Potential Impacts of Whitewater Boating Flows – Phase 2 Report – Pit 1 Project FERC Project No. 2687

FINAL REPORT

Prepared for:

Pacific Gas and Electric Company
San Francisco, California

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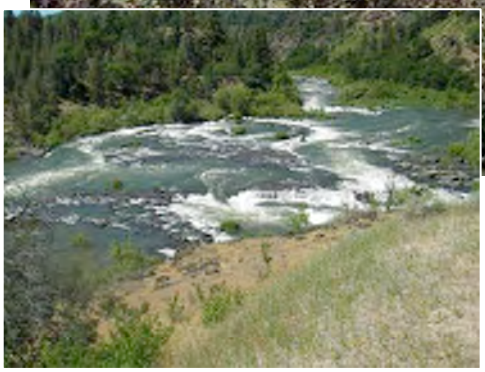

February 29, 2008

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EXECUTIVE SUMMARY

This report is a compliance document pursuant to Article 424 of Pacific Gas & Electric Company's (PG&E) license for the Pit 1 Hydroelectric Project (FERC Project No. 2687), issued by the Federal Energy Regulatory Commission (FERC) on March 19, 2003. Article 424 specified that PG&E prepare a study plan to assess potential impacts on fish, wildlife, cultural, and recreational resources within the Pit 1 Project area that may result from implementation of whitewater boating flows during the period September 15 through October 30. PG&E subsequently prepared and filed the plan, entitled "Potential Impacts of Whitewater Boating Flows Study Plan," with FERC on March 19, 2004 (PG&E 2004). On July 27, 2004, FERC approved the plan (FERC 2004), and PG&E proceeded with its implementation.

The plan specified two phases for completing the study. In October 2005, R2 Resource Consultants (R2) was contracted by PG&E to provide technical assistance in completing Phase 1. This work included the compilation and review of existing resource information. It also included the determination of whether existing site-specific and/or other relevant data and information were sufficient to evaluate potential whitewater flow impacts on the target resources, or whether additional studies were warranted as potential Phase 2 studies. One other component of the work was a reassessment of the feasibility of providing a whitewater flow release in the range of 1,250 cfs to 1,750 cfs from Pit 1 Forebay between September 15 and October 30, based on the new license conditions of a 150-cfs release from Fall River Pond and the requirement to maintain a minimum flow of 700 cfs below Pit 1 Powerhouse. The results of this review and assessment, and recommendations for Phase 2 studies were presented in the document entitled "Potential Impacts of Whitewater Boating Flows - Phase 1 Interim Report - Pit 1 Project - FERC Project No. 2687" (R2 2006a), and in an addendum to the Phase 1 report (R2 2006b).

From the review of project-specific and issue-specific information, the Phase 1 report concluded that one additional study related to potential fish stranding and trapping was warranted and should be conducted to more fully evaluate potential effects of a whitewater recreation release flow (R2 2006a). For most of the other resource areas and associated biota, there was either sufficient existing site-specific information and/or information from ongoing studies from which to evaluate potential impacts directly. The report recommended that the stranding and trapping survey be conducted either during the September 15 to October 30 time frame as part of the Phase 2 whitewater test flow release studies, or earlier in August in conjunction with the flushing flow release, provided it could be structured (i.e., of a similar magnitude) to be representative of a typical whitewater flow release.

The Phase 1 report was transmitted to participating agencies and stakeholders for review by letter dated March 3, 2006. On April 25, 2006, PG&E met with personnel from the California Department of Fish and Game (CDFG), California Department of Parks and Recreation (CA

Parks), and American Whitewater (AW), to discuss the report results, obtain comments, and discuss Phase 2 recommendations. One primary discussion topic was the Phase 1 study finding that there was a low probability that sufficient water would be available from the Project to provide whitewater flows to the Pit River in the range of 1,250-1,750 cfs for two boating days during the September 15–October 30 time period (R2 2006a, 2006b). As a result, PG&E and the stakeholders concluded that Phase 2 studies should include a whitewater boating study to refine the acceptable range of whitewater boating flows above and below the 1,250 cfs level. In addition, all parties agreed that a fish stranding study should be conducted. It was also agreed that these studies would be conducted by augmenting the existing Fall River Pond flushing flows that occurred one weekend a month during June, July, and August of 2006. The study target flows during these weekends were developed during the April 26, 2006 study consultation meeting with CDFG, CA Parks, and AW and a follow-up meeting on May 11, 2006 with AW.

Based on the consultation described above, PG&E prepared and filed a Phase 2 Study Plan with FERC on June 16, 2006 (PG&E 2006b). PG&E subsequently contracted with Spring Rivers Ecological Sciences, LLC (Spring Rivers) and two subcontractors to conduct the Phase 2 study; Confluence Research and Consulting was retained to assist with the whitewater boating study, and R2 was retained to assist with the fish stranding study and preparation of the Phase 2 report. This report presents the results of the Phase 2 study and documentation of agency and stakeholder consultations.

The schedule for the 2006 whitewater flows included three sets of two consecutive weekend day flow releases to be made, with the first set in June, the second in July and the third in August. The whitewater test flows were to be provided between 10 AM and 3 PM on Saturday and Sunday during required Project flushing flow weekends in 2006. The schedule for release of the target flows is presented in Table E-1.

The test flow releases were initiated Friday evening prior to each test flow weekend so that target flows could be achieved by 10 AM Saturday morning. Pit 1 Forebay releases were then reduced after 3 PM on Saturday to restore forebay storage to capacity, and then increased later that evening to provide the 10 AM Sunday target flow. Post-processing of hydrologic data following all test releases indicated that the actual whitewater flow releases to Big Eddy exceeded target flow levels in the whitewater reach on June 17 and July 15, but did not reach target flow levels on June 18, July 16, August 19, and August 20. The estimated actual average flows in the whitewater reach ranged from 73% of the target release (on August 20) to 114% of the target release (on July 15). On average, flows were about 87.5% of target levels.

Table E-1. Schedule of target whitewater test flows to be provided in the Pit River at the downstream end of Big Eddy Pool, June, July, and August, 2006.

Date	Time Window	Target Flow in Pit River at Downstream End of Big Eddy (cfs)
Saturday, June 17, 2006	10:00 AM to 3:00 PM	1,250
Sunday, June 18, 2006	10:00 AM to 3:00 PM	1,750
Saturday, July 15, 2006	10:00 AM to 3:00 PM	1,000
Sunday, July 16, 2006	10:00 AM to 3:00 PM	1,500
Saturday, August 19, 2006	10:00 AM to 3:00 PM	800
Sunday, August 20, 2006	10:00 AM to 1:00 PM	1,250

For the Phase 2 whitewater boating study, boater use information was provided by observers stationed at likely boater take-outs. Surveyors recorded the number of boater groups, numbers of people and boats within each group, types of craft, the time they passed the site, and the take-out location. Flow evaluation information was derived via a survey of whitewater boaters during two of the three weekend releases; no boaters participated in the June 2006 releases. Results suggested that lower flows could still provide whitewater opportunities. The study found that flows that exceed 600 cfs at Big Eddy are boatable in kayaks, and flows of 800 to 1,000 cfs at Big Eddy provide better quality technical trips. The study also showed that large numbers of boaters might be attracted to the river during releases. Complex hydrology and limited flow measurement capability at the Pit 1 Forebay makes it challenging to identify specific Forebay releases that will produce desired flow targets in the high value boating segment below Big Eddy.

For the Phase 2 stranding study, survey sites were selected that were representative of areas and habitat types that would be used by fish species present in the Pit River, and that would be susceptible to the effects of flow fluctuations. Three areas were identified, including Big Eddy Ledges, Lower Canyon Reach – Upper Bar, and Lower Canyon Reach – Lower Bar. Quantitative fish stranding and trapping surveys were completed in conjunction with the August 19 and 20 whitewater flow releases. The surveys found no observable fish stranding and minimal trapping at the three sites in conjunction with flow releases of 600-900 cfs. In this study, "stranding" was defined as the separation of fish from flowing surface water as a result of declining river stage, and "trapping" as the isolation of fish in pockets of water with no access to free-flowing surface water. A total of 37 fish, ranging from 65 to 116 mm in length (fork length) were observed trapped in disconnected waters, with a majority of the observations made at the

Big Eddy Ledges. No stranding and little trapping were observed in the Lower Canyon reach over the two days of flow releases. Less rigorous observations during the June and July 2006 flow releases, which usually met or exceeded 1,250 cfs, likewise indicated a low frequency of trapping and no stranding. Based on the overall results of the surveys, we conclude that whitewater boating releases of up to 1,250 cfs during the September 15 to October 30 time frame would not likely impact existing fish populations in the Pit 1 bypass reach.

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1. INTRODUCTION

This report is a compliance document pursuant to Article 424 of Pacific Gas & Electric Company's (PG&E) license for the Pit 1 Hydroelectric Project (FERC Project No. 2687), issued by the Federal Energy Regulatory Commission (FERC) on March 19, 2003. Article 424 specified that PG&E prepare a study plan to assess potential impacts on fish, wildlife, cultural, and recreational resources within the Pit 1 Project area that may result from implementation of whitewater boating flows during the period September 15 through October 30. PG&E subsequently prepared and filed the plan, entitled "Potential Impacts of Whitewater Boating Flows Study Plan," with FERC on March 19, 2004 (PG&E 2004). On July 27, 2004, FERC approved the plan (FERC 2004), and PG&E proceeded with its implementation.

The plan specified two phases for completing the study. During Phase 1, results from specific Pit 1 Project studies and monitoring programs required by the new license, as well as results from other whitewater-impact studies from the lower Pit River, North Fork Feather River (NFFR), and other rivers in California and elsewhere were to be compiled and synthesized. During Phase 2, a final flow release assessment in the lower Fall River just above the Pit 1 diversion was to be made to assess whether there will be sufficient flow in the fall to make at least the minimum whitewater test flow of 1,250 cfs, as described in the original whitewater feasibility study (PG&E 1996). In addition, any necessary studies identified at the end of Phase 1 would be designed and conducted in conjunction with whitewater test flows. This report provides the results of the Phase 2 studies. A summary of the Phase 1 studies is provided below to provide further context for the Phase 2 studies.

1.1 PHASE 1 INTERIM REPORT SUMMARY

In October 2005, R2 Resource Consultants (R2) was contracted by PG&E to provide technical assistance in completing Phase 1. This work included the compilation and review of existing resource information. That was followed by the determination of whether existing site-specific and/or other relevant data and information were sufficient to evaluate potential whitewater flow impacts on the target resources, or whether additional studies were warranted as potential Phase 2 studies. The work also included a reassessment of the feasibility of providing a whitewater flow release in the range of 1,250 cfs to 1,750 cfs between September 15 and October 30, based on the new license conditions of a 150-cfs release from Fall River Pond and the requirement to maintain a minimum flow of 700 cfs below Pit 1 Powerhouse. The results of this review and assessment, and recommendations for Phase 2 studies were presented in the document entitled "Potential Impacts of Whitewater Boating Flows - Phase 1 Interim Report - Pit

1 Project - FERC Project No. 2687" (R2 2006a), and in an addendum to the Phase 1 report (R2 2006b). A summary of the report follows.

For the whitewater feasibility assessment, HEC-RAS unsteady-flow simulations (USACE 2002a, 2002b, 2002c) were used to determine the minimum inflows needed in the Pit River at the upstream end of the bypass reach for whitewater test releases of 1,250 cfs, 1,500 cfs, and 1,750 cfs. The median 2-day averaged flow available in the Pit River at the upstream end of the bypass reach between September 15 and October 30 was determined for each year from 1976 through 2004. Frequency analyses were performed, using these synthesized 2-day average flows, to determine the availability of the minimum inflows necessary to provide whitewater test flows with and without augmentation from the Pit 1 Forebay.

Based on a set of operational assumptions set by the license, it was determined that without augmentation there would be enough flow available to provide a whitewater flow of 1,250 cfs in 32% of the years, or a whitewater flow of 1,500 cfs in 7% of the years (R2 2006a). Without augmentation, there would never be enough water available naturally to provide a controlled whitewater release of 1,750 cfs between September 15 and October 30. However, by utilizing 462 acre-feet of available water storage of the Pit 1 Forebay, there would be enough flow available to provide whitewater flows of 1,250 cfs, 1,500 cfs, and 1,750 cfs in 87%, 35%, and 11% of the years, respectively (R2 2006b).

From the review of project-specific and issue-specific information, the Phase 1 report concluded that one additional study related to potential fish stranding and trapping from whitewater boating releases was warranted (R2 2006a). For most of the other resource areas and associated biota, there was either sufficient existing site-specific information and/or information from ongoing studies from which to evaluate potential impacts directly. Resource areas with sufficient Project-specific information included water quality, fish (species composition), amphibians (foothill yellow-legged frog), northwestern pond turtle, freshwater mussels, Shasta crayfish, riparian vegetation, wildlife, and cultural resources. For benthic macroinvertebrates and angling resources, the combination of site-specific and issue-specific information from downstream studies allowed for a qualitative assessment of potential impacts. The findings and conclusions regarding potential study needs for each of the resource areas were summarized in tabular format (R2 2006a); a copy of the summary table is contained in Appendix A of this report.

Overall, the Phase 1 interim report concluded that, with two exceptions, the combination of the frequency, timing, duration and magnitude of the potential whitewater recreation flows would not likely negatively impact the majority of the above mentioned resource areas and associated

biota. Hence, additional studies were not warranted or recommended for these resource areas (R2 2006a). The first exception relates to potential fish stranding and trapping effects, which are unknown and warranted additional investigation. The second exception relates to angling, which was generally considered to be adversely affected by whitewater recreation flows. The report recommended that the stranding and trapping survey be conducted either during the September 15 to October 30 time frame as part of the Phase 2 whitewater test flow release studies, or earlier in August in conjunction with the flushing flow release, provided it could be structured (i.e., of a similar magnitude) to be representative of a potential whitewater flow release. In this study, "stranding" was defined as the separation of fish from flowing surface water as a result of declining river stage, and "trapping" as the isolation of fish in pockets of water with no access to free-flowing surface water. These definitions generally conform to those of Hunter (1992).

The Phase 1 report was transmitted to participating agencies and stakeholders for review by letter dated March 3, 2006. On April 25, 2006, PG&E met with personnel from California Department of Fish and Game (CDFG), California Department of Parks and Recreation (CA Parks), and American Whitewater (AW), to discuss the report results, obtain comments, and discuss Phase 2 recommendations. One primary discussion topic was the Phase 1 study finding that there was a low probability that sufficient water would be available from the Project to provide whitewater flows to the Pit River in the range of 1,250-1,750 cfs for two boating days during the September 15-October 30 time period. As a result, PG&E and the stakeholders concluded that Phase 2 studies should include a whitewater boating study to refine the acceptable range of whitewater boating flows above and below the 1,250 cfs level. In addition, all parties agreed that a fish stranding study should be conducted. It was also agreed that these studies would be conducted by augmenting the existing Fall River Pond flushing flows that occurred one weekend a month during June, July, and August of 2006. The study target flows during these weekends were developed after the April 26, 2006 study consultation meeting with CDFG, CA Parks, and AW and a follow-up meeting on May 11, 2006 with AW.

1.2 PHASE 2 STUDIES

Based on the consultation described above, PG&E prepared and filed a Phase 2 Study Plan with FERC on June 16, 2006 (PG&E 2006b). PG&E subsequently contracted with Spring Rivers Ecological Sciences, LLC (Spring Rivers) and two subcontractors to conduct the Phase 2 study; Confluence Research and Consulting was retained to assist with the whitewater boating study (Appendix B), and R2 was retained to assist with the fish stranding study and preparation of the Phase 2 report. This report presents the results of the Phase 2 study and documentation of agency and stakeholder consultations (Appendix C).

