2012		30.6	17.0	26.4	10.8
4/26/2012		39.7	27.6	38.9	10.7
4/27/2012		31.4	18.5	30.2	10.7
4/28/2012		27.6	13.2	21.6	10.7
4/29/2012		25.6	10.6	16.3	10.5
4/30/2012		27.4	12.8	22.9	10.5
5/1/2012		26.8	11.7	20.6	10.8
5/2/2012		25.1	9.9	16.4	10.8

Table A-1. Daily Average Flow (cfs) at Gage Sites During Water Year 2012. Wallowa Falls Hydroelectric Project Water Resources Study.

Date	Royal Purple Inflow (RPI)	East Fork Inflow (EFI)	Bypassed Reach: Upper (BPU)	Bypassed Reach: Lower (BPL)	Powerhouse Tailrace (PHT)
5/3/2012		24.2	9.4	15.7	10.8
5/4/2012		23.2	8.7	14.0	10.7
5/5/2012		21.1	7.2	11.9	10.8
5/6/2012		19.7	6.3	9.4	10.6
5/7/2012		19.7	6.3	9.0	10.7
5/8/2012		21.2	7.4	11.4	10.7
5/9/2012		23.7	8.3	13.8	12.0
5/10/2012		24.3	6.6	10.3	14.7
5/11/2012		24.4	6.4	9.3	14.7
5/12/2012		24.8	7.2	10.8	14.7
5/13/2012		26.3	9.3	15.0	14.7
5/14/2012		28.1	12.4	20.6	14.8
5/15/2012		31.6	17.2	27.5	14.8
5/16/2012		36.1	21.7	31.4	14.8
5/17/2012		36.5	21.5	30.2	14.9
5/18/2012		34.3	19.5	27.5	14.9
5/19/2012		34.2	19.1	26.9	14.9
5/20/2012		35.1	20.4	28.8	14.8
5/21/2012		44.1	28.9	36.1	14.9
5/22/2012		51.0	35.3	42.2	15.0
5/23/2012		41.4	29.1	37.1	14.0
5/24/2012		38.7	28.4	34.2	10.6
5/25/2012		36.6	25.9	30.3	11.0
5/26/2012		34.5	23.1	27.6	10.9
5/27/2012		31.8	20.3	25.7	10.8
5/28/2012		30.1	18.5	23.9	10.9
5/29/2012		30.3	19.0	24.7	10.9
5/30/2012		30.4	20.9	25.0	10.8
5/31/2012	0.8	31.3	23.1	28.6	10.8
6/1/2012	0.4	35.0	26.9	34.4	10.8
6/2/2012	0.5	42.2	35.4	40.8	10.4
6/3/2012	0.4	47.2	38.4	42.8	10.8
6/4/2012	0.3	61.0	45.3	52.4	10.7
6/5/2012	0.9	72.8	52.7	67.5	10.5
6/6/2012	0.5	58.8	45.5	55.1	10.7
6/7/2012	0.2	48.5	40.2	47.6	10.6
6/8/2012	0.4	44.6	36.3	44.2	10.6
6/9/2012	1.7	39.3	31.7	40.7	10.6
6/10/2012	2.4	35.8	26.6	36.9	10.8
6/11/2012	1.3	34.2	24.6	33.4	10.7
6/12/2012	1.1	34.1	24.7	35.1	12.4
6/13/2012	1.0	36.4	25.7	36.0	14.2
6/14/2012	2.2	37.7	26.8	37.4	14.2

Table A-1. Daily Average Flow (cfs) at Gage Sites During Water Year 2012. Wallowa Falls Hydroelectric Project Water Resources Study.

Date	Royal Purple Inflow (RPI)	East Fork Inflow (EFI)	Bypassed Reach: Upper (BPU)	Bypassed Reach: Lower (BPL)	Powerhouse Tailrace (PHT)
6/15/2012	2.5	41.8	30.7	42.8	14.2
6/16/2012	0.5	50.4	37.2	48.1	14.2
6/17/2012	0.2	60.6	39.0	54.8	14.2
6/18/2012	0.9	72.8	43.8	65.6	14.3
6/19/2012	1.8	60.2	42.6	54.0	14.3
6/20/2012	0.6	47.3	32.6	41.5	14.3
6/21/2012	0.0	44.7	29.1	38.6	14.3
6/22/2012	0.1	52.6	32.9	46.0	14.3
6/23/2012	0.6	67.0	39.5	62.3	14.3
6/24/2012	0.4	66.0	40.1	61.3	14.3
6/25/2012	0.7	63.6	40.0	61.5	14.3
6/26/2012	1.3	71.2	41.5	66.3	14.3
6/27/2012	1.2	59.1	40.9	49.6	14.3
6/28/2012	2.1	54.1	43.1	42.5	14.3
6/29/2012	1.2	58.9	46.5	44.7	13.4
6/30/2012	1.3	59.6	47.1	45.7	13.5
7/1/2012	0.8	67.5	52.1	52.9	13.6
7/2/2012	1.1	65.4	51.5	50.9	13.7
7/3/2012	1.1	67.6	53.2	55.0	13.6
7/4/2012	1.4	61.7	51.2	48.6	13.6
7/5/2012	2.6	57.1	45.8	43.6	13.5
7/6/2012	3.5	56.0	50.8	52.8	6.9
7/7/2012	3.6	56.7	51.5	57.4	2.1
7/8/2012	3.1	54.9	52.6	56.0	2.1
7/9/2012	2.9	53.2	50.2	55.6	2.1
7/10/2012	2.6	49.5	50.8	53.0	2.1
7/11/2012	1.8	46.5	49.3	50.5	2.1
7/12/2012	1.7	42.7	45.8	47.7	2.1
7/13/2012	1.5	42.1	37.1	42.0	6.7
7/14/2012	0.8	47.1	39.2	41.2	10.2
7/15/2012	0.6	44.5	36.4	37.3	10.1
7/16/2012	0.9	42.7	34.4	35.1	10.0
7/17/2012	1.5	38.1	32.6	26.9	9.8
7/18/2012	2.2	37.1	28.5	25.4	9.9
7/19/2012	2.7	35.3	25.7	23.5	9.9
7/20/2012	3.4	33.6	23.7	23.4	10.0
7/21/2012	1.8	32.6	22.5	21.1	10.0
7/22/2012	2.6	31.5	21.0	20.7	9.9
7/23/2012	2.1	29.6	20.0	20.5	9.9
7/24/2012	1.9	28.5	19.2	20.8	9.9
7/25/2012	1.6	26.9	14.0	16.0	13.8
7/26/2012	1.7	25.2	12.9	13.4	13.5
7/27/2012	2.7	24.1	12.1	12.4	13.6

Table A-1. Daily Average Flow (cfs) at Gage Sites During Water Year 2012. Wallowa Falls Hydroelectric Project Water Resources Study.

Date	Royal Purple Inflow (RPI)	East Fork Inflow (EFI)	Bypassed Reach: Upper (BPU)	Bypassed Reach: Lower (BPL)	Powerhouse Tailrace (PHT)
7/28/2012	2.9	23.2	11.8	12.0	13.4
7/29/2012	2.4	22.2	11.4	10.6	12.9
7/30/2012	2.7	21.7	10.8	10.5	12.8
7/31/2012	3.1	21.6	10.0	9.5	12.8
8/1/2012	2.3	20.3	9.5	8.8	12.8
8/2/2012	2.4	20.3	9.2	8.3	12.8
8/3/2012	2.5	19.6	8.8	8.0	12.8
8/4/2012	2.7	19.5	8.4	7.2	12.7
8/5/2012	4.1	19.0	7.7	6.8	12.6
8/6/2012	3.1	17.8	6.9	7.1	10.4
8/7/2012	3.4	17.9	6.9	6.0	12.7
8/8/2012	3.2	17.6	6.7	6.3	12.6
8/9/2012	2.0	17.7	6.7	5.6	12.5
8/10/2012	2.6	17.0	6.4	5.6	12.6
8/11/2012	2.5	16.9	6.2	5.4	12.6
8/12/2012	2.4	16.6	5.8	5.1	12.6
8/13/2012	1.7	16.5	16.6	16.6	5.7
8/14/2012	1.7	15.7	20.7	21.9	2.1
8/15/2012	2.4	15.4	19.9	18.0	2.1
8/16/2012	3.0	15.5	14.6	12.5	5.0
8/17/2012	2.3	15.8	5.0	3.6	13.9
8/18/2012	2.1	15.3	4.7	3.6	14.2
8/19/2012	2.2	14.9	4.5	3.9	14.2
8/20/2012	1.3	14.9	4.5	3.9	14.2
8/21/2012	1.6	14.7	5.7	5.0	11.8
8/22/2012	1.0	14.7	7.7	6.4	10.4
8/23/2012	1.3	15.5	5.9	4.7	12.5
8/24/2012	0.5	16.7	11.0	9.0	9.0
8/25/2012	0.4	16.6	19.9	17.5	2.1
8/26/2012	1.3	16.1	18.9	16.9	2.1
8/27/2012	1.0	15.6	18.5	17.1	2.1
8/28/2012	1.3	15.7	18.4	16.5	2.1
8/29/2012	0.8	15.6	18.7	17.0	2.1
8/30/2012	0.3	16.0	19.5	16.0	2.1
8/31/2012	1.1	15.7	19.2	16.1	2.1
9/1/2012	1.7	15.6	18.1	17.2	2.1
9/2/2012	1.7	15.3	18.8	16.2	2.1
9/3/2012	2.3	15.1	18.6	15.7	2.1
9/4/2012	1.4	15.0	18.6	15.8	2.1
9/5/2012	1.5	14.9	18.3	14.8	2.1
9/6/2012	3.3	15.1	18.0	16.0	2.1
9/7/2012	2.5	14.8	17.7	15.5	2.1
9/8/2012	0.6	14.4	17.5	14.0	2.1

Table A-1. Daily Average Flow (cfs) at Gage Sites During Water Year 2012. Wallowa Falls Hydroelectric Project Water Resources Study.

Date	Royal Purple Inflow (RPI)	East Fork Inflow (EFI)	Bypassed Reach: Upper (BPU)	Bypassed Reach: Lower (BPL)	Powerhouse Tailrace (PHT)
9/9/2012	0.9	14.0	17.4	14.4	2.1
9/10/2012	2.0	14.4	16.8	15.4	2.1
9/11/2012	4.0	14.5	17.2	15.5	2.1
9/12/2012	4.4	14.6	17.5	15.2	2.1
9/13/2012	2.7	14.3	12.8	10.6	4.3
9/14/2012	2.4	13.9	4.0	3.1	11.7
9/15/2012	2.6	13.7	4.0	3.5	11.7
9/16/2012	2.6	13.6	4.0	3.5	11.7
9/17/2012	2.4	13.7	3.9	3.3	11.7
9/18/2012	3.1	13.5	3.8	3.3	11.7
9/19/2012	2.8	13.2	3.7	3.2	11.7
9/20/2012	1.8	13.2	3.7	3.1	11.7
9/21/2012	1.3	13.7	3.6	3.0	11.7
9/22/2012	1.5	13.2	3.5	3.1	11.7
9/23/2012	1.4	13.1	4.2	3.6	11.7
9/24/2012	1.0	13.9	4.5	3.6	11.8
9/25/2012	1.3	13.5	4.4	3.4	11.8
9/26/2012	1.4	12.8	4.1	3.3	11.7
9/27/2012	1.2	12.7	3.9	3.1	11.8
9/28/2012	2.1	12.5	3.8	3.1	11.7
9/29/2012	3.9	11.9	3.6	3.2	11.7
9/30/2012	3.1	11.8	3.5	3.2	11.7

Appendix B
Water Temperature Data

Table B-1. Daily Minimum, Mean, Maximum, and 7-DAD Max Water Temperature Values (°C) at Upper Bypassed Reach Site (BPU) During August 2011 Through September 2012.

