

**BLACK CANYON BOATER PROGRAM  
RAMP RATE STUDY,  
BEAR RIVER HYDROELECTRIC PROJECT,  
FERC PROJECT NO. 20**

**YEAR 2 ANNUAL REPORT – FISH  
STRANDING FOLLOWING BOATER-FLOW  
RELEASES**

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# **1.0 INTRODUCTION**

PacifiCorp engaged Cirrus Ecological Solutions (Cirrus) of Logan, Utah, to implement a fish stranding study plan developed by the Bear River Hydroelectric Project Environmental Coordination Committee (ECC). The purpose of the study is to measure fish stranding during the ramp-down following the release of flows provided for recreational boating on 6.2 miles of the Bear River through the Black Canyon below the Grace Dam. These releases are substantially greater (700 – 1,200 cfs) than the minimum instream flow requirement (65 cfs) and are provided for whitewater recreation between April 1 and July 15, pursuant to the new operating license from the Federal Energy Regulatory Commission (FERC) granted on December 22, 2003.

The study plan, as developed by Oasis Environmental, Bigfork, Montana, and modified in 2008 by the ECC, prescribed monitoring during three Scheduled Ramp Rate Test Flows in 2008, 2009, and 2010. A different ramp-down rate was to be used each year: 0.25 feet per hour (ft/hr) in Year 1, then rates of 0.5 or 1.0 ft/hr in Year 2 and Year 3, respectively. Five study plots of at least 1,000 square feet each were established to represent areas of high, medium, and low fish stranding potential, with the distribution of plots roughly proportional to the actual amount of each of these classifications along the 6.2 miles. The potential for stranding was determined prior to the first Scheduled Ramp Rate Test Flow in Year 1 by evaluating variables including bank slope, vegetation, substrate composition, and presence of depressions that could hold water that might trap fish.

This report documents the results from Year 2 of the study. This report also includes data on stage changes and water quality measurements during the boater-flow events provided by PacifiCorp.

## **2.0 METHODS**

The methods developed in the first year of the study were followed in Year 2 with some slight modifications as noted below.

### **2.1 STRANDING POTENTIAL MAPPING**

Cirrus completed mapping of stranding potential in early 2008 following initial visits with PacifiCorp personnel to better define the most significant stranding factors. The final mapping was documented in *Black Canyon Boater Program Ramp Rate Study, Bear River Hydroelectric Project, FERC Project No. 20, Year 1 Annual Report – Fish Stranding Following Boater-Flow Releases* (Cirrus 2008).

### **2.2 STUDY PLOT DIMENSIONS AND LOCATIONS**

The study plots from Year 1 were relocated for Year 2 using GPS coordinates, detailed orthophotos, and the experience of the first year's observers. Boundaries of the subplots were adjusted only slightly.

The distributions and river bank lengths of the final study plots are shown in Table 1. The width – horizontal distance between high and minimum flows – and the areal extent differed with each Scheduled Ramp Rate Test Flow, as a result of slightly different flows and minor changes in river boundaries between boater-flow events.

<b>Table 1. Stranding plot distribution and river bank length.</b>			
<b>Reach</b>	<b>Plot</b>	<b>River Bank Length (feet)</b>	<b>Stranding Potential</b>
2 (0.25 mile below Grace Dam)	1	317	High
	2	270	Low
	3	317	High
	4	212	Medium
3 (3.4 miles below Grace Dam)	2	182	High
	4	217	High
4 (5.9 miles below Grace Dam)	1	260	Medium
	2	250	Low

The locations of the study plots in Reaches 2, 3 and 4 are reproduced in Figures 1, 2, and 3, respectively<sup>1</sup>. Two observers again monitored the four Reach 2 study plots, each person monitoring two plots on one side of the river. Due to the difficulty of access and consequent safety concerns, two observers were again used to monitor the two study plots in Reach 3. The faster ramp-down rate in Year 2 was expected to result in more exposed varial zone during the daylight hours following the initiation of the ramp down. Therefore, two observers – rather than one – were assigned to monitor the two plots in Reach 4 to ensure that the newly exposed varial zone could be searched completely within each hour.

## 2.3 FISH STRANDING MONITORING ON BOATER-FLOW DAYS

Following the 2008 study, some concern was expressed by the ECC regarding the validity of the first study day. Two weeks prior to the first Scheduled Ramp Rate Test Flow, a test flow was released to enable measuring the high water mark and establishment of the varial zone. The test flow suspended large quantities of sediment that had not been disturbed for several years. It was possible that the suspended sediment had a detrimental effect on aquatic populations that may have confounded the results of that first study day. Therefore, the first Scheduled Ramp Rate Test Flow of April 11, 2009, was designed to replicate the first event of 2008, using a ramp down rate of 0.25 ft/hr at approximately the same time of year.

Thereafter, three study days at a ramp-down rate of 0.5 ft/hr were conducted on April 25, May 31, and July 12, 2009. In addition, PacifiCorp conducted four Inflow-dependent Boater Flows on June 13, 14, 20, and 21, which were not monitored for stranded fish.

<sup>1</sup> For consistency, this study used the same reach designations as in the 6-year Black Canyon Monitoring Study. Reach 1 is a control reach, above Alexander Reservoir at Soda Springs.

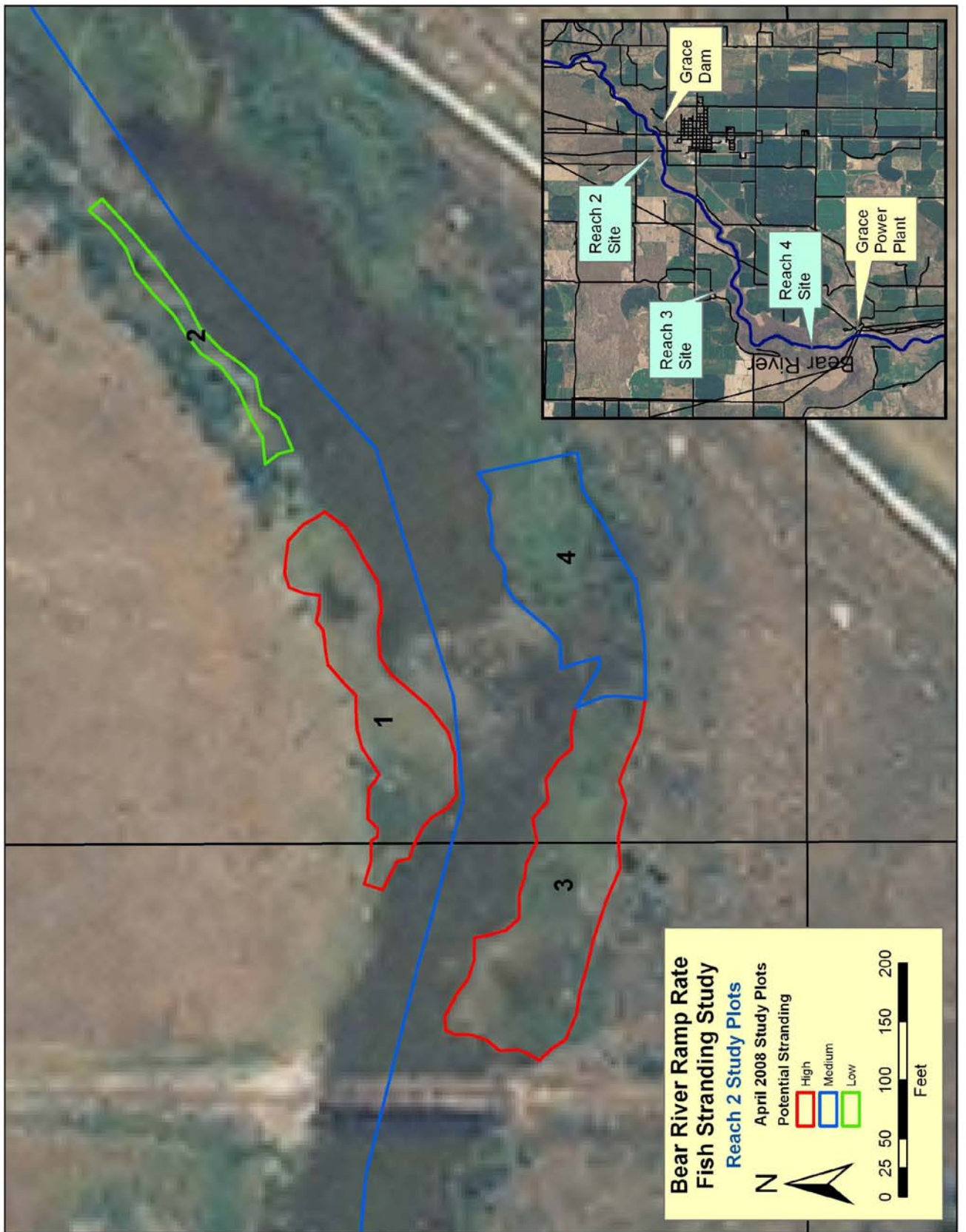


Figure 1. Location of study plots in Reach 2.



Figure 2. Location of study plots in Reach 3.





Figure 3. Location of study plots in Reach 4.

In Year 1, an abnormally low “sag” in river level was discovered below Grace Power Plant from the time water was diverted from the flowline into Black Canyon until flows in the river reached Grace Power Plant almost 2 hours later. To prevent that sag in Year 2, PacifiCorp scheduled water releases from Soda Dam and Grace power plant operations to fill the 6.2 miles of Black Canyon before diverting water from the Grace flowline into Black Canyon. In essence, Grace power plant changes were made 2 hours later than in 2008, the approximate water travel time through Black Canyon. For each of the four Scheduled Ramp Rate Test Flow days, PacifiCorp began releasing the Scheduled Ramp Rate Test Flows from Grace Dam at approximately 09:30 hours, reaching the maximum flow for the release by 11:00 hours. Cirrus’ fish stranding monitoring crews reached each study plot during the maximum flow period in early to mid-afternoon. See Appendix C for an example detailed schedule.

Ramp-down began at Grace Dam at 15:00 hours for the April 11 study day, and at 15:30 hours for the April 25, May 31, and July 12, 2009, study days. Fish stranding monitoring efforts commenced at Reach 2 and Reach 3 at 16:00. Previous observations found that it could take an hour or more for levels to decline downstream following the initiation of ramp-down, so monitoring began somewhat later in Reach 4, at 17:00 hours. Where an observer was assigned two study plots to monitor, they began monitoring the downstream plot on the top of the hour and started the next plot upstream at 30 minutes after the top of the hour.

Observers followed the same procedure during each hourly monitoring period as in Year 1, placing stakes on the boundaries between subplots at the river’s edge on a line perpendicular to the direction of the river. They measured the horizontal distance the river had receded from the previous stake to allow calculation of the areal extent of the varial zone. As they placed stakes at the river’s edge, observers also searched for fish stranded in thick vegetation or in pools that had become separated from the main flow. These efforts continued until almost dark, as late as 21:30 hours at Reach 2, 20:00 hours at Reach 3, and 20:30 hours at Reach 4.

In Year 1, the 0.25 ft/hr ramp-down rate was not expected to reach minimum flows anywhere in Black Canyon by dark, so two observers returned to the study plots in the morning after the boater-flow day to search for stranded fish and measure final varial zones. This procedure was followed for the first study day in Year 2 because it, too, was conducted at a 0.25 ft/hr ramp-down rate. The faster 0.5 ft/hr ramp-down rate used for the other three study days was expected to reach minimum flows in Reach 2 before dark, so a crew returned only to monitor Reach 4 the morning following. After assessing the varial zone areas following the first 0.50 ft/hr Scheduled Ramp Rate Test Flow, however, it became apparent that, even at Reach 2, the minimum flows had not quite been reached by dark, so for the last two Scheduled Ramp Rate Test Flows, observers returned to all three reaches the next morning.

Data, including species, size, and subplot location of stranded fish, and the time and horizontal distance the river had receded each hour in each subplot, were recorded on paper forms.

## **2.4 WATER QUALITY AND STAGE CHANGE MONITORING**

As in Year 1, PacifiCorp arranged for the deployment of three water quality sensors, one in the Grace Forebay and two on the Bear River at the mouth of Black Canyon near Grace Power Plant (one sensor filtered and one unfiltered) to monitor water temperature, specific conductivity, percent saturated dissolved oxygen, dissolved oxygen concentration, depth, and turbidity.



Measurements were made every 15 minutes beginning before water levels began to rise and continuing into the next day after water levels dropped to normal flows.

In order to acquire a temporal profile of river levels during a ramp-down below the Grace power plant, during the two April Scheduled Ramp Rate Test Flows stage change was monitored by PacifiCorp at four locations downstream of Grace power plant with one additional water level logger placed at the downstream end of the Black Canyon. The monitoring substantiated that the revised schedule reduced the sudden drop in water level downstream of the Grace power plant relative to the 2008 event monitored by water level loggers. The details are in Appendix B.

## **3.0 RESULTS**

This section describes the sizes and characteristics of the stranding potential zones and study plots, as well as the stranded fish found during the Scheduled Ramp Rate Test Flows.

### **3.1 WEATHER CONDITIONS**

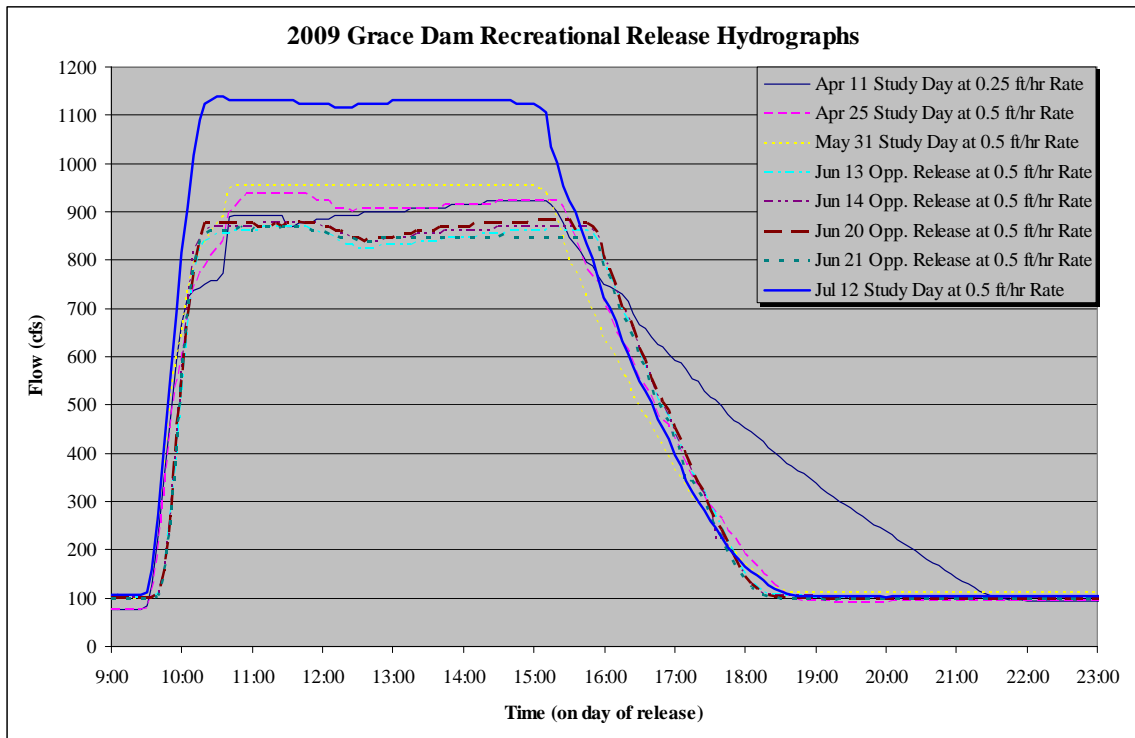
Weather conditions for the scheduled ramp rate study days are shown in Table 2.

<b>Table 2. Weather conditions within 24 hours after noon on flow days at Soda Springs, ID.<sup>1</sup></b>				
<b>Flow Date/Weather Parameter</b>	<b>April 11</b>	<b>April 25</b>	<b>May 31</b>	<b>July 12</b>
Air Temp Min/Max (F)	28-48	50	41-66	50-87
Wind Speed Min/Max (mph)	N/A	13	N/A	10
<sup>1</sup> Data from this station ("KU78" in Soda Springs) was tagged as "suspect" by the University of Utah's Mesonet. Data presented acquired from Weather Underground ( <a href="http://www.wunderground.com">www.wunderground.com</a> ) and are incomplete.				

### **3.2 FLOWS AND STUDY PLOT CHARACTERISTICS**

Eight recreation releases were made in 2009, four Scheduled Ramp Rate Test Flow releases (the April 11, 25, May 31 and July 12 events) and four Inflow Dependent Boater Flow releases (June events). The 5-minute resolution hydrographs for all events are shown in Figure 4. Note that the April 11<sup>th</sup> release was at the previous year's ramp-down rate of 0.25 ft/hr. The other ramp-down rates for 2009 were fairly consistent and very close to the target ramp-down rate of 0.5 feet per hour (Table 3).

The slight dips in flows mid-event shown in Figure 4 are slight deviations from balanced water conditions in the Grace forebay. The timing of these deviations coincides with decreasing generation at Grace as water passing through Black Canyon reaches the tailrace of the power plant (2 hours after start of recreational release into Black Canyon). In addition to this change, the upstream flow from Soda plant decreases, so the difference between these two changes causes the fluctuation. The schedule of water releases and additional details on the water operations are provided in Appendix C.



**Figure 4. 2009 recreational release hydrographs. The flow-dependent releases are termed “Opportunistic Releases” in the legend.**

**Table 3. Summary of down ramp rate and average flow rate for all 2009 recreational releases.**

Date	Event Type	Average Down-Ramp Rate (feet per hour)	Average Event Flow (cfs)
11-Apr	Study (0.25 feet per hour)	0.23	889
25-Apr	Study	0.43	898
31-May	Study	0.40	954
13-Jun	Flow-Dependent	0.49	839
14-Jun	Flow-Dependent	0.53	854
20-Jun	Flow-Dependent	0.50	858
21-Jun	Flow-Dependent	0.52	845
12-Jul	Study	0.46	1,118

The areal extents of the study plots are show in Table 4. They differed between study days as a result of slight differences in flow and channel configurations caused by shifting substrate and vegetation growth during the season.