The report is organized into the following five sections:

- Section 1 – INTRODUCTION, which provides Project background relating to Article 424, a summary of the Phase 1 interim report findings, and report context;
- Section 2 – FLOW RELEASE OPERATIONS AND ANALYSIS, which describes the release schedule of the whitewater test flows and provides an analysis of hydrologic data to estimate flows in the Pit River at the downstream end of Big Eddy;
- Section 3 – WHITEWATER BOATING STUDY, which describes the methods and findings of the whitewater evaluation component of Phase 2, summarizes known whitewater boating use since 2003, and analyzes the boater survey data for 2006 for comparison to the 1996 flow-recreation study results;
- Section 4 – FISH STRANDING STUDY, which describes the methods and findings of the Phase 2 fish trapping and stranding survey within the bypass reach of the Pit River during the August 2006 test release; and
- Section 5 – CONCLUSIONS AND RECOMMENDATIONS, which discusses the information gathered from the Phase 2 studies, and provides recommendations regarding the proposed whitewater releases.

The report also contains three appendices:

- Appendix A – PHASE 1 INTERIM REPORT SUMMARY OF PHASE 1 STUDY RECOMMENDATIONS, which contains a summary table of the information reviewed for each potentially affected resource area and study recommendations made based upon those reviews.
- Appendix B – WHITEWATER BOATER STUDY REPORT, which contains the report prepared jointly by Confluence Research and Consulting and Spring Rivers, April 2007.
- Appendix C – AGENCY AND STAKEHOLDER CONSULTATIONS, which contains documentation of consultations pertaining to the Whitewater Effects Study.

2. FLOW RELEASE OPERATIONS AND ANALYSIS

Whitewater test flows released to the Pit 1 bypass reach as part of the Phase 2 studies in 2006 were provided by flow augmentation from the Pit 1 Forebay (Figure 2-1). Specific target flows were identified in consultation with CDFG, CA Parks, and AW during an April 26, 2006 meeting, with adjustments made during a follow-up meeting with AW on May 11, 2006. The schedule for the 2006 flushing/whitewater flows included three sets of two-consecutive-weekend-day flow releases, with the first set in June, the second in July, and the third in August (Table 2-1). The target flows were to be provided at the downstream end of the Big Eddy Pool, which marks the put-in location for most whitewater boaters (Figure 2-1).

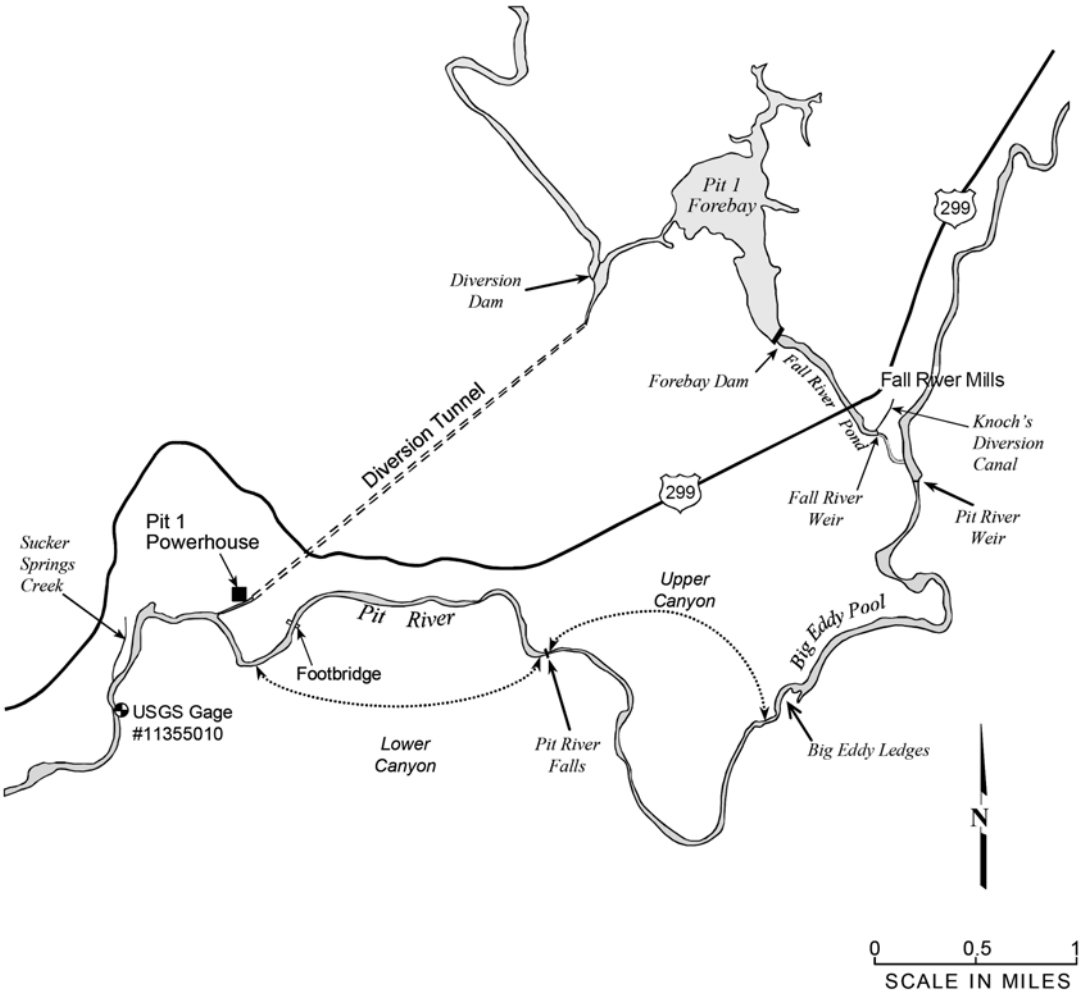

Figure 2-1. Schematic of the Pit 1 Project and Pit 1 bypass reach.

Table 2-1. Schedule of target whitewater test flows to be provided in the Pit River at the downstream end of Big Eddy Pool, June, July, and August, 2006.

Date	Time Window	Target Flow in Pit River at Downstream End of Big Eddy (cfs)
Saturday, June 17, 2006	10:00 AM to 3:00 PM	1,250
Sunday, June 18, 2006	10:00 AM to 3:00 PM	1,750
Saturday, July 15, 2006	10:00 AM to 3:00 PM	1,000
Sunday, July 16, 2006	10:00 AM to 3:00 PM	1,500
Saturday, August 19, 2006	10:00 AM to 3:00 PM	800
Sunday, August 20, 2006	10:00 AM to 1:00 PM	1,250

The whitewater test flows were to be provided between 10 AM and 3 PM on Saturday and Sunday during required Project flushing flow weekends[1] in 2006. The test flow releases were initiated Friday evening so that target flows could be achieved by 10 AM Saturday morning. Pit 1 Forebay releases were then reduced after 3 PM on Saturday to restore forebay storage to capacity, and then increased later that evening to provide the 10 AM Sunday target flow. Downramping to base flow would also begin at 3 PM on Sunday, following the whitewater test flows. However, to allow scheduled fish stranding surveys to be made during daylight hours on Sunday, August 20, the timing of the downramping on that day was moved forward to begin at 1 PM. This change represented a one-time variation from Condition 13 of the 401 Water Quality Certification. Details of the flow release schedule and process are described below.

2.1 TEST FLOW RELEASE OPERATIONS

Delivery of the target flows within the specific time frames listed in Table 2-1 through releases from Pit 1 Forebay is complicated by several factors:

- A minimum flow of 700 cfs must be maintained in the Pit River at the USGS Gage (No. 11355010) downstream from Pit 1 Powerhouse, as required by Article 402 of the Project

[1] Condition 13 of the 401 Water Quality Certification of the new license requires the release of flushing flows for two consecutive days (Saturday and Sunday), three times per year (FERC 2003). Flushing flows are defined as 1,250 cfs or the natural flow to the Pit 1 Forebay, whichever is less. Flushing flow releases are to commence in either May or June as warranted by vegetation growth in the Fall River Pond, with subsequent flows occurring in July and August. Flow releases are to be made from approximately 2 AM Saturday morning and continue until about 3 PM the following Sunday, at which time they are ramped down.

license. Thus, flow releases from the Pit 1 Powerhouse must be gradually ramped down, and flow releases from Pit 1 Forebay must be gradually ramped up, until the 700-cfs requirement can be maintained without flow through the powerhouse.

- Under normal operations, at least 177 cfs is released from Pit 1 Forebay to Fall River Pond (Figure 1) from June through October to satisfy two downstream flow requirements (27 cfs for Knoch's diversion from Fall River Pond and 150 cfs for the Pit 1 bypass reach). The flow in the Pit River at the Fall River confluence is the sum of incoming flows from the Pit River above, and the 150-cfs release from Fall River Pond. This combined flow would typically be much less than the target flows listed in Table 2-1 during the months of June, July, and August.

- It can take about 7 hours for an increase in flow release from Pit 1 Forebay to be fully realized at the downstream end of Big Eddy Pool (PG&E 1996). The lengthy travel time can be attributed to: (1) the backing up of water for several miles in the Pit River upstream of the Pit River Weir, which is located just below the confluence with the Fall River; and (2) the slow movement of water through the approximately 1.6-mile (2.5-km) length of Big Eddy Pool.

- During the Phase 2 study, no gage was available to measure whitewater flow releases in real time from the Pit 1 Forebay to the Fall River. However, per Article 403 of the License for the Pit 1 Hydroelectric Project (FERC 2003), the gage that will be installed at the Pit 1 Dam Spillway Channel will be able to measure flows in excess of 175 cfs. Such flows will be validated using empirical stage/discharge relationships developed as high flow events occur at the spillway and, thus, the range of flows listed in Table 2-1 will be able to be measured.

- To estimate flows in the range of those listed in Table 2-1, it is necessary to measure the water surface elevation in the Pit 1 Forebay and to measure the gate opening of each of two 22.5-foot-wide radial gates. The gate opening and water surface elevation are used to determine the flow through each radial gate. The total flow release is the sum of the flows through the two gates.

- To provide whitewater flow releases will usually require the use of water stored in the Pit 1 Forebay. As storage is depleted, the water surface elevation in the Pit 1 Forebay drops and gate openings at the two radial gates must be continuously adjusted to maintain the desired flow release. Operators must manually adjust the Forebay gates several times to keep the release constant as the reservoir level drops. These manual adjustments, and the calculations upon which they are made, have some level of imprecision (Martin 2007).

To address the uncertainties associated with providing whitewater test flows, a previous analysis was performed (R2 2006a, 2006b) to assess how much flow would be needed, in the Fall River

and Pit River combined, to deliver the whitewater test flows if 462 acre-feet of storage were available for release from Pit 1 Forebay. Based on a review of USGS records from the gage on the Pit River below the Pit 1 Powerhouse, and adjusting for accretion and Knoch's diversion, it was concluded that there was sufficient water available to provide four of the six targeted whitewater test releases (1,250 cfs on June 17, 1,000 cfs on July 15, 800 cfs on August 19, and 1,250 cfs on August 20). Of the remaining two days, there was sufficient water available to come within 100 cfs of the targeted test releases of 1,750 cfs on June 18 and 1,500 cfs on July 16.

2.2 DETERMINATION OF TEST FLOW RELEASE REQUIREMENTS

Flow needs in the whitewater boating reach would best be analyzed using the flow data from a water quality monitoring station established by Tim Sagraves, a consultant to PG&E, near the downstream end of Big Eddy. However, the gage at this station was intended to monitor flows in the range of minimum release requirements, which are much less than the target whitewater test releases.

The water quality station's gage used a recording transducer to monitor stage in the Pit River at the downstream end of Big Eddy every 15 minutes during a period in 2006 that included the six whitewater test releases. A stage/discharge rating curve has been developed (by T. Sagraves) for the stage-recording transducer, but the rating curve is based on flows ranging from 126 cfs to 821 cfs. The rating curve is considered to be relatively accurate for flows in this range; however, it may not be as accurate for most of the target release flows listed in Table 2-1, because it would be necessary to extrapolate the rating curve beyond the range of the highest measured flow (821 cfs).

To improve estimates of actual flows in the whitewater reach downstream of Big Eddy, concurrent hydrographs with flows measured at 15-minute intervals were obtained from the USGS Gage No. 11355010 on the Pit River downstream from the Pit 1 Powerhouse, and from flow releases to the Pit River from the Pit 1 Powerhouse (Figure 2-1). By accounting for travel time and accretion flows to the Pit River, the flow hydrographs from these two locations were used to derive a flow hydrograph for the downstream end of Big Eddy.

The following steps were taken to determine flow hydrographs in the whitewater reach:

1. The USGS gage hydrograph was synchronized with the Pit 1 Powerhouse hydrograph. Unless synchronized, abrupt changes in flow at the USGS gage and through the Pit 1 Powerhouse, as illustrated in Figures 2-2, 2-3, and 2-4, can be a source of error (i.e., large fluctuations in flow when the differences between the two hydrographs are calculated).

To achieve synchronization, flows measured at the USGS gage on the Pit River downstream from the Pit 1 Powerhouse were shifted ahead in time to account for travel between the powerhouse and the gage. A travel time of 13 minutes was found to be sufficient to synchronize the hydrographs for the two locations.

2. Accretion flows from Sucker Springs Creek (36 cfs) and flow releases from the Pit 1 Powerhouse were both subtracted from the synchronized gage flows derived in Step 1.

3. The flows derived in Step 2 were then shifted 2.75 hours ahead to account for the travel time between the downstream end of Big Eddy and the Pit 1 Powerhouse. A travel time of 2.75 hours was found to be sufficient to synchronize the calculated hydrograph with the hydrograph measured at the water quality monitoring station at the downstream end of Big Eddy.

4. Accretion flows between the downstream end of Big Eddy and the Pit 1 Powerhouse (110 cfs) were then subtracted from the flows derived in Step 3. The resultant flow values are estimates of the test flows that were provided at the top of the whitewater reach (i.e., the downstream end of Big Eddy).

Flows estimated via this methodology are presented with flows measured at the water quality monitoring station in the Pit River at the downstream end of Big Eddy in Figures 2-2, 2-3, and 2-4 for the June, July, and August whitewater test releases, respectively. There was good agreement between the two flow estimates for flows less than 821 cfs, the highest flow used to develop the stage/discharge rating curve at the water quality monitoring station. This suggested that the procedure outlined above could be used to provide a reasonable estimate of flows in the bypass reach.

While the flows measured at the water quality monitoring station were considered relatively accurate for flows ranging from 126 to 821 cfs, they were less accurate for flows in excess of 821 cfs. The higher magnitude flows estimated by the procedure outlined above were greater than the measured flows at the water quality monitoring station, as illustrated in Figures 2-2 and 2-3. The estimated flows are considered to be more accurate at these higher levels than the flows measured at the water quality monitoring station (because the latter has an extrapolated stage-flow discharge curve above 821 cfs).

Target whitewater test flows are compared with the estimates of the actual flows for the six test releases in Table 2-2. Based on the flow estimates derived herein, it would appear that the whitewater flows provided exceeded target flow levels in the whitewater reach on June 17 and July 15, but did not reach target flow levels on June 18, July 16, August 19, and August 20. Results of the two Phase 2 studies reported here discuss estimated flows summarized in Table 2-2 (the flows experienced and evaluated by the boaters) rather than target flows.

