Weber Hydroelectric Project
FERC Project No. 1744

Final Study Plan
Water Resources

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For Public Review

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1.0 INTRODUCTION

PacifiCorp, a subsidiary of Berkshire Hathaway Energy, plans to file a new application for relicense of a major project, the Weber Hydroelectric Project (Project), Federal Energy Regulatory Commission (FERC or Commission) Project No. 1744, on the Weber River in Weber, Morgan, and Davis counties in Utah. The current license will expire on May 31, 2020. The Project has a generation capacity of 3.85 megawatts (MW) and is located partially on federal lands managed by the Wasatch-Cache National Forest, and partially on lands owned by the Union Pacific Railroad Company. PacifiCorp filed a Notice of Intent to File Application for New License (NOI) and a Pre-Application Document (PAD) to initiate the FERC Alternative Licensing Process (ALP) for the Project on May 29, 2015.

During preparation of the PAD, PacifiCorp conducted a desktop-level assessment to evaluate existing water resource data for the Weber River and to inform analysis of potential Project impacts on water resources. The results of the desktop-level assessment are presented in Section 3 for both hydrology and water quality. In addition to the hydrology analysis conducted during the PAD process, the U.S. Fish and Wildlife Service (USFWS) requested an additional flow analysis to more specifically characterize the current flow regime within the Project Area. One finding from the desktop-level assessment is that recent comprehensive water quality data (within the last 10 years) for the portion of the Weber River in question are lacking. This lack of data prohibits a rigorous assessment of potential project impacts to this resource from Project operations without obtaining additional water quality data. The importance of such data is evident given that the Weber River is a highly valued and heavily used resource in Utah, with several stakeholder groups deeply vested for a variety of reasons that include agriculture, municipal water supply, recreation, and fishing. Generally speaking, water quality in the Weber River watershed is moderately degraded with approximately 56% of assessed water bodies meeting beneficial uses as defined and classified in Utah Administrative Code R317-2-6 and R317-2-13 (Weber River Partnership 2014). Common causes for impairments include low dissolved oxygen (DO), high temperatures, high nutrient levels, sedimentation, and habitat degradation.

As a result of the assessments made in the PAD and the draft study plan (which only included water quality and not the noted additional information on hydrology), this revised study plan includes two components: a new analysis of hydrology, including specifically new information regarding the flow regime in the Project Area, and minor edits including the addition of chlorophyll *a* to the proposed sampling regime for the water quality portion of the overall study plan. The water quality study plan was developed to achieve two goals: 1) to gain a better understanding of current water quality in the Project Area; and 2) to determine the effect of Project operation on water quality and address the specific 401 water quality certification standards to ensure that the federally permitted or licensed activities are conducted in a manner that complies with applicable discharge and water quality requirements in order to maintain the chemical, physical, and biological integrity of waters of the United States within the State. Achievement of the study plan goals will identify whether there is a need to develop project-specific mitigation measures for water quality in the Project Area. The guiding principles behind the water quality study plan and monitoring strategy will be the beneficial uses and associated Utah water quality standards assigned by the Utah Division of Water Quality to the portion of the Weber River within the Project Area.

2.0 PROJECT AREA

For the purposes of this document, the FERC Project Boundary (or Project Boundary) is defined as all lands and waters within the existing FERC Project Boundary for the Weber Hydroelectric Project No. 1744, as denoted on the Project's Exhibit G. The Project Area is the area that contains all Project features (encompassing the FERC Project Boundary defined above) and that extends out for the purposes of characterization and analysis from the farthest edge of the Project Boundary across the river to the far riverbank (including the river regardless of which side of the river the Project features are found), as shown in Figure 1.

The existing Project consists of:

(1) a 27-foot-high, 79-foot-long concrete diversion dam, having two radial gates approximately 29 feet wide, and a 35-foot-wide intake structure, for a total width of 114 feet, on the Weber River;

(2) a 9,107-foot-long, 5-foot to 6.3-foot diameter steel pipeline partially encased in concrete beginning at the intake and terminating at the powerhouse on the Weber River;

(3) a 3-foot by 18-foot non-operative fish passage structure (used however to pass the minimum flow through the calibrated slide gate opening);

(4) a powerhouse containing a generating unit with a rated capacity of 3,850 kilowatt (kW) operating under a head of 185 feet producing a 30-year average annual energy output of 16,932 megawatt-hours (MWh);

(5) a discharging pipe returning turbine flows into the Weber River at the powerhouse; and,

(6) a 77-foot-long, 46-kilovolt (kV) transmission line which connects to the Weber substation.

Figure 1. Weber Hydro Relicensing Project Location.

3.0 BACKGROUND

3.1 Hydrology Existing Data

The desktop assessment conducted during the PAD process utilized the entire U.S. Geological Survey (USGS) period of record (94 years) at the gage just upstream of the Project Area (No. 10136500) to calculate data in Table 1. Average monthly minimum flows ranged from 140 cfs in December to 868 cfs in May while average monthly maximum flows ranged from 271 in November to 2,134 cfs in May. Average mean monthly flows ranged from 192 cfs to 1,450 cfs (November and May). Table 1 lists all average monthly minimum, mean and maximum flow data for Station USGS gage No. 10136500. A table in the new assessment (Section 4.1, Table 8) summarizes additional computed power flows and bypass flows as well as the USGS gage data at the Gateway gage, which serves as the inflow. The new assessment in Section 4.1 utilizes only the last 10 years of hydrological data for the Project reach of the river, given the near universality of future forecasts which indicate the likelihood for warmer, drier periods with a resultant reduction in winter snowfall, and a potential increase in winter and spring precipitation as rainfall, as compared to the longer 94-year period of record. Note that even in warmer, drier periods, elevated runoff years are still expected, as illustrated by the most recent 10-year period of record.

Streamflow:

- Low flow: 192 cfs; Flow parameter: Monthly mean flow (November).
- High flow: 1450 cfs; Flow parameter: Monthly mean flow (May).
- Average flow: 536 cfs Flow parameter: Average yearly flow.

Table 1. Average monthly flow data for USGS gaging station No. 10136500 for the 94.3-year period of record 7/1/1919 to 9/30/2014 (missing 335 days: 9/1/1919 to 7/31/1920).

Month	Average of Monthly Minimum Flow across all years (cfs)	Average of Monthly Mean Flow across all years (cfs)	Average of Monthly Maximum Flow across all years (cfs)
January	147	219	392
February	182	270	472
March	262	484	900
April	538	958	1549
May	868	1450	2134
June	604	1100	1735
July	412	527	732
August	360	439	529
September	254	353	477
October	156	232	354
November	149	192	271
December	140	205	349

Figure 2 provides a flow duration curve for the total contribution of the Weber River as described above. Flows for Gage Site 10136500 met or exceed 87 cfs 90% of the time, 339 cfs 50% of the time and 1,260 cfs 10% of the time. A Dependable Capacity of 1,420 kW was estimated using the critical month method. The critical month method uses the lowest monthly average flow for the 94.3-year period of record (192 cfs) from USGS gage 10136500 and considered this to be the approximate minimum inflow one can expect at the Project diversion. The minimum in-stream flow for the bypass reach of 34 cfs was subtracted from the lowest monthly average flow as this would not be available for generation. A simple h/k factor conversion (9 kW/cfs) for the power plant was then used to convert 158 cfs to 1,420 kW.

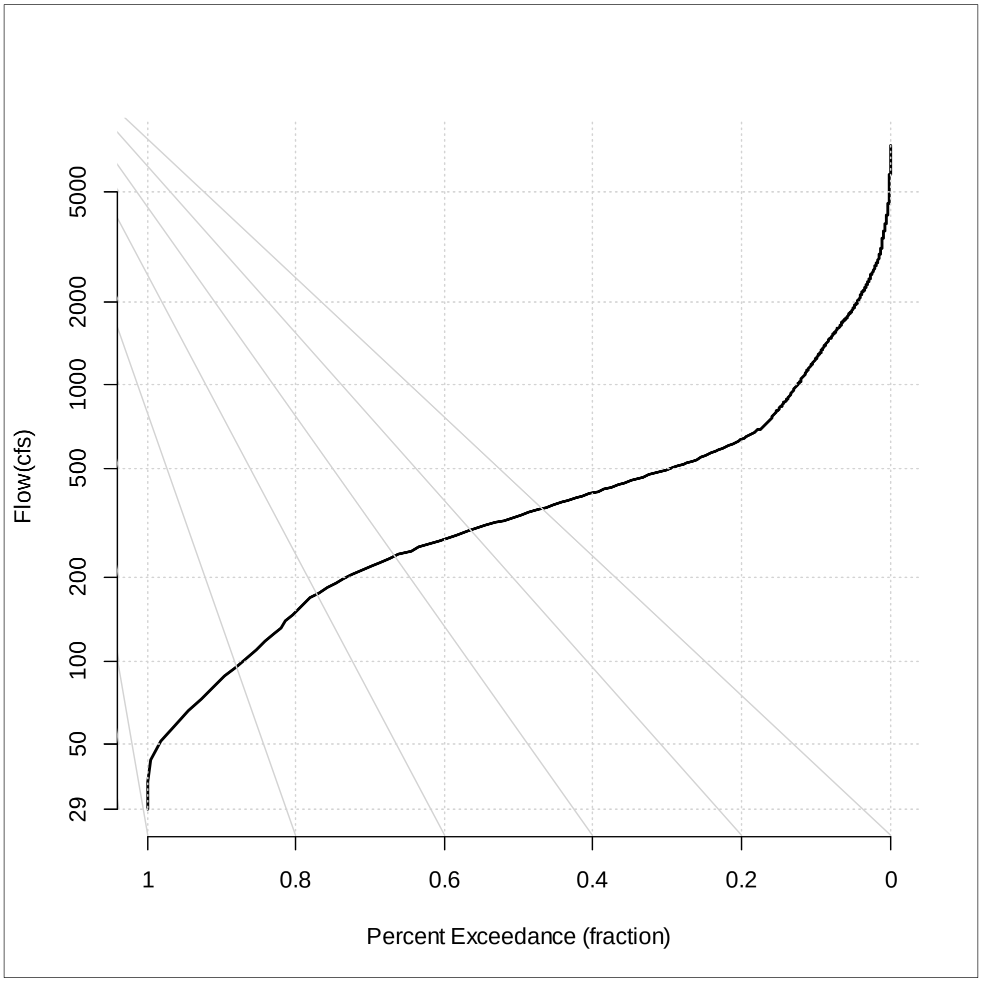


Figure 2. Flow duration curve of daily mean flows for Weber River at Gateway, UT, over the entire 94.3-year period of record (USGS gage No. 10136500).