<b>Table 4. Dimensions and areal extent of study plots.</b>							
<b>Reach</b>	<b>Plot</b>	<b>Stranding Potential</b>	<b>Total Plot Length (ft)</b>	<b>Total Plot Area (sq ft)</b>			
				<b>Study Day 1 Apr 11</b>	<b>Study Day 2 Apr 25</b>	<b>Study Day 3 May 31</b>	<b>Study Day 4 Jul 12</b>
2	1	High	317	16,872	17,997	17,070	17,226
2	2	Low	270	1,747	1,744	1,709	2,938
2	3	High	317	22,840	18,322	21,921	17,966
2	4	Medium	211	9,000	7,553	10,958	7,187
3	2	High	182	6,815	5,869	6,800	6,608
3	4	High	217	8,200	7,419	7,368	7,612
4	1	Medium	260	3,491	3,203	3,153	3,025
4	2	Low	250	3,251	3,197	3,015	2,809

Vegetation patterns and types also differed between the plots. In Reach 2, the river banks on river right<sup>2</sup> are denuded of shrubs and forbs due to heavy grazing. On river left, shrubs and small trees are still growing on the banks, and wetland plants occupy the shallows. Flat areas with small pools are found after down-ramp on both sides, particularly in plots 1 and 3. Exposed areas on river right also include numerous small pockets created by the hooves of livestock.

Reach 3 lies in the bottom of the canyon below steep basalt boulder fields. Dense, thick shrubs grow along the river's edge, some of which are inundated during high flows. Several wide, flat areas are exposed at low water with small pools remaining after releases. Study plots were chosen to monitor these pools in particular. By the July release date, extensive nettle and wetland plants were growing throughout the shallows.

Reach 4 is somewhat different from either Reach 2 or 3. The river is wide but constrained by steep banks of basalt boulders, resulting in only small increases in river width during the Scheduled Ramp Rate Test Flows. Thick stands of wetland plants (primarily cattail) grow along the river's edge and are inundated during high flows. Lowering water levels trapped silts in the cattails, but created only a few small isolated pools. Significantly more nettle was found in Year 2 than in Year 1.

There are also occasional islands with shrubs and wetland-specific plants in Reaches 2 and 4. These were not surveyed due to the difficulty of safe access.

### 3.3 STRANDED FISH

Table 5 identifies the fish found stranded on each of the three study days. No fish were found after the first Scheduled Ramp Rate Test Flow, intended to replicate the first 0.25 ft/hr ramp-down rate in Year 1. On the second Scheduled Ramp Rate Test Flow (the first at 0.5 ft/hr) only two small fish were found, both of which were discovered the afternoon of the ramp-down. One

<sup>2</sup> "River right" and "river left" refer to the respective sides of the river when facing downstream.

was a redbside shiner, the other a northern leatherside chub. Both were photographed and returned to the river. No stranded fish were found after the third Scheduled Ramp Rate Test Flow.

<b>Table 5. Fish species, numbers, and approximate sizes found stranded in study plots.</b>					
<b>Reach</b>	<b>Plot</b>	<b>Study Day 1 Apr 11</b>	<b>Study Day 2 Apr 25</b>	<b>Study Day 3 May 31</b>	<b>Study Day 4 Jul 12</b>
2	1	0	0	0	1 common carp (17 mm); 27 common carp (19 mm); ~ 5 unknown (~19 mm)
2	2	0	0	0	0
2	3	0	1 redbside shiner (19 mm); 1 northern leatherside chub (19 mm)	0	>35 common carp (12 mm); >7 common carp (14 mm); 5 common carp (17 mm); >7 common carp (19 mm); 8 redbside shiner (18 mm); >12 redbside shiner (19 mm); 5 redbside shiner (25 mm); >7 Utah sucker (32 mm);
2	4	0	0	0	0
3	2	0	0	0	0
3	4	0	0	0	10 mottled sculpin (9 mm); 10 mottled sculpin (11 mm); 3 Utah sucker (21 mm); 3 Utah sucker (23 mm); 4 Utah sucker (27 mm);
4	1	0	0	0	0
4	2	0	0	0	0

On the afternoon of the fourth Scheduled Ramp Rate Test Flow, several fish were found in Reach 2. Small carp were found in Plot 1 (on river right); two were collected for positive identification in the lab, six were caught and released to the river, and approximately 20 could not be caught because they retreated into dense vegetation. A single small redbside shiner was caught and released in Plot 3 (on river left).

On the day following the fourth Scheduled Ramp Rate Test Flow, stranded fish were found in both Reach 2 and Reach 3. In Reach 2, approximately five small fish were observed in Plot 1, but could not be caught or identified. In Plot 3, over 50 small common carp were found (eight of different sizes were collected for lab identification); over 20 small redbside shiner were found

(three of which were collected for lab identification and five were returned to the river); and more than seven Utah chub were discovered (one of which was collected for identification).

In Reach 3, several fish were found in the isolated pools in Plot 4 on the day following the Scheduled Ramp Rate Test Flow. All of the stranded fish were identified, including: 20 mottled sculpin (four of which were collected for lab identification), and 10 Utah suckers (three of which were collected for lab identification).

Detailed observations generally followed those in Year 1 with the following exceptions:

1. Vegetation in Reach 2 was slightly more dense in Plots 3 and 4.
2. More fish were visibly stranded after the July 13 event in the larger pool than in the smaller pools in Reach 2, Plot 1.
3. More of the small pools were connected by small channels in Reach 2, Plots 3 and 4.
4. No livestock were present during the May 31 and July 12 events.
5. The only predators found were garter snakes and frogs. Frogs were only found during the last two events and only on river right.
6. Pools in Reach 3 that drained to the river in Year 1 were isolated in Year 2.
7. Vegetation, notably nettle, was less dense in Reach 3, but was denser in Reach 4.
8. In Reach 2, approximately 1.5 person-hours were necessary to search the final exposed varial zone on the days following the Scheduled Ramp Rate Test Flows.
9. In Reach 3, approximately 1 person-hour was necessary to search the final exposed varial zone on the days following the Scheduled Ramp Rate Test Flows.
10. In Reach 4, approximately 1 person-hour was necessary to search the final exposed varial zone on the days following the Scheduled Ramp Rate Test Flows.

### **3.4 WATER QUALITY MEASUREMENTS**

Detailed results from the water quality monitoring during the first three Scheduled Ramp Rate Test Flows and four Inflow-Dependent Boater Flow Days are included in Appendix A. Data have not been scrubbed for outliers. DO does not appear to have been a problem during any of the releases.

## **4.0 DISCUSSION**

Very few fish were found following the 0.25-foot-per-hour Scheduled Ramp Rate Test Flows in 2008, the first year of this study. There were concerns expressed by various observers that the Varial Mapping Flow on April 14, 2008, after no large flows for several years, created such turbidity that fish were either killed or flushed downstream prior to the first Scheduled Ramp Rate Test Flow. As a result, the first Scheduled Ramp Rate Test Flow of 2009 was conducted at the same time of year as in the first year, and at a 0.25 ft/hr rate. No stranded fish were found.

The other three study days were conducted at a faster ramp-down rate 0.5 ft/hr. Only two fish were found during the April 25 study day, one of which was a small northern leatherside chub, and no fish were found the day after the study day. No fish were found on May 31, the third study day, or on the day following the test flow.



By July 12, however, there were numerous yearling fish found in pools left within the wide flat areas of Reach 2 and Reach 3. Some were discovered the afternoon of the study day; others were not located until the day following the test day. As in Year 1, stranded fish retreated into the dense vegetation along the periphery of the pools, making capture difficult.

The presence of significant numbers of stranded yearlings after the July 12 release is consistent with the life stage of these species. Redside shiners, in particular, probably did not spawn until water temperatures warmed up in mid to late June, and an ideal spawning area exists in the shallows created by a beaver dam just upstream of the Reach 2 study plots. Cutthroat and rainbow trout spawn earlier in the spring, but there is little or no suitable spawning habitat below the dam above Reach 2, consistent with none of these species having been found stranded.

It is still possible, of course, that fish were stranded but not detected. This is especially true in Reach 4 where vegetation grows in very thick stands along the edge of the river.

The increased number of stranded fish may well be due to a faster ramp-down rate. The third year of the study will test an even faster rate of 1.0 ft/hr, which will help to evaluate this hypothesis.

**APPENDIX A. DO AND TURBIDITY MEASUREMENTS DURING THREE SCHEDULED RAMP RATE TEST FLOWS AND FOUR INFLOW-DEPENDENT BOATER FLOW DAYS IN 2009.**

<b>Table A1. DO concentration and turbidity during five boater flows in 2009.</b>						
	DO (mg/L)			Turbidity (NTU)		
Date/Time	Black Canyon (unfiltered)	Black Canyon (filtered)	Grace Dam Forebay	Black Canyon (unfiltered)	Black Canyon (filtered)	Grace Dam Forebay
<b>Scheduled Ramp Rate Test Flow #1</b>						
4/11 0:01	7.83	8.88	13.96	11.4	25.3	10.3
4/11 0:16	7.77	8.87	13.92	11	22	9.8
4/11 0:31	7.84	8.87	13.98	11.9	24.7	10.1
4/11 0:46	7.86	8.87	13.84	10.5	20.6	10.3
4/11 1:01	7.87	8.88	13.91	11.1	34.7	10.4
4/11 1:16	7.89	8.89	13.94	10.4	35.8	9.9
4/11 1:31	7.92	8.9	13.99	10.3	32.8	9.6
4/11 1:46	7.94	8.91	13.94	9.8	37.4	10.4
4/11 2:01	7.96	8.92	13.87	10.6	31.9	9.9
4/11 2:16	7.99	8.94	13.88	10	34.6	13.1
4/11 2:31	8.01	8.95	13.87	9.8	24.1	10.9
4/11 2:46	8.03	8.97	13.94	10	45.3	10.2
4/11 3:01	8.05	8.99	13.88	9.5	24.5	10.4
4/11 3:16	8.07	9	13.92	9.5	23.3	10
4/11 3:31	8.09	9.01	14.04	9.8	21.9	10.2
4/11 3:46	8.12	9.03	14.12	9.4	24.5	10.3
4/11 4:01	8.14	9.05	14.13	10	13.3	10
4/11 4:16	8.17	9.07	14.19	10	26.1	10.4
4/11 4:31	8.21	9.08	14.25	10.3	11.5	10.3
4/11 4:46	8.24	9.11	14.24	10.2	13.1	10
4/11 5:01	8.26	9.14	14.26	9.4	12.3	10.1
4/11 5:16	8.28	9.16	14.33	9.4	16.8	10.4
4/11 5:31	8.28	9.19	14.4	9.6	13.7	10.8
4/11 5:46	8.31	9.22	14.42	9.5	11.9	10.6
4/11 6:01	8.36	9.24	14.34	10	10.3	10.3
4/11 6:16	8.4	9.27	14.37	9.4	23	10.2
4/11 6:31	8.45	9.29	14.4	9.9	12.2	10.7
4/11 6:46	8.5	9.32	14.45	9.8	16.2	10.1

**Table A1 (cont.). DO concentration and turbidity during five boater flows in 2009.**

Date/Time	DO (mg/L)			Turbidity (NTU)		
	Black Canyon (unfiltered)	Black Canyon (filtered)	Grace Dam Forebay	Black Canyon (unfiltered)	Black Canyon (filtered)	Grace Dam Forebay
4/11 7:01	8.52	9.36	14.46	9.5	10.9	10.6
4/11 7:16	8.58	9.41	14.49	9.4	13.5	10.4
4/11 7:31	8.66	9.48	14.47	9.2	19.8	10.4
4/11 7:46	8.74	9.56	14.45	9.2	11.6	10.6
4/11 8:01	8.88	9.65	14.48	11.7	17.8	10.4
4/11 8:16	8.95	9.76	14.42	9.7	45.1	10.9
4/11 8:31	9.04	9.86	14.45	9.4	46.6	10.4
4/11 8:46	9.17	9.96	14.44	9.8	12.2	10.9
4/11 9:01	9.26	10.05	14.45	8.7	13.1	11.3
4/11 9:16	9.32	10.12	14.49	8.4	12.3	10.9
4/11 9:31	9.4	10.17	14.47	10.6	14.5	11.7
4/11 9:46	9.45	10.22	14.42	8.4	14.5	11.9
4/11 10:01	9.5	10.26	14.39	8.3	12	11.9
4/11 10:16	9.54	10.29	14.31	7.9	12.3	13.6
4/11 10:31	9.58	10.33	14.25	8.1	8.4	12.5
4/11 10:46	9.62	10.35	14.22	7.8	10.3	12.5
4/11 11:01	9.62	10.35	14.17	8	8.2	13.2
4/11 11:16	9.61	10.34	14.1	7.6	8.1	14.1
4/11 11:31	9.59	10.34	13.97	7.4	7.6	13.5
4/11 11:46	9.59	10.33	13.92	8.3	8.4	14.4
4/11 12:01	8.74	9.99	13.84	1193.1	680.1	14.2
4/11 12:16	8.6	6.85	13.84	752.8	8.1	14.5
4/11 12:31	8.97	7.14	13.82	752	15.4	15.4
4/11 12:46	8.96	9.66	13.76	637.5	144	15.1
4/11 13:01	8.9	7.97	13.75	499.6	7.7	15.5
4/11 13:16	8.84	2.85	13.74	378.1	495.9	15.8
4/11 13:31	8.79	1.84	13.73	1428.2	35.4	15.7
4/11 13:46	8.76	3.08	13.73	232.7	9.8	17.5
4/11 14:01	8.74	1.29	13.69	199.3	484.6	15.8
4/11 14:16	8.76	0.93	13.78	177.4	15.8	15.6
4/11 14:31	8.79	1.53	13.81	154.7	22	15.3
4/11 14:46	8.82	9.45	13.85	149.7	135	16.1
4/11 15:01	8.8	9.5	13.92	138.9	125.7	16.1
4/11 15:16	8.82	9.51	13.95	127.3	108.3	16.7
4/11 15:31	8.83	9.52	13.96	724.4	102.7	17.3
4/11 15:46	8.85	9.53	13.99	103.4	92.3	17.7
4/11 16:01	8.86	9.53	14.02	98.9	86.7	17.4

<b>Table A1 (cont.). DO concentration and turbidity during five boater flows in 2009.</b>						
	DO (mg/L)			Turbidity (NTU)		
Date/Time	Black Canyon (unfiltered)	Black Canyon (filtered)	Grace Dam Forebay	Black Canyon (unfiltered)	Black Canyon (filtered)	Grace Dam Forebay
4/11 16:16	8.85	9.53	14.06	94.6	83.3	17.1
4/11 16:31	8.86	9.54	14.03	128.2	78.4	17
4/11 16:46	8.88	9.55	14.06	89.4	78.6	18.3
4/11 17:01	8.88	9.56	14.09	88.4	74.4	18.4
4/11 17:16	8.9	9.57	14.1	79.2	68	18.3
4/11 17:31	8.91	9.57	14.08	83.7	68.1	16.9
4/11 17:46	8.91	9.58	14.09	78.4	67.6	17.9
4/11 18:01	8.92	9.57	14.15	71.7	70.2	17.7
4/11 18:16	8.92	9.57	14.21	71.1	67.8	18.5
4/11 18:31	8.93	9.57	14.22	86.6	1139.3	17.2
4/11 18:46	8.91	9.57	14.2	65.5	1168.7	17.8
4/11 19:01	8.93	9.57	14.2	65.6	62.2	18
4/11 19:16	8.93	9.57	14.22	62.6	56.5	18.2
4/11 19:31	8.94	9.56	14.2	65.6	54.8	18.8
4/11 19:46	8.94	9.56	14.18	59.7	55.4	18.8
4/11 20:01	8.95	9.56	14.21	61.4	55.7	18.4
4/11 20:16	8.95	9.57	14.16	62.7	2274.9	18.6
4/11 20:31	8.96	9.57	14.16	54.8	50.9	17.5
4/11 20:46	8.98	9.58	14.26	53.4	45.5	18.5
4/11 21:01	8.99	9.58	14.27	56.2	43.8	18.7
4/11 21:16	8.99	9.57	14.2	135.8	42.4	18.1
4/11 21:31	9	9.58	14.19	51	43	18.4
4/11 21:46	9	9.58	14.27	52.3	39	18.6
4/11 22:01	9.02	9.56	14.28	48.8	39.1	18.1
4/11 22:16	9.03	9.55	14.3	46.1	36.5	18
4/11 22:31	9.03	9.55	14.3	44.7	35.2	18.1
4/11 22:46	9.04	9.54	14.28	43.9	33	18.5
4/11 23:01	9.05	9.34	14.27	43.2	31.9	17
4/11 23:16	9.05	9.19	14.31	43	32.9	17.5
4/11 23:31	9.06	8.97	14.32	40	30.4	17.7
4/11 23:46	9.06	8.94	14.36	38.6	28.3	16.9
4/12 0:01	9.06	9.14	14.35	36.6	26.9	16.9
4/12 0:16	9.07	9.25	14.36	36.1	25.3	17
4/12 0:31	9.06	9.27	14.35	36.6	24.7	17.2
4/12 0:46	9.06	9.13	14.36	32.3	23.7	16.7
4/12 1:01	9.06	9.2	14.38	33.1	22.6	17.5
4/12 1:16	9.07	9.08	14.31	31	20.8	16.7
4/12 1:31	9.06	9.14	14.25	28.6	19.5	16.9