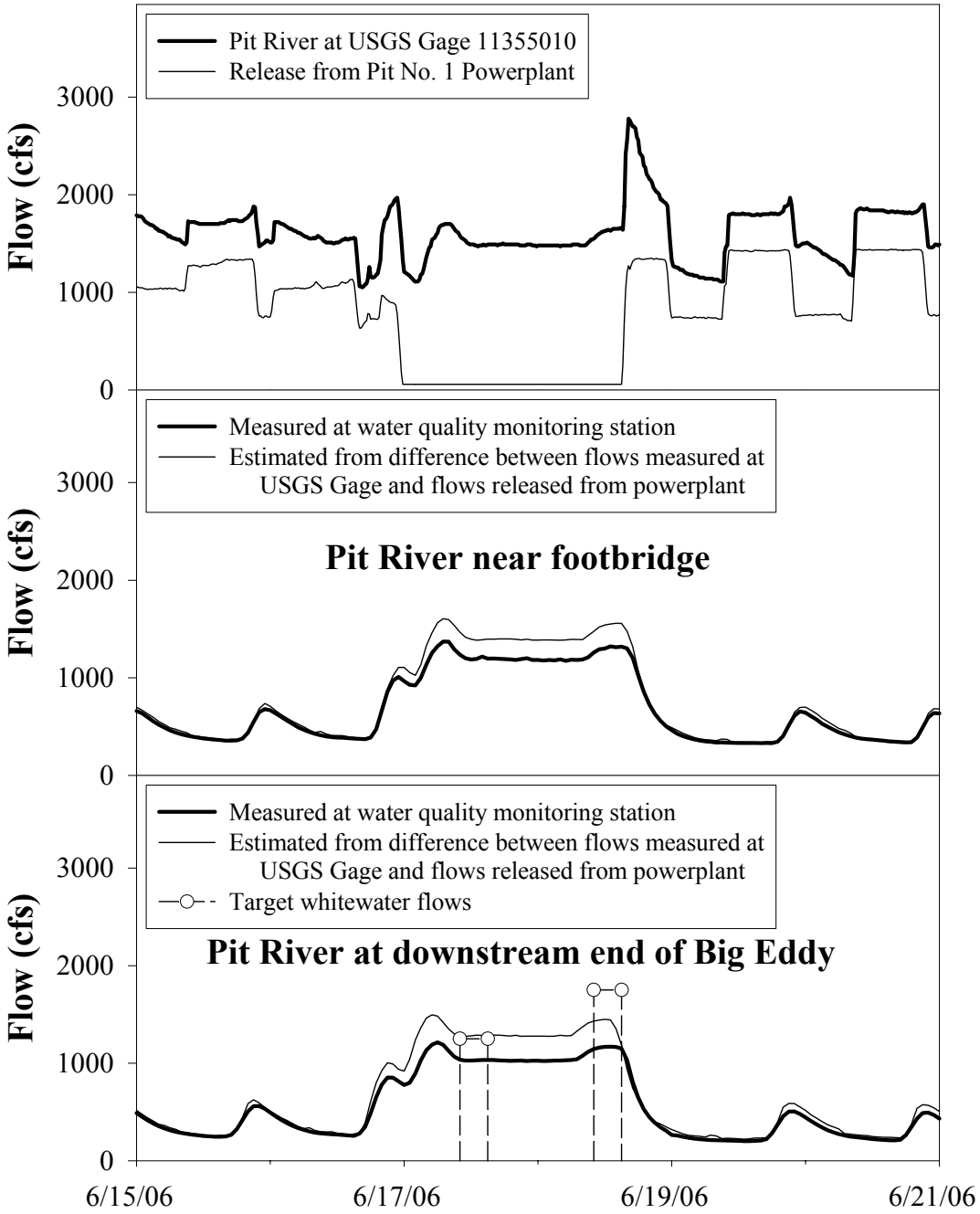

Figure 2-2. Measured flows in the Pit River at the USGS Gage (11355010), measured flows released from the Pit 1 Powerhouse to the Pit River, measured and estimated flows in the Pit River at the footbridge, and measured and estimated flows in the Pit River at the downstream end of Big Eddy, June 15 to 20, 2006. The comparison of flows indicates that the difference between flows measured at the USGS Gage and flows releases from the powerplant can provide a reasonable estimate of flows in the Pit River at the downstream end of Big Eddy.

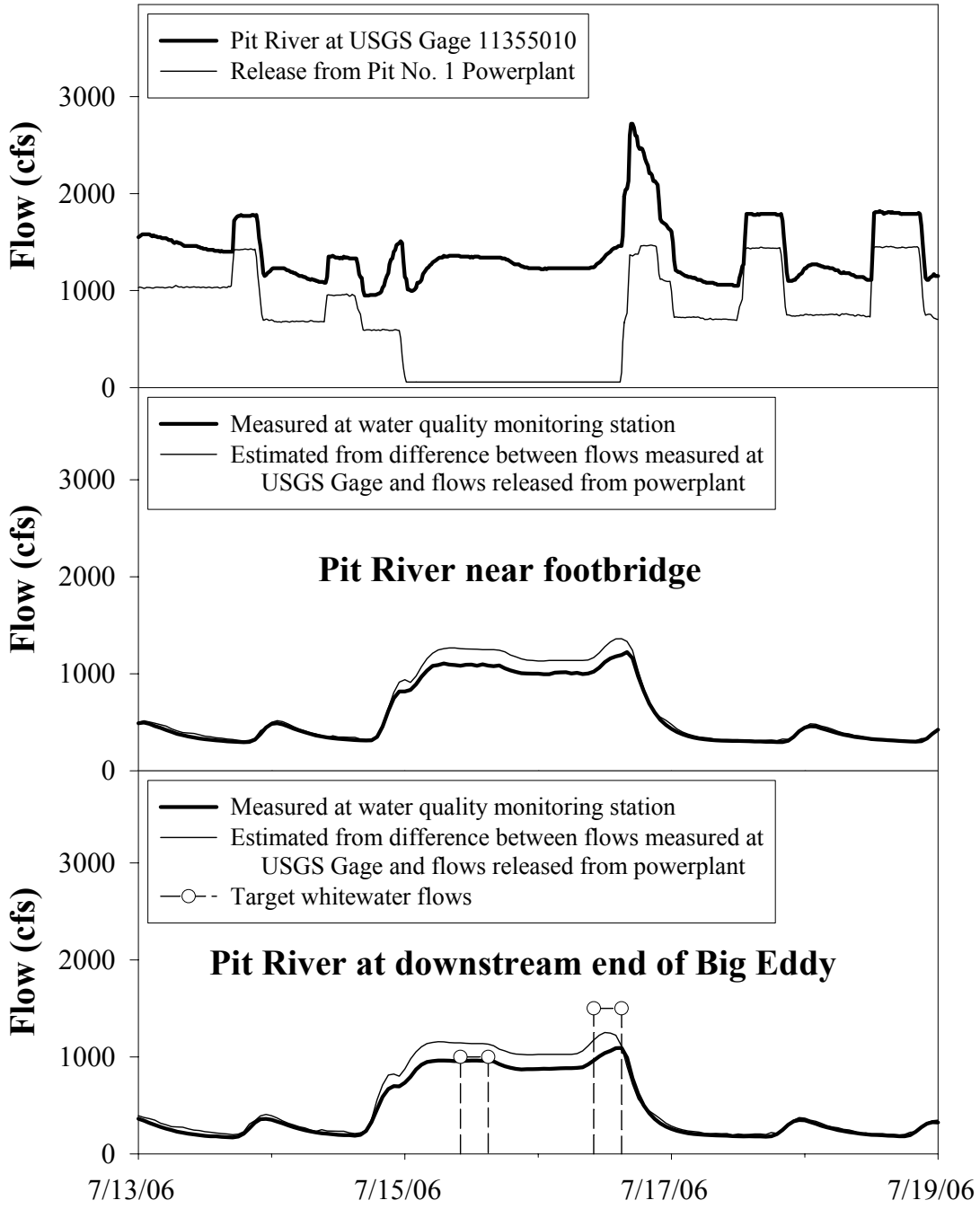

Figure 2-3. Measured flows in the Pit River at the USGS Gage (11355010), measured flows released from the Pit 1 Powerhouse to the Pit River, measured and estimated flows in the Pit River at the footbridge, and measured and estimated flows in the Pit River at the downstream end of Big Eddy, July 13 to 18, 2006. The comparison of flows indicates that the difference between flows measured at the USGS Gage and flows releases from the powerplant can provide a reasonable estimate of flows in the Pit River at the downstream end of Big Eddy.

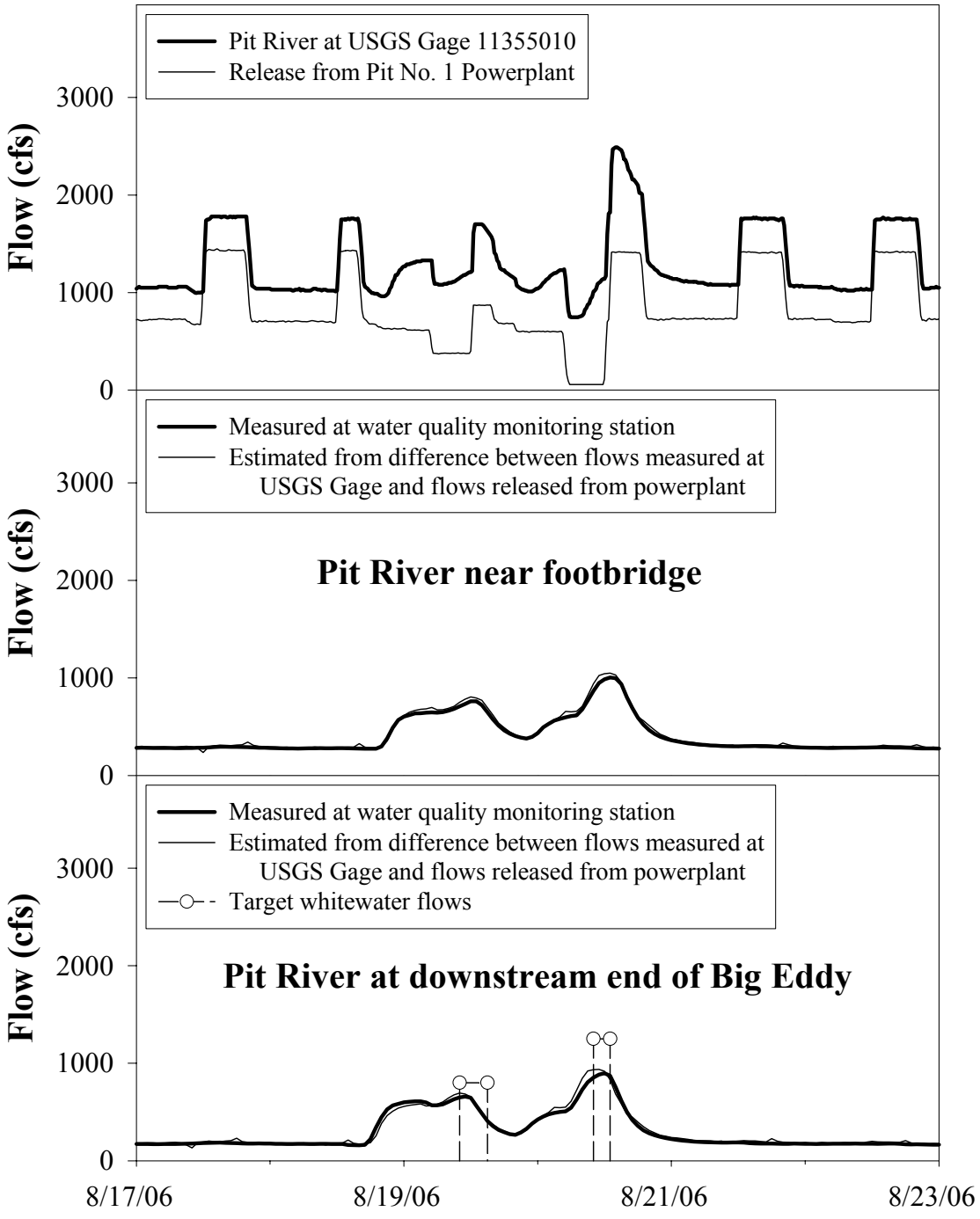

Figure 2-4. Measured flows in the Pit River at the USGS Gage (11355010), measured flows released from the Pit 1 Powerhouse to the Pit River, measured and estimated flows in the Pit River at the footbridge, and measured and estimated flows in the Pit River at the downstream end of Big Eddy, August 17 to 22, 2006. The comparison of flows indicates that the difference between flows measured at the USGS Gage and flows releases from the powerplant can provide a reasonable estimate of flows in the Pit River at the downstream end of Big Eddy.

Table 2-2. Comparison of target whitewater test flows with estimated flows in the Pit River at the downstream end of Big Eddy Pool, June, July, and August 2006.

Date	Target Flow (cfs)	Estimated Flow (cfs)		
		Minimum	Average	Maximum
Saturday, June 17, 2006	1,250	1,270	1,280	1,290
Sunday, June 18, 2006	1,750	1,180	1,400	1,480
Saturday, July 15, 2006	1,000	1,130	1,140	1,140
Sunday, July 16, 2006	1,500	1,110	1,220	1,250
Saturday, August 19, 2006	800	420	590	690
Sunday, August 20, 2006	1,250	830	910	940

3. PHASE 2 WHITEWATER BOATING STUDY

The Phase 2 whitewater boating study was completed by Confluence Research and Consulting (CRC). The study was conducted in 2006 as part of the flushing flow releases required by the license (one weekend per month during June, July, and August [CRC 2007]), which were modified to provide whitewater test flow releases. This section describes the methods used and findings of that study. The entire report (CRC 2007) is contained in Appendix B of this document.

The Phase 2 whitewater boating study was conducted to address the following objectives:

- Summarize known whitewater boating use since flushing flows began in 2003;
- Re-assess boating flows from the 1996 study (WRC Environmental 1996) using a revised survey instrument that is consistent with more recent "state of the art" flow assessments. The instrument was used to examine evaluations of present flows and specified flows for target boating opportunities, and focused on the low end of "technical" and "standard" opportunities; and to
- Analyze boater survey data to re-assess whitewater evaluations for different craft and skill types and compare them to findings from the 1996 boating study.

3.1 METHODS

3.1.1 Target and Actual Flows

Typically, boaters were only aware of what the planned target release from Pit 1 was, and it was that value upon which their assessments were based. In most cases, however, boaters did not know what flows at Big Eddy were during the study, as those data were not available. Table 3-1 provides the estimated target flow release magnitude, the estimated actual release as determined via hydrologic analysis post-test flow releases, the estimated average flow at the downstream end of Big Eddy, and the percent of target flow observed at Big Eddy. For simplicity, the estimated average flows are used throughout the rest of the report when discussing what boaters observed and evaluated. The estimated actual average flows in the whitewater reach ranged from 73% of the target release (on August 20) to 114% of the target release (on July 15). On average, flows were about 87.5% of target levels.

Table 3-1. Phase 2 Study target releases from Pit 1 Forebay and flows experienced in Pit 1 bypass reach in 2006.

Month	Day	Target release into Pit 1 Reach[a] (cfs)	Estimated Release Into Pit 1 Reach[b] (cfs)	Average Estimated Flow at Big Eddy[c] (cfs)	% of Target Flow Estimated at Big Eddy	Number of Boaters
June	Saturday, 17th	1,250	1,640	1,280	102.4	0
	Sunday, 18th	1,750	1,770	1,400	80	0
July	Saturday, 15th	1,000	1,240	1,140	114	17
	Sunday, 16th	1,500	1,550	1,220	81.3	24
August	Saturday, 19th	800	785	590	74	27
	Sunday, 20th	1,250	1,235	910	73	60

[a] Stakeholder-recommended target releases at downstream end of Big Eddy

[b] PG&E Pit 1 Powerhouse release records

[c] Estimated flows at downstream end of Big Eddy

3.1.2 Boating Use Estimates

Boating use during previous flushing flow releases was measured by Spring Rivers' staff through observations at the Pit 1 footbridge (Figure 1-2, a good observation spot 1.5 km upstream of the BLM Campground). Observers were typically stationed at this site from 10 AM until 5 PM to count boaters who used the flows. Because observers on the bridge were several meters above boaters, the noise from the riffle prevented direct interviews. As a result, the 2006 observations and interviews were conducted at likely boater take-outs, including the BLM Campground and Highway 299 Bridge. Surveyors recorded the number of boater groups, numbers of people and boats within each group, type of craft (e.g., kayak, raft, tube), the time they passed the site, and the take-out location. A copy of the observation form that was used is included as Attachment A in the CRC (2007) report (Appendix B).