The preceding information notes a minimum instream flow of 34 cfs. The current minimum flow requirement "to protect and enhance the fish and wildlife resources of the Weber River" from the existing 1990 Weber FERC license, is for 34-50 cfs, depending on the annual spring runoff forecast for the Weber River watershed, as determined by the National Resource Conservation Service (NRCS) and the National Weather Service (NWS). Specifically:

a) Annually, from October 1 – March 31 a continuous flow of 34 cfs or inflow, whichever is less;
b) Annually from April 1 to September 30 a continuous flow of 34-50 cfs, depending on the latest projected runoff forecast of the NRCS and NWS, or inflow, whichever is less;

Runoff forecast (percent of normal runoff)	Required minimum flow (or inflow)
>=100 percent	50 cfs
69-99 percent	34.5 to 49.5 (50 cfs X % of normal
<=68 percent	34 cfs

PacifiCorp committed to this seasonal flow regime of 34-50 cfs, or inflow, whichever is less, sometime in the 1950s; as noted, the flows change seasonally and proportionally during the irrigation season as the annual runoff forecast volume changes. Although the same minimum flow regime has been utilized by PacifiCorp hydro operations continuously since approximately the 1950s, it was only made a license requirement in the most recent 1990 Weber FERC license. Even as a voluntary operational condition over approximately the first 40 years it was implemented, this measure was adopted for the long-term benefit of the fishery, and has been in place for approximately 60+ years at this point. The existing minimum instream flows in the Project Area appear to be protective of the fishery including species of special concern. The Utah Division of Wildlife Resources (UDWR) rates the Project reach of the Weber River as Class IIIB, a quality fishery with species of special concern (Bonneville cutthroat trout and bluehead sucker). Bonneville cutthroat is also listed as a sensitive species. Both bluehead sucker and a unique fluvial population of BCT are present in the Project Area river reach, between the Weber diversion dam and powerhouse. PacifiCorp's minimum flow regime appears to be protective of the fishery in the Project Area as compared to some other reaches of the mainstem Weber River (Paul Thompson – pers. comm. 2015; Paul Burnett – pers. comm. 2015). Within the larger Weber watershed surrounding the Project, however, minimum instream flow rates are smaller and relatively less common overall. Unrelated to this license study plan/relicensing process, discussions regarding minimum instream flow issues in the wider watershed are ongoing (Cole Panter, pers. comm., Dec. 2015).

Table 2 and Figure 3 are based on information provided by the Weber River Water Commissioner and indicate the various established fish and wildlife operating criteria at other diversions within the wider Weber watershed, and which reaches of the Weber River are affected by these flows. Based on additional information provided by the Bureau of Reclamation (BOR), Weber Basin Water Conservancy District (WBWCD), and other primary water users in the larger Weber watershed outside of the Project Area, they note that:

- All of the current operating criteria for fish and wildlife, other than PacifiCorp's, were established when WBWCD was created.
- Many facilities are either bypassing flow for senior water right holders or are not diverting so instream flows can vary throughout the year.
- Several Weber Basin Project features (mostly diversion dams) are required to have a minimum bypass flow (see Table 2 and Figure 3). Bypass flows can be composed of stored water releases for downstream delivery or water necessary to satisfy downstream senior (priority) water rights, and thus can be diverted by downstream users.
- Operating criteria for fish and wildlife may be different in application than protected minimum instream flows.

Table 2. Established fish and wildlife operating criteria for major facilities in the Weber watershed.

Facility	Capacity	Units	Minimum Bypass (cfs)	Tributary	Live Capacity (ac-ft)	Dead Pool (ac-ft)
Abes Lake	150	ac-ft	No Criteria	Upper Fork of Weber	NA	No Criteria
Anchor Lake	150	ac-ft	No Criteria	Upper Fork of Weber	NA	No Criteria
Fish Lake	1060	ac-ft	No Criteria	Upper Fork of Weber	NA	No Criteria
Round Lake	24	ac-ft	No Criteria	Upper Fork of Weber	NA	No Criteria
Sand Lake	110	ac-ft	No Criteria	Upper Fork of Weber	NA	No Criteria
Cliff Lake	286	ac-ft	No Criteria	Upper Fork of Weber	NA	No Criteria
Lovina Lake	150	ac-ft	No Criteria	Upper Fork of Weber	NA	No Criteria
Seymour Lake	370	ac-ft	No Criteria	Upper Fork of Weber	NA	No Criteria
Kamas Lake	70	ac-ft	No Criteria	Upper Fork of Weber	NA	No Criteria
Boyer & Joyce Lake	1587	ac-ft	No Criteria	Chalk Creek	NA	No Criteria
Smith & Morehouse	8350	ac-ft	7	Smith & Morehouse Creek	7600	750
Weber Provo Canal	1000	cfs	No Criteria	Weber	NA	NA
Rockport Reservoir	62120	ac-ft	25	Weber	60860	1260
Echo Reservoir	74000	ac-ft	No Criteria	Weber	74000	No Criteria
Lost Creek Reservoir	22510	ac-ft	8, or inflow if less	Lost Creek	20010	2500
Stoddard Diversion	700	cfs	15-30	Weber	NA	NA
Gateway Canal	700	cfs	NA	Weber	NA	NA
East Canyon Reservoir	51190	ac-ft	5, or inflow if less	East Canyon Creek	48100	3090
Gateway Tunnel	435	cfs	No Criteria	Weber	NA	NA
PacifiCorp Weber Plant	365	cfs	34-50, or inflow if less	Weber	NA	NA
DWCCC Canal	320	cfs	No Criteria	Weber	NA	NA
Slaterville Structure	1000	cfs	0-150	Weber	NA	NA
Willard Canal	1050	cfs	NA	Weber	NA	NA
Willard Bay Reservoir	218900	ac-ft	NA	Weber	202000	16900
Causey Reservoir	7870	ac-ft	25, or inflow if less	Weber	6870	1000
Ogden Valley Dam	100	cfs	No Criteria	South Fork Ogden	NA	NA
Pineview Reservoir	114150	ac-ft	10	Ogden	110150	4000
PacifiCorp Pioneer	200	cfs	NA	Ogden	NA	NA

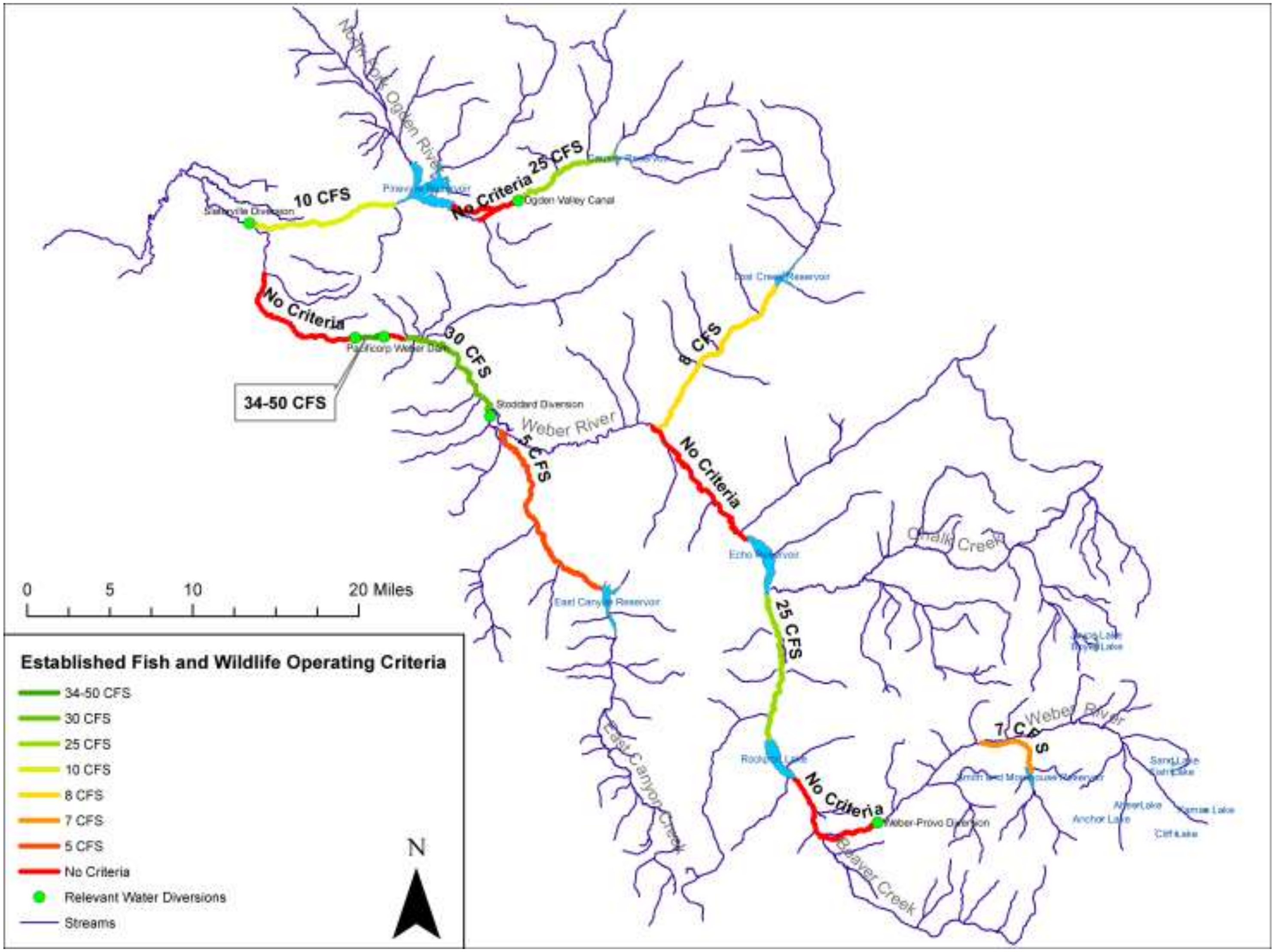


Figure 3. Established operating criteria for reaches in the Weber watershed.

3.2 Water Quality Existing Data

A water quality analysis as it relates to the Weber Dam and its operation was conducted using existing water quality data from the Weber River-3 Assessment Unit (AU) (UT16020102-002). According to the *2014 Integrated Report* (Utah Department of Environmental Quality [UDEQ] 2014), AUs are delineated by the Utah Division of Water Quality based on similarity in physical, chemical, and biological conditions of a waterbody. The Weber River-3 AU extends from the confluence with the Ogden River upstream to the confluence with Cottonwood Creek. It is approximately 19.5 miles long and encompasses the entirety of the Weber Project Area. Beneficial uses for this portion of the river are identified as Class 2B, 3A, and 4. The description for each Class is provided in Table 3. The *2014 Integrated Report* lists the Weber River-3 AU as "not supporting" because it does not meet beneficial use 3A due to a biological impairment (UDEQ 2014). While this AU is listed as impaired and will require a total maximum daily load (TMDL) study, the current TMDL priority is low (UDEQ 2014), and has not been scheduled.