<b>Table A1 (cont.). DO concentration and turbidity during five boater flows in 2009.</b>						
	DO (mg/L)			Turbidity (NTU)		
Date/Time	Black Canyon (unfiltered)	Black Canyon (filtered)	Grace Dam Forebay	Black Canyon (unfiltered)	Black Canyon (filtered)	Grace Dam Forebay
4/12 1:46	9.08	8.93	14.29	27.6	18.4	17.3
4/12 2:01	9.08	8.96	14.31	26.8	17.7	16.6
4/12 2:16	9.07	8.59	14.33	374.1	16.9	16.3
4/12 2:31	9.08	8.66	14.36	24.3	16.1	17
4/12 2:46	9.08	8.75	14.38	24.2	15.8	15.8
4/12 3:01	9.08	8.94	14.34	23.8	14.8	16.1
4/12 3:16	9.09	8.81	14.28	24.4	14.4	16.1
4/12 3:31	9.1	8.7	14.33	25.8	13.8	15.3
4/12 3:46	9.11	8.54	14.34	22.2	13.9	16.9
4/12 4:01	9.12	8.8	14.38	22.9	13.3	15.1
4/12 4:16	9.04	8.55	14.36	23.4	13	15.4
4/12 4:31	9.12	8.58	14.4	32.8	12.8	15.3
4/12 4:46	9.14	8.72	14.35	22.1	13	15.5
4/12 5:01	9.14	8.66	14.34	21.3	12.2	15.6
4/12 5:16	9.15	8.65	14.25	22.2	11.8	14.5
4/12 5:31	9.15	8.69	14.2	163.2	11.9	14.7
4/12 5:46	9.17	8.54	14.27	20.9	12.2	14.6
4/12 6:01	9.18	8.52	14.27	22.3	12.8	14.5
4/12 6:16	9.18	8.47	14.28	21.8	11	14.8
4/12 6:31	9.2	8.49	14.31	20.1	11.8	15.4
4/12 6:46	9.21	8.56	14.27	24.6	11.9	14.7
4/12 7:01	9.23	8.78	14.24	101.4	11	14.3
4/12 7:16	9.27	8.59	14.3	460.3	11.2	14.8
4/12 7:31	9.32	8.76	14.28	24.5	11.2	14.7
4/12 7:46	9.36	8.88	14.3	20.1	10.8	14.2
4/12 8:01	9.42	9.02	14.35	21.6	10.6	14.5
4/12 8:16	9.46	9.09	14.35	23.1	10.7	14.2
4/12 8:31	9.52	9.44	14.33	20.1	10.2	13.7
4/12 8:46	9.58	9.81	14.25	20	10.5	14.1
4/12 9:01	9.63	8.6	14.16	20.4	10.6	14.2
4/12 9:16	9.67	9.06	14.13	20	10.8	13.6
4/12 9:31	9.7	8.88	14.11	21.6	10.8	13.2
4/12 9:46	9.73	8.8	14.17	29.4	13.1	13.3
4/12 10:01	9.75	8.95	14.2	20.8	9.3	13.2
4/12 10:16	9.75	9.05	14.21	20.9	9.4	12.8
4/12 10:31	9.76	8.95	14.39	23.2	9	14.5
4/12 10:46	9.75	9.12	14.35	19.5	9.8	14.2
4/12 11:01	9.72	9.25	14.12	29.6	10.1	12.4



<b>Table A1 (cont.). DO concentration and turbidity during five boater flows in 2009.</b>						
	DO (mg/L)			Turbidity (NTU)		
Date/Time	Black Canyon (unfiltered)	Black Canyon (filtered)	Grace Dam Forebay	Black Canyon (unfiltered)	Black Canyon (filtered)	Grace Dam Forebay
4/12 11:16	9.7	8.96	14.25	30.4	8.5	14.7
4/12 11:31	9.66	8.93	14.19	23.1	8.6	14.8
4/12 11:46	9.61	8.69	14.18	30.3	8.8	15
4/12 12:01	9.56	8.78	14.14	18.9	8.3	14.2
4/12 12:16	9.56	8.71	14.19	100.5	8.4	14.1
4/12 12:31	9.51	8.82	14.07	20.8	8.3	13.3
4/12 12:46	9.46	8.92	14.22	22.2	23	13
4/12 13:01	9.36	8.95	14.27	20.9	9.8	13
4/12 13:16	9.32	8.55	14.18	22.9	8.1	13
4/12 13:31	9.32	8.34	14.23	21.5	9.4	12.9
4/12 13:46	9.32	8.47	14.14	22.4	10.1	12.4
4/12 14:01	9.27	8.42	14.31	24.4	32.6	13.3
4/12 14:16	9.27	7.93	14.21	22.1	29.6	13
4/12 14:31	9.25	7.55	14.39	23.2	8.2	12.7
4/12 14:46	9.26	7.74	14.44	34.8	8.1	12.8
4/12 15:01	9.25	7.94	14.36	21.4	31.4	12.5
4/12 15:16	9.27	7.82	14.44	21.1	7.9	13.1
4/12 15:31	9.26	7.86	14.31	33.5	7.9	13.3
4/12 15:46	9.23	7.75	14.23	22	27.4	13
4/12 16:01	9.16	7.59	14.15	20	7.9	13.1
4/12 16:16	8.66	7.17	14.18	20	19.2	12.3
4/12 16:31	8.6	7.47	14.17	32.2	28.6	12.6
4/12 16:46	8.2	6.95	14.19	24.5	21.9	12.3
4/12 17:01	8.21	7.26	14.18	25.8	21.3	11.9
4/12 17:16	8.32	7.12	14.19	23.7	55.8	12.1
4/12 17:31	8.36	5.93	14.22	28.3	42.8	11.9
4/12 17:46	8.37	8.17	14.26	23	52.3	12.2
4/12 18:01	8.38	8.31	14.23	22.7	47.6	12.4
4/12 18:16	8.36	8.27	14.27	42.4	37	11.9
4/12 18:31	8.34	7.88	14.26	38.6	7.7	12.4
4/12 18:46	8.28	7.88	14.23	22.5	53.1	12.7
4/12 19:01	8.25	7.88	14.23	46.8	7.5	12.8
4/12 19:16	8.16	7.98	14.2	28	54.5	12.8
4/12 19:31	8.12	7.87	14.19	21.7	7.6	12.5
4/12 19:46	8.08	7.79	14.2	22.5	7.7	13.8
4/12 20:01	8.05	7.74	14.29	22.8	7.5	12
4/12 20:16	8.02	7.84	14.31	23.5	7.3	12.3
4/12 20:31	8.01	7.76	14.29	22.8	7.3	12.9

<b>Table A1 (cont.). DO concentration and turbidity during five boater flows in 2009.</b>						
	DO (mg/L)			Turbidity (NTU)		
Date/Time	Black Canyon (unfiltered)	Black Canyon (filtered)	Grace Dam Forebay	Black Canyon (unfiltered)	Black Canyon (filtered)	Grace Dam Forebay
4/12 20:46	7.87	7.57	14.26	24.3	37.4	13.3
4/12 21:01	8	7.49	14.22	22.7	8.2	12.5
4/12 21:16	7.99	7.07	14.16	22.7	36.9	13.4
4/12 21:31	7.98	6.79	14.23	19.6	7.3	13.7
4/12 21:46	7.99	7.18	14.24	18.4	15.9	13.6
4/12 22:01	7.89	7.19	14.32	18.2	16.1	12.6
4/12 22:16	7.31	6.91	14.41	19.2	7.8	16.3
4/12 22:31	7.96	6.79	14.42	18.3	58.1	14.9
4/12 22:46	8.04	6.79	14.44	18.3	47.5	14.4
4/12 23:01	8.03	7.02	14.55	18.3	7.5	13.6
4/12 23:16	8.05	6.7	14.65	18.6	83.6	13.3
4/12 23:31	8.05	6.66	14.64	21	71.8	13.4
4/12 23:46	8.06	6.55	14.62	17.7	8.2	13
<b>Scheduled Ramp Rate Test Flow #2</b>						
4/25 0:01	11.62	9.49	10.42	6.1	4.3	9.3
4/25 0:16	11.37	9.51	10.46	6.2	4.3	9.2
4/25 0:31	11.26	9.51	10.53	6.1	4.5	9
4/25 0:46	11.17	9.51	10.42	5.9	5	9.4
4/25 1:01	11.07	9.52	10.37	6.1	4.5	9.1
4/25 1:16	11.03	9.52	10.33	6.2	4.6	9.4
4/25 1:31	11.22	9.55	10.29	6.1	5.2	9.1
4/25 1:46	12.09	9.56	10.31	7.1	5.3	9.6
4/25 2:01	12.1	9.59	10.34	6.4	4.7	9.1
4/25 2:16	12.02	9.6	10.39	6.5	5.7	9
4/25 2:31	11.95	9.61	10.36	6.2	4.4	11
4/25 2:46	11.95	9.63	10.34	6.8	4.5	9.5
4/25 3:01	11.91	9.63	10.31	6.1	4.7	9.7
4/25 3:16	11.86	9.64	10.42	6.4	4.5	9.5
4/25 3:31	11.84	9.65	10.47	6.4	4.8	9.7
4/25 3:46	11.75	9.65	10.5	6.2	32.8	9.5
4/25 4:01	11.67	9.65	10.5	6.3	5	9.1
4/25 4:16	11.58	9.66	10.53	6.2	4.8	10
4/25 4:31	11.47	9.68	10.54	6.5	4.5	9.6
4/25 4:46	11.38	9.69	10.53	6.2	6.5	9.7
4/25 5:01	11.3	9.7	10.53	6.4	5.4	9.4
4/25 5:16	11.42	9.72	10.51	7.3	4.6	9.9
4/25 5:31	11.24	9.73	10.53	6.5	4.6	9.5
4/25 5:46	11.19	9.74	10.52	6.4	5.4	10.1

<b>Table A1 (cont.). DO concentration and turbidity during five boater flows in 2009.</b>						
	DO (mg/L)			Turbidity (NTU)		
Date/Time	Black Canyon (unfiltered)	Black Canyon (filtered)	Grace Dam Forebay	Black Canyon (unfiltered)	Black Canyon (filtered)	Grace Dam Forebay
4/25 6:01	11.21	9.76	10.45	6.5	5.2	9.7
4/25 6:16	11.31	9.79	10.44	6.8	5.1	9.7
4/25 6:31	11.24	9.82	10.41	7.3	5.3	9.4
4/25 6:46	11.28	9.87	10.3	7.3	5.7	10
4/25 7:01	11.32	9.92	10.39	6.8	5.9	9.3
4/25 7:16	11.4	10.01	10.42	8.3	5.1	9.5
4/25 7:31	11.5	10.12	10.43	6.6	5.5	9.5
4/25 7:46	11.64	10.24	10.44	7	5.2	9.5
4/25 8:01	11.82	10.37	10.49	6.6	4.8	9.4
4/25 8:16	11.98	10.52	10.52	6.6	5	9.8
4/25 8:31	12.06	10.6	10.48	6.7	4.7	9.8
4/25 8:46	12.21	10.71	10.52	6.4	4.8	9.8
4/25 9:01	12.7	10.88	10.5	6.7	4.7	9.7
4/25 9:16	12.49	10.9	10.47	6.2	4.8	9.7
4/25 9:31	12.53	11	10.53	6.5	4.7	10.1
4/25 9:46	12.57	11.06	10.33	6.2	4.6	10.8
4/25 10:01	12.63	11.12	10.31	6.3	4.4	10.9
4/25 10:16	12.67	11.15	10.32	6.2	4.7	11.9
4/25 10:31	12.73	11.18	10.28	6.3	4.7	12.2
4/25 10:46	12.77	11.21	10.32	6.2	4.5	12.2
4/25 11:01	14.32	11.23	10.27	5.9	4.1	12.3
4/25 11:16	14.22	11.23	10.29	7.7	4.3	13
4/25 11:31	13.23	11.22	10.29	6.4	5	13.7
4/25 11:46	12.9	11.19	10.22	5.8	4.3	14.1
4/25 12:01	12.51	11	10.23	268.6	263.1	13.8
4/25 12:16	11.59	10.05	10.23	819.3	279.4	14.2
4/25 12:31	11.68	10.18	10.12	248.4	239.5	15.1
4/25 12:46	11.54	10.08	10.1	217.2	206.6	15.5
4/25 13:01	11.38	9.95	10.12	184.5	183.5	16.1
4/25 13:16	11.29	5.91	10.14	136.5	134.7	15.1
4/25 13:31	11.23	9.85	10.16	104.9	103.1	15.3
4/25 13:46	11.2	9.82	10.18	81.7	91.9	15.1
4/25 14:01	11.16	9.8	10.16	76.3	71.2	15
4/25 14:16	11.16	9.8	10.16	69.3	66.8	15.5
4/25 14:31	11.19	9.81	10.24	63.8	62.5	15
4/25 14:46	11.21	9.83	10.25	58.4	59.5	15
4/25 15:01	11.25	9.84	10.15	53.6	51.9	15.8
4/25 15:16	11.3	9.85	10.2	51.7	53.9	16.1

<b>Table A1 (cont.). DO concentration and turbidity during five boater flows in 2009.</b>						
	DO (mg/L)			Turbidity (NTU)		
Date/Time	Black Canyon (unfiltered)	Black Canyon (filtered)	Grace Dam Forebay	Black Canyon (unfiltered)	Black Canyon (filtered)	Grace Dam Forebay
4/25 15:31	11.26	9.84	10.21	52.2	45.5	15.7
4/25 15:46	11.29	9.87	10.2	49	46.4	15.4
4/25 16:01	11.27	9.88	10.14	48.4	47.4	15.6
4/25 16:16	11.36	9.9	10.19	47.1	45.7	14.5
4/25 16:31	11.34	9.93	10.18	48.8	43.4	15.2
4/25 16:46	11.3	9.94	10.25	48.4	44.7	15
4/25 17:01	11.3	9.94	10.25	44.2	41	14.5
4/25 17:16	11.3	9.94	10.32	42.8	39.7	14.4
4/25 17:31	11.29	9.94	10.39	43.9	40.2	14.4
4/25 17:46	11.32	9.94	10.15	401.3	39.4	13.8
4/25 18:01	11.44	9.93	10.31	45.4	37.7	14.1
4/25 18:16	11.29	9.93	10.37	44.8	42.4	14.3
4/25 18:31	11.28	9.92	10.33	43	38.3	13.7
4/25 18:46	11.28	9.92	10.27	42.1	38.8	14.5
4/25 19:01	11.31	9.91	10.4	39	37.4	13.9
4/25 19:16	11.28	9.91	10.41	40.1	36.7	13.7
4/25 19:31	11.28	9.9	10.11	35.9	32.1	14.1
4/25 19:46	11.29	9.89	10.22	38.2	32.8	14.1
4/25 20:01	11.28	9.88	10.27	32.1	31.8	14.8
4/25 20:16	11.26	9.85	10.16	30.2	28.4	19.8
4/25 20:31	11.24	9.47	10.24	28.1	25.4	14.4
4/25 20:46	11.24	9.83	10.27	26	24.5	13.9
4/25 21:01	11.25	9.84	10.26	24.6	23	14
4/25 21:16	11.25	9.71	10.14	23.4	20.3	14.3
4/25 21:31	11.3	9.84	10.12	21.4	19.8	13.9
4/25 21:46	11.36	9.85	10.12	20.4	17.9	15.2
4/25 22:01	11.35	9.85	10.17	19	16.2	14.1
4/25 22:16	11.49	9.86	10.18	17.8	14.8	13.9
4/25 22:31	11.43	9.86	10.17	16.7	13.7	14.6
4/25 22:46	18.15	9.87	10.14	15.2	13.1	14.3
4/25 23:01	12.29	9.87	10.01	14.4	12.5	15.2
4/25 23:16	12.01	9.87	10.03	13.6	11.2	13.9
4/25 23:31	11.87	9.88	10.04	13.1	11	13.6
4/25 23:46	11.71	9.87	10.02	12.6	10.3	14.3
4/26 0:01	11.66	9.9	9.98	12.2	9.8	13.7
4/26 0:16	11.58	9.91	9.95	11.9	9.7	13.6
4/26 0:31	11.66	9.92	9.82	11.5	9.3	13.5
4/26 0:46	11.59	9.93	9.83	11	8.9	13.7

**Table A1 (cont.). DO concentration and turbidity during five boater flows in 2009.**

Date/Time	DO (mg/L)			Turbidity (NTU)		
	Black Canyon (unfiltered)	Black Canyon (filtered)	Grace Dam Forebay	Black Canyon (unfiltered)	Black Canyon (filtered)	Grace Dam Forebay
4/26 1:01	11.57	9.95	9.91	10.8	8.7	13
4/26 1:16	11.62	9.96	9.93	10.7	8.8	12.6
4/26 1:31	11.62	9.98	9.96	10.7	8.4	13
4/26 1:46	11.61	9.99	9.89	8.7	8.5	13.1
4/26 2:01	11.63	10	9.93	8.3	7.9	13.1
4/26 2:16	11.66	10.02	9.91	8	7.8	13
4/26 2:31	11.65	10.02	9.88	8.6	8.5	12.7
4/26 2:46	11.68	10.04	9.91	8.1	9.4	13.1
4/26 3:01	11.69	10.05	9.63	7.9	8.3	12.8
4/26 3:16	11.67	10.06	9.81	7.9	8	12.7
4/26 3:31	11.68	10.07	9.88	7.7	7.5	12.5
4/26 3:46	11.69	10.09	9.89	7.5	7.1	12.3
4/26 4:01	11.71	10.08	9.86	7.8	7	12.8
4/26 4:16	11.73	10.09	9.67	7.3	6.7	12.8
4/26 4:31	11.74	10.11	9.59	7.6	6.7	12.4
4/26 4:46	11.75	10.11	9.64	7.8	6.7	12.9
4/26 5:01	11.75	10.11	9.7	7.5	6.7	12.5
4/26 5:16	11.77	9.89	9.71	8.5	6.1	12.2
4/26 5:31	11.79	10.15	9.74	8.8	6.4	12.9
4/26 5:46	11.78	10.16	9.72	6.9	6.2	12.8
4/26 6:01	11.79	10.16	9.74	6.9	6.1	12.3
4/26 6:16	11.8	10.17	9.75	6.9	6.2	12.4
4/26 6:31	11.82	10.19	9.56	7	6.5	12.1
4/26 6:46	11.88	10.21	9.57	7.6	6.4	12.3
4/26 7:01	11.95	10.27	9.57	6.7	6.2	12.8
4/26 7:16	12.08	10.35	9.55	6.6	6.8	12.6
4/26 7:31	12.14	10.42	9.62	7.2	6.2	12.1
4/26 7:46	12.68	10.48	9.63	6.5	5.9	12.6
4/26 8:01	12.88	10.63	9.6	6.2	5.6	12.8
4/26 8:16	12.68	10.76	9.5	6.1	5.7	12.5
4/26 8:31	12.83	10.88	9.61	7.4	6.2	12.2
4/26 8:46	12.79	10.93	9.59	6.8	5.8	13.3
4/26 9:01	12.75	10.91	9.69	6.7	5.4	12.5
4/26 9:16	12.78	10.95	9.46	6.3	5.7	13
4/26 9:31	12.79	10.98	9.41	6	5.2	13.3
4/26 9:46	12.84	11.02	9.44	8.4	5.2	14.5
4/26 10:01	12.81	10.99	9.5	8.6	5.2	14.2
4/26 10:16	12.82	10.05	9.62	10.3	5	12.2