3.1.3 Reassessment of Boating Flows (Survey)

The primary source of evaluative information about flows was a survey of whitewater boaters during two of the three weekend releases; no boaters participated in the June 2006 releases. As boaters completed their runs (concurrent with the use observations; see above), surveyors asked them to complete survey forms.

Survey content was developed from items used in previous studies, and is consistent with planned whitewater boating monitoring planned on the Pit 3, 4, and 5 Project downstream. The

survey items were developed from well-established, flow-recreation, research protocols (Whittaker et al. 1993; Whittaker et al. 2006). A copy of the instrument is included as Attachment B in the CRC (2007) report (Appendix B). Analysis focused on descriptive statistics (means, medians, graphic displays of frequencies) and comparisons of means between groups using different craft. This allowed re-assessment of the 1996 Pit 1 Whitewater Boating Study results (WRC Environmental 1996).

The proposed study releases were posted on the AW internet site, and AW encouraged boaters to participate. By agreement with stakeholders, a representative "panel" for the study (multiple craft and skill types) was not developed. This was because the study was viewed as a "refinement" of flows rather than a larger scale "controlled flow study" for boating or other recreation. As a result, self-selected participants were judged sufficient.

3.2 RESULTS

3.2.1 Boating Use Observations from 2003 to 2006

Spring Rivers has monitored boating use on Pit 1 during flushing flows since the current license took effect in 2003. Nearly all use has been with kayaks, including a small number of inflatable kayaks (IKs); raft use has been rare. There has been no observed tubing or canoeing use. The days with use observations and the numbers of boaters observed (by group, people, and craft) are given in Table 3-2; Figure 3-1 shows the number of people observed boating per year.

From 2003 to present, flushing flows have been publicized annually in local newspapers (i.e., Mountain Echo, Intermountain News, Redding Record Searchlight) and provided to AW for inclusion on their website. The AW website includes dates and magnitudes of flushing flows as well as weekend flow forecast estimates for non-flush weekends.

Data show that use was relatively low on observation days until the 2006 releases. Use in 2006 was disproportionately higher than other years, probably due to AW efforts to increase turnout for the July and August releases in 2006. Prior to the 2006 releases, an average of 1.5 groups with 4.0 people per group boated each release (the high was 4 groups and 20 people in June 2003). In contrast, an average of 5.25 groups with 5.8 people per group boated each release during the four days of releases publicized by AW in July and August 2006. The two days of publicized releases in June 2006 had no observed boating use (Table 3-2).

From 2003 to 2005, there was no particular pattern among use through the season. The initial June 2003 release attracted 20 boaters, but in subsequent years there were more boaters for releases later in the year. In 2006, much higher use levels were attained for the later releases.

Table 3-2. Boating use observations in the reach of the Pit River below Big Eddy from 2003-2006.

Year	Date	Target Release into Pit 1 Reach (cfs)	Number of Groups	Number of People	Number of Kayaks	Number of Rafts
2003	June 21–22	1,050[a]	4	20	20	0
	July 19–20	1,000–1,200[b]	1	5	5	0
	August 23–24	1,000–1,200[b] (0[c])	0	0	0	0
2004	May 22–23	960[a]	0	0	0	0
	July 17–18	1,100[a]	1	2	1	0
	August 28–29	900[a]	1	5	5	0
2005	June 4–5	1,250[b]	0	0	0	0
	July 16–17	1,000[b]	0	0	0	0
	August 27–28	800[b]	2	4	4	0
2006	June 17	1,250[b]	0	0	0	0
	June 18	1,750[b]	0	0	0	0
	July 15	1,000[b]	3	24	24	0
	July 16	1,500[b]	2	17	17	0
	August 19	800[b]	6	27	27	0
	August 20	1,250[b]	10	60	53	2

[a] Target release published in local newspapers

[b] Target release supplied to and published on AW website

[c] No flushing flow due to levee failure

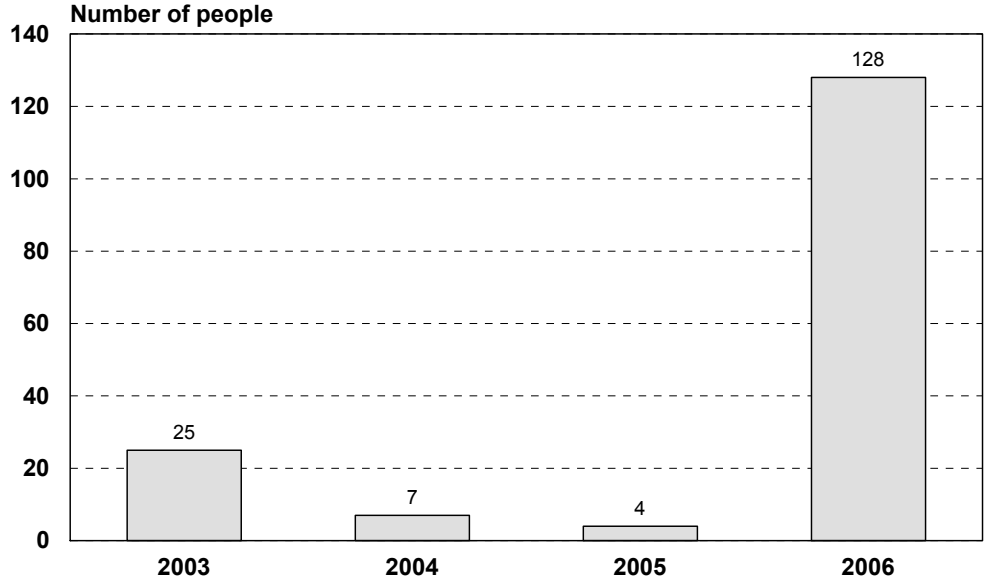

Figure 3-1. Number of people boating, 2003-2006. Note: Whitewater boating flow reassessment conducted in 2006.

3.2.2 Boating Use Observations in 2006

Boating use information collected during the 2006 flow releases is provided in Table 3-3. It is important to note that a few boaters ran the reach more than once and were not surveyed the second time; in addition, a few other boaters may have been missed, particularly on high use days in August. However, observers do not think the number of "missed boaters" was high and there were no refusals to participate in the study.

Table 3-3. Boating use observations compiled for the reach of the Pit River below Big Eddy in 2006.

Day / Flow	Estimated Release (cfs)	Flow at Big Eddy[a] (cfs)	Number of Surveys	Number of Groups	Number of people	Number of Kayaks[b]	Number of Rafts
17-Jun-06	1,640	1,280	0	0	0	0	0
18-Jun-06	1,770	1,400	0	0	0	0	0
15-Jul-06	1,240	1,140	24	3	24	24	0
16-Jul-06	1,550	1,220	13	2	17	17	0
19-Aug-06	790	590	26	6	27	27	0
20-Aug-06	1,235	910	55	10	60	53	2
Total			**118**	**21**	**128**	**121**	**2**

[a] Estimated flow at downstream end of Big Eddy.
[b] Includes inflatable kayaks.

Nearly all boaters put-in at Big Eddy (only one group put-in at the Cassel-Fall River Road Bridge), and most took out at the BLM campground (only two groups in July 2006 continued to Highway 299). Weather conditions on all study days were generally excellent (little cloud cover, temperatures between 60 and 100 degrees, and light winds).

3.2.3 Profile of Surveyed Boaters

Of the 118 boaters surveyed, 107 (91%) were hard shell kayakers, 7 (6%) were rafters, and 4 (4%) were inflatable kayakers. For the analysis, all boaters were combined except when comparing rafters to those using kayaks/IKs (although the small sample of rafters limits the usefulness of that data set). Given the difficulty of the reach (see below) and the relatively small skill differences (all appeared to be highly skilled; Table 3-4), all boaters were analyzed together.

Table 3-4. Boater skill levels.

Class	Percent of Boaters
III	5
III to IV	1
IV or IV+	53
IV to V	3
V	38

Table 3-5 shows the proportion of boaters reporting previous trips on Pit 1. In general, most had relatively little previous experience, despite the availability of provided boatable flows on several occasions since 2003 (in addition to normal spring runoff and occasional spill flows).

Table 3-5. Number of trips completed by boaters in the Pit 1 reach of the Pit River, prior to the 2006 flow releases.

Number of Trips	Percent of Boaters
None	49
1	23
2 to 5	20
5 or more	8

Boaters were generally from California (89%) but included a few boaters from Washington (2), Oregon (11), and Nevada (15). Of the California boaters, 42% were from Chico and Redding, with others from Mount Shasta, Sacramento, and the Bay Area.

3.2.4 Sources of Flow Information

Boaters were asked where they typically look for flow information for the Pit River. Most reported the internet (81%), but did not specify individual sites used to get flow information (although 3% listed the AW webpage; other sites included dreamflows.com and boof.com).

About 8% reported learning flow information from friends or word of mouth, with a similar percentage reporting a mix of internet or other sources. Only one person reported using a flow phone.

3.2.5 Evaluating Pit 1 Whitewater Difficulty

Overall, Pit 1 boaters rated the reach from Big Eddy to the BLM campground (the canyon run) as a Class III or Class IV run. About 20% reported it was Class III or III+, 32% reported it was Class III-IV, and 46% reported it was Class IV. Only 2% reported it was Class IV-V, although at least one respondent mentioned that Pit River Falls was Class V (half the boaters portaged the falls, which probably was not considered in some ratings). Difficulty ratings were generally unrelated to flow.

3.2.6 Portages and Stops

Boaters were asked to report the number of portages, the number of stops, and the time spent at stops (for lunch, scouting, or other reasons). Half (50%) of the boaters ***portaged*** Pit River Falls in its entirety; 3% portaged part of the falls, and 47% reported no portages. However, there were many more portages at the first three releases than at the last release. Higher proportions portaged Pit River Falls at 600 cfs (71%) and at 950 cfs (92%) than at 1,050 cfs (54%) and 800 cfs (31%). Results suggest that a "line" over the falls had been developed over the course of the releases (particularly at 800 cfs) and more boaters began to run it. We would expect this trend to continue in future years.

Most boaters (97%) reported ***stopping*** at least once during their trips; the average was 1.3 times, and the "typical range" was 1 to 3 stops per trip. The most common stopping locations were Pit River Falls, the springs just above the falls, the ledge at the start of the run, and just after the first rapid. When asked to report the length of time boaters spent on the shore at these stops or scouting, the average length was 41 minutes (median = 30 minutes).

3.2.7 Evaluations of Present Flows

Boaters were asked to rate the overall quality of the flow they observed using a 5-point acceptability scale. Mean responses for all boaters for each flow were graphed as a flow evaluation curve, as shown in Figure 3-2. Results suggest that even the lowest flow (590 cfs at the downstream end of Big Eddy) was acceptable to most boaters, but many preferred higher flows. The highest flow in the study (1,220 cfs at the downstream end of Big Eddy) was near an optimal level and the lowest (590 cfs at the downstream end of Big Eddy) was well above a "marginal flow."

The slight "dip" in the curve at 1,140 cfs appears to be a sampling artifact (i.e., the result of different portions of the overall surveyed boater population rating the different flow levels). Ninety percent of the sample evaluated one or two flows, 8% rated three flows, and only one participant rated all four. Those who rated more than one flow tended to rate higher flows better, and the higher flow of each weekend pair (among those who saw two or more) was generally rated higher or the same. If the same boaters had evaluated all four flows, and the flows had been assessed closer in time, the curve would be expected to be "smoother."

Specified flow questions (see below) were designed to provide more complete information about how types of opportunities and the quality of trips change as flows increase, but those results are confounded by the fact that the target releases (about which boaters were informed) were not the same as the flows experienced in the boating reach during the study.

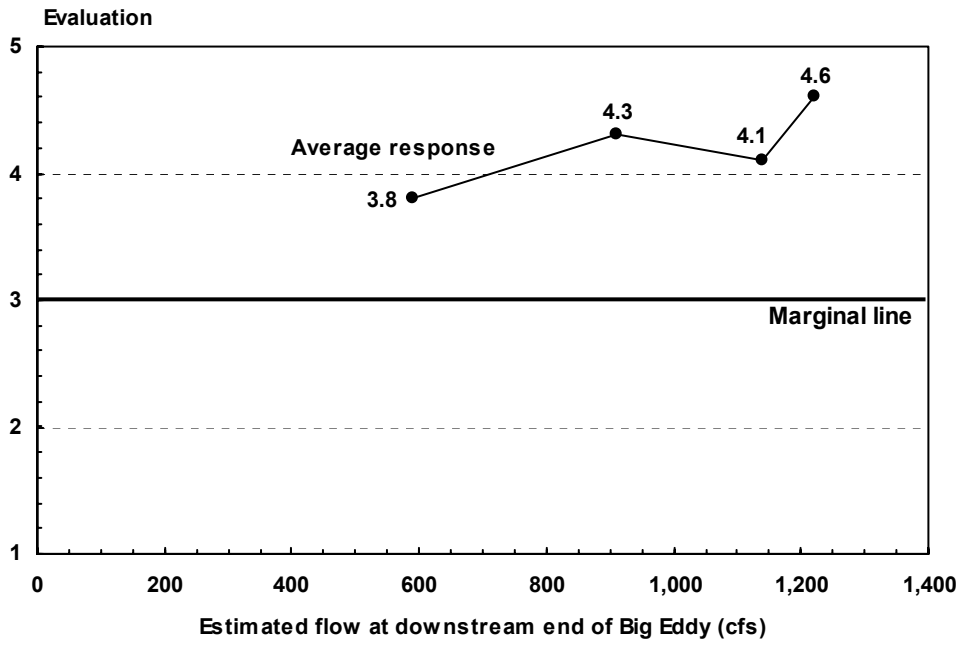

Figure 3-2. Flow evaluation curve for the reach of the Pit River below Big Eddy, based on post-run evaluations.

3.2.8 Specified Flow Questions

A series of "specified flow" questions asked boaters to identify acceptable and optimal ranges for technical, standard, and big water trips. The responses are summarized as follows:

Technical boating: Lower flow trips with technical routes through rapids, fewer route options, less powerful hydraulics, and occasional boatability problems (hitting or becoming stuck on rocks in the channel).

Standard boating: Medium flow trips with less technical whitewater, more route options, stronger hydraulics, larger waves, and infrequent boatability problems.

Big water boating: Higher flow trips with powerful hydraulics, larger waves, and no boatability problems.