Table 3. Summary of use designations for the Weber River-3 Assessment Unit.

Class	Designated Beneficial Use
2B	Protected for infrequent primary contact recreation where there is a low likelihood of ingestion of water or a low degree of bodily contact with water.
3A	Protected for cold-water species of game fish and other cold-water aquatic life, including the necessary aquatic organisms in their food chain
4	Protected for agricultural uses including irrigation of crops and stock watering
Source: Utah Administrative Code R317-2	

Water quality data for the Weber River-3 AU were obtained from the U.S. Environmental Protection Agency STORET Data Warehouse. Database queries covered two STORET stations, one of which is located approximately 1 river mile upstream of the Project Area (Station ID 4921000) and one that is located approximately 12.6 miles downstream of the Project Area (Station ID 4922990) (Figure 4). Data from 1995 to 2006 were used, and the specific parameters analyzed included pH, specific conductance, turbidity, DO, temperature, alkalinity, phosphate, hardness, and total suspended solids (TSS). Monthly and annual water quality parameters are summarized in Tables 4, 5 and 6.

Seasonal water temperatures from 1995 to 2006 ranged from lows of 0–2°C during the winter (December through February) to highs of 14–19°C during the summer months (June through August). Variation in average annual temperature is relatively small with the greatest difference occurring from 1998 to 1999 (see Table 6). From 1995 to 2005, maximum temperatures occurred during the summer months with the highest temperature recorded during the summer of 2003 at 22.2°C (Figure 5). The UDEQ cold-water fishery temperature standard states that greater than 10% of samples must exceed 20°C in order for the waterbody to be listed as impaired. It should be noted that while this data set does include temperatures that surpass 20°C, fewer than 10% of the samples exceeded 20°C. In addition to denoting the 20°C standard,

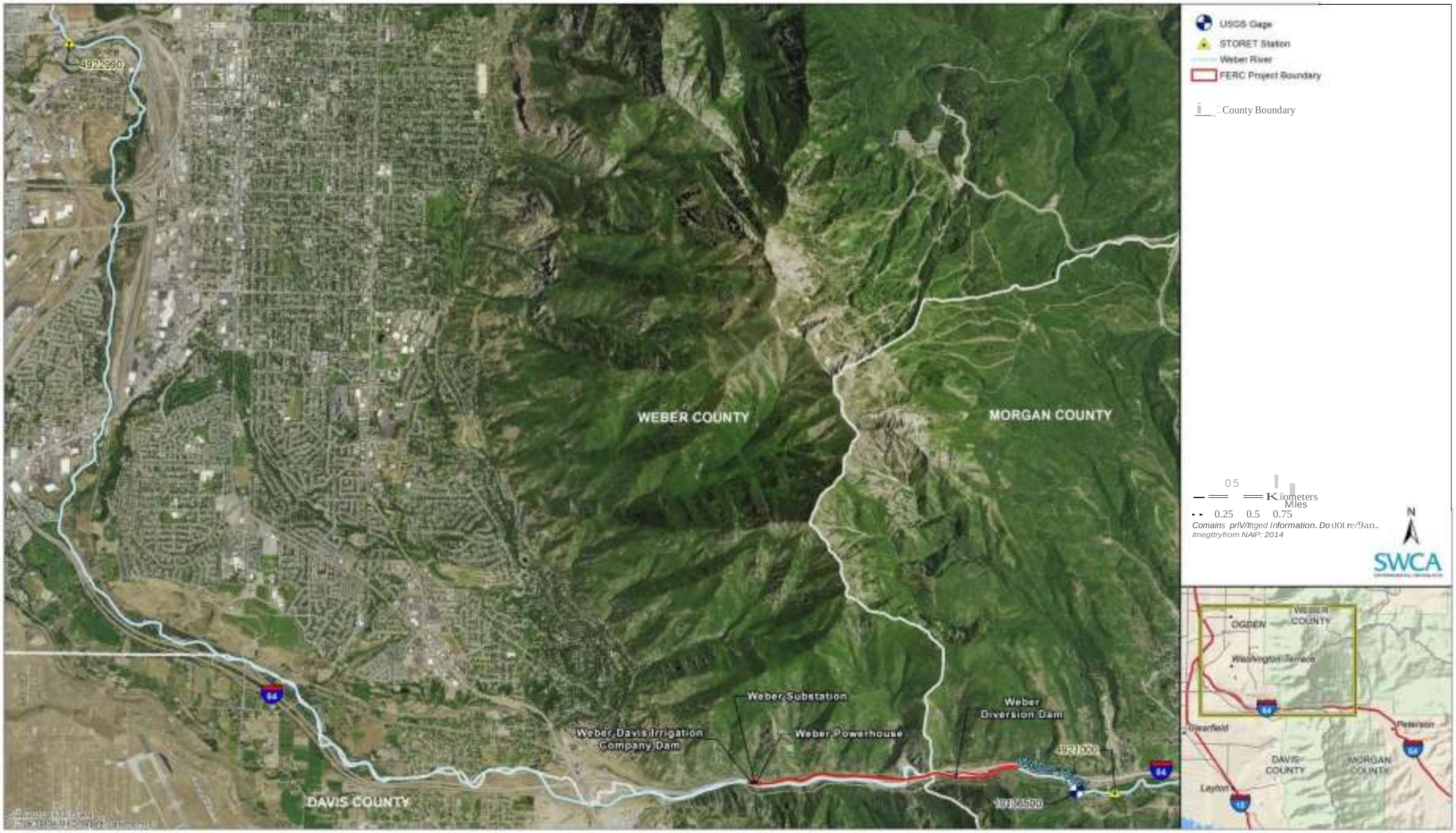


Figure 4. Map of existing water quality data locations.

Table 4. Monthly summary of water quality data for field parameters* for the Weber River-3 assessment unit, 1995–2006

	January	February	March	April	May	June	July	August	September	October	November	December	Mean
pH													
Average	8.2	8.2	8.1	8.0	8.2	8.2	8.4	8.3	8.4	8.2	8.3	8.3	8.2
Maximum	8.5	8.6	8.9	8.4	9.2	9.3	8.7	9.0	8.7	8.8	8.7	8.5	8.8
Minimum	8.0	7.4	7.0	7.2	7.1	6.7	8.1	8.0	8.1	7.5	8.0	8.0	7.6
Specific conductance (umho/cm)													
Average	571	609	470	365	359	419	529	579	553	551	649	585	520
Maximum	909	766	679	472	611	569	843	669	623	634	846	732	696
Minimum	235	538	291	238	140	263	293	482	294	348	537	512	348
Turbidity (NTU)													
Average	12.7	4.5	29.3	26.6	15.6	6.4	2.3	3.2	5.8	3.0	2.8	2.7	9.6
Maximum	62.3	13.1	99.3	110.0	44.4	18.4	6.5	7.9	14.1	6.8	5.9	3.6	32.7
Minimum	1.5	1.3	2.9	3.5	1.8	1.7	1.0	0.8	1.2	0.8	0.9	1.4	1.6
DO (mg/L)													
Average	10.8	10.9	9.4	9.8	9.9	9.4	10.2	10.4	10.3	9.9	11.8	12.1	10.4
Maximum	13.5	12.9	11.5	10.6	13.0	12.2	13.4	13.2	14.1	12.7	13.4	13.7	12.9
Minimum	8.3	9.7	8.0	8.8	8.2	8.4	7.6	7.5	7.4	6.3	9.9	11.1	8.4
Temperature, water (ºC)													
Average	2.8	4.2	6.2	8.6	12.4	14.7	19.7	17.2	14.6	8.7	7.6	2.3	9.9
Maximum	3.7	7.2	9.2	12.5	17.2	17.7	22.2	20.1	18.0	10.4	10.6	4.2	12.7
Minimum	0.1	1.8	3.4	5.1	6.1	10.5	15.9	14.4	12.4	6.9	5.4	0.7	6.9

Notes: umho/cm = micromhos per centimeter; NTU = nephelometric turbidity units*;* mg/L = milligrams per liter; ºC = degrees Celsius
*Utah State water quality standard limits listed in Table 9 of Section 4.2, this document.

Table 5. Summary of monthly water quality data for nutrient, sediment, and hardness parameters for the Weber River-3 assessment unit, 1995-2006

	January	February	March	April	May	June	July	August	September	October	November	December	Mean
Alkalinity, carbonate as CaCO3 (mg/L)													
Average	213	213	167	124	125	157	187	213	211	219	217	215	188
Maximum	256	235	241	159	192	202	202	231	233	241	226	239	221
Minimum	163	184	93	97	81	100	162	190	193	203	194	197	155
Hardness, Ca + Mg (mg/L)													
Average	267	267	197	152	153	198	224	247	250	249	260	246	226
Maximum	382	306	277	183	239	252	265	272	267	283	285	281	274
Minimum	200	235	111	125	93	110	186	223	236	223	229	174	179
Phosphate-phosphorus as P (mg/L)													
Average	0.061	0.044	0.062	0.067	0.065	0.032	0.030	0.052	0.044	0.036	0.024	0.055	0.048
Maximum	0.140	0.074	0.176	0.213	0.224	0.064	0.050	0.094	0.094	0.055	0.034	0.231	0.121
Minimum	0.022	0.020	0.021	0.021	0.021	0.021	0.020	0.021	0.010	0.026	0.020	0.020	0.020
Solids, total suspended (mg/L)													
Average	26.0	12.1	80.8	52.6	52.1	13.3	23.4	13.3	14.8	4.4	6.4	5.9	25.4
Maximum	86.7	21.2	273.0	166.0	135.5	37.6	97.0	35.2	44.0	12.8	17.6	12.0	78.2
Minimum	0.0	0.0	5.6	4.0	4.4	4.0	4.0	0.0	0.0	0.0	0.0	0.0	1.8

Table 6. Summary of average annual water quality for the Weber River-3 assessment unit, 1995–2006.