**Table A1 (cont.). DO concentration and turbidity during five boater flows in 2009.**

Date/Time	DO (mg/L)			Turbidity (NTU)		
	Black Canyon (unfiltered)	Black Canyon (filtered)	Grace Dam Forebay	Black Canyon (unfiltered)	Black Canyon (filtered)	Grace Dam Forebay
4/26 10:31	12.83	10.88	9.64	5.9	4.8	12.3
4/26 10:46	12.83	11	9.52	5.6	4.8	13.7
4/26 11:01	12.82	10.88	9.54	5.9	5	13.7
4/26 11:16	12.87	11.03	9.84	5.3	5	12.9
4/26 11:31	12.81	11.01	9.51	5.4	4.8	14.2
4/26 11:46	12.85	11.04	9.55	5.5	4.7	13.2
4/26 12:01	12.91	11.11	9.48	5.5	4.8	15.9
4/26 12:16	12.92	11.12	9.43	5.5	4.8	15.1
4/26 12:31	12.85	11.09	9.52	5.3	5.9	16.7
4/26 12:46	12.77	10.99	9.57	5.3	13.1	15.8
4/26 13:01	12.82	11.03	9.56	5.5	11.7	16.1
4/26 13:16	12.83	11.05	9.47	5.2	5	16.2
4/26 13:31	12.66	10.91	9.35	5.3	15.2	16
4/26 13:46	12.54	10.81	9.38	5.1	6.6	16.9
4/26 14:01	12.47	10.73	9.46	5.1	18.1	17
4/26 14:16	12.44	10.72	9.4	5.3	20	16.7
4/26 14:31	12.51	10.77	9.46	4.8	34	16.7
4/26 14:46	12.52	10.79	9.59	5.5	14.8	16.7
4/26 15:01	12.45	10.74	9.73	4.8	5.9	15
4/26 15:16	12.44	10.72	9.67	5.4	217.8	15.8
4/26 15:31	12.61	10.68	9.5	5.1	20.7	16.1
4/26 15:46	12.32	10.62	9.6	5.5	23.4	15.2
4/26 16:01	12.31	10.62	9.69	5.2	19.5	15.1
4/26 16:16	12.22	10.58	9.78	7.8	9.8	15.1
4/26 16:31	12.03	10.4	9.71	7.9	61.7	16
4/26 16:46	11.79	10.2	9.95	7.8	19.7	13.9
4/26 17:01	11.87	10.26	9.82	5	30.1	14.4
4/26 17:16	11.88	10.29	9.91	5	15.6	14.9
4/26 17:31	11.98	10.36	9.83	5	16.1	14.7
4/26 17:46	11.93	10.32	9.98	5	68.9	14.4
4/26 18:01	11.76	10.17	10.03	13.7	39.9	14.8
4/26 18:16	11.6	10.04	10.07	4.8	49.6	13.7
4/26 18:31	11.52	9.93	9.74	5.3	33	15.9
4/26 18:46	11.44	9.9	9.82	4.8	37.9	13.9
4/26 19:01	11.38	9.84	9.91	5.1	19.5	14.1
4/26 19:16	11.33	9.79	9.99	5	40.8	13.6
4/26 19:31	11.33	9.76	10.02	5.8	40.5	13.6
4/26 19:46	11.26	9.72	10.01	4.8	30.3	13.7

**Table A1 (cont.). DO concentration and turbidity during five boater flows in 2009.**

Date/Time	DO (mg/L)			Turbidity (NTU)		
	Black Canyon (unfiltered)	Black Canyon (filtered)	Grace Dam Forebay	Black Canyon (unfiltered)	Black Canyon (filtered)	Grace Dam Forebay
4/26 20:01	11.18	9.67	10.03	4.8	17.3	13.8
4/26 20:16	12.76	9.6	9.97	5.1	34.7	13.9
4/26 20:31	12.71	9.56	9.85	5.5	10.3	13.7
4/26 20:46	11.92	9.53	9.92	5.1	44.9	13.9
4/26 21:01	11.51	9.53	9.97	5	391.6	14
4/26 21:16	11.49	9.53	10.05	6.1	56.2	14.4
4/26 21:31	11.5	9.54	9.92	5.4	20.3	13.9
4/26 21:46	11.55	9.54	9.97	5	37.2	14.7
4/26 22:01	11.6	9.58	9.97	5.7	59.8	14.1
4/26 22:16	11.61	9.6	9.99	5.1	43.3	13.5
4/26 22:31	12	9.61	10.02	5.2	2317	14
4/26 22:46	11.59	9.64	9.96	5.9	14.8	14.2
4/26 23:01	11.57	9.64	9.82	5.7	27.6	14.4
4/26 23:16	11.5	9.64	9.8	5.6	17.2	14.2
4/26 23:31	11.48	9.66	9.82	5.4	26.7	14.8
4/26 23:46	11.51	9.65	9.87	5.4	7.2	15.8
<b>Scheduled Ramp Rate Test Flow #3</b>						
5/31 0:01	7	6.27	8.23	0.1	1.3	9
5/31 0:16	7	6.28	8.21	0.3	0.9	8.7
5/31 0:31	7.01	6.31	8.2	0.7	1.1	8.6
5/31 0:46	7.04	6.33	8.16	4.5	1	8.7
5/31 1:01	7.05	6.34	8.19	0.3	1.2	8.7
5/31 1:16	7.05	6.38	8.19	0.6	2	8.3
5/31 1:31	7.07	6.4	8.2	0.2	1	8.3
5/31 1:46	7.1	6.43	8.18	0.4	1.2	8.3
5/31 2:01	7.12	6.47	8.19	0.7	1	8.3
5/31 2:16	7.16	6.51	8.21	0.2	1.1	8.4
5/31 2:31	7.19	6.55	8.2	0.4	2.3	8.6
5/31 2:46	7.23	6.58	8.18	0.5	1.2	8.4
5/31 3:01	7.26	6.64	8.17	0.4	1.1	8.3
5/31 3:16	7.29	6.66	8.15	0.6	3.2	8.6
5/31 3:31	7.31	6.68	8.07	0.4	2.5	8.9
5/31 3:46	7.36	6.75	8	0.4	1.4	8.8
5/31 4:01	7.37	6.81	7.93	0.5	1.6	9
5/31 4:16	7.42	6.84	7.92	0.4	1.4	8.8
5/31 4:31	7.43	6.86	7.94	0.5	1.4	9.5
5/31 4:46	7.5	6.92	7.94	0.4	1.5	8.9
5/31 5:01	7.52	6.94	7.93	0.5	1.8	9.2

<b>Table A1 (cont.). DO concentration and turbidity during five boater flows in 2009.</b>						
	DO (mg/L)			Turbidity (NTU)		
Date/Time	Black Canyon (unfiltered)	Black Canyon (filtered)	Grace Dam Forebay	Black Canyon (unfiltered)	Black Canyon (filtered)	Grace Dam Forebay
5/31 5:16	7.54	6.98	7.9	0.4	5.9	8.7
5/31 5:31	7.58	6.99	7.91	0.7	2.8	9.7
5/31 5:46	7.61	7.03	7.94	0.6	1.9	9.7
5/31 6:01	7.65	7.07	7.86	1	2	10.1
5/31 6:16	7.69	7.14	7.71	0.6	2.7	10
5/31 6:31	7.75	7.33	7.72	0.5	1.3	10.7
5/31 6:46	7.92	7.52	7.64	0.4	1.4	10.9
5/31 7:01	8.1	7.67	7.8	0.4	1.5	9.6
5/31 7:16	8.23	7.8	7.95	0.4	1.5	8.5
5/31 7:31	8.35	8.14	7.97	4.3	1.8	8.4
5/31 7:46	8.66	8.58	7.97	0.7	15.3	8.9
5/31 8:01	9.06	8.88	7.95	0.4	1	8.6
5/31 8:16	9.31	9.22	7.97	0.4	1	9.2
5/31 8:31	9.62	9.59	7.69	0.5	1.8	12.3
5/31 8:46	9.92	9.77	7.55	0.6	1	11.4
5/31 9:01	10.04	9.78	7.81	2.5	1	10.1
5/31 9:16	10.05	9.86	7.71	0.7	1.4	10.3
5/31 9:31	10.13	10.09	7.78	0.6	2	9.7
5/31 9:46	10.38	10.45	7.67	0.7	2	10.1
5/31 10:01	10.64	10.3	6.98	2.3	1.5	14.4
5/31 10:16	10.5	10	7.19	1.3	1.6	13
5/31 10:31	10.21	9.75	6.95	0.5	0.9	14.4
5/31 10:46	9.96	9.74	6.69	0.4	0.8	16.9
5/31 11:01	9.97	9.85	6.75	0.4	1.7	16.9
5/31 11:16	10.06	9.81	6.79	1.4	0.8	17.5
5/31 11:31	10.01	9.68	6.64	0.3	1.2	19.2
5/31 11:46	9.91	9.68	6.55	0.4	0.8	20.8
5/31 12:01	9.59	7.72	6.38	324.4	565.6	20.4
5/31 12:16	8.17	7.69	6.43	405.7	337.7	19.4
5/31 12:31	8.15	7.57	6.49	302.2	311.2	20.9
5/31 12:46	8.06	7.53	6.88	277.1	285.7	17.8
5/31 13:01	8.05	7.42	6.89	257.6	223.1	16.6
5/31 13:16	8.06	7.45	6.9	193.8	177.3	19.1
5/31 13:31	8.08	7.47	7	143.8	143.5	14.7
5/31 13:46	8.1	7.49	7.19	116.4	110.5	15
5/31 14:01	8.1	7.49	7.17	97.4	105.3	15
5/31 14:16	8.1	7.47	7.31	85.9	88.5	15
5/31 14:31	8.09	7.48	7.35	77.4	79	15

**Table A1 (cont.). DO concentration and turbidity during five boater flows in 2009.**

Date/Time	DO (mg/L)			Turbidity (NTU)		
	Black Canyon (unfiltered)	Black Canyon (filtered)	Grace Dam Forebay	Black Canyon (unfiltered)	Black Canyon (filtered)	Grace Dam Forebay
5/31 14:46	8.08	7.49	7.41	69.9	77.9	14.5
5/31 15:01	8.08	7.52	7.61	67.1	73.2	14.2
5/31 15:16	8.09	7.56	7.61	63.8	69.1	14.1
5/31 15:31	8.1	7.57	8.07	57.3	68.6	12.6
5/31 15:46	8.12	7.6	8.01	56.2	65.5	12.1
5/31 16:01	8.14	7.6	8.19	53.5	68	11.7
5/31 16:16	8.13	7.61	8.17	54.1	57.8	11.4
5/31 16:31	8.12	7.6	8.27	51.7	51.4	11.8
5/31 16:46	8.12	7.6	8.2	45.7	61.9	11.7
5/31 17:01	8.13	7.63	8.25	46.1	63.4	11.2
5/31 17:16	8.14	7.68	8.28	47.4	61.3	11.2
5/31 17:31	8.14	7.64	8.4	44.3	49.4	11.1
5/31 17:46	8.13	7.64	8.42	45.1	48.6	11.5
5/31 18:01	8.13	7.64	8.39	39.4	46.5	10.7
5/31 18:16	8.12	7.61	8.4	40.2	45.9	10.9
5/31 18:31	8.11	7.54	8.42	39.2	41.8	11.5
5/31 18:46	8.11	7.59	8.45	33.7	40	10.3
5/31 19:01	8.12	7.64	8.51	30.8	46.8	10.2
5/31 19:16	8.12	7.65	8.55	31.1	100.5	9.9
5/31 19:31	8.09	7.65	8.55	27.9	30	10.2
5/31 19:46	8.07	7.62	8.49	23.6	26.6	10.3
5/31 20:01	8.03	7.68	8.4	22.4	24.3	10.1
5/31 20:16	7.99	7.6	8.33	19.3	27.8	10.2
5/31 20:31	7.95	7.55	8.22	16.8	25.5	9.8
5/31 20:46	7.91	7.5	8.16	14.5	17.3	10.1
5/31 21:01	7.87	7.47	8.18	13.8	15.6	10.2
5/31 21:16	7.87	7.46	8.18	11.7	14.1	10.1
5/31 21:31	7.84	7.44	8.18	11.4	13.3	10
5/31 21:46	7.85	7.43	8.16	11.2	11.6	10
5/31 22:01	7.85	7.4	8.16	10	10.1	9.8
5/31 22:16	7.87	7.06	8.15	7.9	9.4	9.2
5/31 22:31	7.88	6.9	8.11	7.9	8.5	9.6
5/31 22:46	7.9	6.75	8.09	6.8	7.2	9.4
5/31 23:01	7.89	6.82	8.09	6.5	7.1	9
5/31 23:16	7.92	6.74	8.06	5.6	7.1	9.4
5/31 23:31	7.94	6.78	8.06	5.3	6.7	8.7
5/31 23:46	7.95	6.83	8.03	5.4	6.4	8.6
6/1 0:01	7.94	6.83	8.03	5	5.8	9.2

**Table A1 (cont.). DO concentration and turbidity during five boater flows in 2009.**

Date/Time	DO (mg/L)			Turbidity (NTU)		
	Black Canyon (unfiltered)	Black Canyon (filtered)	Grace Dam Forebay	Black Canyon (unfiltered)	Black Canyon (filtered)	Grace Dam Forebay
6/1 0:16	7.96	6.85	8	4.3	7.3	8.6
6/1 0:31	7.96	6.92	7.96	4.2	5.9	9
6/1 0:46	7.98	6.97	7.96	4.2	6.1	9.5
6/1 1:01	7.99	7.08	7.95	7.2	6.7	8.9
6/1 1:16	8	7.15	7.93	3.9	6.4	8.8
6/1 1:31	8	7.16	7.9	3.8	6.2	8.9
6/1 1:46	8.03	7.08	7.89	5.1	5.9	9.4
6/1 2:01	8.04	7.07	7.89	3.7	6.2	8.7
6/1 2:16	8.05	7.2	7.86	3.7	7.1	8.9
6/1 2:31	8.04	7.22	7.85	3.8	5.9	8.7
6/1 2:46	8.05	7.15	7.85	4.4	5.3	8.9
6/1 3:01	8.06	7.17	7.84	3.7	5.3	10.4
6/1 3:16	8.06	7.24	7.84	6.4	5.5	8.9
6/1 3:31	8.07	7.04	7.83	3.5	7.7	11.2
6/1 3:46	8.08	7.24	7.8	4.2	8.4	8.6
6/1 4:01	8.08	7.23	7.78	4.2	7.4	8.9
6/1 4:16	8.09	7.15	7.8	4	9.2	8.7
6/1 4:31	8.09	7.24	7.79	3.4	8.2	8.4
6/1 4:46	8.1	7.19	7.75	3.4	6.9	9.1
6/1 5:01	8.11	7.18	7.77	4.1	9.5	8.9
6/1 5:16	8.11	7.27	7.76	3.9	7.6	9.2
6/1 5:31	8.11	7.21	7.71	4.1	10.7	9.2
6/1 5:46	8.13	7.35	7.68	3.3	10.6	8.6
6/1 6:01	8.14	7.25	7.63	3.5	8.5	9
6/1 6:16	8.17	7.36	7.58	3.7	13.8	8.6
6/1 6:31	8.19	7.23	7.54	3.4	10	9.5
6/1 6:46	8.24	7.34	7.51	3.7	12.8	9.8
6/1 7:01	8.29	7.38	7.46	3.1	29	9.5
6/1 7:16	8.37	7.49	7.44	3.7	19.2	10.6
6/1 7:31	8.5	7.67	7.42	3	30.5	10.8
6/1 7:46	8.62	7.76	7.44	2.6	16.1	10.4
6/1 8:01	8.82	8	7.45	3.1	43.2	10.4
6/1 8:16	8.93	8.01	7.51	3.5	25.6	9.5
6/1 8:31	8.9	7.99	7.44	3.6	23	10.7
6/1 8:46	9.06	8.26	7.64	2.6	43.4	8.8
6/1 9:01	9.2	8.43	7.54	2.1	23.5	9.7
6/1 9:16	9.32	8.38	7.53	2.2	22.4	9.7
6/1 9:31	9.33	8.39	7.43	2.3	20.3	10.6



<b>Table A1 (cont.). DO concentration and turbidity during five boater flows in 2009.</b>						
	DO (mg/L)			Turbidity (NTU)		
Date/Time	Black Canyon (unfiltered)	Black Canyon (filtered)	Grace Dam Forebay	Black Canyon (unfiltered)	Black Canyon (filtered)	Grace Dam Forebay
6/1 9:46	9.37	8.3	7.49	2.6	7.1	10.3
6/1 10:01	9.28	8.12	7.43	4.4	7.6	10.6
6/1 10:16	9.18	8.05	7.4	2.2	8.6	11.6
6/1 10:31	9.17	8.29	7.41	2.1	8.2	10.3
6/1 10:46	9.27	8.48	7.38	2.7	9.7	10.8
6/1 11:01	9.5	8.69	7.4	2	8.9	10.3
6/1 11:16	9.54	8.57	7.34	1.9	9.9	11.5
6/1 11:31	9.52	8.64	7.28	2.4	9.3	12
6/1 11:46	9.67	8.62	7.33	1.8	8.1	11.6
6/1 12:01	9.76	8.7	7.27	1.8	8.6	12.5
6/1 12:16	9.73	8.54	7.32	1.7	8.5	11.5
6/1 12:31	9.25	8.01	7.31	2.9	9.1	11.8
6/1 12:46	8.79	7.78	7.25	1.8	3.2	12.6
6/1 13:01	8.72	7.85	7.24	2.6	4.6	11.8
6/1 13:16	9.01	8	7.2	1.6	3.6	12.5
6/1 13:31	9.16	8.3	7.3	1.4	3	11.4
6/1 13:46	9.45	8.27	7.23	1.7	25.5	12.2
6/1 14:01	9.35	8.29	7.15	1.5	3.3	13.4
6/1 14:16	9.06	7.86	7.44	1.6	3.7	10.9
6/1 14:31	8.69	7.45	7.27	2	3.9	11.9
6/1 14:46	8.43	7.29	7.24	2	3.4	12.1
6/1 15:01	8.24	6.98	7.33	1.9	13.6	11.9
6/1 15:16	8.12	6.49	7.7	2.6	8.1	9.7
6/1 15:31	8.02	7.09	7.52	8	10.1	10.3
6/1 15:46	7.94	7.5	7.27	3.9	8.2	10.9
6/1 16:01	7.92	7.64	8.13	4.8	12.5	8.1
6/1 16:16	7.98	7.82	7.95	4.7	8.7	9
6/1 16:31	8.15	8.11	7.47	5.4	8.7	11.3
6/1 16:46	8.42	8.4	8.2	5.8	9.4	7.9
6/1 17:01	8.67	8.63	8.23	5.1	8.3	8
6/1 17:16	8.87	8.87	8.33	5.4	8.2	8.1
6/1 17:31	9.07	8.94	8.28	5	8	8.6
6/1 17:46	9.1	8.77	8.12	5	7.6	8.7
6/1 18:01	8.93	8.62	8.09	5	7.6	8.6
6/1 18:16	8.8	8.54	8.58	4.5	7.1	7.5
6/1 18:31	8.72	8.4	8.22	4.6	7.1	8.9
6/1 18:46	8.58	8.21	7.99	4.6	7.5	9.9
6/1 19:01	8.4	8.04	8.63	4.7	7	7.3