Table 3-6 contains the means, medians, and the "typical range" (the 25 and 75 percentile responses) of responses relative to the types of boating trips. Figure 3-3 provides a graphic display of mean responses for key opportunities. As discussed above, boaters' responses were based on their "a-priori" knowledge of the flow targets they presumably were experiencing; they were unaware that actual flows differed from target releases. The following results focus on "big picture" findings rather than precise ranges:

- Boaters identified Forebay release flows slightly higher than the lowest in the study (785 cfs release from the Forebay; about 590 cfs at the downstream end of Big Eddy) as the start of technical trips. It is likely that boaters could use the river for transportation at even lower flows, but those trips would be marginal.
- Boaters recognize differences between "technical" and "standard" trips, with Forebay release flows about 1,100 to 1,300 cfs defining the transition between these opportunities. Big Eddy flows at these releases are probably about 800 to 900 cfs. This is consistent with results from the "available trip type" question (see below).
- Standard opportunities become near-optimal with a Forebay release of about 1,200 cfs (850 cfs at the downstream end of Big Eddy), remaining at optimal levels through Forebay releases of about 2,000 cfs (over 1,500 cfs at the downstream end of Big Eddy). This is consistent with post-flow evaluations of the three highest study flows, which were at the low end of the standard range.
- Boaters recognize differences between "standard" and "big water" trips, with Forebay release flows of about 2,000 cfs (over 1,500 cfs at the downstream end of Big Eddy) defining the transition between these opportunities.
- Boaters estimate that "big water opportunities" are optimal above 2,000 cfs from the Forebay (over 1,500 cfs at the downstream end of Big Eddy), and remain optimal through

at least 3,500 cfs. Readers should note that estimates beyond the releases evaluated are speculative.

- There were some differences between rafters and kayakers, although few rafters answered these questions (n=4). In general, rafters would require more water for each of these opportunities; technical trips for rafts range from about 1,050 to 1,700 cfs from the Forebay (about 750 to 1,200 cfs at the downstream end of Big Eddy), while standard trips range from about 1,700 cfs to 3,000 cfs (from 1,200 to 2,500 cfs at the downstream end of Big Eddy).

Table 3-6. Descriptive statistics for "specified flow" questions related to whitewater boating in the reach of the Pit River below Big Eddy; responses refer to Forebay Releases (in cfs).

	Mean	Median	Typical Range
Technical boating			
Lowest acceptable	830	800	750 to 1,000
Low end of optimal	940	1,000	1,000 to 1,400
High end of optimal	1,250	1,200	1,000 to 1,500
Highest acceptable	1,170	1,000	1,000 to 1,400
Standard boating			
Lowest acceptable	1,290	1,200	1,000 to 1,500
Low end of optimal	1,370	1,200	1,000 to 1,500
High end of optimal	1,940	2,000	1,500 to 2,000
Highest acceptable	1,870	1,900	1,500 to 2,000
Big water boating			
Lowest acceptable	2,610	2,000	1,500 to 2,500
Low end of optimal	2,350	2,000	1,680 to 2,500
High end of optimal	4,250	3,500	2,880 to 5,000
Highest acceptable	4,710	5,000	2,750 to 6,000

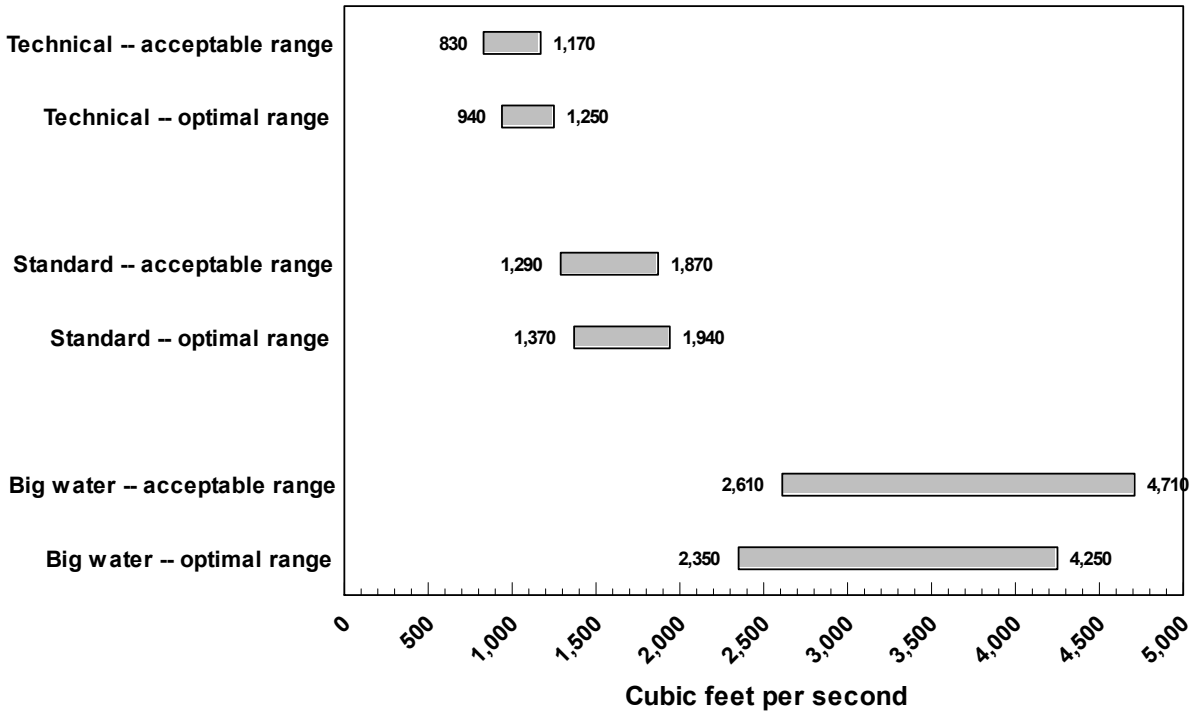

Figure 3-3. Acceptable and optimal flow ranges for technical, standard, and big water trips within the reach of the Pit River below Big Eddy, based on the means of all respondents (flows refer to Forebay releases).

3.2.9 Trip Type Characterization and Preferences

Boaters were asked to specify the type of trip that was ***provided*** at each flow release as well as their ***preference*** for a certain trip type. Results are provided in Table 3-7; the most frequent or modal response is highlighted in bold.

Regarding ***available trip types***, results were consistent with the specified flow ranges discussed above. The lowest flow (590 cfs at the downstream end of Big Eddy) was considered "technical" by a majority of boaters, although a third rated it closer to the transition between technical and standard trips. Relatively few thought it provided a standard or "big water" trip. In contrast, higher proportions of boaters reported that the two middle releases (910 and 1,140 cfs at the downstream end of Big Eddy) offered standard trips or trips at the technical-standard transition type. The highest flow in the study (1,220 cfs at the downstream end of Big Eddy) was considered a standard trip or at the transition between technical and standard trips by equal numbers of boaters; none considered it a big water trip.

Table 3-7. Available and preferred trip types (percent of responses) at different flows (measured in the Pit River at the downstream end of Big Eddy).

Trip Type	590 cfs	910 cfs	1,140 cfs	1,220 cfs
Available trip types				
Technical	**52**	19	13	17
Technical-standard transition	36	**46**	**61**	**41**
Standard	8	33	26	**41**
Standard-big water transition	4	2	0	0
Big water	0	0	0	0
Preferred trip types				
Technical	0	6	13	0
Technical-standard transition	19	13	26	17
Standard	35	27	18	**41**
Standard-big water transition	**39**	**34**	**39**	25
Big water	0	15	4	8

Regarding ***preferred trip types***, more boaters (25 to 39%) indicated a preference for standard trips or the transition between standard and big water trips. Fewer preferred technical trips (0 to 13%), big water trips (8 to 15%), or the transition between technical and standard trips (13 to 26%). All things being equal, boaters preferred higher flows and stronger hydraulics rather than rock-dodging technical flows. Boaters were asked a direct question (see below) for release preferences in light of assumptions about a potential water budget; those results are probably more useful in considering future release amounts and frequencies.

3.2.10 Comparisons to 1996 Study Results

Results from the 2006 study help extend the range of flows that were considered during the 1996 study (WRC Environmental 1996). In general, the 2006 study explored lower flows (four Forebay releases from 785 cfs to 1,550 cfs with resultant flows at the downstream end of Big Eddy ranging from about 590 to 1,220 cfs) than those evaluated during the 1996 survey (five flow levels from 1,325 cfs to 3,550 cfs; Big Eddy flows were not gaged at that time, but likely ranged from about 1,000 to 3,000 cfs). The focus on lower flows in this study is appropriate, given the hydrologic and operational constraints that would make it difficult to provide higher releases in late summer due to low natural inflows.

In the 1996 study, kayakers rated medium-high Forebay releases from 1,700 to 2,800 cfs the highest. Only the lowest Forebay flow (1,325 cfs) received marginal ratings (and only among intermediate-skilled kayakers). While not directly contradicting these findings, the 2006 study does suggest that lower flows are more acceptable than indicated by the 1996 study. Indeed, even 590 cfs at the downstream end of Big Eddy (about 785 cfs Forebay Release) was rated as acceptable, although this flow was considered by kayakers in the 2006 study as providing a technical opportunity and not optimal. For rafting, both the 2006 study and the 1996 study had small sample sizes (2006 study: n=4 to 7 for different variables; 1996 study: n=1 to 5). Because small sample sizes limit the robustness of data, comparisons should be made with even more caution. Nevertheless, similar to the findings with kayaks, the present study suggests that rafts can use the river at lower flows than suggested in the 1996 study. Flows below about 1,700 cfs from the Forebay (about 1,200 cfs at the downstream end of Big Eddy) were considered raftable, but provided lower quality, technical trips.

3.2.11 Preferences for Flow Release Options

Boaters were asked to indicate preferences for different release schedules, if hydropower operations were not able to provide two days of high quality boating flows during drier periods. Boater responses were as follows:

One day with optimum flows..... 25%
Two days with acceptable flows..... 32%
Two days with optimum flows provided for fewer hours each day 43%

Results suggest that more boaters prefer two days of shorter releases at optimal flows, compared to two days with acceptable flows, or one day of optimum flows.

3.2.12 Demand for Acceptable and Optimal Flows by Month

Boaters were also asked to estimate the number of times they would boat the reach each month if acceptable or optimum boating flows were available. Table 3-8 summarizes the mean and "typical ranges" (the 25% and 75% responses of the responses).

Table 3-8. Mean and "typical ranges" of the number of times boaters would run the reach of the Pit River below Big Eddy in various months if acceptable or optimal flows were provided.

	If acceptable flows provided…		**If optimal flows provided…**	
	Mean # of trips	**Typical Range**	**Mean # of Trips**	**Typical Range**
May	1.0	0 to 2	1.3	0 to 2
June	1.5	1 to 2	1.8	1 to 3
July	1.9	1 to 2	2.3	1 to 3
August	2.3	1 to 2	2.7	2 to 4
September	2.3	1 to 3	2.8	2 to 4

Results indicate that there is greater interest in releases occurring later in the summer, which is consistent with the higher turnout for later releases in 2006 (even as those might have been affected by AW publicity efforts). This is also consistent with findings from other studies showing greater interest in regulated river releases in the drier part of the year, when natural boating flows are not available on other rivers. In addition, results from other studies show there would likely be higher use if optimal flow levels could be provided, rather than merely acceptable ones. Providing higher optimal flows in a two-day window, however, would be more challenging from an operational standpoint because of low natural inflows to the Project in the drier parts of the year.

3.2.13 Other Comments

Boaters were asked to provide additional comments about flow levels, access, or other management concerns. A summary of verbatim comments organized by topic area is provided in Attachment B of the full CRC report (see Appendix B). Comments included those that showed enthusiasm for the scenery and whitewater in the canyon, added qualitative detail to flow ratings, clarified internet flow information needs, supported development of access at Big Eddy to minimize as much flat water paddling as possible, and indicated an interest in additional camping opportunities in the area. The comments requesting additional camping opportunities were all from the high-boater-turnout weekend in August (Appendix B, Attachment B).

4. PHASE 2 FISH STRANDING STUDY

Three years of information regarding fish species composition and relative abundance have been collected since minimum flow requirements and flushing flow releases were implemented to comply with current license conditions (PG&E 2005b; PG&E 2006; URS 2007). Sampling of fish communities has focused on characterizing longitudinal gradients extending from Fall River Pond (immediately below the Pit 1 Forebay) into the lower Fall River and extending through the Pit 1 Canyon reach of the Pit River. Data collected from these surveys have been compared with data from surveys conducted in 1991-1992 to monitor any changes in species composition or relative abundance that may be attributable to the new flow regimes.

As noted by Reiser et al. (2005), pulse-type flows (PTFs) associated with whitewater flow releases can potentially impact fish populations in a variety of ways, including stranding and trapping, displacement, and increased bioenergetic costs. Of these, the most easily determined impacts are those related to stranding and trapping, which can be evaluated directly with studies of pre- and post-PTF conditions. In this study, "stranding" was defined as the separation of fish from flowing surface water as a result of declining river stage, and "trapping" as the isolation of fish in pockets of water with no access to free-flowing surface water (Hunter 1992). The issue of stranding and trapping was assessed for the reach of the Pit River below the Pit 1 Powerhouse (PG&E 1993a), but the results of that study cannot be directly applied to the Canyon reach due to scale, flow magnitude, and channel morphology differences. In addition, fish surveys conducted in September 2004, 2005, and 2006 upstream of the Pit 1 Powerhouse after the last of the three required flushing flow releases for each year were not designed to evaluate the effects of PTFs. As a result, the Phase 1 report concluded that the existing information and data were not sufficient to evaluate the potential for stranding and trapping in the Canyon reach in response to whitewater flow releases (see Appendix A). As a result, a fish stranding and trapping study was designed and conducted in 2006 in conjunction with the flushing flow/whitewater boating flow test releases (see Table 2-1).

4.1 METHODS

The fish stranding and trapping study was completed in two sequential steps: Step 1 involved a reconnaissance and survey site selection; Step 2 entailed post-PTF stranding/trapping surveys. These are described in detail below.

4.1.1 Step 1 – Site Reconnaissance and Selection

Appropriate sites were selected within the Pit 1 bypass reach that were representative of areas and habitat types, where fish species present in the Pit River would be potentially susceptible to

the effects of flow fluctuations. This involved an initial review of aerial photographs and topographic maps to identify areas that contained channel morphologies conducive to stranding and trapping, as were described by Reiser et al. (2005). Such areas would include:

- Split Channels that would be disconnected from the main channel as flows recede, and that could become dewatered;
- Backwaters with gradual bed slopes (<2-4 percent) and aquatic vegetation; and
- Point Bars that occurred over cobble substrates and/or in topographic micro-depressions.

Next, a preliminary selection was made, based on channel profile, confinement, substrate type, and gradient characteristics at areas subject to temporary inundation and subsequent dewatering (i.e., the varial zone). These sites were then observed in the field during flushing/whitewater test flow releases in June 2006 to verify that a reasonable potential for trapping and stranding existed (i.e., the inundation of bars and/or side channels). An additional field trip was made during flow releases in July 2006 to conduct reconnaissance-level surveys of fish stranding and to further refine the methods and sampling schedule that would be applied during the August survey. Final site selection focused on potential stranding sites of sufficient length (>30 m) that were considered to have the highest potential for stranding (i.e., side channels, low gradient varial zones, expansive cobble-boulder bars).

4.1.2 Step 2 – Stranding and Trapping Survey

A focused field study was subsequently conducted during, and immediately following, the August 2006 test flow release period, at the sites identified in Step 1. The August flow release was chosen for detailed surveys, because it was a time of year when fish life stages and spatial distribution patterns within the bypass reach would be more comparable to what might be encountered during the originally proposed September 15 - October 30 study period. In addition to operational and water supply considerations, it was thought that test flow releases conducted during August would actually pose a greater risk to the fish communities, because of the presence of smaller sized fish, than would occur during tests in September and October. Hence, results obtained during an August survey would likely serve as an indicator of the upper level of impacts that might occur, if flow releases occurred in September-October.

Study sites were visited initially on August 17, 2006, two days prior to the test flow releases, to determine if fish already existed in some of the pools or depressions containing perennial standing water at lower flows, and to identify those pools and depressions that might be associated with trapping or stranding.