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
pH	8.3	8.5	8.2	8.3	8.2	8.3	8.2	8.4	8.4	8.0	8.0	8.0
Specific conductance (umho/cm)	479	494	510	528	434	511	499	544	644	488	512	554
Turbidity (NTU)	9.9	5.7	21.0	5.9	24.1	3.7	2.7	1.7	3.1	8.8	–	–
DO (mg/L)	9.8	10.6	9.3	9.8	9.7	10.8	11.2	11.5	12.0	10.2	10.4	10.8
Temperature, water (ºC)	9.9	9.5	9.7	10.9	8.3	10.5	10.3	10.5	12.3	10.4	11.0	–
Alkalinity, carbonate as CaCO3 (mg/L)	187	189	189	203	157	193	197	198	215	157	–	–
Hardness, Ca + Mg (mg/L)	219	214	210	238	195	240	229	235	259	209	–	–
Phosphate-phosphorus as P (mg/L)	0.061	0.073	0.084	0.040	0.061	0.049	0.027	0.036	0.029	0.041	–	–
Solids, total suspended (mg/L)	36.1	15.8	46.5	13.8	42.6	5.4	2.7	0.0	10.0	16.3	–	–

Dash = Data not available.

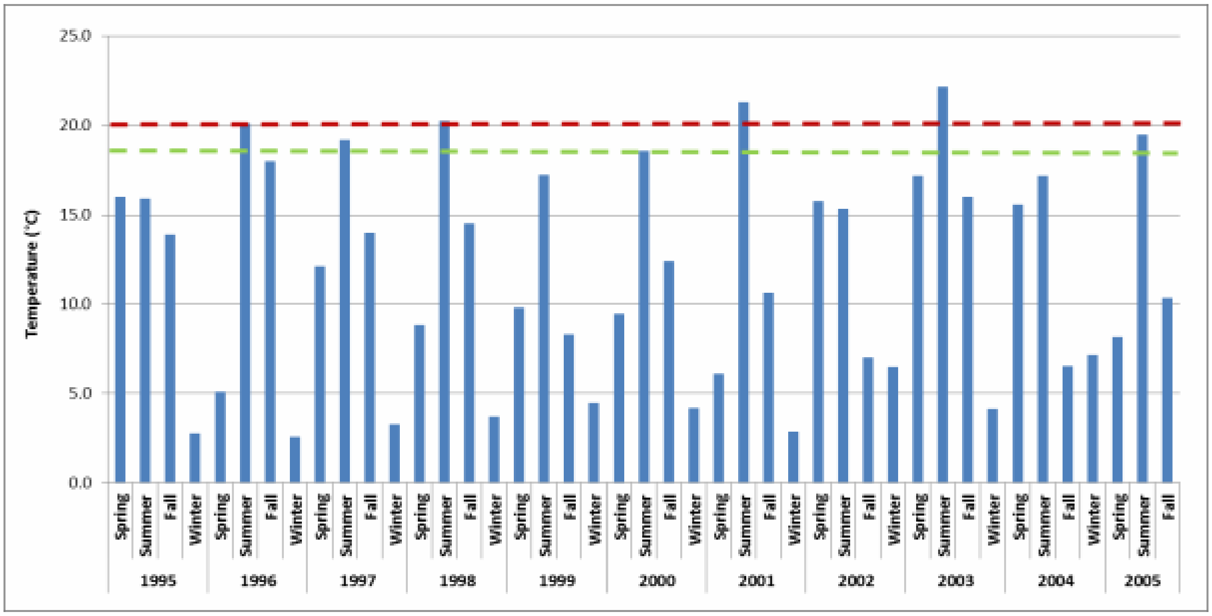


Figure 5. Maximum temperature values by season from 1995 to 2005 compared to the UDEQ temperature standard of 20°C (red dashed line) for Class 3A waters. The average maximum value from 1995 to 2005 is also shown (green dashed line) for reference.

Figure 5 also shows the average maximum temperature from 1995 to 2005, further identifying temperature conditions in the Weber River-3 AU and illustrating that as it relates to fisheries, temperature is not a water quality issue for the time period covered by this data set.

Average alkalinity (ability of the water to neutralize a strong acid) ranged from 124 mg/L to 219 mg/L over the analyzed period with lower values occurring in late spring and higher values occurring in winter. Similarly, total hardness (Ca^{++} and Mg^{++}) ranged from 152 mg/L to 267 mg/L with lower values occurring in late spring and higher values occurring in winter. Data indicate that water hardness and alkalinity in the Weber River-3 AU is on the high end; however, for this area of Utah, these values are reasonable. On a seasonal basis, the highest concentrations are found during low-flow periods driven by groundwater recharge, with low concentrations occurring during snowmelt and spring runoff. The pH along this portion of the Weber River remains relatively stable, with average monthly values ranging from 8.0 in April to 8.4 in July.

High concentrations of DO (6.0–8.0 mg/L or greater) are important for the health and viability of fish and other aquatic life in the Weber River. Low DO concentrations (less than 4.0 mg/L) can cause an increase in stress to fish species and lower resistance to environmental stress and disease, and can ultimately result in mortality (at levels less than 2.0 mg/L). Low DO in water bodies can be related to a number of factors that include decomposition of algae and other organic matter and subsequent depletion of DO. From 1995 to 2006, DO ranged from 6.3 mg/L to 14.1 mg/L in the Weber River-3 AU with an overall average of 10.4 mg/L. The minimum DO water quality standard of 4.0 mg/L as a 1-day minimum was not exceeded during this time period (Figure 6). It should be noted that several other DO state water quality criteria apply to the designated uses assigned to Weber River-3 AU; however, the existing data set used for this analysis precluded the application of these standards.

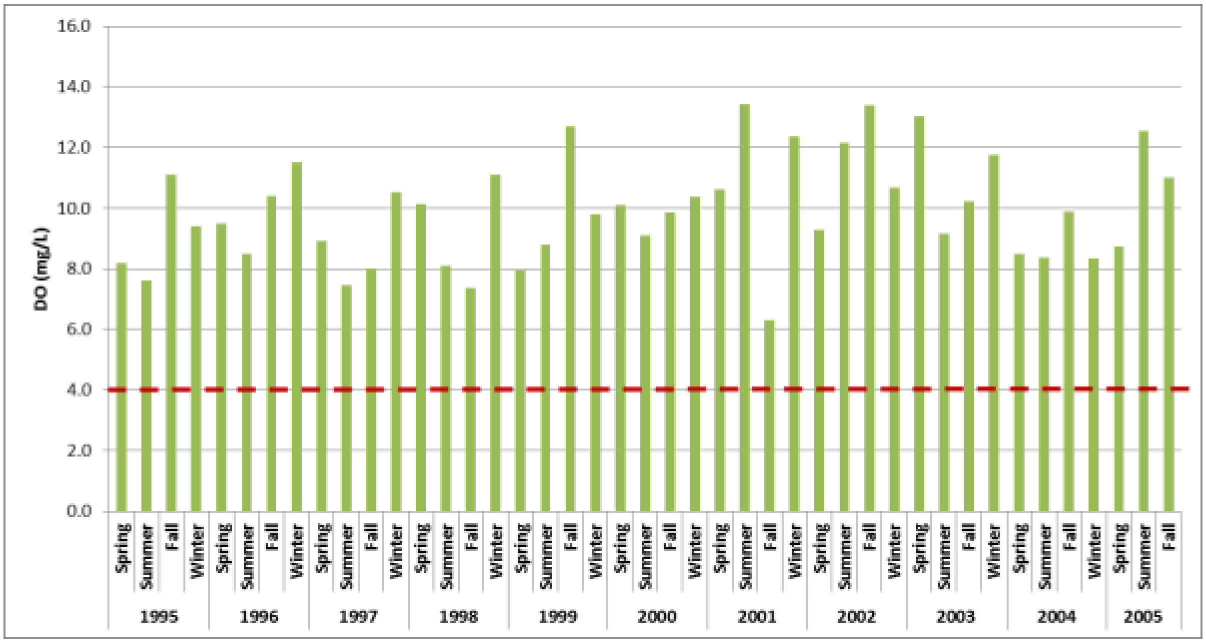


Figure 6. Minimum DO values by season from 1995 to 2005 compared to the UDEQ DO standard of 4.0 mg/L as a 1-day minimum (red dashed line) for Class 3A waters.

Seasonal average specific conductivity ranged from 168 mg/L to 733 mg/L with an average value of 517 mg/L from 1995 to 2005. Seasonally, higher values were observed during the low flows of the winter months (Figure 7), possibly due to groundwater sourcing of flow or surface runoff containing dissolved solids associated with deicing roads.

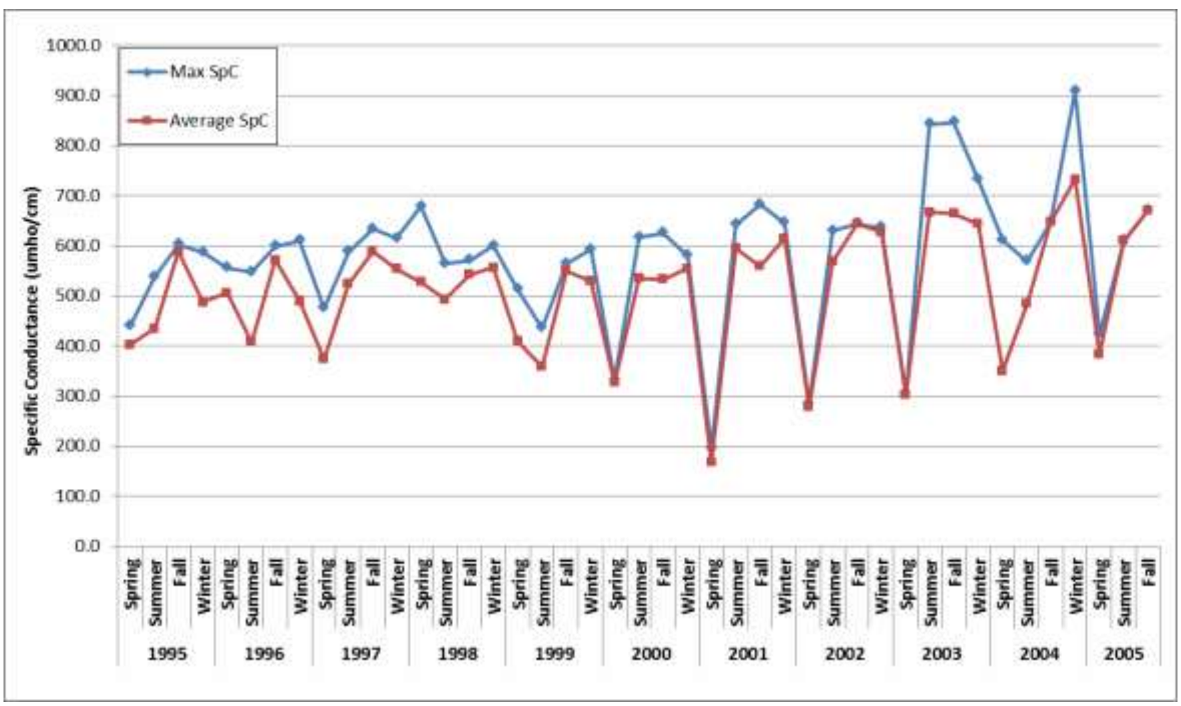


Figure 7. Maximum and average specific conductance by season from 1995 to 2005.