Date	Daily Minimum	Daily Mean	Daily Maximum	7-D Max
8/1/2011	8.6	10.0	11.6	
8/2/2011	8.3	9.8	11.6	
8/3/2011	8.5	9.5	10.5	
8/4/2011	8.6	9.4	10.4	11.0
8/5/2011	8.0	9.4	11.3	10.7
8/6/2011	7.3	9.0	10.9	10.5
8/7/2011	7.3	8.8	10.4	10.5
8/8/2011	7.2	8.6	10.0	10.4
8/9/2011	7.4	8.6	10.2	10.3
8/10/2011	6.8	8.2	10.0	10.2
8/11/2011	6.5	8.2	10.0	10.0
8/12/2011	7.3	8.7	10.5	9.9
8/13/2011	7.5	8.8	10.3	10.0
8/14/2011	6.9	8.1	9.0	10.0
8/15/2011	6.1	7.7	9.5	10.0
8/16/2011	7.0	8.6	10.6	10.0
8/17/2011	6.4	8.1	10.1	10.0
8/18/2011	6.1	7.9	10.1	10.3
8/19/2011	6.3	8.1	10.3	10.4
8/20/2011	7.0	8.6	10.6	10.4
8/21/2011	7.2	8.7	10.6	10.5
8/22/2011	7.2	8.7	10.2	10.6
8/23/2011	7.1	8.9	10.8	10.7
8/24/2011	8.1	9.4	10.8	10.7
8/25/2011	7.6	9.2	11.0	10.7
8/26/2011	7.9	9.3	11.0	10.7
8/27/2011	8.0	9.4	10.8	10.3
8/28/2011	8.0	9.2	10.5	10.0
8/29/2011	7.1	8.4	9.9	9.6
8/30/2011	6.5	7.4	8.4	9.2
8/31/2011	5.3	6.6	8.2	8.8
9/1/2011	5.0	6.4	8.3	8.6
9/2/2011	4.6	6.2	8.0	8.5
9/3/2011	4.8	6.5	8.6	8.5
9/4/2011	5.9	7.2	8.8	8.6
9/5/2011	6.2	7.5	9.0	8.7
9/6/2011	6.2	7.3	8.4	8.8
9/7/2011	6.3	7.6	9.0	8.8
9/8/2011	5.9	7.4	8.9	8.8
9/9/2011	6.3	7.5	9.0	8.7
9/10/2011	6.5	7.5	8.6	8.7
9/11/2011	6.5	7.4	8.5	8.6
9/12/2011	6.2	7.4	8.7	8.4

Table B-1. Daily Minimum, Mean, Maximum, and 7-DAD Max Water Temperature Values (°C) at Upper Bypassed Reach Site (BPU) During August 2011 Through September 2012.

Date	Daily Minimum	Daily Mean	Daily Maximum	7-D Max
9/13/2011	5.8	7.1	8.3	8.1
9/14/2011	7.0	7.7	8.5	8.0
9/15/2011	5.8	6.7	7.5	7.9
9/16/2011	4.6	5.7	6.7	7.7
9/17/2011	6.1	6.7	7.6	7.5
9/18/2011	6.1	6.8	7.8	7.5
9/19/2011	4.8	6.0	7.2	7.6
9/20/2011	5.0	6.1	7.4	7.8
9/21/2011	5.5	6.6	8.1	7.8
9/22/2011	6.0	7.0	8.1	7.7
9/23/2011	5.9	7.0	8.2	7.8
9/24/2011	6.7	7.2	7.8	7.8
9/25/2011	5.1	6.4	7.2	7.7
9/26/2011	6.2	6.9	7.8	7.6
9/27/2011	6.3	6.7	7.2	7.6
9/28/2011	5.2	6.2	7.4	7.5
9/29/2011	6.3	7.0	7.9	7.5
9/30/2011	6.9	7.3	7.8	7.3
10/1/2011	6.1	6.7	7.2	7.2
10/2/2011	6.1	6.6	7.2	6.8
10/3/2011	6.2	6.3	6.6	6.4
10/4/2011	5.0	5.8	6.1	6.1
10/5/2011	4.5	4.7	4.9	5.9
10/6/2011	4.8	5.0	5.3	5.7
10/7/2011	5.0	5.3	5.8	5.5
10/8/2011	4.3	5.0	5.8	5.4
10/9/2011	5.1	5.3	5.5	5.6
10/10/2011	5.1	5.2	5.4	5.7
10/11/2011	4.4	4.9	5.4	5.8
10/12/2011	4.4	4.9	5.9	5.8
10/13/2011	5.2	5.7	6.4	5.8
10/14/2011	5.8	5.9	6.2	5.7
10/15/2011	5.3	5.8	6.0	5.7
10/16/2011	3.9	4.5	5.2	5.7
10/17/2011	3.9	4.4	5.0	5.6
10/18/2011	4.6	4.9	5.5	5.5
10/20/2011	4.0	4.7	5.5	5.3
10/21/2011	4.4	4.9	5.7	5.3
10/22/2011	3.9	4.7	5.4	5.0
10/23/2011	4.1	4.7	5.2	4.6
10/24/2011	2.5	3.9	4.6	4.3
10/25/2011	2.3	2.6	2.9	4.0
10/26/2011	1.8	2.6	3.3	3.8
10/27/2011	2.3	2.7	3.2	3.7

Table B-1. Daily Minimum, Mean, Maximum, and 7-DAD Max Water Temperature Values (°C) at Upper Bypassed Reach Site (BPU) During August 2011 Through September 2012.

Date	Daily Minimum	Daily Mean	Daily Maximum	7-D Max
10/28/2011	2.2	2.9	3.5	3.7
10/29/2011	3.2	3.5	3.8	3.7
10/30/2011	2.8	3.6	4.5	3.6
10/31/2011	2.8	3.7	4.4	3.5
11/1/2011	1.9	2.4	2.8	3.4
11/2/2011	2.3	2.5	2.7	3.2
11/3/2011	2.5	2.7	2.9	2.9
11/4/2011	2.1	2.4	2.7	2.6
11/5/2011	2.1	2.2	2.3	2.6
11/6/2011	2.2	2.4	2.6	2.6
11/7/2011	2.1	2.2	2.4	2.6
11/8/2011	2.0	2.3	2.5	2.6
11/9/2011	2.3	2.5	2.7	2.7
11/10/2011	2.5	2.7	3.0	2.7
11/11/2011	2.6	2.8	3.0	2.8
11/12/2011	2.4	2.6	2.9	2.8
11/13/2011	2.6	2.7	2.8	2.8
11/14/2011	2.6	2.7	2.8	2.8
11/15/2011	2.2	2.4	2.6	2.7
11/16/2011	2.1	2.3	2.6	2.6
11/17/2011	2.5	2.6	2.7	2.5
11/18/2011	2.2	2.3	2.5	2.5
11/19/2011	2.0	2.1	2.3	2.5
11/20/2011	2.2	2.3	2.4	2.6
11/21/2011	2.4	2.5	2.7	2.6
11/22/2011	2.5	2.7	2.8	2.7
11/23/2011	2.8	2.9	3.0	2.8
11/24/2011	2.8	2.9	3.0	2.9
11/25/2011	2.1	2.5	2.8	2.9
11/26/2011	2.1	2.4	2.8	2.9
11/27/2011	2.8	2.9	3.1	2.9
11/28/2011	2.6	2.9	3.0	2.8
11/29/2011	2.3	2.6	2.9	2.8
11/30/2011	2.4	2.6	2.9	2.7
12/1/2011	2.1	2.1	2.4	2.6
12/2/2011	2.1	2.2	2.3	2.5
12/3/2011	1.9	2.2	2.5	2.5
12/4/2011	2.2	2.4	2.6	2.4
12/5/2011	1.8	1.9	2.2	2.4
12/6/2011	2.2	2.3	2.5	2.4
12/7/2011	2.2	2.3	2.5	2.3
12/8/2011	1.9	2.0	2.2	2.3
12/9/2011	2.0	2.1	2.2	2.3
12/10/2011	2.1	2.2	2.3	2.2

Table B-1. Daily Minimum, Mean, Maximum, and 7-DAD Max Water Temperature Values (°C) at Upper Bypassed Reach Site (BPU) During August 2011 Through September 2012.

Date	Daily Minimum	Daily Mean	Daily Maximum	7-D Max
12/11/2011	2.1	2.2	2.2	2.2
12/12/2011	2.0	2.1	2.2	2.2
12/13/2011	1.8	1.9	2.0	2.2
12/14/2011	2.0	2.1	2.3	2.2
12/15/2011	2.2	2.2	2.3	2.2
12/16/2011	1.9	2.1	2.2	2.2
12/17/2011	2.0	2.1	2.1	2.2
12/18/2011	2.0	2.1	2.3	2.2
12/19/2011	1.8	2.0	2.2	2.1
12/20/2011	1.9	2.0	2.1	2.1
12/21/2011	1.8	1.9	2.0	2.2
12/22/2011	1.6	1.7	1.9	2.2
12/23/2011	1.9	2.1	2.3	2.3
12/24/2011	2.1	2.3	2.5	2.3
12/25/2011	2.4	2.5	2.6	2.4
12/26/2011	2.2	2.3	2.5	2.5
12/27/2011	2.4	2.5	2.7	2.6
12/28/2011	2.5	2.6	2.7	2.5
12/29/2011	2.3	2.4	2.5	2.5
12/30/2011	2.1	2.5	2.7	2.5
12/31/2011	1.6	1.8	2.1	2.5
1/1/2012	1.7	2.2	2.5	2.6
1/2/2012	2.5	2.6	2.7	2.6
1/3/2012	2.3	2.4	2.5	2.6
1/4/2012	2.5	2.7	2.9	2.5
1/5/2012	2.3	2.8	2.9	2.5
1/6/2012	1.7	1.9	2.2	2.5
1/7/2012	1.8	1.9	2.0	2.5
1/8/2012	2.0	2.3	2.6	2.4
1/9/2012	2.0	2.2	2.5	2.2
1/10/2012	2.0	2.4	2.6	2.2
1/11/2012	1.5	1.7	1.9	2.3
1/12/2012	1.4	1.5	1.7	2.2
1/13/2012	1.8	1.9	2.1	2.0
1/14/2012	2.1	2.2	2.4	1.9
1/15/2012	1.5	1.7	2.0	1.9
1/16/2012	1.4	1.4	1.5	2.0
1/17/2012	1.4	1.5	1.6	2.1
1/18/2012	1.7	1.9	2.2	2.1
1/19/2012	2.2	2.3	2.4	2.1
1/20/2012	2.2	2.3	2.4	2.2
1/21/2012	2.1	2.3	2.4	2.3
1/22/2012	1.6	1.8	2.1	2.3
1/23/2012	1.6	2.0	2.2	2.3

Table B-1. Daily Minimum, Mean, Maximum, and 7-DAD Max Water Temperature Values (°C) at Upper Bypassed Reach Site (BPU) During August 2011 Through September 2012.

Date	Daily Minimum	Daily Mean	Daily Maximum	7-D Max
1/24/2012	1.5	1.8	2.2	2.2
1/25/2012	2.2	2.4	2.4	2.2
1/26/2012	1.9	2.3	2.5	2.3
1/27/2012	1.5	1.6	1.8	2.3
1/28/2012	1.4	1.8	2.3	2.3
1/29/2012	2.2	2.4	2.6	2.3
1/30/2012	2.1	2.3	2.4	2.3
1/31/2012	1.9	2.1	2.3	2.3
2/1/2012	2.1	2.2	2.5	2.2
2/2/2012	1.6	1.9	2.1	2.1
2/3/2012	1.3	1.5	1.8	2.0
2/4/2012	1.5	1.7	1.9	2.0
2/5/2012	1.6	1.7	1.9	2.0
2/6/2012	1.5	1.6	1.8	2.1
2/7/2012	1.7	1.9	2.1	2.2
2/8/2012	2.0	2.2	2.4	2.3
2/9/2012	2.2	2.4	2.6	2.3
2/10/2012	2.4	2.5	2.7	2.4
2/11/2012	2.3	2.4	2.5	2.4
2/12/2012	1.8	2.1	2.3	2.3
2/13/2012	1.6	1.8	1.9	2.2
2/14/2012	1.7	1.9	2.0	2.1
2/15/2012	1.6	1.7	1.9	2.0
2/16/2012	1.5	1.7	2.0	2.0
2/17/2012	1.6	1.9	2.1	2.0
2/18/2012	1.8	1.9	2.0	2.0
2/19/2012	1.7	1.8	1.9	2.1
2/20/2012	1.6	1.8	2.1	2.1
2/21/2012	2.0	2.2	2.4	2.2
2/22/2012	2.0	2.4	2.6	2.2
2/23/2012	1.6	1.8	2.0	2.2
2/24/2012	1.4	1.8	2.2	2.1
2/25/2012	1.6	1.8	2.1	2.0
2/26/2012	1.5	1.7	1.8	1.9
2/27/2012	1.2	1.5	1.7	1.9
2/28/2012	1.3	1.5	1.7	1.8
2/29/2012	1.6	1.7	1.8	1.9
3/1/2012	1.7	1.7	1.8	1.9
3/2/2012	1.5	1.7	1.9	2.0
3/3/2012	1.9	2.1	2.3	2.0
3/4/2012	1.9	2.0	2.2	2.0
3/5/2012	1.9	2.0	2.1	2.0
3/6/2012	1.4	1.5	1.8	2.0
3/7/2012	1.2	1.4	1.7	2.0

Table B-1. Daily Minimum, Mean, Maximum, and 7-DAD Max Water Temperature Values (°C) at Upper Bypassed Reach Site (BPU) During August 2011 Through September 2012.