On the days of the test flow releases (August 19 and 20), field crews were stationed at each of the selected study sites to make fish stranding observations, as the flows ramped back down to the base-flow level under the 150-cfs release. Each field crew monitored only one riverbank for fish stranding. Survey efforts included the observation and enumeration of stranded fish within the designated survey area. Members of each field crew were assigned "search lanes" in which they were responsible for making observations of stranding or trapping. The crews then proceeded upstream or downstream within their search lanes to a designated end-point, and then shifted to new search lanes and proceeded in the opposite direction to the other end-point. This process was repeated, until the entire survey area was covered.

In making observations, crew members lifted or moved surface cobbles and small boulders covering likely stranding locations. They also examined cracks and depressions in bedrock, and carefully combed through riparian vegetation to check for stranded fish. Large, embedded substrates that provided little or no risk of trapping organisms were not overturned. Large, disconnected pools that had filled during the test flow were surveyed visually, and larger pools were also electrofished to collect any trapped fish that might be hiding. All captured fish were identified to species, measured (fork length – FL [mm]), and released back into the main channel of the river.

A follow-up survey was made the day after the test flow releases (August 21, 2006) to search for any stranded fish or fish trapped in the remaining pools or pockets of water, that may have been missed during the previous surveys.

4.2 RESULTS

4.2.1 Reconnaissance and Site Selection

The primary focus of this study element was to determine whether potential fish stranding and trapping following whitewater boating flows could pose a risk to fish populations. Consequently, emphasis was placed on selecting sites that contained channel morphologies conducive to stranding and trapping. Based on the review of USGS aerial photographs and topographic maps of the Pit 1 bypass reach, as well as reconnaissance visits during June and July 2006, three areas were identified as the major areas posing stranding risk: Big Eddy Ledges, Lower Canyon Reach – Upper Bar, and Lower Canyon Reach – Lower Bar (Figure 4-1). No sites were established in the Upper Canyon Reach since the channel within this segment is narrow and relatively confined. Thus, fish present in this reach would be less vulnerable to the risk of stranding and trapping.

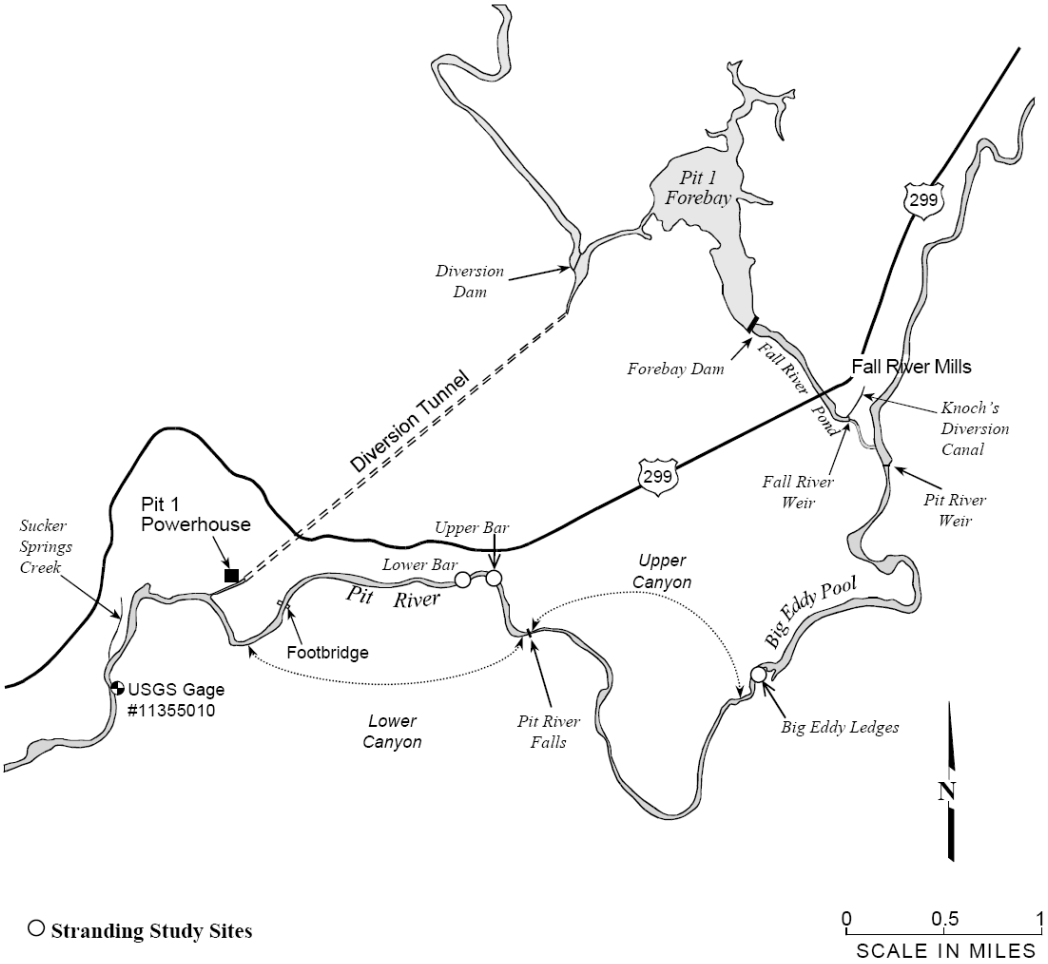

Figure 4-1. Lower Pit 1 Project area, from the diversion dam on the Fall River to the Pit River reach below the powerhouse tailrace, showing the three sites (Big Eddy Ledges, Lower Canyon Reach – Upper Bar, and Lower Canyon Reach – Lower Bar) selected for the Phase 2 fish stranding/trapping survey conducted on August 19-21, 2006.

4.2.1.1 Big Eddy Ledges

The Big Eddy Ledges site consists of a series of broad steps of lava bedrock outcroppings, pockmarked with numerous crevices and depressions that distribute flows in various directions. For sampling purposes the site was divided into upper, middle, and lower sections (Figure 4-2). The low-flow channel is constrained within deeper notches eroded into the ledges, but higher flows, including those provided by the flushing/whitewater test flows, spill over the broad ledges. Stranding and trapping risks within the steps occur at potholes, localized channel depressions, disconnected pools, and low-gradient, vegetated areas in the channel margins, as well as in some mid-channel areas, primarily between the middle and lower sections.

Figure 4-2. Orthographic photograph (USGS) of the Big Eddy Ledges on the Pit River, California, with delineations of the upper, middle, and lower sections selected for the Phase 2 fish stranding/trapping survey conducted on August 19-21, 2006.

All of the ledges were inundated during the test-flow release of about 1,400 cfs on June 18, 2006. Velocities across the ledges were highly variable, ranging (outside of the thalweg) from about 1 ft/s to greater than 5 ft/s. The upper and lower ledges appeared to have the highest potential to result in fish stranding, as large portions of the ledges are dry at the base flow level (Figures 4-3 and 4-5). The middle section has a less distinct low-flow channel and there appeared to be few, if any, disconnected pockets of water (Figure 4-4).

During the reconnaissance following the July test flows, a number of potholes and small pool areas were disconnected from the main channel flow. Small numbers (1-4) of fry (unidentified species) and several bullfrog tadpoles were observed trapped in disconnected pools, although many pools appeared to receive some seepage flow via small connections to the main channel. Although any fish trapped within these areas would not be able to escape until flows increased, the inflow/seepage may be sufficient to maintain suitable water quality conditions until that time. Spot measurements of water temperatures taken at selected mainstem locations within the Big Eddy Ledges and in the Upper Bar of the Canyon site ranged from 19 to 20^{o}C.

Figure 4-3. Site photographs of the upper section of the Big Eddy Ledges on the Pit River, California, taken during the flushing flow release on June 17, 2006 (top) and after the release (bottom).

Figure 4-4. Site photographs of the middle section of the Big Eddy Ledges on the Pit River, California, taken during the flushing flow release on June 17, 2006 (top) and after the release (bottom).

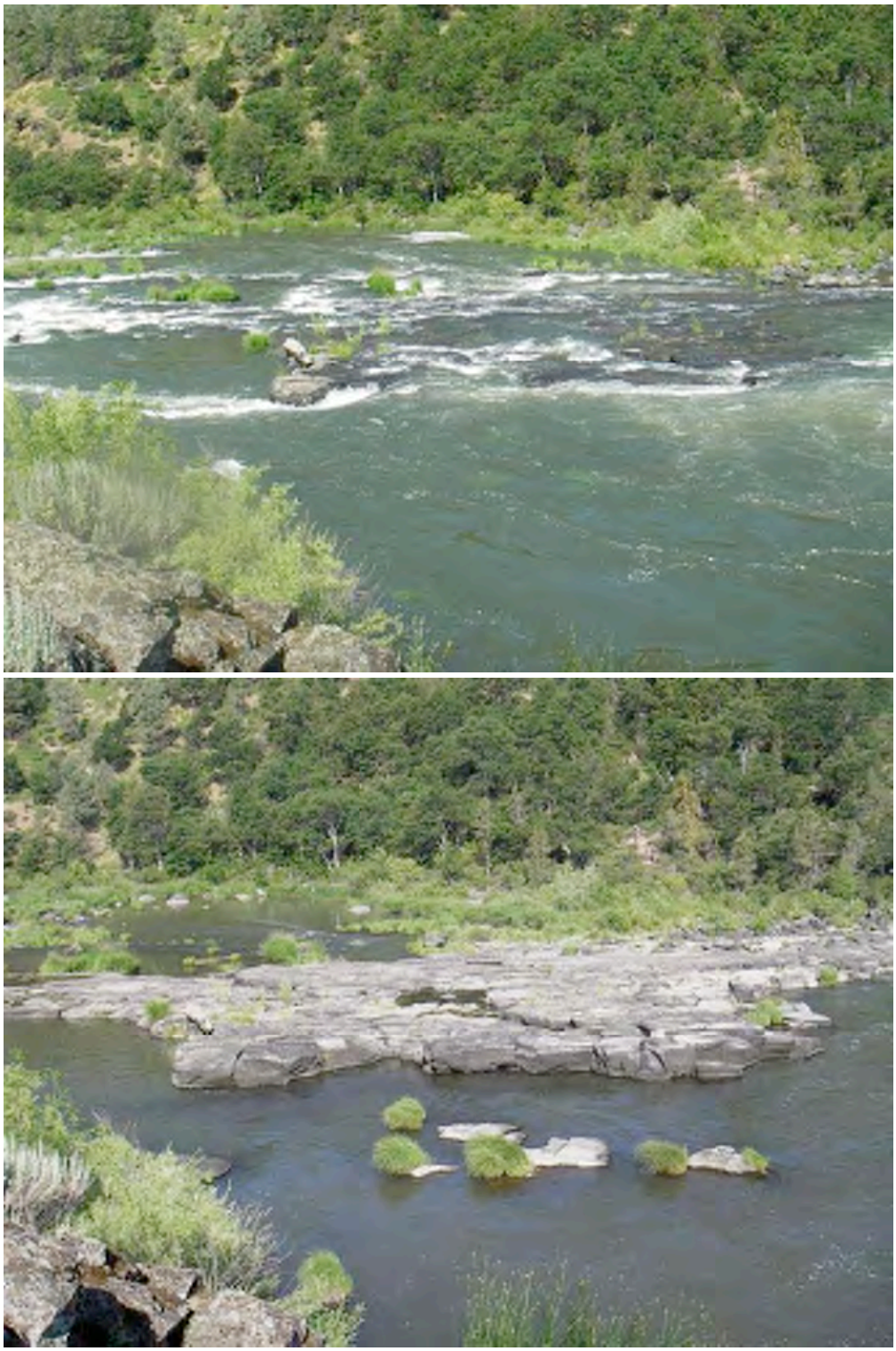

Figure 4-5. Site photographs of the lower section of the Big Eddy Ledges on the Pit River, California, taken during the flushing flow release on June 17, 2006 (top) and after the release (bottom).

4.2.1.2 Lower Canyon Reach – Upper Bar

Another potential stranding area was located at the upstream end of a boulder bar on the river-left side (left side of the river looking downstream) of the first big bend below Pit River Falls (Figures 4-1 and 4-6). This site consisted of a broad, upper section that measured 39 m long and averaged 9.7 m wide under base-flow (dry) conditions (Figure 4-7). The slope of the upper section averaged about 8% (range 1.75 to 12%). The site also included a second potential stranding area immediately downstream of the broad, upper section. It consisted of a narrow strip that measured approximately 60 m long and averaged about 9 m wide (range 7 to 13 m) (Figure 4-8). The slope of this strip averaged about 7% (range 5 to 9%). Water was observed flowing through this strip during the June 18, 2006 flushing flow, with water velocities ranging from approximately 0.2 to 1.5 ft/sec.

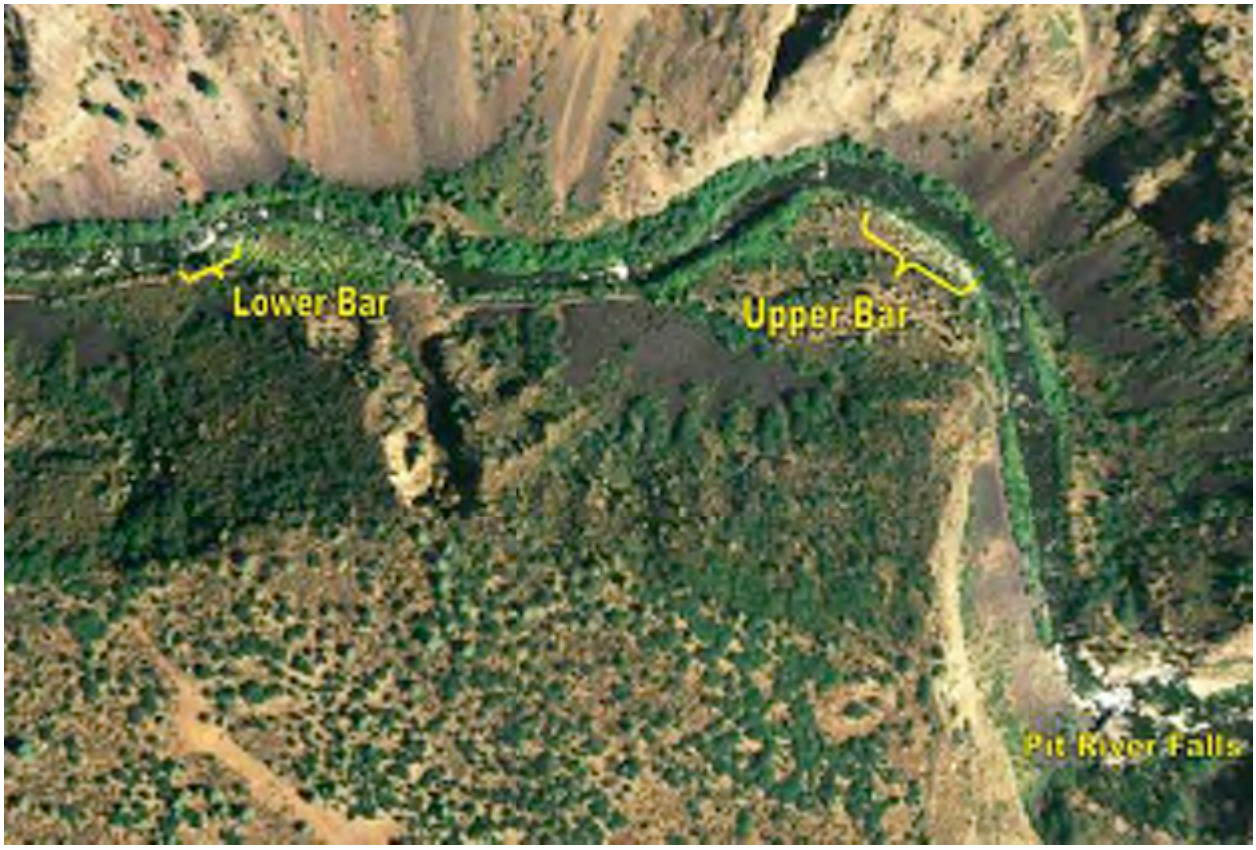

Figure 4-6. Orthographic photograph (USGS) of the Lower Canyon reach downstream of Pit River Falls on the Pit River, California, with delineations of the Upper and Lower bars selected for the Phase 2 fish stranding/trapping survey conducted on August 19-20, 2006.