Turbidity ranged from 1 NTU to 110 NTU with an average value of 10 NTU, and TSS ranged from 0 mg/L to 273 mg/L with an average value of 22 mg/L. These two parameters (turbidity and TSS) are particularly important for understanding macroinvertebrate habitat because an increase in these parameters can indicate that pores of the streambed are becoming clogged with sediments, causing a reduction of habitat diversity and surface area available for microbial and macroinvertebrate growth and, subsequently, for habitat availability and surface protection for eggs and juvenile fish to become limited.

3.2.1 Water Quality Upstream and Downstream of the Dam

Paired data points from 2003 and 2004 were identified from the two water quality monitoring stations and compared to gain insight into differences in water quality upstream and downstream of the Project Area. Table 7 summarizes the number of data pairs available and the average difference and percentage change from upstream to downstream in water quality for all paired water quality samples for these stations. Trends were graphically explored for specific conductance and turbidity due to the magnitude of difference in matched pairs. Both specific conductance and turbidity are higher at the downstream sampling station versus the upstream sampling station (Figures 8 and 9). These differences are likely due to the fact that the upstream and downstream sampling stations are far enough apart (13.6 miles total) that other factors may be influencing these parameters, including that the downstream site is likely being affected by the urban corridor it traverses. Additional data will be acquired so that the degree to which the Project is affecting water quality can be identified. While historical data are useful for characterizing the evolution of water quality in the watershed, the addition of more recently collected data in closer proximity to the Project Area will be helpful for determining current trends and informing additional resource studies and courses of action during the relicensing process.

Table 7. Paired water quality parameters and average percentage of difference for upstream and downstream sampling locations.

Parameter	Number of Data Pairs	Average Upstream	Average Downstream	Average Difference	Percentage Change
pH	25	8.1	8.2	+0.1	+1.2%
Specific conductance (umho/cm)	24	500.0	601.0	+101.2	+20.2%
Turbidity (NTU)	13	5.0	8.2	+3.2	+64%
O (mg/L)	13	10.9	10.7	-0.3	-1.8%
Temperature, water (ºC)	13	11.6	11.1	-0.5	-4.3%
Alkalinity, carbonate as $CaCO_3$ (mg/L)	13	173.0	186.0	+12.7	+7.5%
Hardness, Ca + Mg (mg/L)	13	220.7	235.8	+15.0	+6.8%

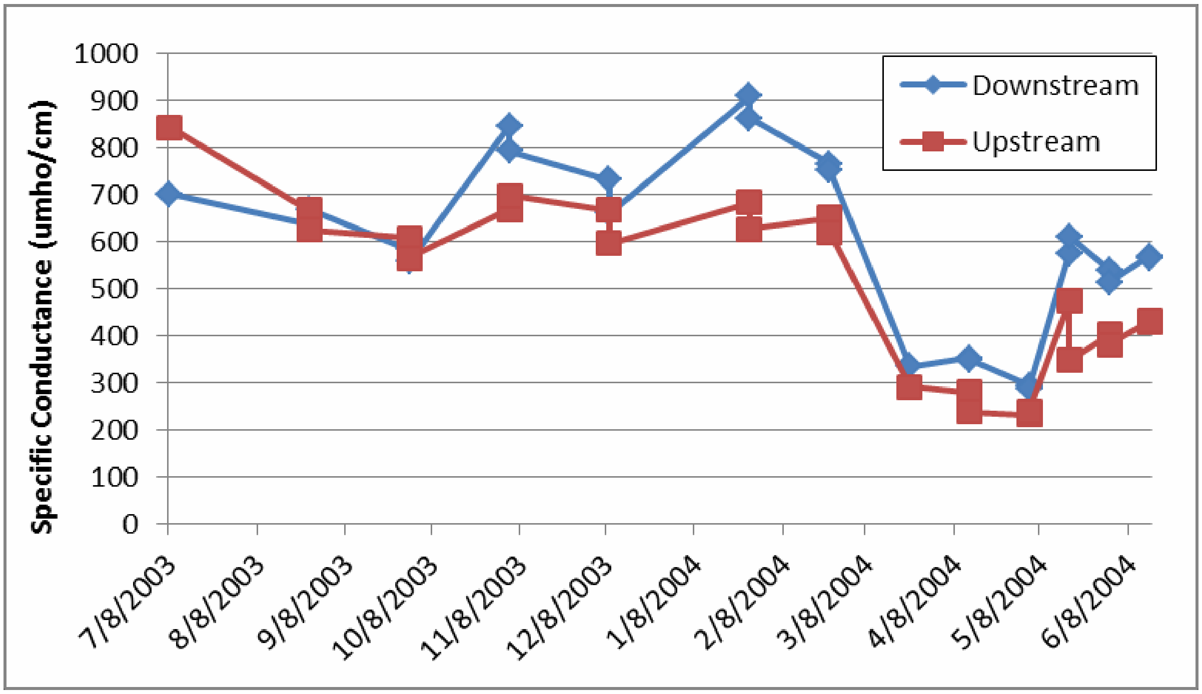


Figure 8. Matched pair values for specific conductance upstream and downstream of the dam from 2003 to 2004.

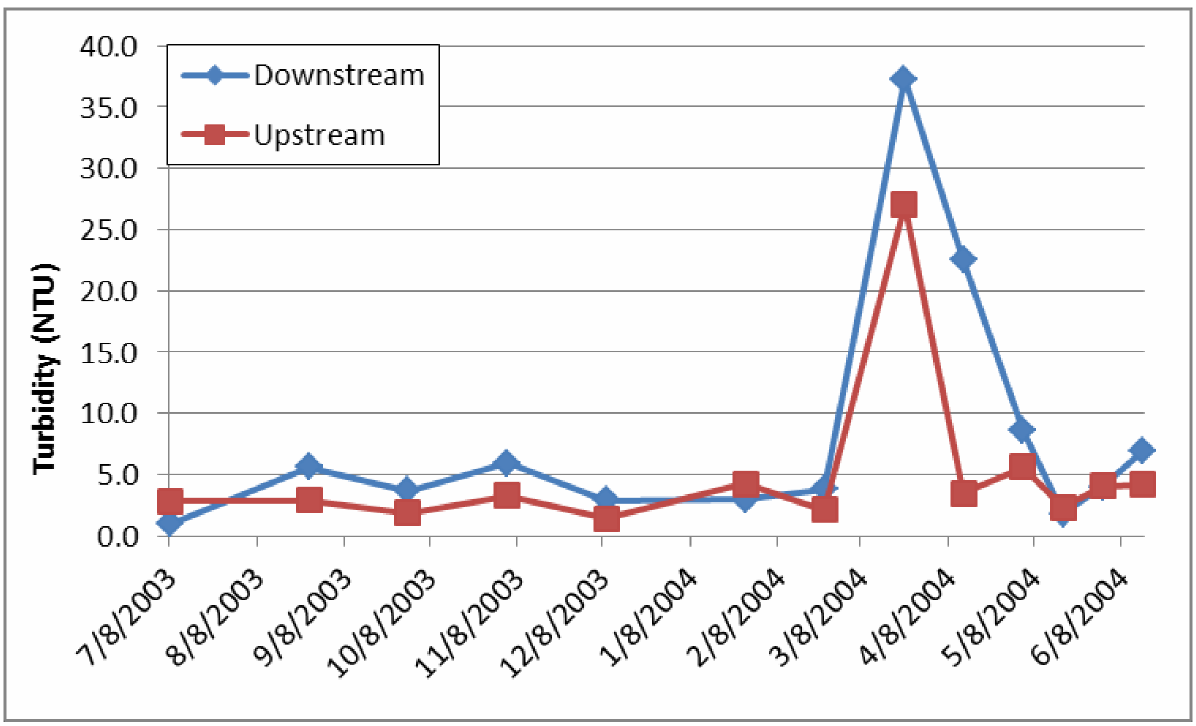


Figure 9. Matched pair values for turbidity upstream and downstream of the dam from 2003 to 2004.

3.3 Nexus to the Project

Project operations are not expected to affect water resources in the Project Area. There are no proposed changes to the hydrologic regime of the Weber River resulting from the continued operation of the Project. With regard to water quality, it may be affected by all types of diversion dams; however, the Weber Hydroelectric Project is a run-of-the-river facility with a very small forebay and associated short retention time. PacifiCorp does not flush the Project forebay to reduce sediment buildup, although limited dredging may occur periodically on an as-needed basis. Historically, when dredging does occur, any dredged materials are removed and disposed of at an off-site location. There are no other Project operations that are known to affect water quality parameters such as temperature, pH, and DO.

4.0 PROPOSED WATER RESOURCES STUDY

4.1 Hydrology Assessment

At the request of the USFWS, an additional flow assessment was conducted to characterize flows in the Project Area in more detail and to gain a better understanding of the specific timing and quantity of flow at various temporal scales. Specifically, the assessment looked at flow volumes and percentages in the bypassed reach of the Weber River, including the existing minimum flow, which varies between 34-50 cfs, or inflow if less, annually, based on the annual flow forecast for the Weber River. The assessment was made to more clearly describe the current existing hydrologic conditions in the Project Area and, in part, the larger Weber River watershed.

At the request of the USFWS, The Montana Method (Tenant 1976) was initially used to better assess the flow regime in the Project Area; however, the resultant information did not provide relevant nor useful information regarding flows in the Project Area, due to the highly diverted/altered water flow regime in the Weber River watershed. After further discussion with the USFWS, an alternative analysis was developed and utilized to more accurately characterize the existing flow regime in this reach of the Weber River.

4.1.1 Methods and Analysis

An estimate of actual bypass flows was computed (see Table 8) using the following sources of information:

- Weber River at Gateway, UT (USGS gage No. 10136500)
- Daily plant generation metering records
- Monthly FERC form 1 generation data
- Daily log of bypass gate setting and flow

The period of record used was the most recent 10 water years available (October 1, 2005 through September 30, 2015); water years were used in all annual averaging and year identification (wet, normal, dry).

Table 8. 2006-2015 Annual flow summary of inflows, power flows and bypassed flows, showing percentage of annual inflow passed.