Date	Daily Minimum	Daily Mean	Daily Maximum	7-D Max
3/8/2012	1.6	1.8	2.1	2.0
3/9/2012	1.9	2.0	2.1	2.0
3/10/2012	1.9	2.0	2.1	2.0
3/11/2012	1.8	2.0	2.1	2.1
3/12/2012	1.4	1.6	2.0	2.2
3/13/2012	1.1	1.4	1.9	2.2
3/14/2012	1.7	2.0	2.4	2.3
3/15/2012	2.2	2.4	2.7	2.3
3/16/2012	2.0	2.4	2.6	2.4
3/17/2012	2.2	2.4	2.6	2.4
3/18/2012	1.5	1.9	2.2	2.4
3/19/2012	1.6	1.8	2.1	2.4
3/20/2012	1.7	1.9	2.1	2.4
3/21/2012	2.0	2.2	2.5	2.4
3/22/2012	2.3	2.4	2.5	2.5
3/23/2012	2.1	2.3	2.5	2.6
3/24/2012	1.9	2.3	2.9	2.7
3/25/2012	2.2	2.6	3.1	2.8
3/26/2012	2.3	2.5	2.9	2.8
3/27/2012	1.9	2.3	2.6	2.9
3/28/2012	2.4	2.5	2.8	2.9
3/29/2012	2.2	2.5	2.9	2.8
3/30/2012	2.3	2.6	2.8	2.8
3/31/2012	2.5	2.6	3.0	2.8
4/1/2012	2.1	2.4	2.7	2.8
4/2/2012	1.6	2.1	2.5	2.7
4/3/2012	2.1	2.5	3.0	2.5
4/4/2012	1.6	2.1	2.5	2.5
4/5/2012	1.6	1.8	2.1	2.4
4/6/2012	1.6	1.8	2.1	2.5
4/7/2012	1.3	1.7	2.3	2.6
4/8/2012	1.8	2.1	2.7	2.7
4/9/2012	1.9	2.4	3.0	2.9
4/10/2012	2.3	2.9	3.6	3.1
4/11/2012	2.6	2.9	3.5	3.3
4/12/2012	2.4	2.7	3.3	3.4
4/13/2012	2.2	2.7	3.3	3.4
4/14/2012	2.6	3.0	3.6	3.4
4/15/2012	2.3	2.8	3.2	3.4
4/16/2012	2.5	2.8	3.2	3.5
4/17/2012	2.4	2.8	3.6	3.6
4/18/2012	2.6	3.0	3.6	3.7
4/19/2012	2.6	3.1	3.7	3.8
4/20/2012	2.8	3.3	4.1	4.0

Table B-1. Daily Minimum, Mean, Maximum, and 7-DAD Max Water Temperature Values (°C) at Upper Bypassed Reach Site (BPU) During August 2011 Through September 2012.

Date	Daily Minimum	Daily Mean	Daily Maximum	7-D Max
4/21/2012	2.6	3.1	4.2	4.0
4/22/2012	2.6	3.2	4.3	4.0
4/23/2012	2.7	3.1	4.2	3.9
4/24/2012	2.6	3.0	3.7	3.7
4/25/2012	2.7	3.1	3.8	3.5
4/26/2012	2.1	2.5	2.9	3.5
4/27/2012	2.0	2.4	3.0	3.4
4/28/2012	2.0	2.5	2.9	3.4
4/29/2012	2.3	3.0	3.8	3.3
4/30/2012	2.9	3.2	3.7	3.3
5/1/2012	2.2	2.8	3.4	3.3
5/2/2012	2.2	2.7	3.4	3.3
5/3/2012	2.5	2.7	3.0	3.3
5/4/2012	2.3	2.5	2.6	3.4
5/5/2012	1.8	2.4	3.2	3.6
5/6/2012	1.8	2.7	3.8	3.8
5/7/2012	2.0	3.1	4.3	3.9
5/8/2012	2.7	3.6	4.8	4.1
5/9/2012	2.8	3.5	4.7	4.3
5/10/2012	2.2	2.9	3.9	4.5
5/11/2012	2.0	2.9	4.2	4.6
5/12/2012	2.3	3.2	4.6	4.7
5/13/2012	2.5	3.5	5.0	4.7
5/14/2012	2.8	3.7	5.1	4.7
5/15/2012	3.0	3.8	5.3	4.8
5/16/2012	2.9	3.7	5.0	4.8
5/17/2012	3.0	3.4	4.1	4.8
5/18/2012	2.4	3.2	4.4	4.6
5/19/2012	2.4	3.3	4.7	4.4
5/20/2012	2.9	3.7	5.0	4.2
5/21/2012	3.2	3.6	4.2	4.1
5/22/2012	2.9	3.2	3.6	3.9
5/23/2012	2.6	3.0	3.6	3.7
5/24/2012	2.5	2.9	3.3	3.5
5/25/2012	2.7	2.8	3.0	3.6
5/26/2012	2.7	2.9	3.1	3.9
5/27/2012	2.8	3.3	3.9	4.2
5/28/2012	2.8	3.7	4.8	4.7
5/29/2012	3.1	4.0	5.5	5.3
5/30/2012	3.2	4.2	5.7	5.6
6/1/2012	2.9	4.4	6.6	5.8
6/2/2012	2.7	4.5	7.6	6.1
6/3/2012	2.9	3.8	4.8	5.8
6/4/2012	2.8	4.0	5.5	5.7

Table B-1. Daily Minimum, Mean, Maximum, and 7-DAD Max Water Temperature Values (°C) at Upper Bypassed Reach Site (BPU) During August 2011 Through September 2012.

Date	Daily Minimum	Daily Mean	Daily Maximum	7-D Max
6/5/2012	3.0	4.5	7.0	5.4
6/6/2012	2.3	2.7	2.9	4.9
6/7/2012	1.9	3.3	5.6	4.7
6/8/2012	2.2	3.2	4.5	4.8
6/9/2012	2.5	3.2	4.2	4.7
6/10/2012	2.1	2.8	3.5	5.3
6/11/2012	2.6	3.9	5.8	5.7
6/12/2012	2.4	4.2	6.6	6.2
6/13/2012	3.6	5.0	7.2	6.8
6/14/2012	3.1	5.0	8.1	7.4
6/15/2012	2.4	4.8	8.2	7.9
6/16/2012	3.0	5.0	8.1	7.7
6/17/2012	3.0	5.1	7.9	7.3
6/18/2012	4.6	6.1	8.9	7.4
6/19/2012	3.6	4.6	5.8	7.6
6/20/2012	2.7	3.6	4.4	7.8
6/21/2012	2.8	5.1	8.3	8.0
6/22/2012	3.9	6.3	9.7	8.0
6/23/2012	5.4	7.1	9.7	8.6
6/24/2012	5.6	6.8	8.9	9.1
6/25/2012	5.2	6.9	9.5	9.2
6/26/2012	5.1	7.2	9.9	9.4
6/27/2012	4.9	6.1	7.4	9.4
6/28/2012	4.1	6.4	9.5	9.7
6/29/2012	5.3	7.8	10.9	9.6
6/30/2012	6.6	8.0	9.8	9.8
7/1/2012	6.2	8.3	10.6	10.2
7/2/2012	6.9	8.0	9.1	10.4
7/3/2012	5.9	8.1	11.0	10.5
7/4/2012	6.5	8.2	10.6	10.8
7/5/2012	5.1	7.7	10.7	11.1
7/6/2012	6.5	8.4	11.6	11.5
7/7/2012	7.0	9.1	12.0	11.8
7/8/2012	7.9	9.9	12.7	12.0
7/9/2012	8.3	10.0	12.2	12.3
7/10/2012	8.8	10.2	12.4	12.5
7/11/2012	8.7	10.1	12.5	12.6
7/12/2012	8.5	10.2	12.9	12.4
7/13/2012	8.7	10.6	13.0	12.4
7/14/2012	9.2	10.8	12.8	12.3
7/15/2012	9.2	10.0	11.3	12.3
7/16/2012	8.7	10.2	11.9	12.3
7/17/2012	8.9	10.2	11.7	12.3
7/18/2012	8.5	10.4	12.8	12.1

Table B-1. Daily Minimum, Mean, Maximum, and 7-DAD Max Water Temperature Values (°C) at Upper Bypassed Reach Site (BPU) During August 2011 Through September 2012.

Date	Daily Minimum	Daily Mean	Daily Maximum	7-D Max
7/19/2012	8.7	10.5	12.9	12.3
7/20/2012	9.2	10.6	12.5	12.4
7/21/2012	9.5	10.4	11.9	12.3
7/22/2012	7.9	9.9	12.4	12.1
7/23/2012	8.3	10.2	12.5	11.8
7/24/2012	7.9	9.4	11.3	11.7
7/25/2012	6.6	8.7	11.0	11.6
7/26/2012	7.4	9.0	10.9	11.4
7/27/2012	8.1	9.7	11.8	11.3
7/28/2012	8.4	9.8	11.4	11.3
7/29/2012	8.0	9.4	11.2	11.3
7/30/2012	7.7	9.4	11.3	11.3
7/31/2012	8.0	9.5	11.5	11.1
8/1/2012	7.5	9.3	11.3	10.9
8/2/2012	7.1	8.9	10.8	10.8
8/3/2012	7.1	8.6	10.2	10.8
8/4/2012	7.2	8.6	10.1	10.7
8/5/2012	6.9	8.6	10.4	10.7
8/6/2012	7.7	9.3	11.0	10.6
8/7/2012	8.8	9.9	11.2	10.6
8/8/2012	8.4	9.7	11.1	10.6
8/9/2012	8.5	9.4	10.3	10.6
8/10/2012	7.8	9.1	10.4	10.5
8/11/2012	8.0	9.0	10.1	10.5
8/12/2012	7.5	8.8	10.0	10.5
8/13/2012	7.6	8.9	10.2	10.7
8/14/2012	7.6	9.1	11.4	10.8
8/15/2012	6.2	8.5	11.1	10.9
8/16/2012	7.3	9.1	11.5	11.0
8/17/2012	6.7	8.9	11.3	11.1
8/18/2012	6.2	8.4	10.7	10.9
8/19/2012	6.7	8.8	10.9	10.8
8/20/2012	7.4	8.9	10.5	10.6
8/21/2012	7.3	8.8	10.5	10.2
8/22/2012	7.7	8.9	10.3	9.9
8/23/2012	6.4	8.1	10.2	9.7
8/24/2012	4.8	6.5	8.2	9.6
8/25/2012	4.6	6.6	8.9	9.4
8/26/2012	5.7	7.4	9.3	9.1
8/27/2012	6.7	8.0	9.8	8.9
8/28/2012	5.7	7.4	9.2	9.0
8/29/2012	5.4	6.9	8.4	8.9
8/30/2012	4.7	6.5	8.4	8.7
8/31/2012	5.5	7.2	9.0	8.4

Table B-1. Daily Minimum, Mean, Maximum, and 7-DAD Max Water Temperature Values (°C) at Upper Bypassed Reach Site (BPU) During August 2011 Through September 2012.

Date	Daily Minimum	Daily Mean	Daily Maximum	7-D Max
9/1/2012	5.5	6.8	8.2	8.2
9/2/2012	4.1	5.8	7.8	8.2
9/3/2012	4.3	6.0	7.8	8.1
9/4/2012	4.7	6.3	7.9	7.9
9/5/2012	4.5	6.3	8.0	8.0
9/6/2012	5.2	6.5	7.9	8.1
9/7/2012	4.6	6.2	7.9	8.0
9/8/2012	5.2	6.7	8.4	7.7
9/9/2012	6.7	7.5	8.8	7.4
9/10/2012	4.6	6.0	7.3	7.3
9/11/2012	3.5	4.7	5.9	7.2
9/12/2012	2.8	4.4	5.9	7.0
9/13/2012	3.3	4.9	6.7	6.8
9/14/2012	4.4	5.8	7.4	6.7
9/15/2012	5.4	6.3	7.2	6.8
9/16/2012	5.7	6.3	7.1	7.0
9/17/2012	4.5	5.6	6.6	7.0
9/18/2012	4.7	5.8	6.9	7.0
9/19/2012	5.0	6.0	7.1	7.0
9/20/2012	5.0	6.1	7.1	6.9
9/21/2012	4.7	5.9	6.9	7.0
9/22/2012	5.2	6.2	7.2	7.1
9/23/2012	5.9	6.3	6.7	7.0
9/24/2012	6.1	6.6	7.2	6.9
9/25/2012	5.9	6.6	7.4	6.9
9/26/2012	4.9	5.7	6.3	6.9
9/27/2012	4.4	5.5	6.5	6.8
9/28/2012	5.8	6.4	7.1	
9/29/2012	5.6	6.4	7.1	
9/30/2012	4.8	5.7	6.2	

Table B-2. 7-DAD Max Water Temperature Values (°C) at Sites WFI, WRC, RPI, EFI, and BPL During the 2012 Study Period. (See Table B-1 for 7-DAD Max Values at Site BPU).