Figure 4-7. Site photographs of the Upper Bar of the Lower Canyon reach on the Pit River, California, taken during the flushing flow release on June 17, 2006 (top) and at base flow after the release (bottom).

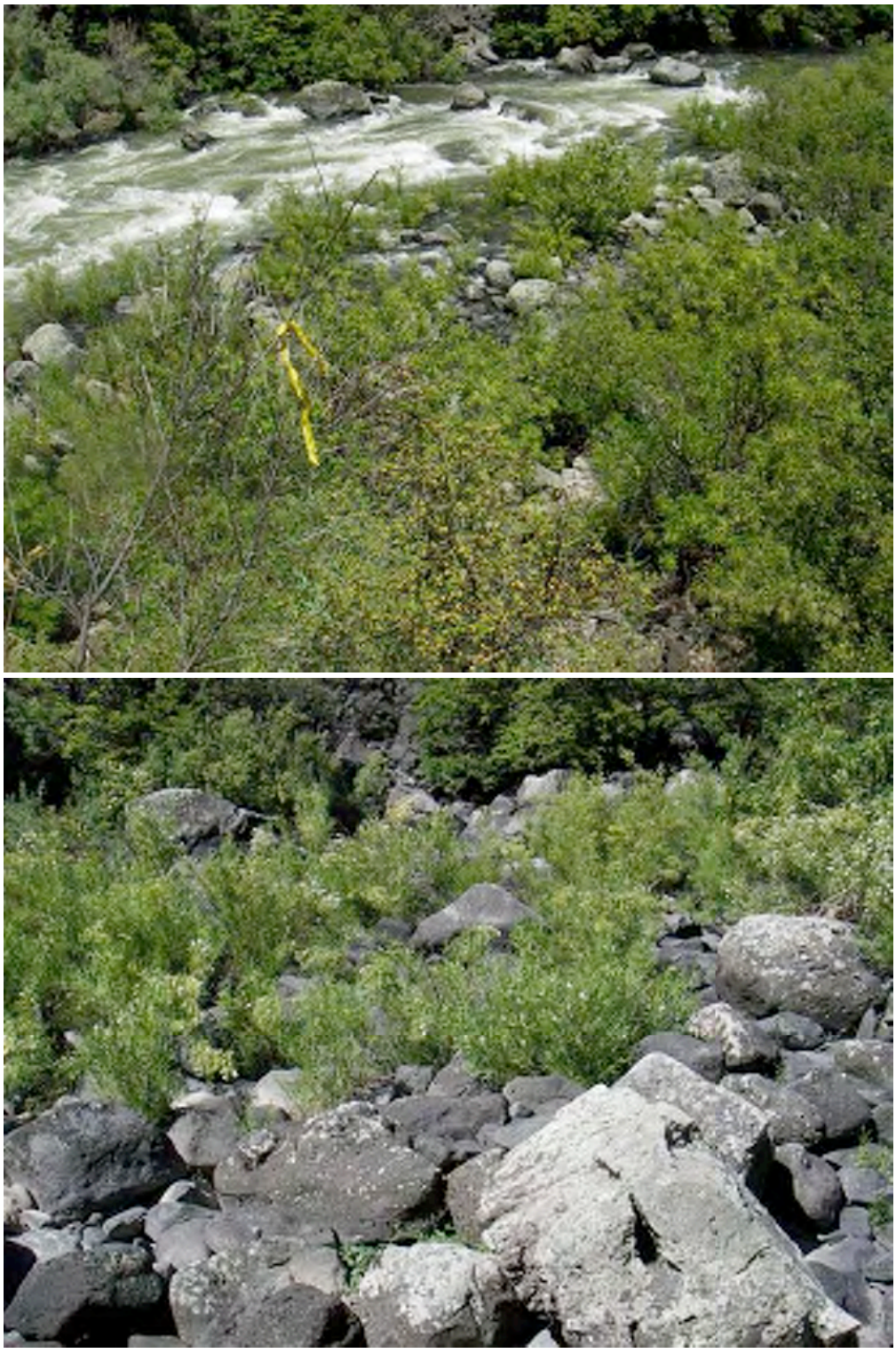

Figure 4-8. Site photographs of the Lower Bar of the Lower Canyon reach on the Pit River, California, taken during the flushing flow release on June 17, 2006 (top) and at base flow after the release (bottom).

Several hundred fry were observed in various pools within the side channel during the July 16, 2006 flow release (estimated 1,220 cfs). Potential routes to the main channel were available at most of these pools during this flow, but observations indicated the pools would become disconnected as flows decreased to the base level.

4.2.1.3 Lower Canyon Reach – Lower Bar

A third stranding site, Lower Bar, was identified a few hundred meters downstream of the Upper Bar site. This stranding area was located at the downstream end of a boulder bar on the river-left side (Figures 4-1 and 4-8). The site was about 50 m long and averaged 18 m wide (range 15 to 21 m). The surface of this boulder bar had numerous depressions that could retain water after a flushing flow release. One large pool area (approximately 2 m x 5 m) at the downstream end of the site contained water prior to the June test-flow release. During the June 18, 2006 test flow, water velocities over this bar ranged from 1 to 2 ft/sec, which in combination with boulders and other channel structures should provide suitable fish habitat. On the morning of the July 16, 2006 test flow, six to eight small (≈ 20 mm) unidentified fry (probably Cyprinids) were observed entering one of the inlet areas to the channel as flows increased, confirming fish use and the possibility of trapping and stranding.

4.2.2 Stranding and Trapping Survey

4.2.2.1 Pre-Release Surveys

Electrofishing surveys were conducted in pools at two sites on August 17, 2006, two days before the scheduled test-flow releases. The pool at the lower end of the Lower Bar site that contained water prior to the June test flows (see Section 4.2.1.3) was dry. At the Big Eddy Ledges, two pools were located and electrofished. The pool in the upper ledge section on river-right measured about 12 m long x 3.5 m wide x 40 cm deep and yielded 18 centrarchids, mostly green sunfish (*Lepomis cyanellus*). They averaged 88.7 mm FL (range 65 to 116 mm FL) (Table 4-1). The pool in the lower ledge section, also on river-right, measured about 5.5 m long x 1.5 m wide x 50 cm deep. It yielded two small largemouth bass (*Micropterus salmoides*) that averaged 61 mm FL.

Table 4-1. Number of fish stranded and trapped during surveys conducted in the Pit 1 bypass reach in association with the August 2006 whitewater-boating, test-flow releases.

		Big Eddy Ledges					Lower Canyon	
		Upper		Middle	Lower		Upper Bar	Lower Bar
Date	Species	Left Bank	Right Bank	Left Bank	Left Bank	Right Bank	Left Bank	Left Bank
Pre-release								
	Green Sunfish	NS	11	NS	NS	0	NS	NS
8/17/2006	Largemouth Bass	NS	5	NS	NS	2	NS	NS
	Unidentified Centrarchid	NS	2	NS	NS	0	NS	NS
	Total Fish	**NS**	**18**	**NS**	**NS**	**2**	**NS**	**NS**
Flow release: 590 cfs (average)								
	Fish Stranded	**0**	**0**	**0**	**0**	**0**	**0**	**0**
	Fish Trapped							
	Green Sunfish	0	7	0	0	0	0	0
	Largemouth Bass	0	3	0	0	3	0	0
	Unidentified Centrarchid	0	0	1	1 [M]	0	0	0
8/19/2006	Hardhead	0	0	0	0	0	1	0
	Tule Perch	0	0	0	0	0	1	0
	Unidentified Cyprinid	2	0	0	1	0	0	0
	Total Fish Trapped	**2**	**10**	**1**	**2**	**3**	**2**	**0**
Flow release: 910 cfs (average)								
	Fish Stranded	**0**	**0**	**0**	**0**	**0**	**0**	**0**
	Fish Trapped							
	Green Sunfish	0	2	0	0	0	0	0
	Largemouth Bass	0	5	0	0	1	0	0
8/20/2006	Unidentified Centrarchid	0	0	0	0	1	0	0
	Hardhead	0	0	0	0	0	6	0
	Unidentified Cyprinid	2	0	0	0	0	0	0
	Total Fish Trapped	**2**	**7**	**0**	**0**	**2**	**6**	**0**
Two-day totals (Stranded)		**0**	**0**	**0**	**0**	**0**	**0**	**0**
Two-day totals (Trapped)		**4**	**17**	**1**	**2**	**5**	**8**	**0**
Post-release								
	Fish Stranded	0	0	0	0	0	0	0
	Fish Trapped							
8/21/2006	Green Sunfish	0	0	1	0	0	0	0
	Mosquitofish	3 [M]	0	0	0	0	0	0
	Total Fish Trapped	**3**	**0**	**1**	**0**	**0**	**0**	**0**

[M] - Mortality from electrofishing

NS - Not Sampled

4.2.2.2 Flow Release Surveys

During the August 19 and 20, 2006 test flow releases, no fish were observed stranded during any of the post release surveys (Table 4-1). A total of 37 fish were captured via hand net or electrofishing along shorelines at the three designated survey sites. These fish were considered to be trapped, although in some cases subsurface flow connections to the mainstem were apparent (Table 4-1). Overall, a total of 24.5 hours were expended in completing the surveys (Table 4-2). Fish lengths ranged from 12 to 117 mm FL, averaging 67.6 mm FL overall (Table 4-3).

Of the 37 trapped fish, 29 were observed at the Big Eddy Ledges site. Of these, 21 fish were found in the upper ledge section, with 17 of the 21 found trapped in small pools along the river-right bank (Table 4-1). Centrarchids were more abundant at the Big Eddy Ledges than other fish, with 12 largemouth bass (averaging 76.3 mm FL), 9 green sunfish (averaging 91.8 mm FL), and 3 unidentified centrarchids (averaging 45.7 mm FL) comprising 82.7% of the total fish observed at the site (Table 4-4). Additionally, the number of trapped fish observed at Big Eddy Ledges was greater on August 19 than on August 20 (18 vs. 11, respectively). One reason may be that the flow at about 6:30 PM on August 20 at the end of the survey was still higher than at the beginning of the survey effort on August 19 at approximately 3:30 PM, suggesting the potential for additional stranding or trapping to have occurred afterwards.

Within the two Lower Canyon sites, only eight fish were observed trapped during the two days of flow releases, all at the Upper Bar site. Seven of these fish were hardhead (*Mylopharodon conocephalus*) (averaging 48 mm FL); the other was a tule perch (*Hysterocarpus traski*) (88 mm FL) (Tables 4-1, 4-3). No fish were observed stranded or trapped at the Lower Bar site in the Lower Canyon reach during the two days of surveys.

4.2.2.3 Post-Release Surveys

Survey crews conducted follow-up visits to all three sites on August 21, 2006 to observe any stranded fish and electrofish disconnected pools for any trapped fish that may have been missed during the flow release surveys. Only four fish (one green sunfish and three mosquitofish [*Gambusia affinis*]) were observed trapped in small disconnected pools at the Big Eddy Ledges site (Table 4-1). All three mosquitofish died when collected by electrofishing. In addition, a side channel that was still connected to the main channel along the river-left side of Big Eddy Ledges was electrofished, resulting in the capture of seven largemouth bass (50 to 110 mm FL). Although connected at the time of the survey, this side channel may have become physically disconnected as flows continued to recede. At the Lower Canyon sites, no fish were observed in any of the disconnected pockets of water.

Table 4-2. Phase 2 stranding/trapping survey effort (hrs:min) during the August 2006 whitewater boating test flow releases within the Pit 1 bypass reach, Pit River, California.

	Lower Canyon		Ledges		Daily
Date	**Upper Bar**	**Lower Bar**	**Right Bank**	**Left Bank**	**Total**
8/19/2006	3:35	4:00	2:45	4:10	14:30
8/20/2006	2:35	2:35	2:05	2:45	10:00
Site Totals	6:10	6:35	4:50	6:55	**24:30**

Table 4-3. Number and average length (mm FL) of trapped fish, by species, collected on August 19-20, 2006 as part of the Phase 2 fish stranding/trapping survey within the Pit 1 bypass reach, Pit River, California.

		Fork Length (mm)		
Species	**Number Collected**	**Average**	**Min**	**Max**
Big Eddy Ledges				
Green Sunfish	9	91.8	30	107
Largemouth Bass	12	76.3	48	117
Unidentified Centrarchid	3	45.7	12	100
Unidentified Cyprinid	5	20.0	13	30
Site Overall	29	71.8	12	117
Lower Canyon Bars				
Hardhead	7	48.3	36	60
Tule Perch	1	88.0	-	-
Site Overall	8	53.3	36	88
Survey Overall	37	67.6	12	117

4.2.2.4 September 2006 Fish Surveys

Annual fish surveys were conducted approximately three weeks after the August test-flow releases, as part of the Pit 1 Project Eagle Monitoring Program required by Condition 18 in the new license. From September 11-13, 2006, fish populations in Project-affected waters were sampled by electrofishing (URS 2007). Of particular interest are results from reaches that would correspond with those sites established for the August stranding study. Due to differences in sampling effort between the August fish stranding survey and the September fish monitoring efforts, comparisons here are limited to inferences regarding species composition.

Green sunfish comprised 41% of all fish collected within Big Eddy Pool, and largemouth bass comprised 27% (Table 4-4). Just downstream in the Upper Canyon section (from the top of Big Eddy Ledges to Pit River Falls), the relative abundance was reversed, with green sunfish representing 12% of fish sampled and largemouth bass representing 36%. The percent composition represented by largemouth bass trapped at Big Eddy Ledges in August was similar to that found in the Upper Canyon during the annual fish sampling, suggesting that fish observed trapped in pools were representative of the more abundant fish species found in that section of the river. The downstream decrease in the percentage composition of green sunfish suggests that sunfish were flushed from the lower end of Big Eddy pool during the test-flow releases in August, and were finding immediate shelter in pools and vegetation in the upper section of Big Eddy Ledges.

Comparisons for the Lower Canyon section (Pit River Falls to the footbridge) are more limited, given the low numbers of fish observed in that area during the August stranding and trapping study (n=8, of which 7 were hardhead). Nevertheless, results from the September 2006 sampling efforts reveal that hardhead was the most abundant fish collected in the Lower Canyon section, representing 43% of all fish collected (Table 4-4). This suggests, as would be expected, that the most abundant fish in the reach are those most likely to be trapped and/or stranded.

Table 4-4. Relative abundances (%) of fish collected within selected reaches in the Pit 1 bypass reach, Pit River, California, as part of the Year 3 fish monitoring effort (September 11-13, 2006) and the Phase 2 fish stranding/trapping study survey (August 19-20, 2006).