Water Year	Classification	Weber River at Gateway (inflow gage, cfs)	Power Flow Power (cfs)	Bypassed Flow (cfs, % of inflow)
2006	Wet	617	246	380 (62%)
2007	Normal	266	223	62 (23%)
2008	Normal	361	199	171 (47%)
2009	Wet	471	197	279 (59%)
2010	Normal	338	178	166 (49%)
2011	Wet	1182	258	929 (79%)
2012	Normal	298	253	58 (19%)
2013	Dry	162	122	49 (30%)

Water Year	Classification	Weber River at Gateway (inflow gage, cfs)	Power Flow Power (cfs)	Bypassed Flow (cfs, % of inflow)
2014	Dry	213	64	150 (70%)*
2015	Dry	184	123	69 (38%)
	10-year Median:	318	198	158 (50%)
	10-yr Average:	409	186	231 (57%)

* PacifiCorp's flowline maintenance abnormally increased bypass flows in 2014.

The following graphs were developed based on data from the 2006-2015 water years' period of record. Figure 10 depicts the flow exceedance curve for the 2006-2015 period of record. Figure 11 shows the daily bypass flows on a 7-day rolling-average for the same period of record. Figure 12 shows bypass flows on a 7-day average as a percentage of the total inflow to the project, again for the same period of record. Appendix A, Figure A-1, depicts a plot array of monthly flow exceedance curves for both the more recent period of record and the complete (94-year) period of record. Also included in Appendix A, Figure A-2, are two additional graphs that display both average daily flows and minimum daily flows at the Gateway gage over the time periods that cover major water project construction in the Weber Basin.

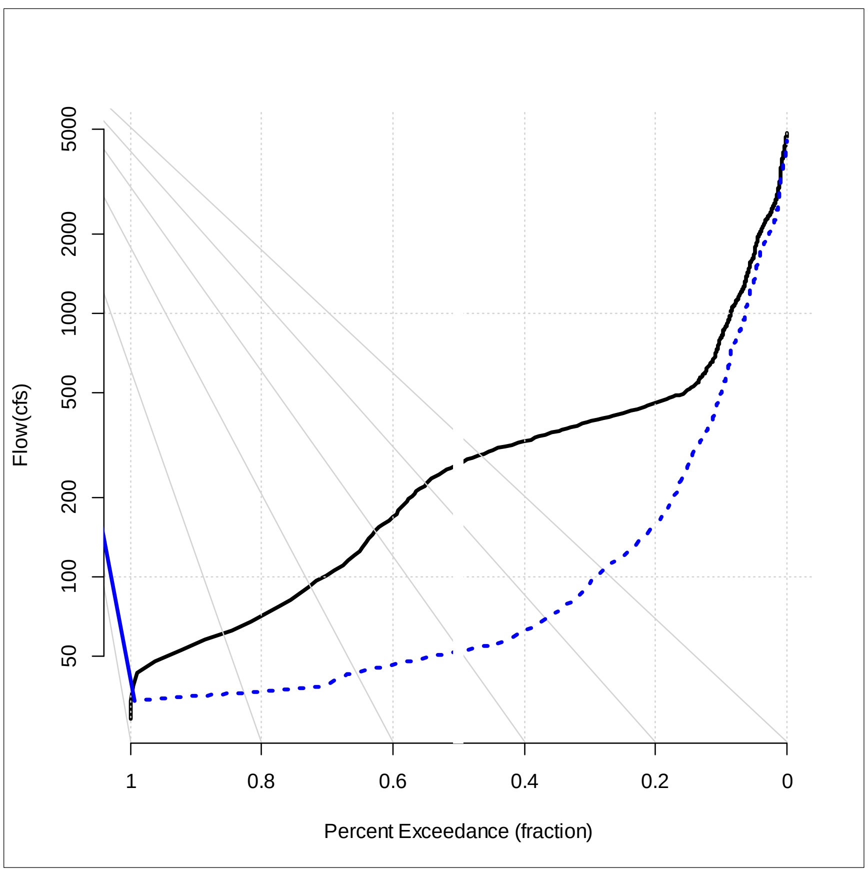


Figure 10. Flow exceedance for the 2006-2015 water years period of record. Solid black line is the flow at the Gateway gage; dashed blue line is the computed flow in the Weber Project bypassed reach.

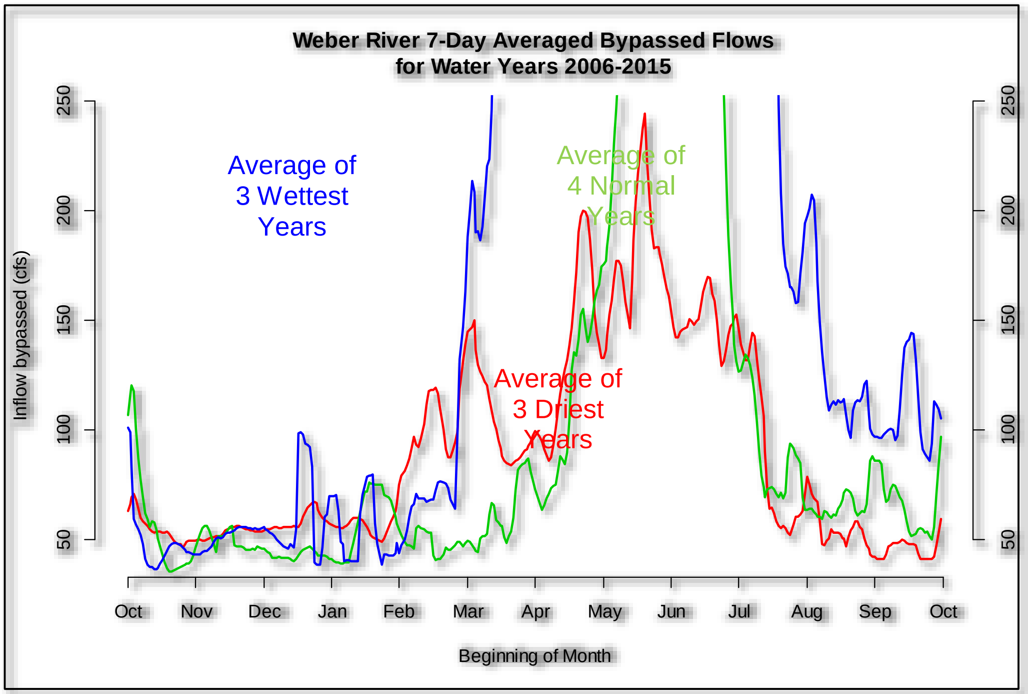


Figure 11. Daily bypass flows (7-day rolling-average) summarized by tercile. The highest flows are truncated to allow detail at lower flows. Detail for these periods is available in Figure 12.

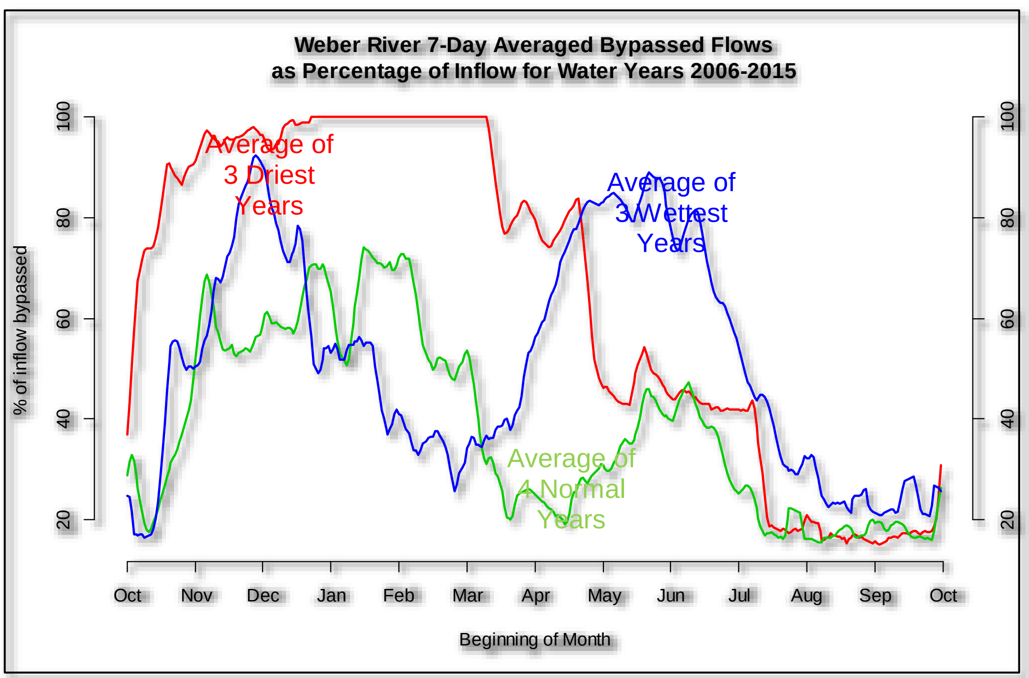


Figure 12. 10 years of 7-day averaged flows shown as a percentage of the total inflow to the project.

As noted previously in Section 3.1, PacifiCorp has provided a seasonally and annually variable 34-50 cfs (or inflow, if inflow is less), for approximately the last 60+ years. Although initially voluntary, this measure was adopted for the long-term benefit of the fishery and appears to be protective of Project Area aquatic resources.

PacifiCorp intends to propose continued implementation of the existing, protective minimum instream flow regime as part of our required Proposed Mitigation and Enhancement Measures for the relicensing of the Project. As such, no further hydrology studies are proposed as part of the Weber relicensing study plan effort.

4.2 Water Quality Study

4.2.1 Water Quality Monitoring Locations

PacifiCorp will evaluate the current water quality conditions in the Project Area to determine if beneficial uses and associated Utah state water quality standards are being met and address the specific 401 water quality certification standards to ensure that the federally permitted or licensed activities are conducted in a manner that complies with applicable discharge and water quality requirements in order to maintain the chemical, physical, and biological integrity of waters of the United States within the State.

PacifiCorp has selected three locations to monitor water quality: 1) upstream of the Weber Diversion Dam in the eastern portion of the Project Area, 2) downstream of the Project dam in the bypass reach, and 3) the lower end of the bypass reach just downstream of the point where bypass water mixes with powerhouse discharge, and upstream of the point it enters the Weber-Davis Canal (Figure 13; note a fourth site as described below and only for chlorophyll *a* will likely be added immediately upstream of the Weber project diversion dam). Water quality instrumentation (sondes) will be placed in the river at locations most likely to be representative of the entire stream channel. Where possible, bridges or other infrastructure will be used to secure sondes in the middle of the river. At the third downstream-most site, the sonde will be placed as close to the middle of the river as possible and anchored by chaining it to boulders. The precise water quality monitoring locations will need to be determined on the ground prior to deployment of the sondes in order to ensure that they are appropriately placed for the spectrum of annual flow variability. The specific water quality monitoring site locations will be determined in coordination with UDWQ staff and any other interested members of the Weber Project license stakeholder group, and will be detailed further in the Water Resource technical report which should be available for review in 2017 (Section 4.2.4).