Date	West Fork Inflow (WFI)	Wallowa River (WRC)	Royal Purple Inflow (RPI)	East Fork Inflow (EFI)	Bypassed Reach: Lower (BPL)
10/23/2011				4.5	
10/24/2011				4.1	4.9
10/25/2011				3.7	4.4
10/26/2011				3.5	4.1
10/27/2011				3.4	3.9
10/28/2011				3.3	3.9
10/29/2011				3.2	3.8
10/30/2011				3.1	3.7
10/31/2011				3.0	3.7
11/1/2011				2.8	3.4
11/2/2011				2.4	2.7
11/3/2011				2.0	2.0
11/4/2011				1.6	1.3
11/5/2011				1.6	0.9
11/6/2011				1.6	0.8
11/7/2011				1.6	0.7
11/8/2011				1.7	0.8
11/9/2011				1.8	1.0
11/10/2011				1.9	1.2
11/11/2011				2.0	1.5
11/12/2011				1.9	1.7
11/13/2011				1.9	1.5
11/14/2011				1.9	1.6
11/15/2011				1.8	1.4
11/16/2011				1.7	1.1
11/17/2011				1.6	0.9
11/18/2011				1.6	0.8
11/19/2011				1.7	1.0
11/20/2011				1.7	1.4
11/21/2011				1.8	1.5
11/22/2011				1.8	1.7
11/23/2011				1.9	1.8
11/24/2011				2.1	2.2
11/25/2011				2.1	2.4
11/26/2011				2.2	2.4
11/27/2011				2.2	2.2
11/28/2011				2.1	2.0
11/29/2011				2.0	1.7
11/30/2011				1.9	1.5
12/1/2011				1.8	1.1
12/2/2011				1.7	0.7
12/3/2011				1.6	0.3
12/4/2011				1.5	0.0

Table B-2. 7-DAD Max Water Temperature Values (°C) at Sites WFI, WRC, RPI, EFI, and BPL During the 2012 Study Period. (See Table B-1 for 7-DAD Max Values at Site BPU).

Date	West Fork Inflow (WFI)	Wallowa River (WRC)	Royal Purple Inflow (RPI)	East Fork Inflow (EFI)	Bypassed Reach: Lower (BPL)
12/5/2011				1.5	-0.1
12/6/2011				1.5	-0.1
12/7/2011				1.5	-0.1
12/8/2011				1.5	-0.1
12/9/2011				1.5	-0.1
12/10/2011				1.4	-0.1
12/11/2011				1.4	-0.1
12/12/2011				1.6	0.0
12/13/2011				1.7	0.1
12/14/2011				1.7	0.2
12/15/2011				1.8	0.4
12/16/2011				1.8	0.5
12/17/2011				1.9	0.6
12/18/2011				1.8	0.7
12/19/2011				1.7	0.6
12/20/2011				1.7	0.5
12/21/2011				1.7	0.4
12/22/2011				1.7	0.4
12/23/2011				1.7	0.4
12/24/2011				1.7	0.5
12/25/2011				1.8	0.7
12/26/2011				1.9	1.1
12/27/2011				2.0	1.4
12/28/2011				1.8	1.5
12/29/2011				1.8	1.5
12/30/2011				1.9	1.7
12/31/2011				1.8	1.7
1/1/2012				1.9	1.9
1/2/2012				2.0	2.0
1/3/2012				1.8	1.7
1/4/2012				1.9	1.6
1/5/2012				1.9	1.7
1/6/2012				1.9	1.6
1/7/2012				1.9	1.5
1/8/2012				1.7	1.1
1/9/2012				1.4	0.7
1/10/2012				1.5	0.6
1/11/2012				1.6	0.8
1/12/2012				1.4	0.6
1/13/2012				1.2	0.4
1/14/2012				1.1	0.2
1/15/2012				1.3	0.4
1/16/2012				1.4	0.7

Table B-2. 7-DAD Max Water Temperature Values (°C) at Sites WFI, WRC, RPI, EFI, and BPL During the 2012 Study Period. (See Table B-1 for 7-DAD Max Values at Site BPU).

Date	West Fork Inflow (WFI)	Wallowa River (WRC)	Royal Purple Inflow (RPI)	East Fork Inflow (EFI)	Bypassed Reach: Lower (BPL)
1/17/2012				1.5	1.1
1/18/2012				1.5	1.2
1/19/2012				1.5	1.3
1/20/2012				1.7	1.5
1/21/2012				1.8	1.8
1/22/2012				1.8	1.9
1/23/2012				1.8	1.9
1/24/2012				1.7	1.6
1/25/2012				1.7	1.5
1/26/2012				1.8	1.7
1/27/2012				1.8	1.8
1/28/2012				1.8	1.8
1/29/2012				1.9	1.8
1/30/2012				1.8	1.6
1/31/2012				1.8	1.6
2/1/2012				1.7	1.4
2/2/2012				1.6	1.2
2/3/2012				1.5	0.9
2/4/2012				1.5	0.8
2/5/2012				1.5	0.7
2/6/2012				1.6	0.9
2/7/2012				1.8	1.2
2/8/2012				1.9	1.4
2/9/2012				1.9	1.5
2/10/2012				2.0	1.5
2/11/2012				2.0	1.4
2/12/2012				1.9	1.2
2/13/2012				1.8	0.9
2/14/2012				1.8	0.6
2/15/2012				1.7	0.4
2/16/2012				1.7	0.2
2/17/2012				1.8	0.2
2/18/2012				1.8	0.3
2/19/2012				1.9	0.6
2/20/2012				1.9	0.8
2/21/2012				1.9	0.9
2/22/2012				1.8	1.0
2/23/2012				1.8	0.9
2/24/2012				1.7	0.9
2/25/2012				1.5	0.7
2/26/2012				1.4	0.3
2/27/2012				1.4	0.2
2/28/2012				1.3	0.0

Table B-2. 7-DAD Max Water Temperature Values (°C) at Sites WFI, WRC, RPI, EFI, and BPL During the 2012 Study Period. (See Table B-1 for 7-DAD Max Values at Site BPU).

Date	West Fork Inflow (WFI)	Wallowa River (WRC)	Royal Purple Inflow (RPI)	East Fork Inflow (EFI)	Bypassed Reach: Lower (BPL)
2/29/2012				1.4	0.0
3/1/2012				1.6	0.2
3/2/2012				1.8	0.4
3/3/2012				1.8	0.6
3/4/2012				1.8	0.6
3/5/2012				1.9	0.7
3/6/2012				2.1	0.9
3/7/2012				2.1	1.0
3/8/2012				2.1	1.1
3/9/2012				2.0	1.0
3/10/2012				2.1	1.0
3/11/2012				2.2	1.2
3/12/2012				2.2	1.6
3/13/2012				2.1	1.7
3/14/2012				2.1	1.8
3/15/2012				1.9	1.8
3/16/2012				1.9	1.7
3/17/2012				2.0	1.8
3/18/2012				2.0	1.9
3/19/2012				2.0	1.8
3/20/2012				2.0	1.8
3/21/2012				2.1	1.9
3/22/2012				2.4	2.2
3/23/2012				2.5	2.6
3/24/2012				2.6	2.8
3/25/2012				2.7	3.0
3/26/2012				2.8	3.2
3/27/2012				2.8	3.4
3/28/2012				2.8	3.6
3/29/2012				2.6	3.4
3/30/2012				2.6	3.4
3/31/2012				2.7	3.5
4/1/2012				2.6	3.4
4/2/2012				2.4	3.0
4/3/2012				2.4	2.7
4/4/2012				2.3	2.4
4/5/2012				2.4	2.5
4/6/2012				2.6	2.8
4/7/2012				2.7	3.1
4/8/2012				3.0	3.5
4/9/2012				3.2	4.0
4/10/2012				3.4	4.5
4/11/2012				3.6	5.0

Table B-2. 7-DAD Max Water Temperature Values (°C) at Sites WFI, WRC, RPI, EFI, and BPL During the 2012 Study Period. (See Table B-1 for 7-DAD Max Values at Site BPU).

Date	West Fork Inflow (WFI)	Wallowa River (WRC)	Royal Purple Inflow (RPI)	East Fork Inflow (EFI)	Bypassed Reach: Lower (BPL)
4/12/2012				3.6	5.1
4/13/2012				3.6	5.1
4/14/2012				3.5	5.0
4/15/2012	5.5	5.9		3.6	5.0
4/16/2012	5.5	5.9		3.6	5.1
4/17/2012	5.8	6.2		3.7	5.4
4/18/2012	6.0	6.4		3.8	5.7
4/19/2012	6.4	6.9		4.0	6.1
4/20/2012	6.9	7.4		4.2	6.6
4/21/2012	6.9	7.5		4.3	6.7
4/22/2012	7.0	7.5		4.3	6.8
4/23/2012	6.6	7.2		4.1	6.6
4/24/2012	6.2	6.7		3.9	6.2
4/25/2012	5.7	6.2		3.6	5.7
4/26/2012	5.4	5.8		3.5	5.4
4/27/2012	5.2	5.5		3.4	5.2
4/28/2012	5.1	5.4		3.3	4.9
4/29/2012	5.0	5.2		3.3	4.6
4/30/2012	5.1	5.3		3.4	4.7
5/1/2012	4.9	5.1		3.2	4.6
5/2/2012	5.0	5.3		3.3	4.6
5/3/2012	5.1	5.3		3.3	4.5
5/4/2012	5.4	5.6		3.5	4.6
5/5/2012	5.8	6.0		3.8	5.1
5/6/2012	6.1	6.4		4.1	5.5
5/7/2012	6.4	6.6		4.3	5.6
5/8/2012	6.9	7.1		4.7	5.9
5/9/2012	7.3	7.5		5.0	6.3
5/10/2012	7.5	7.7		5.2	6.7
5/11/2012	7.6	7.9		5.3	7.0
5/12/2012	7.6	7.9		5.4	7.1
5/13/2012	7.6	7.9		5.4	7.2
5/14/2012	7.5	7.8		5.4	7.3
5/15/2012	7.4	7.8		5.4	7.3
5/16/2012	7.3	7.7		5.4	7.2
5/17/2012	7.2	7.5		5.4	7.1
5/18/2012	6.9	7.2		5.2	6.9
5/19/2012	6.5	6.8		4.8	6.4
5/20/2012	6.2	6.4		4.6	5.9
5/21/2012	6.2	6.3		4.5	5.7
5/22/2012	5.9	6.0		4.2	5.4
5/23/2012	5.5	5.6		3.8	5.1
5/24/2012	5.3	5.4		3.6	4.8

Table B-2. 7-DAD Max Water Temperature Values (°C) at Sites WFI, WRC, RPI, EFI, and BPL During the 2012 Study Period. (See Table B-1 for 7-DAD Max Values at Site BPU).

Date	West Fork Inflow (WFI)	Wallowa River (WRC)	Royal Purple Inflow (RPI)	East Fork Inflow (EFI)	Bypassed Reach: Lower (BPL)
5/25/2012	5.3	5.5		3.7	4.9
5/26/2012	5.8	5.9		4.2	5.2
5/27/2012	6.1	6.2		4.4	5.5
5/28/2012	6.5	6.6		4.9	6.1
5/29/2012	7.1	7.3		5.5	6.8
5/30/2012	7.3	7.6		5.8	7.2
6/1/2012	7.4	7.7		6.0	7.4
6/2/2012	7.5	7.9		6.2	7.7
6/3/2012	6.9	7.3	5.9	5.7	7.2
6/4/2012	6.7	7.1	5.6	5.7	7.1
6/5/2012	6.3	6.7	4.9	5.3	6.7
6/6/2012	5.9	6.3	4.5	4.9	6.1
6/7/2012	5.8	6.1	4.5	4.7	5.8
6/8/2012	5.9	6.1	4.5	4.7	5.8
6/9/2012	5.9	6.0	5.2	4.7	5.6
6/10/2012	6.5	6.6	5.5	5.3	6.3
6/11/2012	6.8	6.9	6.1	5.6	6.6
6/12/2012	7.2	7.3	6.8	6.2	7.1
6/13/2012	7.6	7.7	7.5	6.7	7.6
6/14/2012	8.0	8.2	7.8	7.3	8.3
6/15/2012	8.3	8.5	7.5	7.8	8.7
6/16/2012	8.0	8.3	7.1	7.6	8.6
6/17/2012	7.6	7.9	7.2	7.3	8.1
6/18/2012	7.6	7.9	7.4	7.3	8.1
6/19/2012	7.8	8.1	7.6	7.5	8.3
6/20/2012	8.0	8.3	7.7	7.7	8.6
6/21/2012	8.0	8.4	7.8	7.9	8.8
6/22/2012	8.0	8.4	8.4	7.9	8.8
6/23/2012	8.5	8.8	8.7	8.5	9.4
6/24/2012	8.7	9.0	8.8	8.9	9.7
6/25/2012	8.7	9.1	9.0	9.3	9.9
6/26/2012	8.8	9.2	8.9	9.5	10.1
6/27/2012	8.7	9.1	9.1	9.5	10.1
6/28/2012	9.0	9.3	9.1	9.7	10.3
6/29/2012	9.0	9.3	9.3	9.7	10.4
6/30/2012	9.1	9.4	9.8	9.8	10.6
7/1/2012	9.5	9.8	9.9	10.3	11.0
7/2/2012	9.7	10.0	9.9	10.3	11.2
7/3/2012	9.7	10.0	10.3	10.4	11.3
7/4/2012	10.0	10.3	10.6	10.7	11.5
7/5/2012	10.2	10.5	11.0	11.0	11.8
7/6/2012	10.6	10.9	11.2	11.4	12.2
7/7/2012	10.8	11.1	11.7	11.6	12.4

Table B-2. 7-DAD Max Water Temperature Values (°C) at Sites WFI, WRC, RPI, EFI, and BPL During the 2012 Study Period. (See Table B-1 for 7-DAD Max Values at Site BPU).