<b>Table A1 (cont.). DO concentration and turbidity during five boater flows in 2009.</b>						
	DO (mg/L)			Turbidity (NTU)		
Date/Time	Black Canyon (unfiltered)	Black Canyon (filtered)	Grace Dam Forebay	Black Canyon (unfiltered)	Black Canyon (filtered)	Grace Dam Forebay
6/1 19:16	8.22	7.88	8.76	5	7.7	7.6
6/1 19:31	8.09	7.75	8.68	5.6	7.6	8
6/1 19:46	7.98	7.65	8.56	4.4	6.8	8.1
6/1 20:01	7.9	7.6	8.59	4.7	6.6	7.6
6/1 20:16	7.87	7.52	8.56	3.9	6.5	7.8
6/1 20:31	7.88	7.13	8.47	4.1	6.2	8.8
6/1 20:46	7.87	7.05	8.46	4.3	5.8	8
6/1 21:01	7.81	7.01	8.27	3.6	5.4	8.6
6/1 21:16	7.78	6.74	8.34	4	6.1	8.4
6/1 21:31	7.75	6.73	8.04	3.4	5.4	8.7
6/1 21:46	7.74	6.72	7.99	3.2	5.9	8.4
6/1 22:01	7.74	6.71	8.25	3.1	5.1	8.2
6/1 22:16	7.75	6.8	8.24	3.2	4.9	9.7
6/1 22:31	7.75	6.88	8.2	2.9	8.6	8.3
6/1 22:46	7.76	6.93	8.18	2.6	4.8	8
6/1 23:01	7.77	6.74	8.16	2.6	4.7	8.1
6/1 23:16	7.78	6.82	8.17	3.4	4.6	8.1
6/1 23:31	7.78	6.86	8.16	2.2	4.3	8.3
6/1 23:46	7.8	6.91	8.13	2.1	7	8.4
<b>Inflow-dependent Boater Flow Days #1 and #2</b>						
6/13 0:01	7.77	7.78	8.28	2.2	3.4	20.5
6/13 0:16	7.78	7.78	8.27	2.5	4.6	20.2
6/13 0:31	7.79	7.81	8.3	2.6	3.9	20.6
6/13 0:46	7.82	7.83	8.27	2.3	3.9	20.8
6/13 1:01	7.83	7.84	8.07	2.7	3.8	20.4
6/13 1:16	7.85	7.86	7.85	2.3	3.7	20
6/13 1:31	7.87	7.88	7.84	2.5	3.8	19.8
6/13 1:46	7.9	7.92	7.89	2.5	4.2	19.6
6/13 2:01	7.92	7.92	7.94	2.8	4.9	20.9
6/13 2:16	7.95	7.94	7.98	2.5	4.2	21.1
6/13 2:31	7.97	7.95	8.01	2.6	4	21.6
6/13 2:46	7.99	7.98	7.94	2.8	4	22.3
6/13 3:01	8.01	7.99	7.97	2.8	4.2	20.7
6/13 3:16	8.04	8	7.98	6.3	4.4	20.3
6/13 3:31	8.06	8.04	8.01	2.6	4.3	20.2
6/13 3:46	8.07	8.04	7.97	4.2	4.3	20.5
6/13 4:01	8.1	8.06	8.02	2.7	4.2	19.5
6/13 4:16	8.12	8.09	8.03	2.9	4.3	19.4

**Table A1 (cont.). DO concentration and turbidity during five boater flows in 2009.**

Date/Time	DO (mg/L)			Turbidity (NTU)		
	Black Canyon (unfiltered)	Black Canyon (filtered)	Grace Dam Forebay	Black Canyon (unfiltered)	Black Canyon (filtered)	Grace Dam Forebay
6/13 4:31	8.14	8.08	7.92	3	4.4	20
6/13 4:46	8.16	8.11	7.94	6.2	4.5	20.6
6/13 5:01	8.18	8.12	7.96	5.7	4.6	21.6
6/13 5:16	8.2	8.15	7.91	5.7	5.1	20.8
6/13 5:31	8.21	8.08	7.94	4.8	4.7	20.8
6/13 5:46	8.23	8.15	7.92	3.1	4.8	21.1
6/13 6:01	8.26	8.21	7.92	6.3	4.8	20.5
6/13 6:16	8.31	8.31	7.86	3.9	4.7	19.9
6/13 6:31	8.44	8.36	7.92	5.3	4.8	20.6
6/13 6:46	8.54	8.49	7.94	6.7	4.7	21.1
6/13 7:01	8.64	8.61	7.92	4.8	4.5	20.3
6/13 7:16	8.86	8.93	7.94	12.2	4.3	21.3
6/13 7:31	9.12	9.24	7.92	2.9	4.2	20.6
6/13 7:46	9.42	9.51	7.92	2.7	4.6	19.8
6/13 8:01	9.63	9.64	7.92	3.3	4.5	20.3
6/13 8:16	9.87	10.01	7.94	4.3	4.3	19.4
6/13 8:31	10.26	10.15	7.93	9.1	4	20.6
6/13 8:46	10.36	10.35	7.95	2.6	4	20.8
6/13 9:01	10.55	10.5	7.88	10.4	3.9	20.4
6/13 9:16	10.76	10.72	7.92	2.7	3.8	20.7
6/13 9:31	10.94	10.72	7.93	2.4	3.8	21.5
6/13 9:46	10.99	11.07	7.95	2.1	3.8	24.5
6/13 10:01	11.36	11.34	7.96	2.2	3.6	22.7
6/13 10:16	11.48	11.52	7.94	2.1	3.6	20.9
6/13 10:31	11.75	11.64	7.95	2.5	3.6	21.3
6/13 10:46	11.81	11.14	7.95	2.2	3.7	20.9
6/13 11:01	11.33	11.01	7.94	2.3	3.7	20.6
6/13 11:16	11.21	11.36	7.95	2.2	3.7	20.1
6/13 11:31	11.61	11.4	7.97	2.3	3.7	20.3
6/13 11:46	11.64	11.48	7.96	2.1	3.5	21.3
6/13 12:01	11.72	11.73	7.97	2.1	3.9	20.2
6/13 12:16	11.63	8.41	7.93	152.7	302.2	21.4
6/13 12:31	8.68	8.29	7.92	283.6	267.7	20.2
6/13 12:46	8.58	8.2	7.92	199.2	542.7	20.4
6/13 13:01	8.5	8.21	7.94	191.2	646.2	18.8
6/13 13:16	8.43	8.15	7.97	196.5	749.1	19.6
6/13 13:31	8.45	8.11	7.98	193.3	2222.4	19.7
6/13 13:46	8.47	8.18	8	168.5	1616.5	19.4

<b>Table A1 (cont.). DO concentration and turbidity during five boater flows in 2009.</b>						
	DO (mg/L)			Turbidity (NTU)		
Date/Time	Black Canyon (unfiltered)	Black Canyon (filtered)	Grace Dam Forebay	Black Canyon (unfiltered)	Black Canyon (filtered)	Grace Dam Forebay
6/13 14:01	8.46	8.19	8.02	101	1253.4	20.3
6/13 14:16	8.47	8.21	8.03	94.1	567.5	18.5
6/13 14:31	8.48	8.13	8.08	81.9	3597.9	19.5
6/13 14:46	8.54	5.31	8.1	81.3	296.7	20.1
6/13 15:01	8.56	1.92	8.19	63	287.1	19.4
6/13 15:16	8.55	1.76	8.18	60.3	260.6	19.5
6/13 15:31	8.55	1.57	8.18	56.9	740.1	19.3
6/13 15:46	8.51	1.69	8.27	56.5	803.2	20.9
6/13 16:01	8.46	1.51	8.27	52.1	1887	20.8
6/13 16:16	8.45	1.27	8.24	339.2	3003.4	19.7
6/13 16:31	8.49	0.79	8.29	47.6	2015.6	19.2
6/13 16:46	8.54	-0.29	8.3	54	1563.5	19
6/13 17:01	8.56	0.21	8.49	47.4	2208.4	19
6/13 17:16	8.55	1.54	8.46	46.3	1484.2	17.1
6/13 17:31	8.5	1.52	8.5	52.2	3429.1	18
6/13 17:46	8.52	3.07	8.62	43.8	994.4	17.5
6/13 18:01	8.52	4.52	8.61	40.4	3604.8	17.6
6/13 18:16	8.49	4.65	8.65	45.6	1885.4	17.9
6/13 18:31	8.45	3.88	8.63	35.7	3598.6	17.5
6/13 18:46	8.43	2.99	8.64	41.9	3595.3	18.3
6/13 19:01	8.42	1.41	8.64	39.3	980.8	17.5
6/13 19:16	8.44	0.39	8.64	36.9	3589.1	17
6/13 19:31	8.46	0.99	8.54	38.6	1350.8	18.3
6/13 19:46	8.48	2.12	8.56	47.3	937.5	18.9
6/13 20:01	8.5	1.36	8.56	30.9	1294.1	17.3
6/13 20:16	8.54	-0.11	8.56	30	1205.8	17.7
6/13 20:31	8.53	0.59	8.59	32.8	1246	17.2
6/13 20:46	8.51	1.23	8.6	23.6	1276.3	17.3
6/13 21:01	8.47	1.64	8.59	21.3	2856.1	16.9
6/13 21:16	8.44	1.92	8.53	19.1	819.8	17.2
6/13 21:31	8.42	2.17	8.57	17.5	1562.5	17.3
6/13 21:46	8.34	2.29	8.53	16.2	2651.4	16.7
6/13 22:01	8.4	2.38	8.54	14.8	744.6	17.4
6/13 22:16	8.41	2.56	8.51	12.6	3554.6	16.5
6/13 22:31	8.42	2.67	8.51	11.6	1349.6	16.7
6/13 22:46	8.43	2.73	8.51	31.1	857.9	16.7
6/13 23:01	8.44	2.83	8.5	10	701.7	16.2
6/13 23:16	8.45	2.72	8.5	9.8	1389.4	16.5

**Table A1 (cont.). DO concentration and turbidity during five boater flows in 2009.**

Date/Time	DO (mg/L)			Turbidity (NTU)		
	Black Canyon (unfiltered)	Black Canyon (filtered)	Grace Dam Forebay	Black Canyon (unfiltered)	Black Canyon (filtered)	Grace Dam Forebay
6/13 23:31	8.46	2.92	8.51	9	440.7	16
6/13 23:46	8.47	2.97	8.49	9.2	521.4	16.1
6/14 0:01	8.47	2.63	8.5	8.5	1554	16.3
6/14 0:16	8.48	2.4	8.52	8.8	3538.2	16
6/14 0:31	8.5	2.7	8.49	7.9	380.6	16
6/14 0:46	8.51	3.11	8.5	8.9	3203.4	16.1
6/14 1:01	8.51	3.29	8.46	7.3	337.9	16.2
6/14 1:16	8.54	3.5	8.48	7.2	1120.2	16
6/14 1:31	8.55	3.51	8.44	7.6	866	15.9
6/14 1:46	8.56	3.49	8.44	6.4	822.1	17
6/14 2:01	8.57	3.46	8.4	6.5	3528.4	16
6/14 2:16	8.57	3.45	8.42	6.5	3527.1	15.9
6/14 2:31	8.57	3.46	8.39	6.5	1011.9	16.2
6/14 2:46	8.58	3.46	8.4	6.3	1880	16.3
6/14 3:01	8.57	3.54	8.37	6.2	2653.4	16.1
6/14 3:16	8.6	3.63	8.35	6.1	237.6	16.6
6/14 3:31	8.61	3.95	8.37	6.8	606	15.5
6/14 3:46	8.62	3.97	8.35	5.8	1123.7	15.5
6/14 4:01	8.63	3.94	8.31	5.9	2053.6	15.6
6/14 4:16	8.65	3.94	8.34	6.2	1067.9	16.3
6/14 4:31	8.6	3.93	8.33	5.9	482	15.5
6/14 4:46	8.66	3.92	8.32	5.6	866.3	16
6/14 5:01	8.67	3.96	8.31	5.7	363	16.6
6/14 5:16	8.68	4	8.25	5.7	581.9	18.3
6/14 5:31	8.68	4.04	8.26	5.6	1421.8	17.3
6/14 5:46	8.69	4.1	8.24	6.2	389.5	16.8
6/14 6:01	8.74	4.16	8.28	84.5	1931.8	16.2
6/14 6:16	8.78	4.22	8.32	16.4	1022.7	15.9
6/14 6:31	8.83	4.27	8.29	7.5	3507.8	15.6
6/14 6:46	8.92	4.29	8.15	6.5	548.9	17.4
6/14 7:01	9.04	4.37	8.11	9.5	406	17.1
6/14 7:16	9.14	4.47	8.15	31.7	315.1	16.9
6/14 7:31	9.25	4.5	8.1	18.7	1138.7	16.9
6/14 7:46	9.39	4.56	8.09	31.5	1133.4	16.5
6/14 8:01	9.55	4.62	8.06	450.5	399.9	16.4
6/14 8:16	9.67	4.65	8.02	173.1	453.6	17.2
6/14 8:31	9.74	4.7	8.04	122.4	653.4	16.6
6/14 8:46	9.87	4.72	8.04	174	324.7	16.9

**Table A1 (cont.). DO concentration and turbidity during five boater flows in 2009.**

Date/Time	DO (mg/L)			Turbidity (NTU)		
	Black Canyon (unfiltered)	Black Canyon (filtered)	Grace Dam Forebay	Black Canyon (unfiltered)	Black Canyon (filtered)	Grace Dam Forebay
6/14 9:01	9.94	4.74	8.09	234.7	298.4	16.7
6/14 9:16	9.96	4.8	8	89.4	878.2	17
6/14 9:31	10.08	4.81	8	49.2	3522.5	16.2
6/14 9:46	10.18	4.86	8.03	37.5	1609.4	18.4
6/14 10:01	10.3	4.89	8.04	35.7	1543.8	18.6
6/14 10:16	10.32	5.01	8.02	39.4	1945.9	17.8
6/14 10:31	10.35	5.05	8.03	54.2	895.3	18.4
6/14 10:46	10.45	5.04	8	92.5	227.2	19.2
6/14 11:01	10.4	5.04	8.01	50.7	338	18.9
6/14 11:16	9.5	5.05	8.03	50.3	235.8	19
6/14 11:31	10.37	5.08	8.05	38.1	866.8	19.4
6/14 11:46	10.43	5.09	8.05	27.7	3594.4	19.6
6/14 12:01	10.39	5.11	8.04	42.3	3086.1	19.1
6/14 12:16	9.81	4.58	8.07	86.2	3608	19.4
6/14 12:31	8.73	3.9	8.08	523.8	3610.6	19.2
6/14 12:46	8.6	4.03	8.08	135.7	3572	20.5
6/14 13:01	8.49	4.26	8.12	322.9	231.3	19.2
6/14 13:16	8.39	4.34	8.16	902	932.8	19.2
6/14 13:31	8.4	4.35	8.23	363.5	1799.3	19.1
6/14 13:46	8.44	4.37	8.27	195.9	1202.3	18.1
6/14 14:01	8.45	4.35	8.32	897.6	3643.3	18.9
6/14 14:16	8.48	4.12	8.37	434.6	656.5	19.2
6/14 14:31	8.49	3.88	8.41	462.6	3131.9	19
6/14 14:46	8.44	3.9	8.47	311.4	732.3	19.4
6/14 15:01	8.47	3.6	8.47	176.2	498	19.1
6/14 15:16	8.4	3.06	8.51	260.6	1006.6	18.8
6/14 15:31	8.53	2.05	8.52	170.4	833.6	19.2
6/14 15:46	8.53	1.6	8.51	116.2	2339.1	19.2
6/14 16:01	8.48	2.24	8.45	286.6	1498.7	18.3
6/14 16:16	8.43	3.14	8.54	108	704	17
6/14 16:31	8.52	3.86	8.41	99.2	1997.7	15.8
6/14 16:46	8.5	4.03	8.74	216.7	658	15
6/14 17:01	8.46	4.18	8.77	785.9	435.6	15.8
6/14 17:16	8.52	4.29	8.8	227.2	3634.7	15.3
6/14 17:31	8.56	4.38	8.82	203.9	1119.5	15.2
6/14 17:46	8.52	4.44	8.89	154.1	1491.6	16.4
6/14 18:01	8.49	4.49	8.84	161.1	1538.3	15.8
6/14 18:16	8.48	4.52	8.81	138.3	237.7	16.1