4.2.2 Water Quality Parameters

As stated previously, this portion of the Weber River is a part of the Weber River-3 AU, which extends from the confluence with the Ogden River upstream to the confluence with Cottonwood Creek. It is approximately 19.5 miles long, and beneficial uses for this portion of the river are identified as 2B, 3A, and 4. Utah state water quality standards associated with these beneficial uses, as well as the potential for impacts from Project operations, drove the selection of

Figure 13. Water quality sampling locations

parameters to be monitored for this study plan. Water quality parameters to be monitored include temperature, pH, DO, and turbidity. In addition to monitoring the four parameters with state water quality standards, PacifiCorp also proposes to monitor TSS and specific conductance because these two parameters can lend additional insight into water quality issues. Chlorophyll *a* will also be measured and used as a proxy to determine algal biomass throughout the Project Area.

Currently, there is no existing chlorophyll *a* data for the Project Area and because algae is the primary food source for bluehead suckers it is important to understand its spatial and temporal variation. Note that due to the existence of a septic leach field system located immediately upstream of the Weber Project at the UDOT rest area, and the potential for resultant confounding effects, an additional monitoring site will be added immediately upstream of the Weber diversion dam, for chlorophyll *a* only. The water quality parameters and associated Utah state water quality standards are listed in Table 9.

Table 9. Monitored Parameters and Associated Utah Water Quality Standards

Parameter	Utah Water Quality Standard
Temperature (max/change)	20°C /2°C
pH	6.5–9.0
DO[1] (30-day average) (7-day average) (1-day minimum)	 6.5 mg/L 9.5/5.0 mg/L 8.0/4.0 mg/l
Turbidity (increase)	10 NTU
TSS	No water quality standard
Specific conductance	No water quality standard
Chlorophyll *a*	No water quality standard

[1] First number in column details when early life stages are present; second number details when all other life stages are present.

To capture current water quality conditions and evaluate potential impacts to water quality from Project operations, a YSI 6920 V2-2 multiparameter water quality sonde will be deployed at each of the three sampling locations in January 2016. The sondes will be used to record temperature, pH, DO, turbidity, and specific conductance data on an hourly basis. The sondes will remain at the three locations for approximately one year to capture all hydrologic periods, including baseflow, spring runoff, and storm flows. Grab samples for laboratory analysis of TSS and chlorophyll *a* will be taken once a month and during any planned Project operations that may affect TSS.

4.2.2.1 Biological Assessments

The *2014 Integrated Report* lists the Weber River-3 AU as “not supporting” because it did not meet beneficial use 3A due to a biological impairment (UDEQ 2014; note however that the 2014 report did *not* include the most recent 2013 data due to laboratory turn-around time). UDWQ determines biological impairments through the use of biological assessments that are conducted using the River Invertebrate Prediction and Classification System (RIVPACS) model which classifies sites based on macroinvertebrate fauna. RIVPACS generates quantitative model outputs that are assigned narrative descriptions that are then used to support narrative water quality criteria (UDEQ 2014).

The Weber River-3 AU was first listed as biologically impaired in 2008 (which was finalized in the 2014 Integrated Report and which used data collected prior to 2008), however, the most recent biological assessment conducted by UDWQ in 2013 indicates that beneficial uses are currently being met. Specifically, the 2013 assessment examined four sites within the Weber River-3 AU, one of which is located in the Project Area. Of the four sites sampled within the Weber River-3 AU, two were found to be in GOOD condition, one in FAIR condition, and one in POOR condition, based on the RIVPACS model output (Figure 14). According to the UDWQ assessment methodology for listing biological impairments, more than one site per reach must be determined to be listed as “not-in POOR condition for the supporting” (in this case, only one of the four sites was in POOR condition), therefore, the most current data for Weber River-3 AU indicates that beneficial use 3A is currently being met. Per discussion with UDWQ staff, these findings will likely result in a recommendation for delisting of the Weber River-3 AU. Additionally, the site located within the Project Area is in GOOD condition and the site upstream of the Project Area is in POOR condition indicating that Project operations are unlikely to be affecting biological integrity. Due to the potential recommendation for delisting of the Weber River-3 AU and the site-specific results of the 2013 biological assessment, additional macroinvertebrate sampling and habitat characterization are not included as a part of this study plan.

4.2.3 Quality Assurance, Quality Control

QA/QC is an integral part of any water quality study plan and is best described as a set of activities and procedures designed to assure the reliability and accuracy of data and the attainment of quality standards. QA/QC is addressed by establishing both field and laboratory checks that result in qualitative and quantitative measurements of data quality. QA/QC procedures carried out for this study plan include calibrating and servicing water quality sondes on a monthly basis. After sonde deployment, monthly service trips will be conducted (at the same time as TSS sampling) to ensure that sondes are recording data properly. All sondes will be calibrated according to manufacturer’s instructions, and batteries will be replaced during monthly checks. Prior to sampling for TSS, all sampling containers will be acquired from the contract laboratory. Once collected, samples will be kept on ice and delivered to a state-certified laboratory in Salt Lake City within the appropriate holding time and under the standard chain of custody protocols.

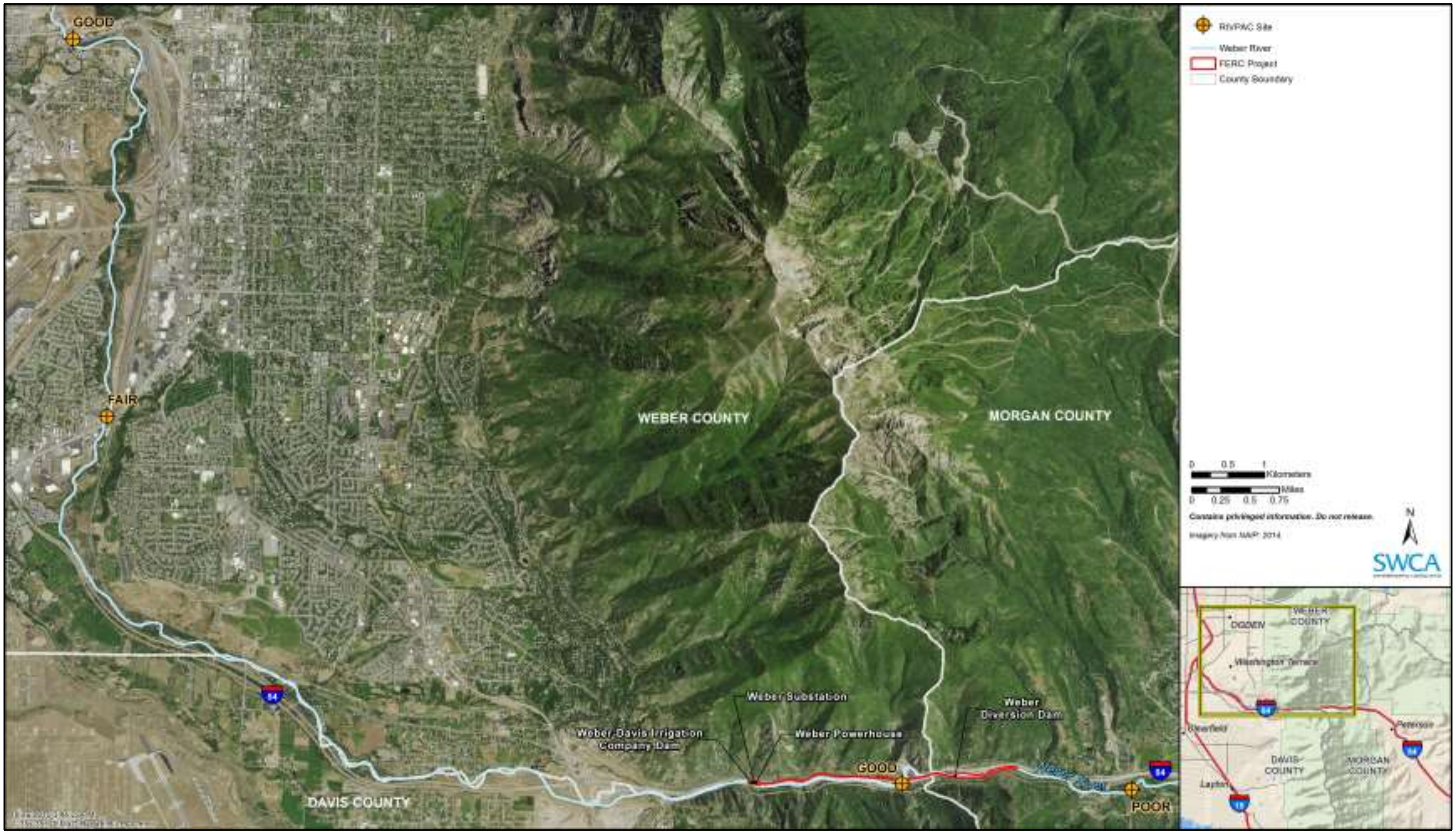


Figure 14. RIVPAC assessment locations in the Weber River-3 AU.

4.2.4 Reporting

Results of the water quality study will be presented in a technical report that will include the following components:

- Detailed descriptions of the procedures and methods used to collect and analyze water quality data
- Presentation of the water quality results in both tabular and graphical format
- Statistical analysis of the water quality results by hydrologic period
- Discussion and summary of findings with a comparison to State water quality standards both up and down gradient of the Project area.
- Identification of project impacts on water quality including a discussion of any impacts from proposed project facility modifications.
- Recommendations for mitigation of project impacts on water quality (if any)

4.2.5 Schedule and Cost

No additional external costs are expected to result from the additional hydrology analysis conducted for and presented in this study plan, as the work was completed by PacifiCorp staff and is not expected to result in additional field studies. Water quality monitoring equipment was installed at the four sampling locations identified in Section 4.1 by late January 2016. Data will be gathered for approximately 1 year to capture all hydrologic periods and any Project operations that may impact water quality. Following the field effort, all water quality data will be analyzed and presented in a draft technical report (Section 4.2.4). Stakeholder and agency comments will be addressed within a 2-week period following the 30-day review period, and the report then will be finalized and submitted to FERC. The estimated cost for each component of this study is presented in Table 10.

Table 10. Proposed tasks and associated potential estimated costs

Task	**Cost**
Water quality sondes deployment and use	$8,000
Water quality sampling	$12,000
Laboratory analysis	$2,000
Reporting	$8,000
Total	**$30,000**

5.0 REFERENCES

Burnett, Paul. 2015. Weber Watershed Project Coordinator, Trout Unlimited. Personal communication with Eve Davies, Principal Scientist, PacifiCorp, regarding Bonneville cutthroat trout and bluehead sucker in the Weber Hydro Relicensing Project Area. October 2015.