Date	West Fork Inflow (WFI)	Wallowa River (WRC)	Royal Purple Inflow (RPI)	East Fork Inflow (EFI)	Bypassed Reach: Lower (BPL)
7/8/2012	11.1	11.4	12.0	11.9	12.8
7/9/2012	11.4	11.7	12.3	12.2	13.2
7/10/2012	11.6	11.9	12.4	12.4	13.5
7/11/2012	11.8	12.0	12.1	12.6	13.6
7/12/2012	11.6	11.9	12.2	12.4	13.5
7/13/2012	11.6	11.9	11.9	12.4	13.5
7/14/2012	11.7	11.9	11.8	12.3	13.4
7/15/2012	11.8	12.0	11.8	12.4	13.5
7/16/2012	12.1	12.2	11.7	12.4	13.6
7/17/2012	12.2	12.4	11.6	12.5	13.6
7/18/2012	12.2	12.4	11.9	12.4	13.6
7/19/2012	12.6	12.7	11.9	12.6	13.7
7/20/2012	13.0	13.1	11.9	12.8	13.9
7/21/2012	13.2	13.2	11.6	12.9	13.7
7/22/2012	13.1	13.1	11.3	12.7	13.4
7/23/2012	13.1	13.0	11.2	12.4	13.1
7/24/2012	13.3	13.1	11.2	12.4	13.0
7/25/2012	13.6	13.3	11.0	12.4	13.0
7/26/2012	13.8	13.3	10.9	12.2	12.9
7/27/2012	13.8	13.3	10.9	12.1	12.7
7/28/2012	14.0	13.4	10.9	12.1	12.7
7/29/2012	14.2	13.7	10.8	12.2	12.8
7/30/2012	14.4	13.8	10.5	12.2	12.8
7/31/2012	14.2	13.6	10.2	11.9	12.5
8/1/2012	14.1	13.5	10.1	11.7	12.2
8/2/2012	14.1	13.5	10.0	11.7	12.1
8/3/2012	14.2	13.6	10.0	11.7	12.2
8/4/2012	14.3	13.7	10.1	11.7	12.3
8/5/2012	14.6	13.9	10.1	11.8	12.5
8/6/2012	14.6	13.9	10.2	11.7	12.5
8/7/2012	14.8	14.0	10.2	11.8	12.7
8/8/2012	14.9	14.1	10.2	11.8	12.8
8/9/2012	15.0	14.2	10.2	11.8	12.8
8/10/2012	14.9	14.1	10.1	11.7	12.7
8/11/2012	14.8	14.0	9.8	11.6	12.6
8/12/2012	14.5	13.8	9.8	11.4	12.3
8/13/2012	14.6	13.9	9.8	11.4	12.3
8/14/2012	14.6	13.9	9.7	11.3	12.3
8/15/2012	14.5	13.8	9.6	11.3	12.3
8/16/2012	14.4	13.7	9.4	11.2	12.3
8/17/2012	14.3	13.7	9.2	11.0	12.3
8/18/2012	14.1	13.4	9.2	10.9	12.3
8/19/2012	14.1	13.4	9.0	10.8	12.3

Table B-2. 7-DAD Max Water Temperature Values (°C) at Sites WFI, WRC, RPI, EFI, and BPL During the 2012 Study Period. (See Table B-1 for 7-DAD Max Values at Site BPU).

Date	West Fork Inflow (WFI)	Wallowa River (WRC)	Royal Purple Inflow (RPI)	East Fork Inflow (EFI)	Bypassed Reach: Lower (BPL)
8/20/2012	13.9	13.2	8.8	10.6	12.0
8/21/2012		13.1	8.4	10.4	11.8
8/22/2012		12.9	8.2	10.1	11.4
8/23/2012		12.6	8.1	9.8	11.0
8/24/2012		12.5	8.0	9.7	10.7
8/25/2012		12.6	7.8	9.7	10.5
8/26/2012		12.6	7.6	9.6	10.3
8/27/2012		12.5	7.4	9.4	10.1
8/28/2012		12.3	7.6	9.2	9.9
8/29/2012		12.3	7.5	9.4	10.1
8/30/2012		12.3	7.2	9.3	10.0
8/31/2012		11.9	6.9	9.1	9.7
9/1/2012		11.6	6.7	8.8	9.4
9/2/2012		11.4	6.7	8.6	9.2
9/3/2012		11.3	6.6	8.6	9.2
9/4/2012		11.3	6.5	8.5	9.1
9/5/2012		11.1	6.6	8.3	9.0
9/6/2012		11.2	6.7	8.4	9.1
9/7/2012		11.5	6.7	8.5	9.3
9/8/2012		11.4	6.4	8.4	9.2
9/9/2012		11.1	6.1	8.1	8.8
9/10/2012		10.8	5.9	7.8	8.5
9/11/2012		10.5	5.9	7.7	8.2
9/12/2012		10.3	5.9	7.7	8.3
9/13/2012		10.1	5.7	7.5	8.2
9/14/2012		9.9	5.6	7.3	8.1
9/15/2012		9.8	5.8	7.3	8.1
9/16/2012		9.9	6.1	7.5	8.4
9/17/2012		10.2	6.2	7.7	8.8
9/18/2012		10.3	6.2	7.7	9.0
9/19/2012		10.3	6.2	7.6	9.0
9/20/2012		10.2	6.2	7.6	9.0
9/21/2012		9.9	6.3	7.5	8.9
9/22/2012		10.0	6.4	7.6	9.0
9/23/2012		10.0	6.3	7.6	9.1
9/24/2012		9.9	6.3	7.4	9.0
9/25/2012		9.7	6.4	7.4	8.9
9/26/2012		9.7	6.3	7.4	9.0
9/27/2012		9.8	6.2	7.3	8.9

Appendix C
Dissolved Oxygen Data

Table C-1. Dissolved Oxygen Measurements (in mg/L and % saturation) at East Fork Inflow Site (EFI) During the 72-hour Sampling Event of September 2012.

Date	Time	Water Temperature (°C)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (% saturation)
9/25/2012	9:00	6.0	10.9	109.2
9/25/2012	9:30	6.2	11.0	110.7
9/25/2012	10:00	6.4	11.1	111.3
9/25/2012	10:30	6.6	11.0	111.4
9/25/2012	11:00	6.9	10.9	111.4
9/25/2012	11:30	7.2	10.9	112.0
9/25/2012	12:00	7.4	10.8	111.4
9/25/2012	12:30	7.5	10.7	110.9
9/25/2012	13:00	7.7	10.7	111.3
9/25/2012	13:30	7.8	10.6	110.7
9/25/2012	14:00	7.8	10.6	110.3
9/25/2012	14:30	7.8	10.6	110.7
9/25/2012	15:00	7.8	10.5	110.0
9/25/2012	15:30	7.8	10.5	109.7
9/25/2012	16:00	7.8	10.5	109.9
9/25/2012	16:30	7.7	10.5	109.3
9/25/2012	17:00	7.6	10.5	108.9
9/25/2012	17:30	7.6	10.5	109.3
9/25/2012	18:00	7.5	10.5	108.9
9/25/2012	18:30	7.3	10.6	108.9
9/25/2012	19:00	7.2	10.6	108.8
9/25/2012	19:30	7.0	10.6	108.7
9/25/2012	20:00	6.9	10.7	108.5
9/25/2012	20:30	6.7	10.7	108.5
9/25/2012	21:00	6.6	10.7	108.5
9/25/2012	21:30	6.4	10.7	108.0
9/25/2012	22:00	6.3	10.7	107.9
9/25/2012	22:30	6.1	10.8	107.9
9/25/2012	23:00	6.0	10.9	108.4
9/25/2012	23:30	5.9	10.9	108.0
9/26/2012	0:00	5.8	10.9	108.4
9/26/2012	0:30	5.7	11.0	108.7
9/26/2012	1:00	5.6	11.0	108.8
9/26/2012	1:30	5.5	11.0	108.3
9/26/2012	2:00	5.3	11.1	108.7
9/26/2012	2:30	5.2	11.1	108.2
9/26/2012	3:00	5.2	11.1	108.2
9/26/2012	3:30	5.1	11.2	108.7
9/26/2012	4:00	5.0	11.2	108.9
9/26/2012	4:30	4.9	11.3	109.0
9/26/2012	5:00	4.8	11.2	108.5
9/26/2012	5:30	4.7	11.2	108.4
9/26/2012	6:00	4.7	11.3	108.9
9/26/2012	6:30	4.6	11.3	108.7
9/26/2012	7:00	4.6	11.4	109.4

Table C-1. Dissolved Oxygen Measurements (in mg/L and % saturation) at East Fork Inflow Site (EFI) During the 72-hour Sampling Event of September 2012.

Date	Time	Water Temperature (°C)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (% saturation)
9/26/2012	7:30	4.5	11.4	109.3
9/26/2012	8:00	4.5	11.4	109.4
9/26/2012	8:30	4.5	11.4	109.7
9/26/2012	9:00	4.6	11.4	110.0
9/26/2012	9:30	4.9	11.4	110.9
9/26/2012	10:00	5.1	11.4	111.4
9/26/2012	10:30	5.4	11.3	110.8
9/26/2012	11:00	5.7	11.2	111.1
9/26/2012	11:30	6.0	11.2	111.1
9/26/2012	12:00	6.2	11.1	110.9
9/26/2012	12:30	6.4	11.0	111.1
9/26/2012	13:00	6.5	10.9	110.4
9/26/2012	13:30	6.7	10.9	110.5
9/26/2012	14:00	6.8	10.8	109.9
9/26/2012	14:30	6.8	10.8	110.0
9/26/2012	15:00	6.7	10.8	109.5
9/26/2012	15:30	6.7	10.8	109.8
9/26/2012	16:00	6.7	10.8	109.8
9/26/2012	16:30	6.6	10.8	109.7
9/26/2012	17:00	6.5	10.8	109.5
9/26/2012	17:30	6.5	10.8	108.8
9/26/2012	18:00	6.4	10.8	108.9
9/26/2012	18:30	6.3	10.8	108.3
9/26/2012	19:00	6.2	10.8	108.2
9/26/2012	19:30	6.0	10.9	108.7
9/26/2012	20:00	5.9	10.9	108.3
9/26/2012	20:30	5.8	10.9	108.3
9/26/2012	21:00	5.7	10.9	108.2
9/26/2012	21:30	5.6	11.0	108.7
9/26/2012	22:00	5.4	11.0	108.3
9/26/2012	22:30	5.3	11.1	108.8
9/26/2012	23:00	5.2	11.2	109.2
9/26/2012	23:30	5.1	11.1	108.5
9/27/2012	0:00	5.0	11.2	109.0
9/27/2012	0:30	4.9	11.3	109.2
9/27/2012	1:00	4.8	11.3	109.3
9/27/2012	1:30	4.7	11.3	109.4
9/27/2012	2:00	4.6	11.4	109.5
9/27/2012	2:30	4.5	11.4	109.4
9/27/2012	3:00	4.5	11.4	109.5
9/27/2012	3:30	4.4	11.4	109.5
9/27/2012	4:00	4.3	11.5	109.5
9/27/2012	4:30	4.3	11.4	108.9
9/27/2012	5:00	4.2	11.5	109.3
9/27/2012	5:30	4.2	11.5	109.5
9/27/2012	6:00	4.1	11.5	109.7
9/27/2012	6:30	4.1	11.6	109.8

Table C-1. Dissolved Oxygen Measurements (in mg/L and % saturation) at East Fork Inflow Site (EFI) During the 72-hour Sampling Event of September 2012.

Date	Time	Water Temperature (°C)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (% saturation)
9/27/2012	7:00	4.1	11.5	109.4
9/27/2012	7:30	4.0	11.6	109.9
9/27/2012	8:00	4.0	11.6	110.4
9/27/2012	8:30	4.1	11.7	110.8
9/27/2012	9:00	4.2	11.6	110.3
9/27/2012	9:30	4.5	11.5	110.3
9/27/2012	10:00	4.8	11.4	110.7
9/27/2012	10:30	5.2	11.3	110.8
9/27/2012	11:00	5.5	11.2	110.7
9/27/2012	11:30	5.8	11.2	110.9
9/27/2012	12:00	6.1	11.1	111.3
9/27/2012	12:30	6.4	11.1	111.4
9/27/2012	13:00	6.6	10.9	110.4
9/27/2012	13:30	6.8	10.8	110.0
9/27/2012	14:00	6.8	10.8	110.2
9/27/2012	14:30	6.9	10.8	109.8
9/27/2012	15:00	7.1	10.7	109.4
9/27/2012	15:30	7.1	10.7	109.3
9/27/2012	16:00	7.1	10.6	109.0
9/27/2012	16:30	7.1	10.6	108.8
9/27/2012	17:00	7.0	10.7	109.0
9/27/2012	17:30	7.0	10.7	109.0
9/27/2012	18:00	6.9	10.6	108.2
9/27/2012	18:30	6.8	10.7	108.4
9/27/2012	19:00	6.7	10.6	107.8
9/27/2012	19:30	6.6	10.6	107.7
9/27/2012	20:00	6.4	10.7	108.2
9/27/2012	20:30	6.3	10.7	107.7
9/27/2012	21:00	6.2	10.8	108.2
9/27/2012	21:30	6.1	10.8	108.3
9/27/2012	22:00	6.0	10.8	107.8
9/27/2012	22:30	5.9	10.8	107.7
9/27/2012	23:00	5.9	10.8	107.5
9/27/2012	23:30	5.8	10.9	108.0
9/28/2012	0:00	5.8	10.9	107.7
9/28/2012	0:30	5.8	10.9	108.0
9/28/2012	1:00	5.8	10.9	107.5
9/28/2012	1:30	5.8	10.8	107.3
9/28/2012	2:00	5.8	10.8	107.3
9/28/2012	2:30	5.8	10.8	107.2
9/28/2012	3:00	5.8	10.9	107.8
9/28/2012	3:30	5.8	10.8	107.4
9/28/2012	4:00	5.8	10.8	107.2
9/28/2012	4:30	5.8	10.8	107.1
9/28/2012	5:00	5.9	10.8	107.7
9/28/2012	5:30	5.9	10.9	107.9
9/28/2012	6:00	5.9	10.8	107.4

Table C-1. Dissolved Oxygen Measurements (in mg/L and % saturation) at East Fork Inflow Site (EFI) During the 72-hour Sampling Event of September 2012.