<b>Table A1 (cont.). DO concentration and turbidity during five boater flows in 2009.</b>						
	DO (mg/L)			Turbidity (NTU)		
Date/Time	Black Canyon (unfiltered)	Black Canyon (filtered)	Grace Dam Forebay	Black Canyon (unfiltered)	Black Canyon (filtered)	Grace Dam Forebay
6/14 18:31	8.45	4.56	8.83	208.3	1159.4	15.5
6/14 18:46	8.41	4.62	8.84	116.3	1003	15.2
6/14 19:01	8.45	4.63	8.84	281.8	3610.2	15.1
6/14 19:16	8.43	4.49	8.8	160.1	2816.6	16.4
6/14 19:31	8.43	4.32	8.81	139.5	442.6	15.5
6/14 19:46	8.42	4.27	8.78	161.5	3606.9	14.2
6/14 20:01	8.41	4.41	8.76	144.2	3604.9	14.4
6/14 20:16	8.41	4.43	8.74	149.1	3602.7	14.4
6/14 20:31	8.4	4.56	8.73	131.4	3600.8	13.4
6/14 20:46	8.41	4.71	8.75	136.4	1956.4	14
6/14 21:01	8.4	4.66	8.75	132.8	3595.5	13.7
6/14 21:16	8.39	4.64	8.73	138.8	1616.6	13.1
6/14 21:31	8.38	4.68	8.72	131.8	1163.8	13.4
6/14 21:46	7.97	4.82	8.72	151.3	1660.2	13.7
6/14 22:01	7.36	4.94	8.71	163	2400.4	13.5
6/14 22:16	8.36	4.73	8.71	134.8	3578.2	13.6
6/14 22:31	8.39	4.49	8.67	128.1	3575.1	13.3
6/14 22:46	8.37	4.37	8.64	124	3571.9	13.4
6/14 23:01	8.41	4.34	8.61	129.2	2515.4	13.6
6/14 23:16	8.41	4.38	8.61	123.9	3565.3	13.3
6/14 23:31	8.42	4.4	8.6	123.5	3562.3	13.6
6/14 23:46	8.41	4.49	8.6	129.2	497.6	13.6
6/15 0:01	8.46	4.53	8.58	150.3	192.2	12.8
6/15 0:16	8.49	4.62	8.57	142.6	307.1	13.3
6/15 0:31	8.51	4.66	8.58	148.6	302.4	13.6
6/15 0:46	8.53	4.68	8.56	196.3	314.3	13.3
6/15 1:01	8.54	4.73	8.55	179.1	365.7	12.6
6/15 1:16	8.58	4.84	8.57	178.8	335.7	13.6
6/15 1:31	8.58	4.84	8.56	177.6	316.5	14.4
6/15 1:46	8.61	4.93	8.57	171.9	319.3	14.2
6/15 2:01	8.61	4.96	8.56	170.2	339.9	14.4
6/15 2:16	8.63	4.99	8.54	141.5	341.7	14
6/15 2:31	8.66	4.99	8.54	136.6	335.7	14
6/15 2:46	8.63	5.04	8.51	135	330.9	13.9
6/15 3:01	8.66	5.1	8.51	133.5	331	14.3
6/15 3:16	8.67	5.2	8.46	124.7	314	14.1
6/15 3:31	8.65	5.23	8.48	125.6	303.4	13.9
6/15 3:46	8.69	5.28	8.49	124.2	301.2	13.5

**Table A1 (cont.). DO concentration and turbidity during five boater flows in 2009.**

Date/Time	DO (mg/L)			Turbidity (NTU)		
	Black Canyon (unfiltered)	Black Canyon (filtered)	Grace Dam Forebay	Black Canyon (unfiltered)	Black Canyon (filtered)	Grace Dam Forebay
6/15 4:01	8.7	5.08	8.45	127.6	286.4	13.7
6/15 4:16	8.71	5.04	8.45	139.9	267.7	13.4
6/15 4:31	8.7	5.08	8.5	144.4	236.1	13.1
6/15 4:46	8.71	4.99	8.47	132.3	270.7	13.1
6/15 5:01	8.73	5.22	8.37	141.6	262.9	14.9
6/15 5:16	8.78	5.51	8.44	133.8	216.7	13.4
6/15 5:31	8.79	5.56	8.46	486.9	217.5	14.1
6/15 5:46	8.8	5.42	8.4	125.1	220.8	15.6
6/15 6:01	8.82	5.39	8.4	127.8	222.5	15
6/15 6:16	8.85	5.42	8.34	125.1	211.9	15.9
6/15 6:31	8.9	5.42	8.36	123	214.1	14.9
6/15 6:46	8.94	5.44	8.33	133.3	212.2	15.1
6/15 7:01	8.98	5.49	8.26	123.7	211.1	14.5
6/15 7:16	9.04	5.52	8.26	281	213.8	14.7
6/15 7:31	9.15	5.49	8.24	141.1	214.8	15.9
6/15 7:46	9.24	5.5	8.27	142.2	215.8	15.8
6/15 8:01	9.35	5.53	8.23	143.4	212.1	15.8
6/15 8:16	9.51	5.42	8.21	123.5	213.5	16.3
6/15 8:31	9.67	5.48	8.22	123.8	216	16.6
6/15 8:46	9.88	5.46	8.19	132.9	213.6	17.7
6/15 9:01	9.84	5.38	8.15	132	213.4	15.5
6/15 9:16	9.91	5.59	8.16	122.9	213.8	17.3
6/15 9:31	9.91	5.65	8.16	102.1	218.9	17.2
6/15 9:46	9.99	5.65	8.15	112.3	218.7	17.3
6/15 10:01	10.1	5.63	8.17	113.8	208.6	17.3
6/15 10:16	10.1	5.6	8.13	117.4	206.9	18
6/15 10:31	10.11	5.66	8.13	113.6	209.2	17.5
6/15 10:46	10	5.54	8.13	121.3	215.6	17.1
6/15 11:01	10.1	5.64	8.12	121.1	212.8	18.4
6/15 11:16	10.27	5.64	8.11	112.3	234.6	18.1
6/15 11:31	10.37	5.65	8.13	107.7	192.5	19.2
6/15 11:46	10.44	5.7	8.24	135	200.9	16.6
6/15 12:01	10.51	5.68	8.21	129.3	207.9	17.2
6/15 12:16	10.49	5.67	8.16	133.5	223.5	17.1
6/15 12:31	10.42	5.68	8.19	113.6	234.1	16.6
6/15 12:46	10.52	5.67	8.26	113.5	243.8	16.9
6/15 13:01	10.3	5.63	8.21	110.7	254	16.5
6/15 13:16	10.13	5.59	8.2	110.7	302.7	16.9



<b>Table A1 (cont.). DO concentration and turbidity during five boater flows in 2009.</b>						
	DO (mg/L)			Turbidity (NTU)		
Date/Time	Black Canyon (unfiltered)	Black Canyon (filtered)	Grace Dam Forebay	Black Canyon (unfiltered)	Black Canyon (filtered)	Grace Dam Forebay
6/15 13:31	9.77	5.49	8.23	102.4	308.7	16.2
6/15 13:46	10.02	5.53	8.28	103.8	310.6	16.5
6/15 14:01	9.98	5.58	8.25	123.4	318.8	16.4
6/15 14:16	9.55	5.61	8.16	122.4	323.1	16.6
6/15 14:31	9	5.58	8.28	127.9	325.7	16.4
6/15 14:46	8.81	5.54	8.16	110.2	329.3	16.6
6/15 15:01	8.79	5.5	8.3	108.5	291	15.6
6/15 15:16	8.92	5.51	8.36	107.8	260.3	15.6
6/15 15:31	9.16	5.55	8.4	102.8	253.2	15.5
6/15 15:46	9.46	5.5	8.38	107.9	227.1	15.4
6/15 16:01	9.79	5.53	8.42	112.5	241.5	15.5
6/15 16:16	9.92	5.55	8.27	113.1	239.7	16.8
6/15 16:31	9.97	5.58	8.34	120.5	234.9	15.8
6/15 16:46	10	5.58	8.38	120.3	234	15.5
6/15 17:01	9.95	5.58	8.43	118.4	235.4	15.7
6/15 17:16	9.91	5.64	8.44	117	221.3	15.1
6/15 17:31	9.98	5.55	8.45	118.5	241.8	14.8
6/15 17:46	10.15	5.59	8.58	121.5	242	14.2
6/15 18:01	10.16	5.57	8.54	112.1	238.3	14.6
6/15 18:16	10.07	5.53	8.5	114.9	209.2	14.3
6/15 18:31	9.77	5.64	8.57	107.6	193.5	14.5
6/15 18:46	9.4	5.64	8.55	108.7	170.9	15
6/15 19:01	9.28	5.59	8.65	102.1	172.7	14.4
6/15 19:16	9.16	5.6	8.77	101.8	179.9	14.1
6/15 19:31	9.19	5.44	8.77	105.2	309.8	14
6/15 19:46	9.14	5.27	8.76	103.2	3070.1	13.9
6/15 20:01	8.82	3.67	8.76	101.3	3558.2	14.3
6/15 20:16	8.63	3.18	8.79	112.6	3289.2	13.8
6/15 20:31	3.21	4.03	8.81	101.3	2897.2	14.2
6/15 20:46	8.45	4.39	8.78	132	3594.9	13.8
6/15 21:01	8.42	5.12	8.82	136.1	2141.5	14.5
6/15 21:16	8.38	5.38	8.77	119.7	2201.7	13.7
6/15 21:31	8.34	5.48	8.81	113.2	639.4	15
6/15 21:46	8.37	4.66	8.79	109.9	2155.5	14.4
6/15 22:01	8.23	4.42	8.78	110.7	1260.9	13.8
6/15 22:16	8.31	2.72	8.78	109.6	1482.7	14.1
6/15 22:31	8.38	1.5	8.77	111.9	3573.3	13.8
6/15 22:46	8.4	1.93	8.77	108.8	3571.5	14.3

<b>Table A1 (cont.). DO concentration and turbidity during five boater flows in 2009.</b>						
	DO (mg/L)			Turbidity (NTU)		
Date/Time	Black Canyon (unfiltered)	Black Canyon (filtered)	Grace Dam Forebay	Black Canyon (unfiltered)	Black Canyon (filtered)	Grace Dam Forebay
6/15 23:01	8.39	2.15	8.75	105.9	858.3	14.4
6/15 23:16	8.39	1.9	8.75	107.4	3568.9	13.6
6/15 23:31	8.4	1.57	8.76	120.5	3568.2	13.7
6/15 23:46	8.41	2.6	8.76	121.1	2878.6	14.3
<b>Inflow-dependent Boater Flow Days #4 and #5</b>						
6/20 0:01	8.05	7.72	9.01	1.8	2.8	9.7
6/20 0:16	8.07	7.74	9.09	2.1	2.8	10
6/20 0:31	8.08	7.75	8.96	1.9	3.1	10
6/20 0:46	8.09	7.77	8.98	2.1	3.1	9.8
6/20 1:01	8.1	7.77	8.97	1.9	2.8	9.7
6/20 1:16	8.12	7.8	8.92	1.8	5.4	10
6/20 1:31	8.15	7.82	8.93	1.8	2.9	10.5
6/20 1:46	8.17	7.85	8.99	1.8	3.3	10.7
6/20 2:01	8.2	7.88	8.97	1.8	3.1	10.1
6/20 2:16	8.23	7.91	8.93	2	2.9	10.3
6/20 2:31	8.27	7.94	8.95	1.8	3.1	9.6
6/20 2:46	8.29	7.95	8.98	2.2	3.5	10.2
6/20 3:01	8.31	7.97	8.9	1.8	2.9	10
6/20 3:16	8.33	8	8.89	2	3.2	10.3
6/20 3:31	8.36	8.02	8.88	1.8	3.2	10
6/20 3:46	8.38	8.06	8.79	2	3.1	10.9
6/20 4:01	8.42	8.08	8.66	2.3	3.1	10.8
6/20 4:16	8.44	8.1	8.72	2	5.4	9.9
6/20 4:31	8.47	8.12	8.79	2	3.7	10.1
6/20 4:46	8.49	8.14	8.76	2	3.7	9.9
6/20 5:01	8.52	8.16	8.68	2.4	3.6	12.2
6/20 5:16	8.54	8.17	8.5	2.3	3.6	12
6/20 5:31	8.57	8.2	8.42	2.5	3.5	11.6
6/20 5:46	8.61	8.24	8.45	2.3	3.9	11.7
6/20 6:01	8.66	8.31	8.38	2.8	6.8	11.2
6/20 6:16	8.75	8.39	8.39	2.4	5.3	11.7
6/20 6:31	8.85	8.49	8.21	2.6	4.5	11.7
6/20 6:46	8.96	8.63	8.35	2.8	12.3	12.3
6/20 7:01	9.12	8.88	8.3	2.9	4	12.5
6/20 7:16	9.39	9.02	8.26	2.5	3.5	12
6/20 7:31	9.55	9.16	8.18	2.4	3.4	11.3
6/20 7:46	9.67	9.24	8.21	2.2	3.7	11.1
6/20 8:01	9.75	9.39	8.24	2.1	3.4	11.2

**Table A1 (cont.). DO concentration and turbidity during five boater flows in 2009.**

Date/Time	DO (mg/L)			Turbidity (NTU)		
	Black Canyon (unfiltered)	Black Canyon (filtered)	Grace Dam Forebay	Black Canyon (unfiltered)	Black Canyon (filtered)	Grace Dam Forebay
6/20 8:16	9.95	9.59	8.19	2.5	3.2	11.1
6/20 8:31	10.13	9.68	8.19	3.3	3.5	12.5
6/20 8:46	10.3	10.07	8.42	2	3.1	11.1
6/20 9:01	10.69	10.41	8.17	2	3.1	12.3
6/20 9:16	11.06	10.62	8.12	2	3	12.1
6/20 9:31	11.26	10.91	8.3	2.1	3.1	12
6/20 9:46	11.63	11.28	8.31	2.1	3.1	13.1
6/20 10:01	11.99	11.63	8.21	2	2.9	15.6
6/20 10:16	12.31	11.85	8.23	1.7	2.8	15
6/20 10:31	12.58	11.5	8.23	1.7	3.4	14.4
6/20 10:46	12.08	11	8.2	3.4	2.8	14.7
6/20 11:01	11.7	11.24	8.18	1.5	2.6	14.9
6/20 11:16	11.84	11.27	8.19	1.7	2.7	15.5
6/20 11:31	11.8	10.62	8.17	1.5	2.6	16.2
6/20 11:46	11.32	11.08	8.19	1.6	2.6	15
6/20 12:01	11.78	10.72	8.21	1.7	17.9	16.9
6/20 12:16	10.8	8.66	8.21	113.3	221.3	16
6/20 12:31	9.13	8.57	8.21	126.3	124.3	16.1
6/20 12:46	9.05	8.46	8.25	102.1	121.9	15.6
6/20 13:01	8.9	8.36	8.25	124.2	119.7	14.6
6/20 13:16	8.81	8.36	8.29	92.8	103.6	14.9
6/20 13:31	8.81	8.39	8.36	85.9	85.3	15
6/20 13:46	8.84	8.42	8.39	69.7	72.9	15.5
6/20 14:01	8.87	7.64	8.49	58.7	64.3	14.5
6/20 14:16	8.92	8.49	8.55	51.8	54.6	14.7
6/20 14:31	8.96	8.5	8.56	45.2	56.7	13.7
6/20 14:46	8.96	8.47	8.7	43.1	50.5	13.7
6/20 15:01	8.92	8.5	8.7	44.7	48.8	14
6/20 15:16	8.97	8.55	8.74	40.3	48.7	13.3
6/20 15:31	9.02	8.38	8.76	38.2	44.1	14.5
6/20 15:46	8.99	8.39	8.78	35.2	46.5	13.1
6/20 16:01	9.04	8.5	8.75	36.8	43.8	13
6/20 16:16	8.99	8.39	8.77	35.2	42.4	13.3
6/20 16:31	8.97	8.17	8.78	34.6	42.2	14.4
6/20 16:46	9	8.49	8.77	33.5	38.3	11.5
6/20 17:01	9.04	8.16	8.81	31.3	44	11.4
6/20 17:16	9.03	7.83	8.72	31.4	37.2	11.6
6/20 17:31	9.05	7.7	8.73	31.8	45.8	11.9

**Table A1 (cont.). DO concentration and turbidity during five boater flows in 2009.**

Date/Time	DO (mg/L)			Turbidity (NTU)		
	Black Canyon (unfiltered)	Black Canyon (filtered)	Grace Dam Forebay	Black Canyon (unfiltered)	Black Canyon (filtered)	Grace Dam Forebay
6/20 17:46	9.06	8.26	8.69	30.2	35.6	11.1
6/20 18:01	9.09	8.33	8.78	29.6	37	11.2
6/20 18:16	9.09	8.21	8.76	28.9	39.7	10.8
6/20 18:31	9.14	8.12	8.8	30.4	33.6	10.8
6/20 18:46	9.12	8.1	8.77	27.4	32.5	11.2
6/20 19:01	9.11	7.72	8.75	26.6	34.4	12.2
6/20 19:16	9.06	7.23	8.73	26.9	29.2	11
6/20 19:31	9.02	7.32	8.73	25.8	31.4	11.4
6/20 19:46	9.01	7.31	8.66	26	28.9	11.4
6/20 20:01	9	7.13	8.68	22.8	26.5	11
6/20 20:16	9.03	6.68	8.74	20.5	25	11.1
6/20 20:31	9.03	6.36	8.74	18.7	20.9	11.1
6/20 20:46	9	6.36	8.7	17.2	18.8	10.8
6/20 21:01	8.98	6.42	8.7	15.6	18.4	10.8
6/20 21:16	8.96	6.4	8.68	14.2	18.1	10.9
6/20 21:31	8.96	6.36	8.65	13.1	15.3	11.1
6/20 21:46	8.96	6.5	8.61	11.9	13.8	11.7
6/20 22:01	8.96	6.81	8.55	10.2	13.7	11.4
6/20 22:16	8.97	6.78	8.63	10.1	12.5	11.1
6/20 22:31	8.98	6.78	8.6	8.4	11.7	11.6
6/20 22:46	9.01	6.64	8.57	7.8	10.7	11.2
6/20 23:01	9.03	6.04	8.59	7.3	10.9	12.4
6/20 23:16	9.04	6.55	8.57	6.9	9.9	11.7
6/20 23:31	9.07	6.57	8.58	6.9	10	11.3
6/20 23:46	9.09	5.93	8.57	6.5	9.6	12.2
6/21 0:01	9.12	5.53	8.49	6.7	8.7	11.7
6/21 0:16	9.13	5.48	8.54	6.5	8.8	11.6
6/21 0:31	9.15	6.85	8.48	6.2	8.3	11.9
6/21 0:46	9.16	8.16	8.46	6.1	9	11.7
6/21 1:01	9.18	7.99	8.49	6.3	8.3	12
6/21 1:16	9.2	7.22	8.48	6.1	15.1	12.8
6/21 1:31	9.22	7	8.47	7	7.5	13.3
6/21 1:46	9.23	6.49	8.29	5.9	7.5	12.6
6/21 2:01	9.24	6.84	8.35	6	8.2	12
6/21 2:16	9.26	6.66	8.37	7.5	7.6	11.6
6/21 2:31	9.27	7.12	8.35	4.6	9.5	11.8
6/21 2:46	9.28	6.86	8.44	4.5	8.5	11.5
6/21 3:01	9.29	6.96	8.37	4.7	7.9	11.7