Panter, Cole. 2015. Weber and Ogden River Water Commissioner. Personal communication with Eve Davies, Principal Scientist, PacifiCorp, regarding minimum instream flow issues in the Weber watershed. December 2015.

Tennant, D.L. 1976. Instream flow regimens for fish, wildlife, recreation and related environmental resources. *Fisheries.* Volume 1 (4): 6-10.

Thompson, Paul. 2015. Aquatics Program Manager, Utah Division of Wildlife Resources. Personal communication with Eve Davies, Principal Scientist, PacifiCorp regarding Bonneville cutthroat trout and bluehead sucker in the Weber Hydro Relicensing Project Area. October 2015.

Utah Department of Environmental Quality (UDEQ). 2014. *2014 Integrated Report*. Available at: http://www.deq.utah.gov/ProgramsServices/programs/water/wqmanagement/assessment/curr entIRoct.htm. Accessed July 22, 2015.

Utah Administrative Code R317-2. 2013. Standards of Quality for Waters of the State. Accessed: August 26, 2015. Available at: http://www.rules.utah.gov/publicat/code/r317/r317-002.htm.

Weber River Partnership. 2014. *Weber River Watershed Plan.* Available at: https://extension.usu.edu/waterquality/files/uploads/Utah_Water_Week/Final_Weber_River_Restoration_Plan_2014.pdf. Accessed March 29, 2016.

Appendix A – Hydrology

The plot array on the following page (Figure A-1) shows monthly flow exceedance curves for the 2006-2015 water years' period of record. The solid black line is the flow at the Gateway gage; the dashed blue line is the computed flow in the Weber Project bypassed reach. Also shown in grey are the full period of record flow exceedance curves for the Gateway gage (solid grey) and the computed flow in the Weber Project bypassed reach (dotted grey line)

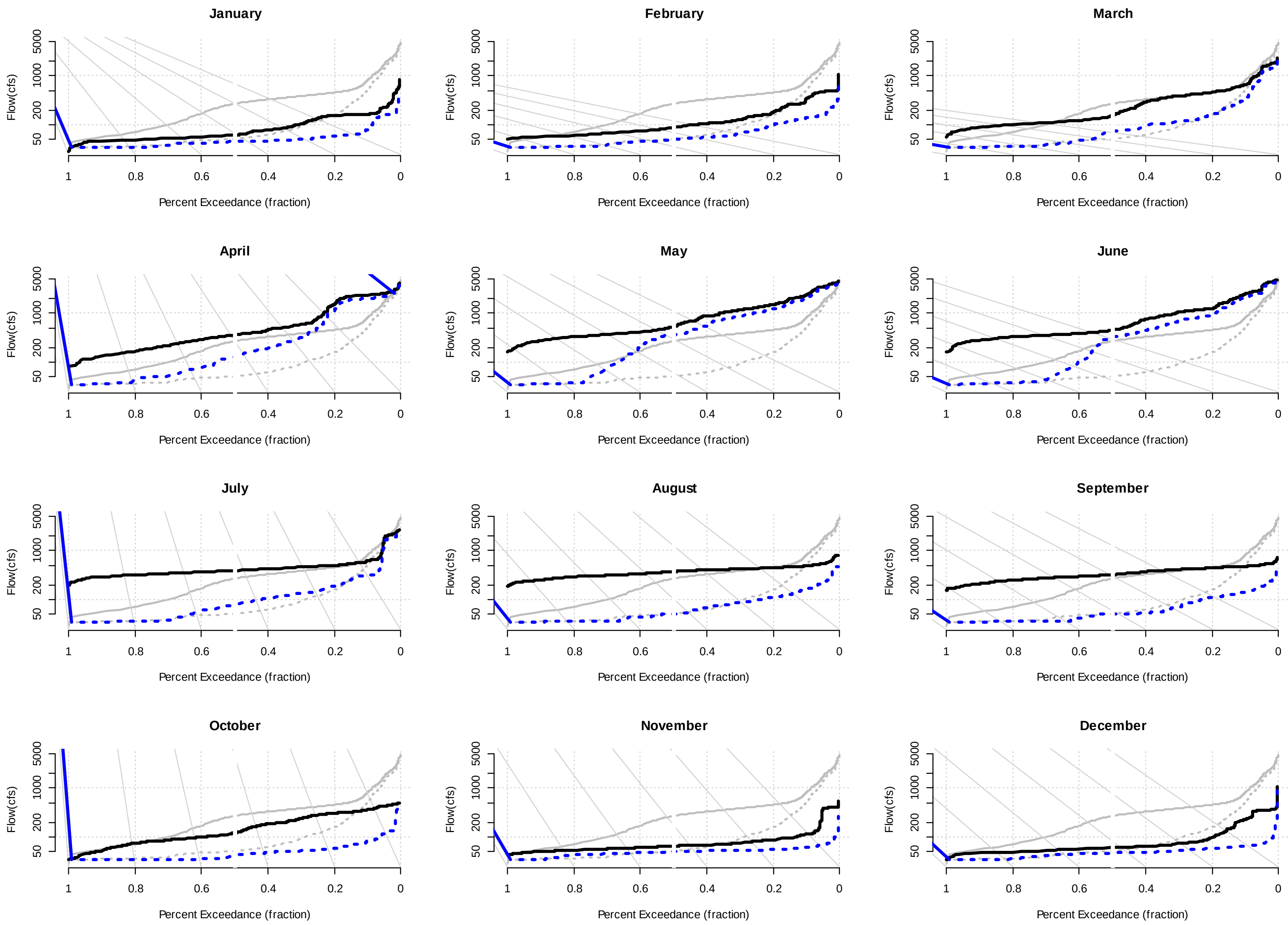
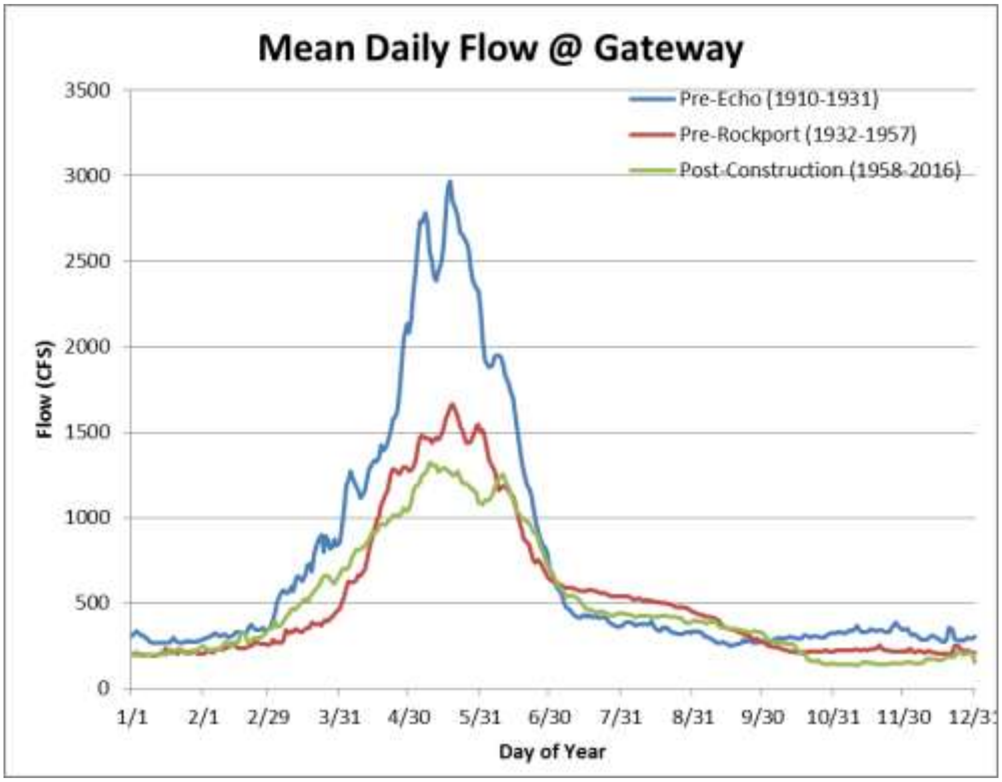


Figure A-1. Monthly Flow Exceedance Curves



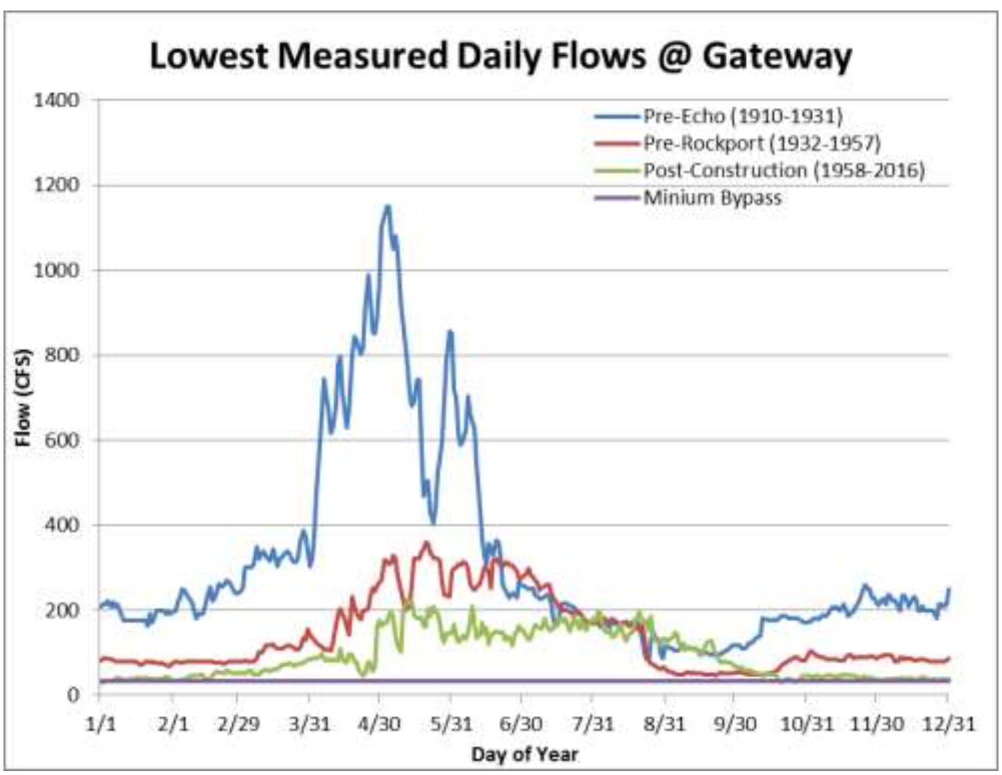


Figure A-2. Average daily flows and minimum daily flows at the Gateway gage.