Date	Time	Water Temperature (°C)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (% saturation)
9/28/2012	6:30	5.9	10.8	107.3
9/28/2012	7:00	5.9	10.9	108.2
9/28/2012	7:30	5.9	10.8	107.9
9/28/2012	8:00	6.0	10.9	108.8
9/28/2012	8:30	6.2	10.8	108.7
9/28/2012	9:00	6.4	10.8	108.9

Table C-2. Dissolved Oxygen Measurements (in mg/L and % saturation) at the Bypassed Reach Upper Site (BPU) During the 72-Hr Sampling Event of August 2012.

Date	Time	Water Temperature (°C)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (% Saturation)
8/20/2012	15:30	10.3	8.9	98.7
8/20/2012	16:00	10.4	8.9	98.9
8/20/2012	16:30	10.3	8.9	98.8
8/20/2012	17:00	10.3	8.9	98.8
8/20/2012	17:30	10.2	8.9	98.8
8/20/2012	18:00	10.1	9.0	98.7
8/20/2012	18:30	10.1	9.0	98.6
8/20/2012	19:00	10.0	9.0	98.4
8/20/2012	19:30	9.8	9.0	98.6
8/20/2012	20:00	9.7	9.0	98.6
8/20/2012	20:30	9.6	9.1	98.6
8/20/2012	21:00	9.4	9.1	98.6
8/20/2012	21:30	9.3	9.1	98.4
8/20/2012	22:00	9.2	9.1	98.4
8/20/2012	22:30	9.0	9.2	98.4
8/20/2012	23:00	8.9	9.2	98.4
8/20/2012	23:30	8.7	9.2	98.4
8/21/2012	0:00	8.6	9.3	98.4
8/21/2012	0:30	8.5	9.3	98.7
8/21/2012	1:00	8.4	9.3	98.3
8/21/2012	1:30	8.3	9.3	98.3
8/21/2012	2:00	8.2	9.3	98.2
8/21/2012	2:30	8.1	9.4	99.1
8/21/2012	3:00	8.1	9.4	98.3
8/21/2012	3:30	8.0	9.4	98.7
8/21/2012	4:00	8.0	9.4	98.6
8/21/2012	4:30	8.0	9.4	98.7
8/21/2012	5:00	7.9	9.4	98.7
8/21/2012	5:30	7.9	9.4	98.6
8/21/2012	6:00	7.8	9.5	98.8
8/21/2012	6:30	7.8	9.5	98.8
8/21/2012	7:00	7.8	9.5	98.9
8/21/2012	7:30	7.8	9.5	99.2
8/21/2012	8:00	7.9	9.5	99.2
8/21/2012	8:30	8.0	9.5	99.2
8/21/2012	9:00	8.2	9.4	99.3
8/21/2012	9:30	8.4	9.4	99.4
8/21/2012	10:00	8.6	9.4	99.4
8/21/2012	10:30	8.8	9.3	99.4
8/21/2012	11:00	9.0	9.3	99.3
8/21/2012	11:30	9.2	9.2	99.4
8/21/2012	12:00	9.4	9.2	99.6
8/21/2012	12:30	9.5	9.2	99.4
8/21/2012	13:00	9.7	9.1	99.3
8/21/2012	13:30	9.8	9.1	99.3
8/21/2012	14:00	9.9	9.0	99.2
8/21/2012	14:30	10.1	9.0	99.2

Table C-2. Dissolved Oxygen Measurements (in mg/L and % saturation) at the Bypassed Reach Upper Site (BPU) During the 72-Hr Sampling Event of August 2012.

Date	Time	Water Temperature (°C)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (% Saturation)
8/21/2012	15:00	10.1	9.0	99.2
8/21/2012	15:30	10.2	9.0	99.2
8/21/2012	16:00	10.2	9.0	99.2
8/21/2012	16:30	10.1	9.0	99.2
8/21/2012	17:00	10.1	9.0	99.2
8/21/2012	17:30	10.1	9.0	99.1
8/21/2012	18:00	10.0	9.0	98.9
8/21/2012	18:30	9.9	9.0	99.1
8/21/2012	19:00	9.8	9.1	98.9
8/21/2012	19:30	9.6	9.1	98.9
8/21/2012	20:00	9.5	9.1	98.9
8/21/2012	20:30	9.3	9.2	98.9
8/21/2012	21:00	9.1	9.2	98.9
8/21/2012	21:30	9.0	9.2	98.9
8/21/2012	22:00	8.8	9.3	98.9
8/21/2012	22:30	8.6	9.3	98.9
8/21/2012	23:00	8.5	9.3	98.9
8/21/2012	23:30	8.3	9.4	98.9
8/22/2012	0:00	8.2	9.4	98.9
8/22/2012	0:30	8.0	9.4	98.8
8/22/2012	1:00	7.9	9.5	98.9
8/22/2012	1:30	7.7	9.5	99.2
8/22/2012	2:00	7.6	9.6	99.2
8/22/2012	2:30	7.5	9.6	99.2
8/22/2012	3:00	7.4	9.6	99.1
8/22/2012	3:30	7.2	9.6	99.1
8/22/2012	4:00	7.1	9.7	99.1
8/22/2012	4:30	7.0	9.7	99.1
8/22/2012	5:00	6.9	9.7	99.1
8/22/2012	5:30	6.8	9.7	99.1
8/22/2012	6:00	6.7	9.8	99.2
8/22/2012	6:30	6.6	9.8	99.2
8/22/2012	7:00	6.6	9.8	99.1
8/22/2012	7:30	6.5	9.8	99.2
8/22/2012	8:00	6.6	9.8	99.2
8/22/2012	8:30	6.6	9.8	99.4
8/22/2012	9:00	6.9	9.8	99.6
8/22/2012	9:30	7.1	9.7	99.8
8/22/2012	10:00	7.5	9.6	99.7
8/22/2012	10:30	7.8	9.6	99.8
8/22/2012	11:00	8.2	9.5	99.9
8/22/2012	11:30	8.6	9.4	99.9
8/22/2012	12:00	9.0	9.3	99.8
8/22/2012	12:30	9.3	9.2	99.8
8/22/2012	13:00	9.6	9.2	99.8
8/22/2012	13:30	9.8	9.1	99.8
8/22/2012	14:00	9.9	9.1	99.7

Table C-2. Dissolved Oxygen Measurements (in mg/L and % saturation) at the Bypassed Reach Upper Site (BPU) During the 72-Hr Sampling Event of August 2012.

Date	Time	Water Temperature (°C)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (% Saturation)
8/22/2012	14:30	10.0	9.1	99.7
8/22/2012	15:00	10.0	9.1	99.7
8/22/2012	15:30	10.0	9.1	99.7
8/22/2012	16:00	9.9	9.1	99.2
8/22/2012	16:30	9.8	9.1	99.2
8/22/2012	17:00	9.7	9.1	99.2
8/22/2012	17:30	9.5	9.1	99.1
8/22/2012	18:00	9.4	9.2	99.2
8/22/2012	18:30	9.2	9.2	99.1
8/22/2012	19:00	9.0	9.2	99.1
8/22/2012	19:30	8.8	9.3	99.1
8/22/2012	20:00	8.7	9.3	99.1
8/22/2012	20:30	8.5	9.3	98.9
8/22/2012	21:00	8.3	9.4	98.9
8/22/2012	21:30	8.1	9.4	98.9
8/22/2012	22:00	7.9	9.5	98.9
8/22/2012	22:30	7.8	9.5	98.9
8/22/2012	23:00	7.6	9.5	98.9
8/22/2012	23:30	7.4	9.6	98.9
8/23/2012	0:00	7.3	9.6	98.9
8/23/2012	0:30	7.1	9.6	98.8
8/23/2012	1:00	7.0	9.7	98.8
8/23/2012	1:30	6.8	9.7	98.7
8/23/2012	2:00	6.7	9.7	98.7
8/23/2012	2:30	6.6	9.8	98.7
8/23/2012	3:00	6.5	9.8	98.7
8/23/2012	3:30	6.4	9.8	98.7
8/23/2012	4:00	6.4	9.8	98.6
8/23/2012	4:30	6.3	9.8	98.7
8/23/2012	5:00	6.2	9.8	98.7
8/23/2012	5:30	6.2	9.9	98.8
8/23/2012	6:00	6.1	9.9	98.8
8/23/2012	6:30	6.1	9.9	98.8
8/23/2012	7:00	6.1	9.9	98.8
8/23/2012	7:30	6.1	9.9	98.9
8/23/2012	8:00	6.1	9.9	98.9
8/23/2012	8:30	6.3	9.9	99.1
8/23/2012	9:00	6.5	9.8	99.3
8/23/2012	9:30	6.8	9.8	99.3
8/23/2012	10:00	7.2	9.7	99.3
8/23/2012	10:30	7.5	9.6	99.4
8/23/2012	11:00	7.9	9.5	99.4
8/23/2012	11:30	8.3	9.4	99.6
8/23/2012	12:00	8.6	9.3	99.3
8/23/2012	12:30	8.9	9.3	99.3
8/23/2012	13:00	9.2	9.2	99.3
8/23/2012	13:30	9.4	9.2	99.2

Table C-2. Dissolved Oxygen Measurements (in mg/L and % saturation) at the Bypassed Reach Upper Site (BPU) During the 72-Hr Sampling Event of August 2012.

Date	Time	Water Temperature (°C)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (% Saturation)
8/23/2012	14:00	9.6	9.1	99.3
8/23/2012	14:30	9.7	9.1	99.2
8/23/2012	15:00	9.7	9.1	99.2
8/23/2012	15:30	9.7	9.1	99.2

Table C-3. Dissolved Oxygen Measurements (in mg/L and % saturation) at the Bypassed Reach Upper Site (BPU) During the 72-Hr Sampling Event of September 2012.

Date	Time	Water Temperature (°C)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (% Saturation)
9/25/2012	9:00	6.2	9.8	98.6
9/25/2012	9:30	6.4	9.8	98.7
9/25/2012	10:00	6.6	9.8	98.6
9/25/2012	10:30	6.7	9.7	98.8
9/25/2012	11:00	6.9	9.7	98.7
9/25/2012	11:30	7.1	9.6	98.4
9/25/2012	12:00	7.3	9.6	98.6
9/25/2012	12:30	7.4	9.5	98.4
9/25/2012	13:00	7.6	9.5	98.7
9/25/2012	13:30	7.7	9.5	98.6
9/25/2012	14:00	7.7	9.5	98.4
9/25/2012	14:30	7.8	9.5	98.4
9/25/2012	15:00	7.8	9.4	98.6
9/25/2012	15:30	7.8	9.4	98.4
9/25/2012	16:00	7.8	9.4	98.4
9/25/2012	16:30	7.8	9.4	98.3
9/25/2012	17:00	7.8	9.4	98.3
9/25/2012	17:30	7.7	9.4	98.2
9/25/2012	18:00	7.6	9.4	98.1
9/25/2012	18:30	7.5	9.5	97.9
9/25/2012	19:00	7.4	9.5	97.8
9/25/2012	19:30	7.3	9.5	97.9
9/25/2012	20:00	7.2	9.5	97.9
9/25/2012	20:30	7.0	9.6	98.1
9/25/2012	21:00	6.9	9.6	97.9
9/25/2012	21:30	6.8	9.6	98.1
9/25/2012	22:00	6.6	9.7	97.8
9/25/2012	22:30	6.5	9.7	97.9
9/25/2012	23:00	6.4	9.7	97.9
9/25/2012	23:30	6.3	9.8	97.8
9/26/2012	0:00	6.1	9.8	97.8
9/26/2012	0:30	6.0	9.8	97.9
9/26/2012	1:00	5.9	9.8	97.8
9/26/2012	1:30	5.8	9.9	97.9
9/26/2012	2:00	5.7	9.9	97.8
9/26/2012	2:30	5.6	9.9	97.8
9/26/2012	3:00	5.5	9.9	97.7
9/26/2012	3:30	5.4	10.0	97.8
9/26/2012	4:00	5.3	10.0	97.8
9/26/2012	4:30	5.2	10.0	97.7
9/26/2012	5:00	5.2	10.0	97.8
9/26/2012	5:30	5.1	10.0	97.8
9/26/2012	6:00	5.0	10.1	97.8
9/26/2012	6:30	5.0	10.1	97.9
9/26/2012	7:00	4.9	10.1	98.1
9/26/2012	7:30	4.9	10.1	98.1
9/26/2012	8:00	4.8	10.2	98.2

Table C-3. Dissolved Oxygen Measurements (in mg/L and % saturation) at the Bypassed Reach Upper Site (BPU) During the 72-Hr Sampling Event of September 2012.