**Table A1 (cont.). DO concentration and turbidity during five boater flows in 2009.**

Date/Time	DO (mg/L)			Turbidity (NTU)		
	Black Canyon (unfiltered)	Black Canyon (filtered)	Grace Dam Forebay	Black Canyon (unfiltered)	Black Canyon (filtered)	Grace Dam Forebay
6/21 3:16	9.31	6.26	8.3	4.9	7.4	11.8
6/21 3:31	9.32	6.07	8.27	4.5	16.9	12.5
6/21 3:46	9.33	6.56	8.29	4.3	40.2	13.3
6/21 4:01	9.36	7.28	8.24	4.2	7.3	11.9
6/21 4:16	9.37	7.62	8.25	4.4	10.8	11.9
6/21 4:31	9.37	7.21	8.3	4.4	6.5	13.9
6/21 4:46	9.39	6.55	8.32	5.4	8.9	13.3
6/21 5:01	9.41	6.1	8.31	4.2	12	11.4
6/21 5:16	9.42	6.09	8.24	6.4	20.5	12.2
6/21 5:31	9.45	6.54	8.19	4.3	16.6	12.4
6/21 5:46	9.47	6.38	8.08	3.9	7	13.7
6/21 6:01	9.5	6.94	8.23	4.2	6.7	12.2
6/21 6:16	9.57	6.75	8.15	4.7	30.5	13
6/21 6:31	9.65	6.8	8.17	4.1	26.9	13.1
6/21 6:46	9.73	7.1	8.17	3.7	10.1	12.9
6/21 7:01	9.9	7.02	8.17	4.2	19.2	13.1
6/21 7:16	9.88	7.17	8.12	3.6	5.5	13.3
6/21 7:31	9.93	7.27	8.15	3.9	5.8	13.5
6/21 7:46	10.02	7.49	8.16	6.1	5.9	14
6/21 8:01	10.14	7.11	8.13	3.1	5.3	13.4
6/21 8:16	10.41	7.14	8.07	3	5	14.2
6/21 8:31	10.69	6.91	8.1	3	5.4	13.9
6/21 8:46	10.71	6.78	8.1	2.8	4.9	13.8
6/21 9:01	10.81	6.86	8.13	2.6	4.7	13.6
6/21 9:16	11	6.83	8.04	2.6	11.5	13.9
6/21 9:31	11.12	6.79	8.09	2.6	7.2	14.1
6/21 9:46	11.31	6.55	8.19	3.1	4.6	16.4
6/21 10:01	11.41	6.75	8.23	2.6	4.3	17.7
6/21 10:16	11.49	6.89	8.21	2.5	4.3	15.8
6/21 10:31	11.51	6.87	8.21	2.5	4.3	16.7
6/21 10:46	11.61	6.7	8.21	2.3	4.2	15.9
6/21 11:01	11.7	7.75	8.2	2.6	8.1	15.9
6/21 11:16	11.6	8.17	8.22	5	9.9	16.5
6/21 11:31	11.42	8.58	8.2	2.1	4.2	15.7
6/21 11:46	11.43	8.63	8.22	2.2	5.4	16.3
6/21 12:01	11.63	8.35	8.26	2.2	4.1	17
6/21 12:16	11.27	7.71	8.27	44.5	64.6	15.3
6/21 12:31	9.59	6.14	8.22	49.4	60.2	16.2

**Table A1 (cont.). DO concentration and turbidity during five boater flows in 2009.**

Date/Time	DO (mg/L)			Turbidity (NTU)		
	Black Canyon (unfiltered)	Black Canyon (filtered)	Grace Dam Forebay	Black Canyon (unfiltered)	Black Canyon (filtered)	Grace Dam Forebay
6/21 12:46	9.51	4.63	8.29	1895.1	52.4	15.8
6/21 13:01	9.33	3.92	8.34	39	48.6	14.7
6/21 13:16	9.18	4.25	8.35	40.5	41.3	14.4
6/21 13:31	9.1	3.81	8.47	37.7	44.4	14.2
6/21 13:46	9.11	3.09	8.52	41.6	42.1	14.3
6/21 14:01	9.13	3.16	8.59	35.2	41.7	16
6/21 14:16	9.18	3.29	8.61	31.6	35.2	13.5
6/21 14:31	9.22	2.76	8.66	29.4	31.7	15.1
6/21 14:46	9.27	3.12	8.68	28.6	36.9	13.7
6/21 15:01	9.23	1.39	8.76	28	30.9	13.9
6/21 15:16	9.19	2.23	8.8	28.8	30.4	13
6/21 15:31	9.17	2.86	8.82	25.8	30	15.8
6/21 15:46	9.15	3.78	8.85	26	28	14.5
6/21 16:01	9.1	4	8.82	24.4	31	14.4
6/21 16:16	9.02	4.82	8.79	24.6	30.5	13
6/21 16:31	9.12	4.11	8.85	24.7	30.3	12.2
6/21 16:46	9.11	4.18	9.01	24.4	27.5	12.1
6/21 17:01	9.09	3.82	9.03	23.4	27.4	11.4
6/21 17:16	8.96	3.5	8.81	23.4	26.7	10.7
6/21 17:31	8.9	4.5	8.98	24.2	25.4	11.4
6/21 17:46	8.86	6.16	9.03	23.5	28.7	11.7
6/21 18:01	8.91	7.32	9	22.5	30.6	11.5
6/21 18:16	8.85	7.35	9.01	23	29.2	11.6
6/21 18:31	8.82	6.88	9.04	25.2	25.8	11.1
6/21 18:46	8.94	6.63	9.02	20.9	26	11
6/21 19:01	8.97	4.69	9.01	21.4	240.4	11.1
6/21 19:16	8.87	3.63	9	21.8	22.8	11.2
6/21 19:31	8.86	4.26	8.95	19.2	22.5	10.9
6/21 19:46	8.95	5.16	8.91	17.9	20.5	10.9
6/21 20:01	8.97	4.48	8.88	16.7	19.2	10.8
6/21 20:16	8.95	3.11	8.88	16.6	17.9	10.9
6/21 20:31	8.87	3.27	8.86	13.9	16.4	10.6
6/21 20:46	8.84	3.44	8.81	13.3	17	10.4
6/21 21:01	8.8	3.67	8.79	12.3	14.5	10.6
6/21 21:16	8.79	3.8	8.79	10.9	13.3	10.7
6/21 21:31	8.78	3.75	8.79	10	12.5	12.7
6/21 21:46	8.78	3.24	8.79	8.9	13.8	10.6
6/21 22:01	8.78	3.08	8.76	8.2	10.1	10.8

**Table A1 (cont.). DO concentration and turbidity during five boater flows in 2009.**

Date/Time	DO (mg/L)			Turbidity (NTU)		
	Black Canyon (unfiltered)	Black Canyon (filtered)	Grace Dam Forebay	Black Canyon (unfiltered)	Black Canyon (filtered)	Grace Dam Forebay
6/21 22:16	8.8	3.07	8.78	7.2	11.7	11.4
6/21 22:31	8.83	2.94	8.66	7.1	8.8	10.5
6/21 22:46	8.85	2.89	8.71	6.5	8.6	10.4
6/21 23:01	8.87	2.79	8.64	6.2	8.3	10.8
6/21 23:16	8.9	2.77	8.67	5.7	7.8	10.4
6/21 23:31	8.92	2.89	8.62	5.4	8.3	10.4
6/21 23:46	8.96	3.16	8.7	5.1	7.2	10.3
6/22 0:01	8.99	3.35	8.68	4.7	9.2	10.5
6/22 0:16	9	3.39	8.73	4.7	7.6	10.5
6/22 0:31	9.04	3.07	8.63	4.7	7.4	10.5
6/22 0:46	9.06	2.36	8.69	4.5	7.1	10.4
6/22 1:01	9.1	2.42	8.72	4.3	6.9	10.2
6/22 1:16	9.12	2.25	8.69	4.3	6.8	10.6
6/22 1:31	9.13	2.36	8.67	4.2	6.7	10.6
6/22 1:46	9.17	2.28	8.7	4	6.5	10.5
6/22 2:01	9.18	2.17	8.64	4	6.6	10.3
6/22 2:16	9.22	2.48	8.62	4.2	6.5	10.3
6/22 2:31	9.24	2.76	8.6	4	6.5	10.7
6/22 2:46	9.26	2.76	8.51	3.9	6.3	10.3
6/22 3:01	9.3	2.82	8.51	3.9	32.8	10.3
6/22 3:16	9.33	2.75	8.46	3.8	6.1	10.7
6/22 3:31	9.36	2.67	8.47	3.7	6.5	10.6
6/22 3:46	9.38	3.1	8.5	3.6	6.8	10
6/22 4:01	9.42	3.3	8.51	3.6	6.2	10.3
6/22 4:16	9.45	3.48	8.49	3.4	5.9	10.8
6/22 4:31	9.47	3.42	8.47	3.7	5.7	12.2
6/22 4:46	9.49	3.7	8.38	3.4	7.9	10.9
6/22 5:01	9.53	3.77	8.43	3.5	2623.1	11.1
6/22 5:16	9.55	3.59	8.41	3.6	5.8	10.8
6/22 5:31	9.57	3.71	8.45	5.3	7.3	10.8
6/22 5:46	9.61	3.78	8.52	3.5	5.4	10.5
6/22 6:01	9.65	3.87	8.49	3.4	5.6	10.5
6/22 6:16	9.72	4.02	8.39	3.4	5.5	10.7
6/22 6:31	9.8	3.83	8.41	3.7	6.1	10.8
6/22 6:46	9.93	3.99	8.39	3.7	5.4	11.6
6/22 7:01	10.02	3.81	8.29	3.4	5.3	11.5

## **APPENDIX B. WATER LEVEL STUDIES – GRACE POWER PLANT TO ONEIDA RESERVOIR REACH.**

In response to questions about the impact of the boater flow fluctuations on the reach of the Bear River between Grace power plant and Oneida reservoir, PacifiCorp Energy deployed five (5) water level sensors (Solinst Levelogger Model 3001 LT F15) and one barometric pressure logger (Solinst Barologger Model 3001 F5). In 2009, the water release and Grace power plant flows were coordinated to reduce water level fluctuations in the reach between Grace power plant and the Oneida reservoir. This appendix describes the locations, methods, and results of the coordinated operation on the river water levels.

The water level sensors were deployed at the locations shown in Figure B-1 and as described below. The barometric pressure sensor was placed in the Grace operations office near the plant.

1. Pedestrian bridge. In order to quantify the water flowing out of Black Canyon without the influence of the flow through Grace power plant, one levelogger was placed about 200 feet downstream of the pedestrian bridge across the Bear River near the end of Black Canyon.
2. Cove tailrace. The tailrace of the decommissioned Cove power plant contains a stilling well. This location quantifies the water level after the water from the Black Canyon and the Grace power plant recombine. This location is the upper-most location of the reach between Grace power plant and the Oneida Reservoir. This location was also used in the 2008 levelogger studies.
3. Centennial Bridge. This location was approximately midway between the upstream Cove tailrace and the downstream Thatcher Bridge.
4. Thatcher Bridge. This location approximately midway between the upstream Centennial Bridge location and the downstream Cleveland Bridge locations.
5. Cleveland Bridge. This location is at the upper end of Oneida Reservoir where Highway 34 crosses the Bear River. It is likely in the backwater of Oneida Reservoir, but over the timescale of the flow fluctuations, the influence is not noticeable and does not affect any interpretations.

The leveloggers were placed inconspicuously to prevent loss due to theft or vandalism. They were attached to existing poles or large rocks with 50 pound test fishing line. The water depths were not calibrated to any staff gages or elevation datum as the study did not require it. The water levels are relative to the stable period just before the events at all locations to determine the change due to the boater flow event. Since the leveloggers measure absolute pressure, the barologger data was used to correct the raw levelogger data for barometric pressure. The corrected data was then normalized to relative water levels by subtracting the initial water level just before the event.

All five leveloggers were in place for both the April 11<sup>th</sup> and 25<sup>th</sup> events and remained in place in the period in-between the two events. The pedestrian bridge levelogger was retrieved, cleaned and replaced to ensure that it functioned since it was in an area that experienced high sediment load.

Due to the consistent results of these two events, only the Cove tailrace levelogger was redeployed for the May 31<sup>st</sup> boater event.



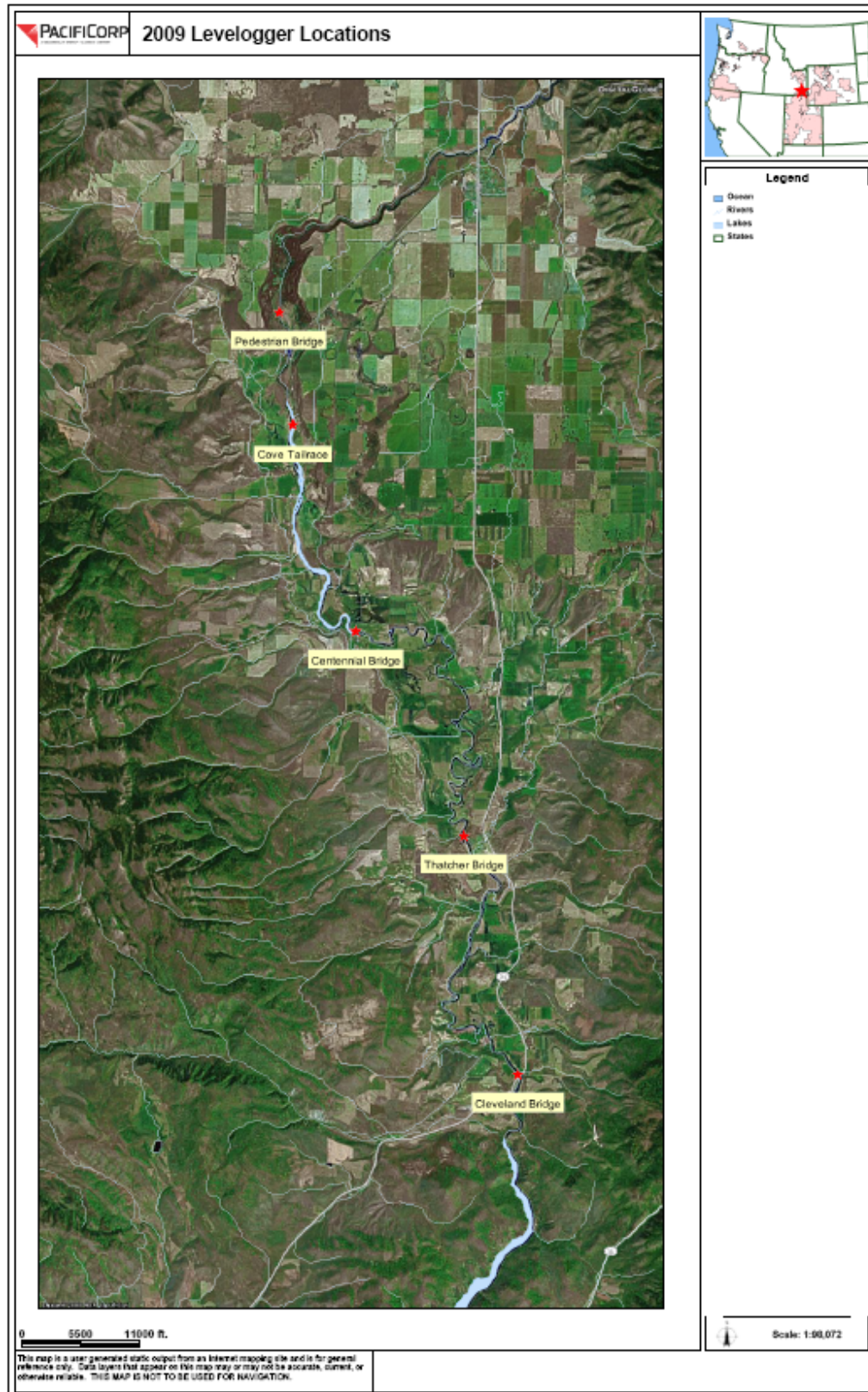


Figure B-1. Location of levelloggers.

**Results**

The results are shown in Figures B-2 through B-4. The most important finding is that water levels in 2009 do not display the dramatic sag at the beginning of the event as the 2008 event shown. The differences in water level changes between downstream sites reflect the low topographic gradient which attenuates the water velocity and results in a broadening of the hydrograph as it passes downstream. The differences in the maximum elevations across events in Figure B-4 are due to slightly different flow rates into the Black Canyon (see Section 3.2 in the body of the report).