Date	Time	Water Temperature (°C)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (% Saturation)
9/26/2012	8:30	4.9	10.2	98.4
9/26/2012	9:00	5.0	10.2	98.6
9/26/2012	9:30	5.1	10.1	98.7
9/26/2012	10:00	5.3	10.1	98.8
9/26/2012	10:30	5.6	10.0	98.9
9/26/2012	11:00	5.8	10.0	98.8
9/26/2012	11:30	5.9	9.9	98.7
9/26/2012	12:00	6.1	9.8	98.4
9/26/2012	12:30	6.3	9.8	98.4
9/26/2012	13:00	6.4	9.8	98.4
9/26/2012	13:30	6.5	9.7	98.4
9/26/2012	14:00	6.6	9.7	98.4
9/26/2012	14:30	6.7	9.7	98.3
9/26/2012	15:00	6.7	9.7	98.2
9/26/2012	15:30	6.7	9.7	98.2
9/26/2012	16:00	6.7	9.7	98.2
9/26/2012	16:30	6.7	9.7	98.2
9/26/2012	17:00	6.6	9.7	98.2
9/26/2012	17:30	6.6	9.7	97.9
9/26/2012	18:00	6.5	9.7	97.9
9/26/2012	18:30	6.4	9.7	98.1
9/26/2012	19:00	6.4	9.7	98.1
9/26/2012	19:30	6.3	9.8	98.1
9/26/2012	20:00	6.2	9.8	98.1
9/26/2012	20:30	6.1	9.8	98.1
9/26/2012	21:00	6.0	9.8	98.1
9/26/2012	21:30	5.9	9.9	98.1
9/26/2012	22:00	5.8	9.9	98.2
9/26/2012	22:30	5.7	9.9	98.1
9/26/2012	23:00	5.6	9.9	97.9
9/26/2012	23:30	5.5	10.0	97.9
9/27/2012	0:00	5.3	10.0	97.9
9/27/2012	0:30	5.2	10.0	97.9
9/27/2012	1:00	5.1	10.0	97.9
9/27/2012	1:30	5.1	10.1	97.9
9/27/2012	2:00	4.9	10.1	97.9
9/27/2012	2:30	4.9	10.1	98.1
9/27/2012	3:00	4.8	10.1	97.9
9/27/2012	3:30	4.7	10.2	97.9
9/27/2012	4:00	4.7	10.2	97.8
9/27/2012	4:30	4.6	10.2	97.9
9/27/2012	5:00	4.5	10.2	97.8
9/27/2012	5:30	4.5	10.2	97.9
9/27/2012	6:00	4.4	10.2	97.9
9/27/2012	6:30	4.4	10.3	98.1
9/27/2012	7:00	4.3	10.3	98.1
9/27/2012	7:30	4.3	10.3	98.1

Table C-3. Dissolved Oxygen Measurements (in mg/L and % saturation) at the Bypassed Reach Upper Site (BPU) During the 72-Hr Sampling Event of September 2012.

Date	Time	Water Temperature (°C)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (% Saturation)
9/27/2012	8:00	4.3	10.3	98.2
9/27/2012	8:30	4.4	10.3	98.4
9/27/2012	9:00	4.5	10.3	98.7
9/27/2012	9:30	4.7	10.3	99.1
9/27/2012	10:00	5.0	10.2	99.2
9/27/2012	10:30	5.2	10.1	99.1
9/27/2012	11:00	5.5	10.1	99.2
9/27/2012	11:30	5.7	10.0	99.1
9/27/2012	12:00	5.9	9.9	98.8
9/27/2012	12:30	6.2	9.9	98.7
9/27/2012	13:00	6.4	9.8	98.7
9/27/2012	13:30	6.5	9.8	98.7
9/27/2012	14:00	6.6	9.7	98.6
9/27/2012	14:30	6.8	9.7	98.7
9/27/2012	15:00	6.9	9.7	98.7
9/27/2012	15:30	7.0	9.7	98.7
9/27/2012	16:00	7.0	9.6	98.6
9/27/2012	16:30	7.0	9.6	98.3
9/27/2012	17:00	7.0	9.6	98.2
9/27/2012	17:30	7.0	9.6	97.9
9/27/2012	18:00	6.9	9.6	98.1
9/27/2012	18:30	6.9	9.6	98.2
9/27/2012	19:00	6.8	9.6	97.9
9/27/2012	19:30	6.7	9.6	97.8
9/27/2012	20:00	6.6	9.7	98.1
9/27/2012	20:30	6.5	9.7	98.1
9/27/2012	21:00	6.5	9.7	97.9
9/27/2012	21:30	6.4	9.7	97.9
9/27/2012	22:00	6.3	9.8	97.9
9/27/2012	22:30	6.2	9.8	98.1
9/27/2012	23:00	6.1	9.8	97.9
9/27/2012	23:30	6.1	9.8	98.1
9/28/2012	0:00	6.0	9.8	98.1
9/28/2012	0:30	6.0	9.8	97.9
9/28/2012	1:00	6.0	9.8	97.9
9/28/2012	1:30	6.0	9.8	98.1
9/28/2012	2:00	5.9	9.8	97.8
9/28/2012	2:30	6.0	9.8	97.9
9/28/2012	3:00	5.9	9.9	98.1
9/28/2012	3:30	6.0	9.8	97.9
9/28/2012	4:00	6.0	9.8	97.9
9/28/2012	4:30	6.0	9.8	97.9
9/28/2012	5:00	6.0	9.8	97.9
9/28/2012	5:30	6.0	9.8	97.9
9/28/2012	6:00	6.0	9.8	97.9
9/28/2012	6:30	6.0	9.8	98.1
9/28/2012	7:00	6.0	9.8	98.2

Table C-3. Dissolved Oxygen Measurements (in mg/L and % saturation) at the Bypassed Reach Upper Site (BPU) During the 72-Hr Sampling Event of September 2012.

Date	Time	Water Temperature (°C)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (% Saturation)
9/28/2012	7:30	6.1	9.9	98.6
9/28/2012	8:00	6.2	9.9	98.6
9/28/2012	8:30	6.2	9.8	98.8
9/28/2012	9:00	6.4	9.8	98.9

Table C-4. Dissolved Oxygen Measurements (in mg/L and % saturation) at the Bypassed Reach Lower Site (BPL) During the 72-Hr Sampling Event of August 2012.

Date	Time	Water Temperature (°C)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (% Saturation)
8/20/2012	18:30	12.0	9.0	98.4
8/20/2012	19:00	11.9	9.0	98.5
8/20/2012	19:30	11.9	9.0	98.5
8/20/2012	20:00	11.8	9.0	98.3
8/20/2012	20:30	11.7	9.0	98.4
8/20/2012	21:00	11.6	9.1	98.4
8/20/2012	21:30	11.5	9.1	98.5
8/20/2012	22:00	11.3	9.1	98.5
8/20/2012	22:30	11.2	9.2	98.4
8/20/2012	23:00	11.0	9.2	98.4
8/20/2012	23:30	10.9	9.2	98.3
8/21/2012	0:00	10.8	9.2	98.3
8/21/2012	0:30	10.7	9.2	98.2
8/21/2012	1:00	10.6	9.3	98.2
8/21/2012	1:30	10.5	9.3	98.3
8/21/2012	2:00	10.4	9.3	98.2
8/21/2012	2:30	10.2	9.4	98.5
8/21/2012	3:00	10.2	9.3	98.2
8/21/2012	3:30	10.1	9.4	98.3
8/21/2012	4:00	10.1	9.4	98.2
8/21/2012	4:30	10.1	9.4	98.4
8/21/2012	5:00	10.1	9.4	98.3
8/21/2012	5:30	10.1	9.4	98.4
8/21/2012	6:00	10.0	9.4	98.5
8/21/2012	6:30	9.9	9.4	98.5
8/21/2012	7:00	9.8	9.5	98.8
8/21/2012	7:30	9.7	9.5	98.9
8/21/2012	8:00	9.6	9.5	98.9
8/21/2012	8:30	9.6	9.6	99.1
8/21/2012	9:00	9.7	9.6	99.3
8/21/2012	9:30	9.8	9.6	99.5
8/21/2012	10:00	9.9	9.5	99.6
8/21/2012	10:30	10.2	9.5	99.6
8/21/2012	11:00	10.3	9.5	99.7
8/21/2012	11:30	10.5	9.4	99.7
8/21/2012	12:00	10.8	9.3	99.6
8/21/2012	12:30	11.0	9.3	99.7
8/21/2012	13:00	11.2	9.2	99.5
8/21/2012	13:30	11.3	9.2	99.3
8/21/2012	14:00	11.5	9.2	99.8
8/21/2012	14:30	11.7	9.2	99.7
8/21/2012	15:00	11.9	9.1	99.7
8/21/2012	15:30	11.9	9.1	99.5
8/21/2012	16:00	11.9	9.1	99.3
8/21/2012	16:30	11.9	9.1	99.3
8/21/2012	17:00	11.8	9.1	99.3
8/21/2012	17:30	11.9	9.1	99.3

Table C-4. Dissolved Oxygen Measurements (in mg/L and % saturation) at the Bypassed Reach Lower Site (BPL) During the 72-Hr Sampling Event of August 2012.

Date	Time	Water Temperature (°C)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (% Saturation)
8/21/2012	18:00	11.9	9.1	99.1
8/21/2012	18:30	11.8	9.1	99.0
8/21/2012	19:00	11.7	9.1	98.9
8/21/2012	19:30	11.6	9.1	99.0
8/21/2012	20:00	11.5	9.1	98.8
8/21/2012	20:30	11.4	9.1	98.8
8/21/2012	21:00	11.2	9.2	98.9
8/21/2012	21:30	11.1	9.2	98.9
8/21/2012	22:00	10.9	9.3	98.9
8/21/2012	22:30	10.7	9.3	98.8
8/21/2012	23:00	10.5	9.3	98.8
8/21/2012	23:30	10.4	9.4	98.8
8/22/2012	0:00	10.2	9.4	98.8
8/22/2012	0:30	10.1	9.4	98.8
8/22/2012	1:00	10.0	9.4	98.8
8/22/2012	1:30	9.9	9.5	98.8
8/22/2012	2:00	9.7	9.5	98.8
8/22/2012	2:30	9.6	9.5	98.8
8/22/2012	3:00	9.5	9.6	98.8
8/22/2012	3:30	9.3	9.6	98.9
8/22/2012	4:00	9.1	9.7	98.9
8/22/2012	4:30	8.9	9.7	98.9
8/22/2012	5:00	8.7	9.7	98.9
8/22/2012	5:30	8.6	9.8	98.8
8/22/2012	6:00	8.4	9.8	98.9
8/22/2012	6:30	8.3	9.8	98.9
8/22/2012	7:00	8.2	9.9	98.9
8/22/2012	7:30	8.1	9.9	98.9
8/22/2012	8:00	8.0	9.9	98.9
8/22/2012	8:30	8.0	9.9	99.0
8/22/2012	9:00	8.0	9.9	99.1
8/22/2012	9:30	8.0	10.0	99.2
8/22/2012	10:00	8.1	9.9	99.3
8/22/2012	10:30	8.2	9.9	99.3
8/22/2012	11:00	8.4	9.9	99.5
8/22/2012	11:30	8.8	9.8	99.6
8/22/2012	12:00	9.3	9.7	99.7
8/22/2012	12:30	9.9	9.6	99.9
8/22/2012	13:00	10.4	9.5	99.8
8/22/2012	13:30	10.7	9.4	99.7
8/22/2012	14:00	10.9	9.3	99.8
8/22/2012	14:30	11.1	9.3	99.9
8/22/2012	15:00	11.1	9.3	99.8
8/22/2012	15:30	11.0	9.3	99.7
8/22/2012	16:00	11.0	9.3	99.6
8/22/2012	16:30	10.9	9.3	99.5
8/22/2012	17:00	10.9	9.3	99.5

Table C-4. Dissolved Oxygen Measurements (in mg/L and % saturation) at the Bypassed Reach Lower Site (BPL) During the 72-Hr Sampling Event of August 2012.