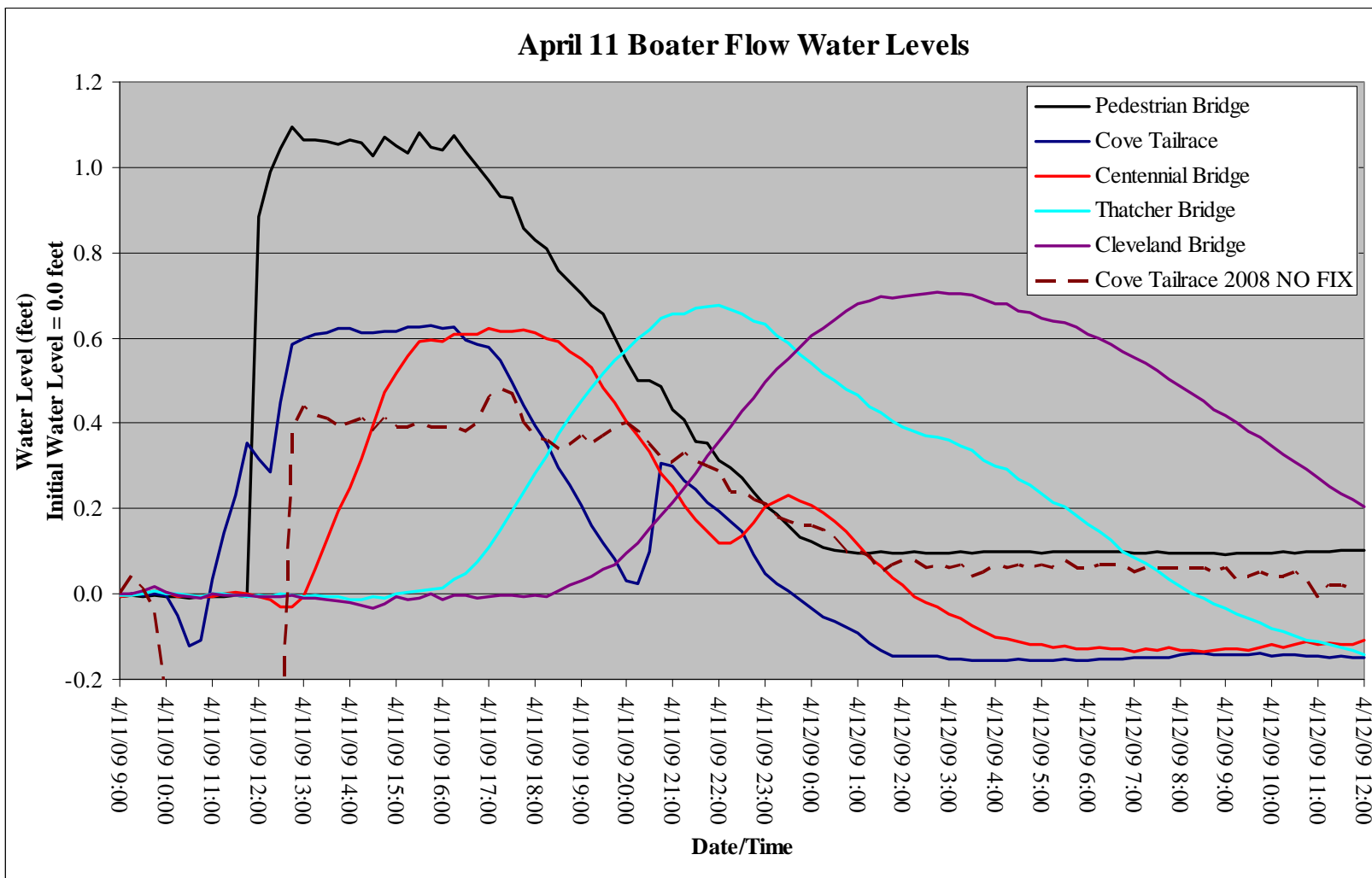


Figure B-2. Water levels (relative to pre-event level) at five locations for 2009 with Cove tailrace 2008 levels shown for comparison.

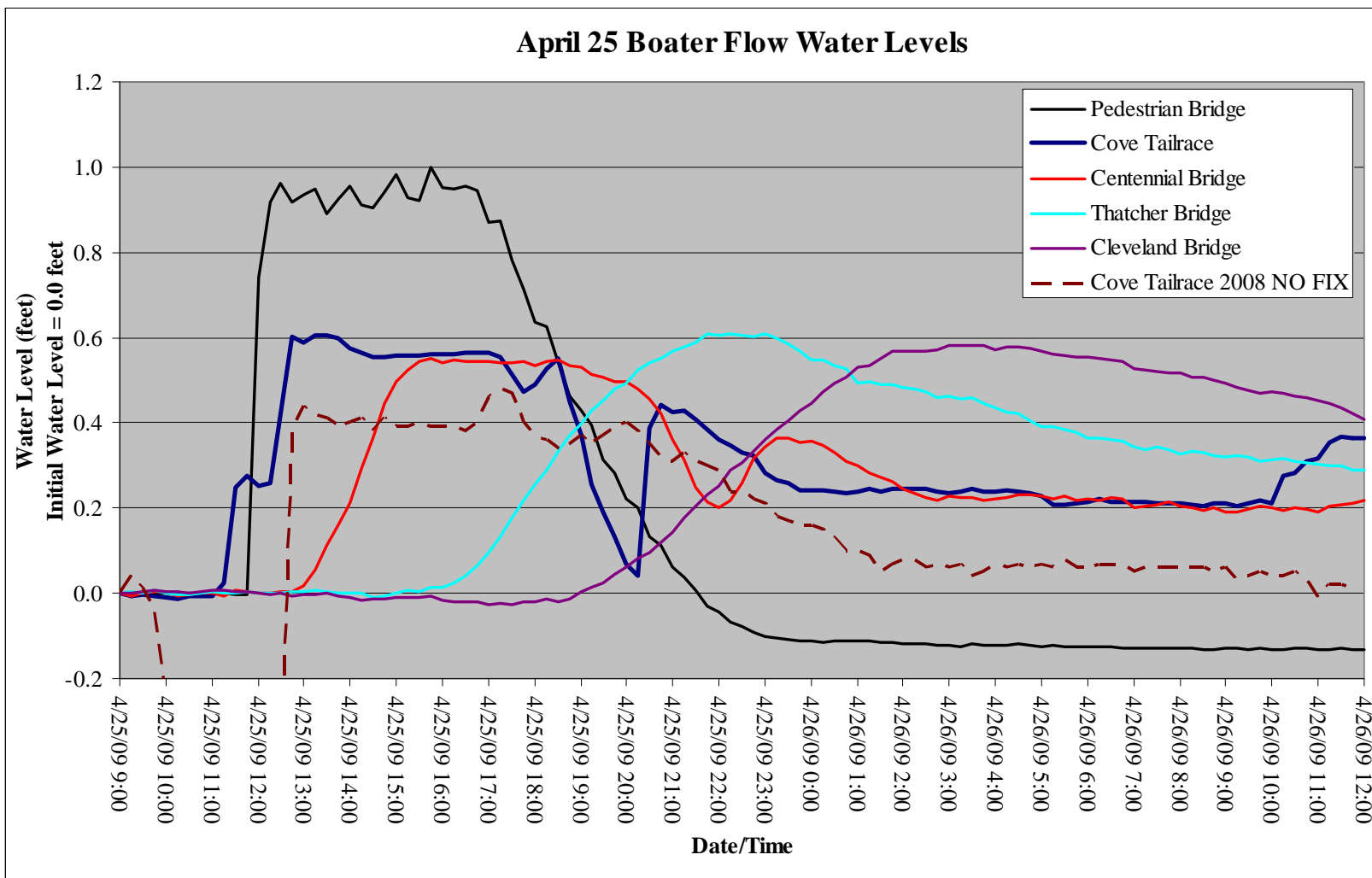


Figure B-3. Water levels (relative to pre-event level) at five locations for 2009 with Cove tailrace 2008 levels shown for comparison.

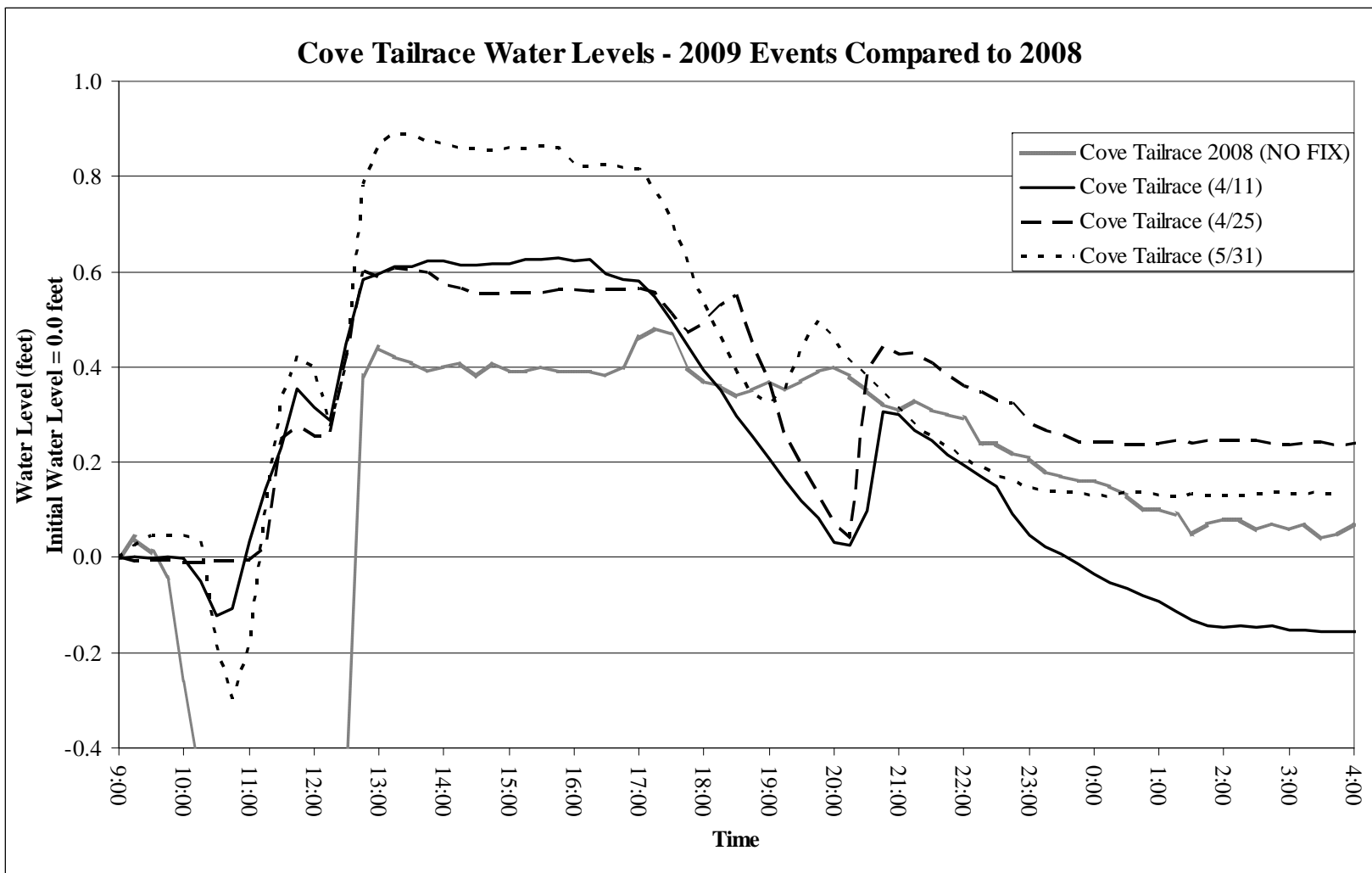


Figure B-4. Cove Tailrace relative water levels for the June 2008 event and three 2009 events (dates shown in legend of graph)

## **APPENDIX C. EXAMPLE OPERATIONAL SCHEDULES FOR SCHEDULED RAMP RATE TEST FLOWS AND INFLOW-DEPENDENT BOATER FLOWS**

The tables below are examples of the water release schedules used in 2009, one for a ramp-down rate study day (Table C-1) and one for an Inflow-dependent Boater Flow day (Table C-2). The purpose for the change from the way it was done in 2008 was to keep the flows below Grace power plant stable. In 2008, it was discovered that due to the slower travel time of water through the Black Canyon relative to water passing through the Grace flowline, power generation flow needed to be offset to avoid an initial “sag” in the flows below Grace power plant. Since the Grace forebay has a very small volume, operations at the upstream Soda plant were adjusted to provide the necessary flows.

The main adjustment to the schedule was time-shifting the generation schedule by 2 hours to allow for the travel time of water through Black Canyon while still providing the required ramp-down rate in the Black Canyon. This required changes to the flow releases from Soda to provide “extra” water for the 2 hours that *both* recreational releases into the Black Canyon and power generation flows were being made (10 am through noon). And at the end of the period, flows from Soda were decreased to allow time for the water in the Black Canyon to drain out while the power plant remained off. The approximate two hour travel time from Soda to Grace informed the release schedule from Soda. Releases at Soda were also determined based on the current irrigation flow diverted by the Last Chance Canal Company (denoted LCCC in the tables) and the required ramp-down rate.

After each event, the actual flows were evaluated and the travel times were adjusted to match observed transient flow travel times, typical adjustments were relatively small, 15 to 30 minutes, but improved the result for both PacifiCorp operations and the stability of flows downstream of Grace power plant (see Appendix B).

<b>Table C-1. Operational Schedule for May 31, study day.</b>						
Time	Soda Flow (CFS)	LCCC Irrigation Diversion (CFS)	Grace Bypass River Stage (ft)	Bypass Flow (CFS)	Grace Generation Flow (CFS)	Flow Below Grace (CFS)
7:00 AM	663	200	2.60	70	393	433
7:15 AM	663	200	2.60	70	393	433
7:30 AM	663	200	2.60	70	393	433
7:45 AM	663	200	2.60	70	393	433
8:00 AM	981	200	2.60	70	393	433
8:15 AM	981	200	2.60	70	393	433
8:30 AM	1408	200	2.60	70	393	433
8:45 AM	1408	200	2.60	70	393	433
9:00 AM	1581	200	2.60	70	393	433
9:15 AM	1581	200	3.26	285	393	433
9:30 AM	1652	200	3.65	490	393	433
9:45 AM	1652	200	3.97	695	393	433
10:00 AM	1722	200	4.25	900	428	468
10:15 AM	1722	200	4.25	900	464	504
10:30 AM	1310	200	4.25	900	499	539
10:45 AM	1310	200	4.25	900	534	574
11:00 AM	1200	200	4.25	900	569	609
11:15 AM	1200	200	4.25	900	605	860
11:30 AM	1200	200	4.25	900	640	1100
11:45 AM	1200	200	4.25	900	320	985
12:00 PM	1200	200	4.25	900	100	970
12:15 PM	1200	200	4.25	900	100	970
12:30 PM	1200	200	4.25	900	100	970
12:45 PM	1200	200	4.25	900	100	970
1:00 PM	1200	200	4.25	900	100	970
1:15 PM	1200	200	4.25	900	100	970
1:30 PM	1063	200	4.25	900	100	970
1:45 PM	1063	200	4.25	900	100	970
2:00 PM	892	200	4.25	900	100	970
2:15 PM	892	200	4.25	900	100	970
2:30 PM	739	200	4.25	900	100	970
2:45 PM	739	200	4.25	900	100	970
3:00 PM	608	200	4.25	900	100	970
3:15 PM	608	200	4.25	900	100	970
3:30 PM	501	200	4.12	806	100	970
3:45 PM	501	200	4.00	720	100	970
4:00 PM	421	200	3.87	631	100	970
4:15 PM	421	200	3.75	553	100	970
4:30 PM	429	200	3.62	474	100	970
4:45 PM	429	200	3.50	404	100	970

<b>Table C-1. (cont.) Operational Schedule for May 31, study day.</b>						
Time	Soda Flow (CFS)	LCCC Irrigation Diversion (CFS)	Grace Bypass River Stage (ft)	Bypass Flow (CFS)	Grace Generation Flow (CFS)	Flow Below Grace (CFS)
5:00 PM	532	200	3.37	336	100	876
5:15 PM	532	200	3.25	279	100	790
5:30 PM	612	200	3.12	224	100	701
5:45 PM	612	200	3.00	179	100	623
6:00 PM	660	200	2.87	137	100	544
6:15 PM	660	200	2.76	105	100	474
6:30 PM	663	200	2.63	76	127	433
6:45 PM	663	200	2.60	70	184	433
7:00 PM	663	200	2.60	70	239	433
7:15 PM	663	200	2.60	70	284	433
7:30 PM	663	200	2.60	70	326	433
7:45 PM	663	200	2.60	70	358	433
8:00 PM	663	200	2.60	70	387	433
8:15 PM	663	200	2.60	70	393	433
8:30 PM	663	200	2.60	70	393	433



**Table C-2. Operational Schedule for June 13 and 14th, flow-dependent release days.**

Time	Soda Flow (CFS)	LCCC Irrigation Diversion (CFS)	Grace Bypass River Stage (ft)	Bypass Flow (CFS)	Grace Generation Flow (CFS)	Flow Below Grace (CFS)
7:30 AM	955	135	2.60	70	750	790
7:45 AM	955	135	2.60	70	750	790
8:00 AM	1070	135	2.60	70	750	790
8:15 AM	1070	135	2.60	70	750	790
8:30 AM	1522	135	2.60	70	750	790
8:45 AM	1522	135	2.60	70	750	790
9:00 AM	1635	135	2.60	70	750	790
9:15 AM	1635	135	2.60	70	750	790
9:30 AM	1635	135	3.30	300	750	790
9:45 AM	1635	135	3.71	523	750	790
10:00 AM	1635	135	4.04	750	750	790
10:15 AM	1635	135	4.04	750	750	790
10:30 AM	1173	135	4.04	750	750	790
10:45 AM	1173	135	4.04	750	750	790
11:00 AM	1085	135	4.04	750	750	790
11:15 AM	1085	135	4.04	750	750	790
11:30 AM	1085	135	4.04	750	750	1020
11:45 AM	1085	135	4.04	750	375	868
12:00 PM	1085	135	4.04	750	100	820
12:15 PM	1085	135	4.04	750	100	820
12:30 PM	1085	135	4.04	750	100	820
12:45 PM	1085	135	4.04	750	100	820
1:00 PM	1085	135	4.04	750	100	820
1:15 PM	1085	135	4.04	750	100	820
1:30 PM	1025	135	4.04	750	100	820
1:45 PM	1025	135	4.04	750	100	820
2:00 PM	849	135	4.04	750	100	820
2:15 PM	849	135	4.04	750	100	820
2:30 PM	705	135	4.04	750	100	820
2:45 PM	705	135	4.04	750	100	820
3:00 PM	631	135	4.04	750	100	820
3:15 PM	631	135	4.04	750	100	820
3:30 PM	599	135	4.04	750	100	820
3:45 PM	599	135	3.87	631	100	820
4:00 PM	676	135	3.75	553	100	820
4:15 PM	676	135	3.62	474	100	820
4:30 PM	774	135	3.50	404	100	820
4:45 PM	774	135	3.37	336	100	820

**Table C-2. (cont.) Operational Schedule for June 13 and 14th, flow-dependent release days.**

Time	Soda Flow (CFS)	LCCC Irrigation Diversion (CFS)	Grace Bypass River Stage (ft)	Bypass Flow (CFS)	Grace Generation Flow (CFS)	Flow Below Grace (CFS)
5:00 PM	867	135	3.25	279	100	820
5:15 PM	867	135	3.12	224	189	790
5:30 PM	935	135	3.00	179	267	790
5:45 PM	935	135	2.87	137	346	790
6:00 PM	955	135	2.76	105	416	790
6:15 PM	955	135	2.63	76	484	790
6:30 PM	955	135	2.60	70	541	790
6:45 PM	955	135	2.60	70	596	790
7:00 PM	955	135	2.60	70	641	790
7:15 PM	955	135	2.60	70	683	790
7:30 PM	955	135	2.60	70	715	790
7:45 PM	955	135	2.60	70	744	790
8:00 PM	955	135	2.60	70	750	790
8:15 PM	955	135	2.60	70	750	790