Date	Time	Water Temperature (°C)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (% Saturation)
8/22/2012	17:30	10.8	9.3	99.2
8/22/2012	18:00	10.7	9.3	99.1
8/22/2012	18:30	10.6	9.3	98.9
8/22/2012	19:00	10.5	9.4	98.9
8/22/2012	19:30	10.3	9.4	98.9
8/22/2012	20:00	10.1	9.4	98.8
8/22/2012	20:30	10.0	9.5	98.8
8/22/2012	21:00	9.8	9.5	98.9
8/22/2012	21:30	9.6	9.5	98.8
8/22/2012	22:00	9.5	9.6	98.8
8/22/2012	22:30	9.3	9.6	98.6
8/22/2012	23:00	9.2	9.6	98.8
8/22/2012	23:30	9.0	9.7	98.8
8/23/2012	0:00	8.9	9.7	98.6
8/23/2012	0:30	8.8	9.7	98.8
8/23/2012	1:00	8.6	9.7	98.6
8/23/2012	1:30	8.5	9.8	98.6
8/23/2012	2:00	8.4	9.8	98.6
8/23/2012	2:30	8.2	9.8	98.4
8/23/2012	3:00	8.1	9.9	98.5
8/23/2012	3:30	8.0	9.9	98.5
8/23/2012	4:00	7.8	9.9	98.4
8/23/2012	4:30	7.7	9.9	98.5
8/23/2012	5:00	7.6	10.0	98.4
8/23/2012	5:30	7.6	10.0	98.4
8/23/2012	6:00	7.5	10.0	98.5
8/23/2012	6:30	7.4	10.0	98.5
8/23/2012	7:00	7.3	10.1	98.6
8/23/2012	7:30	7.3	10.1	98.6
8/23/2012	8:00	7.3	10.1	98.8
8/23/2012	8:30	7.2	10.1	98.6
8/23/2012	9:00	7.3	10.1	98.8
8/23/2012	9:30	7.4	10.1	99.0
8/23/2012	10:00	7.6	10.0	99.1
8/23/2012	10:30	7.7	10.0	99.1
8/23/2012	11:00	8.0	10.0	99.3
8/23/2012	11:30	8.3	9.9	99.3
8/23/2012	12:00	8.8	9.8	99.5
8/23/2012	12:30	9.4	9.7	99.6
8/23/2012	13:00	10.0	9.5	99.6
8/23/2012	13:30	10.4	9.4	99.6
8/23/2012	14:00	10.7	9.4	99.6
8/23/2012	14:30	10.9	9.3	99.6
8/23/2012	15:00	10.9	9.3	99.6
8/23/2012	15:30	10.9	9.3	99.3
8/23/2012	16:00	10.8	9.3	99.2
8/23/2012	16:30	10.8	9.3	99.1

Table C-4. Dissolved Oxygen Measurements (in mg/L and % saturation) at the Bypassed Reach Lower Site (BPL) During the 72-Hr Sampling Event of August 2012.

Date	Time	Water Temperature (°C)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (% Saturation)
8/23/2012	17:00	10.7	9.3	99.0
8/23/2012	17:30	10.6	9.3	98.9
8/23/2012	18:00	10.5	9.3	98.8

Table C-5. Dissolved Oxygen Measurements (in mg/L and % saturation) at the Bypassed Reach Lower Site (BPL) During the 72-Hr Sampling Event of September 2012.

Date	Time	Water Temperature (°C)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (% Saturation)
9/25/2012	7:30	7.9	10.3	102.4
9/25/2012	8:00	7.9	10.3	102.5
9/25/2012	8:30	7.9	10.3	102.7
9/25/2012	9:00	8.0	10.3	102.8
9/25/2012	9:30	8.1	10.3	103.1
9/25/2012	10:00	8.2	10.3	103.0
9/25/2012	10:30	8.4	10.2	103.1
9/25/2012	11:00	8.6	10.2	103.1
9/25/2012	11:30	8.9	10.1	103.4
9/25/2012	12:00	9.2	10.1	103.2
9/25/2012	12:30	9.4	10.0	103.0
9/25/2012	13:00	9.4	10.0	103.1
9/25/2012	13:30	9.5	10.0	103.2
9/25/2012	14:00	9.5	10.0	103.1
9/25/2012	14:30	9.5	10.0	103.1
9/25/2012	15:00	9.6	9.9	103.1
9/25/2012	15:30	9.6	9.9	103.0
9/25/2012	16:00	9.6	9.9	102.9
9/25/2012	16:30	9.6	9.9	102.8
9/25/2012	17:00	9.6	9.9	102.8
9/25/2012	17:30	9.5	9.9	102.5
9/25/2012	18:00	9.5	9.9	102.7
9/25/2012	18:30	9.4	9.9	102.4
9/25/2012	19:00	9.3	10.0	102.5
9/25/2012	19:30	9.1	10.0	102.4
9/25/2012	20:00	9.0	10.0	102.5
9/25/2012	20:30	8.8	10.1	102.7
9/25/2012	21:00	8.7	10.1	102.4
9/25/2012	21:30	8.5	10.1	102.5
9/25/2012	22:00	8.4	10.2	102.4
9/25/2012	22:30	8.2	10.2	102.4
9/25/2012	23:00	8.1	10.2	102.4
9/25/2012	23:30	8.0	10.3	102.4
9/26/2012	0:00	7.9	10.3	102.4
9/26/2012	0:30	7.7	10.3	102.3
9/26/2012	1:00	7.6	10.4	102.4
9/26/2012	1:30	7.5	10.4	102.3
9/26/2012	2:00	7.4	10.4	102.3
9/26/2012	2:30	7.3	10.4	102.3
9/26/2012	3:00	7.2	10.5	102.3
9/26/2012	3:30	7.1	10.5	102.3
9/26/2012	4:00	7.0	10.5	102.2
9/26/2012	4:30	6.9	10.5	102.1
9/26/2012	5:00	6.8	10.6	102.3
9/26/2012	5:30	6.7	10.6	102.2
9/26/2012	6:00	6.7	10.6	102.3
9/26/2012	6:30	6.6	10.6	102.4

Table C-5. Dissolved Oxygen Measurements (in mg/L and % saturation) at the Bypassed Reach Lower Site (BPL) During the 72-Hr Sampling Event of September 2012.

Date	Time	Water Temperature (°C)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (% Saturation)
9/26/2012	7:00	6.5	10.7	102.5
9/26/2012	7:30	6.5	10.7	102.5
9/26/2012	8:00	6.4	10.7	102.5
9/26/2012	8:30	6.4	10.7	102.8
9/26/2012	9:00	6.4	10.7	102.9
9/26/2012	9:30	6.6	10.7	103.1
9/26/2012	10:00	6.6	10.7	103.1
9/26/2012	10:30	6.8	10.7	103.1
9/26/2012	11:00	7.1	10.6	103.1
9/26/2012	11:30	7.4	10.5	103.0
9/26/2012	12:00	7.6	10.4	103.1
9/26/2012	12:30	7.9	10.4	103.0
9/26/2012	13:00	8.1	10.3	103.2
9/26/2012	13:30	8.2	10.3	103.2
9/26/2012	14:00	8.2	10.3	103.1
9/26/2012	14:30	8.2	10.3	103.0
9/26/2012	15:00	8.2	10.3	102.9
9/26/2012	15:30	8.1	10.3	102.8
9/26/2012	16:00	8.0	10.3	102.8
9/26/2012	16:30	7.9	10.3	102.7
9/26/2012	17:00	7.8	10.3	102.7
9/26/2012	17:30	7.7	10.4	102.5
9/26/2012	18:00	7.6	10.4	102.4
9/26/2012	18:30	7.6	10.4	102.4
9/26/2012	19:00	7.5	10.4	102.5
9/26/2012	19:30	7.4	10.4	102.4
9/26/2012	20:00	7.3	10.5	102.5
9/26/2012	20:30	7.2	10.5	102.4
9/26/2012	21:00	7.2	10.5	102.4
9/26/2012	21:30	7.1	10.5	102.5
9/26/2012	22:00	7.0	10.5	102.4
9/26/2012	22:30	6.9	10.6	102.4
9/26/2012	23:00	6.9	10.6	102.4
9/26/2012	23:30	6.8	10.6	102.4
9/27/2012	0:00	6.7	10.6	102.4
9/27/2012	0:30	6.6	10.6	102.4
9/27/2012	1:00	6.5	10.7	102.4
9/27/2012	1:30	6.4	10.7	102.3
9/27/2012	2:00	6.3	10.7	102.3
9/27/2012	2:30	6.2	10.7	102.3
9/27/2012	3:00	6.1	10.8	102.3
9/27/2012	3:30	6.0	10.8	102.3
9/27/2012	4:00	5.9	10.8	102.4
9/27/2012	4:30	5.8	10.8	102.3
9/27/2012	5:00	5.8	10.8	102.3
9/27/2012	5:30	5.7	10.9	102.3
9/27/2012	6:00	5.6	10.9	102.3

Table C-5. Dissolved Oxygen Measurements (in mg/L and % saturation) at the Bypassed Reach Lower Site (BPL) During the 72-Hr Sampling Event of September 2012.

Date	Time	Water Temperature (°C)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (% Saturation)
9/27/2012	6:30	5.6	10.9	102.4
9/27/2012	7:00	5.5	10.9	102.4
9/27/2012	7:30	5.5	10.9	102.5
9/27/2012	8:00	5.5	10.9	102.4
9/27/2012	8:30	5.5	11.0	102.7
9/27/2012	9:00	5.6	10.9	102.8
9/27/2012	9:30	5.8	10.9	103.1
9/27/2012	10:00	6.0	10.9	103.2
9/27/2012	10:30	6.2	10.8	103.2
9/27/2012	11:00	6.5	10.7	103.4
9/27/2012	11:30	7.0	10.6	103.5
9/27/2012	12:00	7.4	10.5	103.2
9/27/2012	12:30	7.7	10.4	103.2
9/27/2012	13:00	8.0	10.4	103.4
9/27/2012	13:30	8.1	10.3	103.5
9/27/2012	14:00	8.1	10.3	103.1
9/27/2012	14:30	8.2	10.3	103.4
9/27/2012	15:00	8.3	10.3	103.5
9/27/2012	15:30	8.3	10.3	103.1
9/27/2012	16:00	8.3	10.2	103.0
9/27/2012	16:30	8.4	10.2	102.8
9/27/2012	17:00	8.3	10.2	102.8
9/27/2012	17:30	8.3	10.2	102.7
9/27/2012	18:00	8.3	10.2	102.5
9/27/2012	18:30	8.2	10.2	102.5
9/27/2012	19:00	8.1	10.2	102.5
9/27/2012	19:30	8.0	10.3	102.5
9/27/2012	20:00	7.9	10.3	102.4
9/27/2012	20:30	7.8	10.3	102.5
9/27/2012	21:00	7.8	10.3	102.5
9/27/2012	21:30	7.7	10.4	102.5
9/27/2012	22:00	7.6	10.4	102.4
9/27/2012	22:30	7.5	10.4	102.4
9/27/2012	23:00	7.5	10.4	102.3
9/27/2012	23:30	7.4	10.4	102.4
9/28/2012	0:00	7.4	10.4	102.4
9/28/2012	0:30	7.4	10.4	102.4
9/28/2012	1:00	7.4	10.4	102.4
9/28/2012	1:30	7.4	10.4	102.4
9/28/2012	2:00	7.4	10.4	102.4
9/28/2012	2:30	7.4	10.4	102.3
9/28/2012	3:00	7.5	10.4	102.4
9/28/2012	3:30	7.5	10.4	102.3
9/28/2012	4:00	7.5	10.4	102.4
9/28/2012	4:30	7.5	10.4	102.3
9/28/2012	5:00	7.6	10.4	102.3
9/28/2012	5:30	7.6	10.4	102.4

Table C-5. Dissolved Oxygen Measurements (in mg/L and % saturation) at the Bypassed Reach Lower Site (BPL) During the 72-Hr Sampling Event of September 2012.

Date	Time	Water Temperature (°C)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (% Saturation)
9/28/2012	6:00	7.6	10.4	102.4
9/28/2012	6:30	7.6	10.4	102.5
9/28/2012	7:00	7.7	10.4	102.7
9/28/2012	7:30	7.8	10.4	102.9
9/28/2012	8:00	7.9	10.4	103.1
9/28/2012	8:30	8.1	10.3	103.2
9/28/2012	9:00	8.2	10.3	103.4
9/28/2012	9:30	8.4	10.3	103.4

Appendix D
Total Dissolved Gas Data

Table D-1. Total Dissolved Gas (TDC) Measurements Taken Twice Daily on Two Consecutive Days per Month for June-September Period in the Project Tailrace.

Date	Time	TDG (% saturation)
July 3, 2012	12:30	97.0
July 3, 2012	19:00	99.0
July 4, 2012	11:00	98.0
July 4, 2012	20:00	97.0
July 24, 2012	8:00	98.8
July 24, 2012	18:15	97.2
July 25, 2012	8:40	99.1
July 25, 2012	20:40	100.0
August 22, 2012	7:20	99.4
August 22, 2012	19:00	99.7
August 23, 2012	9:30	95.7
August 23, 2012	20:15	98.5
September 26, 2012	10:45	99.5
September 26, 2012	14:00	98.3
September 27, 2012	9:30	100.0
September 27, 2012	17:00	97.8