	Big Eddy	Big Eddy Ledges	Upper Canyon	Lower Canyon	Lower Canyon Upper Bar
Common Species Name	**Sep-06**	**Aug-06**	**Sep-06**	**Sep-06**	**Aug-06**
Centrarchids					
Green sunfish	40.5	**31.0**	11.6	0.4	-
Bluegill	22.1	-	-	-	-
Green sunfish x bluegill hybrid	1.5	-	-	-	-
Largemouth Bass	26.7	**41.4**	35.8	2.0	-
Black crappie	0.8	-	2.1	-	-
Sacramento perch	-	-	-	-	-
Unidentifiable Centrarchid	3.8	**10.3**	-	-	-
Cyprinids					
Sacramento sucker	1.5	-	13.7	18.5	-
Carp	3.1	-	-	-	-
Sacramento pikeminnow	-	-	1.1	13.3	-
Hardhead	-	-	8.4	42.7	**87.5**
Golden shiner	-	-	-	-	-
Speckled dace	-	-	-	4.8	-
Unidentifiable Cyprinid	-	**17.2**	-	-	-
Others					
Tule perch	-	-	14.7	1.6	**12.5**
Rainbow trout	-	-	-	2.4	-
Pit sculpin	-	-	12.6	14.1	-
Mosquito fish	-	-	-	-	-
Totals	100	100	100	100	100

5. CONCLUSIONS AND RECOMMENDATIONS

5.1 WHITEWATER BOATING STUDY

PG&E operators have suggested that the Pit 1 Project may not be able to provide the whitewater boating flows suggested in the WRC (1996) study for a sufficient duration during the later summer or fall months, depending upon the water-year type (Martin 2007). This study examined whether lower flows could still provide acceptable or optimal whitewater opportunities, and the findings generally suggest they could. Results of the survey indicate that flows that exceed 600 cfs at Big Eddy are boatable in kayaks, and flows of 800 to 1,000 cfs at Big Eddy provide quality technical trips.

The study also showed that boaters could be attracted to the river during releases, although it is unclear whether the high use during the July and August weekends (bolstered by AW publicity about the study) would be sustained over the long term. Use levels prior to 2006 were relatively light, even though the flows were publicized in advance.

The study suggests it can be challenging to accurately meet defined target flows in the high-value whitewater segment below Big Eddy with specific Forebay releases due to complex hydrology and Project operational constraints. Modeling developed during this study has improved the ability to explain how Pit 1 Forebay releases affect flows below Big Eddy. Additional releases may allow this modeling to become even more accurate, but the number of variables (e.g., existing flow in Pit River, stage height and attenuation upstream of the Pit River Weir, agricultural activities and diversions, channel changes) will always produce variability and error in the equation. Modeling initially appeared to indicate that release flows of a higher magnitude but shorter duration could provide sufficient target boating releases that could prove advantageous to both PG&E and whitewater boaters. The idea was for PG&E to make its releases more quickly, possibly reducing operational costs and generating losses by passing water through the Pit 1 Powerhouse between releases from the forebay. This scenario, however, is not possible due to the following combination of factors: (1) the license requirement to maintain a minimum flow of 700 cfs below Pit 1 Powerhouse at all times (FERC 2003); (2) the lengthy water travel time (about 7 hours) for an increase in flow release from Pit 1 Forebay to be fully realized at the downstream end of Big Eddy Pool; and (3) the limited storage capacity of the Pit 1 Forebay. The storage capacity of the forebay is insufficient to simultaneously satisfy the ongoing maintenance release required to ensure the 700-cfs minimum and store water for the next targeted release. Consequently, there is no advantage to PG&E in releasing shorter duration, higher magnitude flows, because there is insufficient inflow and forebay storage

capacity to generate power even for a short time between whitewater releases and still maintain the 700-cfs minimum flow below the Pit 1 Powerhouse (Martin 2008).

5.2 FISH STRANDING STUDY

The Phase 2 fish stranding survey results indicated that the range of flows provided during the whitewater boating study resulted in no observable fish stranding and minimal trapping at three sites within the Pit 1 bypass reach. During the quantitative survey in August, a total of 37 fish, ranging from 65 to 116 mm FL, were observed trapped in disconnected waters, with a majority of these observations made at the Big Eddy Ledges site. The two sites established within the Lower Canyon reach showed little or no trapping over the two days of flow releases. Ancillary observations made during the July reconnaissance trip likewise found no stranded and few trapped fish.

The stranding and trapping results are consistent with earlier assessments of the Pit 1 bypass reach, which concluded that trapping would likely be a greater concern for whitewater flow releases than stranding, because of the confined, irregular channel morphology and the limited number of low-gradient bars available (EA 1993a, 1993b). Channel morphology of the Pit 1 bypass reach is generally similar to that in the Pit 3, 4, and 5 reaches where a study conducted in August 2002 evaluated trapping after the downramping of whitewater test flows from about 1,800 cfs to base flows of 100-150 cfs (Spring Rivers 2003). In that study, most fish found trapped throughout the river were between 30-110 mm FL, similar in size to what was observed in this study and within the range that would be expected for a September 15-October 30 whitewater flow release.

The study within the Pit 3, 4, 5, reaches also found a wide number of species that were trapped, including rainbow trout, Sacramento sucker, Pit sculpin, hardhead, Sacramento pikeminnow, speckled dace, Pit roach, and bluegill (Spring Rivers 2003). Based on those results, many of the species present in the Pit 1 bypass reach would have been expected to be susceptible to trapping after a whitewater flow release. However, trapped fish largely consisted of the most abundant fish within the given study reach. Hence, population-level effects resulting from some limited trapping of the more abundant fish species would be expected to be negligible. This is especially true if the whitewater boating flows are limited to those provided as part of the flushing flow releases (i.e., June, July, and August), rather than providing additional flows specifically for whitewater boating during September 15-October 30.

Importantly, based on earlier stranding surveys conducted below the Pit 1 Powerhouse (PG&E 1993), we would expect a higher incidence of stranding in August, when fish are smaller, than in

September-October. Thus, results of the Pit 1 bypass reach stranding and trapping survey conducted in August would likely represent a higher-risk scenario than in September-October, even though the risk to population levels would still appear to be negligible, as stated above. As such, because no stranding and only low levels of trapping were observed within the Big Eddy Ledges and Lower Canyon reaches during the August flow releases, it could be assumed that stranding and trapping during a September 15-October 30 period, when similar or fewer numbers of small fish would be present, would likewise be low. The resulting conclusion, therefore, would be that whitewater boating flow releases within the range of 600-900 cfs would not likely impact fish populations via stranding and trapping. As to whether a flow release at the originally recommended level of 1,250 cfs would have a greater impact on fish populations, less rigorous observations during the June and July 2006 flow releases, which usually met or exceeded 1,250 cfs, likewise indicated no stranding and a low frequency of trapping. Thus, we further conclude that whitewater boating releases of up to 1,250 cfs during the September 15 to October 30 time frame would not likely impact existing fish populations in the Pit 1 bypass reach.

5.3 RECOMMENDATION

PG&E's current recommendation, based on agency and stakeholder consultations (Appendix C), is to defer final recommendations on the potential effects of whitewater flow releases until the conclusion of the five-year comprehensive monitoring studies of critical biological resources and their habitats within the Pit 1 Project. These monitoring studies include Shasta crayfish (Article 410, 411), bald eagle (Article 419), fish (SWRCB Condition 18), northwestern pond turtles (Article 421), foothill yellow-legged frogs (Article 420), flushing flow effects on Fall River Pond vegetation (Article 401, SWRCB Condition 14), and water quality (Article 401, SWRCB Conditions 16 and 17). The purpose of these license-required studies is to monitor potential effects of the changes in flow regime under the current Project license, including conditions specified in the 401 Certification. Resource-specific recommendations derived from the monitoring studies will be provided at the conclusion of the 5-year monitoring period (i.e. filed with FERC in spring 2009 and 2010). PG&E proposes to corroborate these resource-specific recommendations with the conclusions of this study to provide a final recommendation for whitewater boating flows during the September 15-October 30 period specified by FERC (FERC 1999. 2003). The resource-specific conclusions will provide more comprehensive insight to the potential need for modification of project operations. PG&E proposes to file a final recommendation for whitewater boating flows with the resource agencies, stakeholders, and FERC by December 31, 2010.

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APPENDIX A

Phase 1 Interim Report Summary Table

Table A-1. Summary of the Phase 1 Interim report's information reviewed and recommendations for further study for resource areas in the Pit 1 Project that could be affected by whitewater boating flows.

Resource Area	Type of Information	Suitability of Information	Sufficiency of Information	Need for Additional Studies (basis) and Type of Study
Flow Regulation/Hydrology Water Quality	Site specific water quality monitoring; water quality monitoring during whitewater flow studies available from other projects.	Yes • 2 years of site-specific water quality and temperature data have been collected under new flow regime; • Nine sites sampled include above (in Fall River), within and below bypass reach; • Water quality and temperature monitoring results taken during 3 whitewater boating flow studies in Upper American River Project available.	Yes • Data collected from May 16 – October 31 • Temperature data taken in 20-min. intervals with redundancy recorders; • pH, specific conductance, dissolved oxygen, total dissolved solids, and turbidity taken bi-weekly, but inferences can be made to flushing flow events.	No If water quality measurements will be before, during, and after at least one flushing flow event in the remaining 3 years of the 5-year study plan, as noted in Whitewater Boating Flows Study Plan (PG&E 2004).

Table A-1. Summary of the Phase 1 Interim report's information reviewed and recommendations for further study for resource areas in the Pit 1 Project that could be affected by whitewater boating flows.

Resource Area	Type of Information	Suitability of Information	Sufficiency of Information	Need for Additional Studies (basis) and Type of Study
Fishery Resources	Site specific fish surveys; results from other fish stranding studies available: results from other recreation (angling)-flow studies.	Yes • 2 years of site-specific fish data have been collected post-flushing flow implementation; • sites sampled have included above (in Fall River), within and below bypass reach; • additional fish data available from 1991-1992 prior to bypass and flushing flow releases • recreation (angling)-flow studies conducted on Pit 3,4, and 5 Project, and on Klamath River.	Yes for general fish monitoring; and angling. No for assessment of potential stranding and trapping • Sampling conducted in September; • Gear type (electrofishing) selective toward larger fish; • Stranding and trapping surveys not conducted within bypass reach.	Yes – Stranding and Trapping • Type: stranding and trapping type study either during September 15 to October 30 period, or in conjunction with August flushing flow release, at locations where stranding risk high (based on channel morphology). No – Recreation (angling) • Results from two studies conducted on streams of similar channel morphology and baseflows suggest that whitewater flows greater than 1,000 cfs would negatively impact angling. Similar effect likely for the Pit 1 bypass reach.

Table A-1. Summary of the Phase 1 Interim report's information reviewed and recommendations for further study for resource areas in the Pit 1 Project that could be affected by whitewater boating flows.

Resource Area	Type of Information	Suitability of Information	Sufficiency of Information	Need for Additional Studies (basis) and Type of Study
Aquatic Invertebrates: Benthic Macroinvertebrates	Yes Site specific BMI study; results from other BMI studies available.	Yes • Project-specific study completed in 1991-1992 (McElravy 1993) to evaluate effects of daily peaking below Pit 1 Powerhouse; some data collected above powerhouse in Lower Canyon section; study provides useful information regarding taxa richness, species diversity, and other metrics that when coupled with information from other studies can be used in assessing potential impacts in the Pit 1 bypass reach; • Studies in other California rivers indicate some impacts occur, but problems in study design can preclude significant conclusions.	Yes • Sufficient data and information available from other studies, that when coupled with the Pit River data collected by McElravy (1993) will allow for a reasonable assessment of potential impacts that may result from recreational PTFs of the type proposed for the Pit 1 bypass reach.	No • Site-specific study considered; however, a) no suitable spatial control site exists; b) temporal control would need to be established to reflect baseline conditions; this would require 5-6 years of pre-test flow release data; and c) even after completion of such a study, there would likely be substantial uncertainty in determining the extent to which the whitewater PTF releases were actually influencing the BMI communities. Therefore, no additional studies warranted. • Information provided in McElravy (1993) study along with an extensive review of data and information from other issue-specific PTF studies allows for a qualitative assessment of the type and extent of impacts expected to occur in conjunction with a two-day whitewater boating flow release.

Table A-1. Summary of the Phase 1 Interim report's information reviewed and recommendations for further study for resource areas in the Pit 1 Project that could be affected by whitewater boating flows.

Resource Area	Type of Information	Suitability of Information	Sufficiency of Information	Need for Additional Studies (basis) and Type of Study
Aquatic Invertebrates: Freshwater Mussels	Site specific mussel studies; results from other mussel studies available	Yes • Mollusk inventory surveys of Pit 1 and Hat 1 and 2 in 1993-1995 • Mollusk study of 13 sites within Pit 1 Project area in 1995 to survey species of concern, California floater and montane peaclam • Malinda Gulch mussel beds in Pit 4 reach monitored during 2002 high test flow releases • CEC-funded study of effects of PTFs on Pit River mussel reproductive success	Yes • Mollusk study in 1995 found mussels throughout Pit 1 study area and assessed effects of daily peaking flows below powerhouse on mussels • Malinda Gulch mussels not dislodged or transported out of the bed during high test flows. • CEC-funded study indicates that whitewater flow releases during September 15 – October 30 period would not interfere with mussel reproductive cycles.	No • Ongoing research and surveys involving freshwater mussels appear to be adequate in assessing potential impacts of the proposed whitewater boating flows in September/October.

Table A-1. Summary of the Phase 1 Interim report's information reviewed and recommendations for further study for resource areas in the Pit 1 Project that could be affected by whitewater boating flows.

Resource Area	Type of Information	Suitability of Information	Sufficiency of Information	Need for Additional Studies (basis) and Type of Study
Aquatic Invertebrates: Shasta Crayfish	Site specific Shasta crayfish surveys; USFWS Shasta crayfish recovery plan.	Yes • 5-year Shasta Crayfish Management Plan calls for habitat mapping and crayfish surveys in Pit 1 Project area through 2008; only first-year results available; • USFWS Recovery Plan reviews life history and distributions and defines 8 populations within Pit River drainage, one within the Pit River; • Surveys in 1995 observed Shasta crayfish at 2 locations within bypass reach; and • Survey in 2005 observed Shasta crayfish within the bypass reach, immediately above Pit River Falls.	Yes • Management Plan's first year (2004) efforts focused on Fall River drainage area; • 2005 efforts included habitat mapping and surveys through Pit 1 bypass reach to Lake Britton, documenting a Shasta crayfish population, just above Pit River Falls.	No • Ongoing study plan surveys involving Shasta crayfish appear to be adequate in assessing potential impacts of the proposed whitewater boating flows in September/October.

Table A-1. Summary of the Phase 1 Interim report's information reviewed and recommendations for further study for resource areas in the Pit 1 Project that could be affected by whitewater boating flows.

Resource Area	Type of Information	Suitability of Information	Sufficiency of Information	Need for Additional Studies (basis) and Type of Study
Amphibians: Foothill Yellow-Legged Frogs (FYLF)	Site specific FYLF surveys; results from other FYLF studies available.	Yes • 5-year FYLF Protection Plan calls for habitat mapping and FYLF surveys in Pit 1 Project area through 2008; only first-year results available; • FYLF surveys conducted in Poe an RCC reaches on North Fork Feather River during whitewater boating flow releases; • FYLF monitoring conducted during boating flow release on Camino Dam reach on Silver Creek of the Upper American River Project.	Yes • First year surveys of FYLF Protection Plan found no FYLF present in the Pit 1 Project study area; • No FYLF were found in the Rock Creek reach of NFFR, but were observed and studied in the Cresta reach; • FYLF life history is most susceptible to whitewater boating flows in May and June, when in egg masses or as tadpoles; • Whitewater boating flows in September/ October appear to have little impact on the adult FYLF populations present at that time.	No • Surveys suggest FYLF not present in Pit 1 Project area; • Annual and summary reports generated by the FYLF Protection Plan should be adequate to address any potential effects that whitewater boating flows may have on this species, if present.

Table A-1. Summary of the Phase 1 Interim report's information reviewed and recommendations for further study for resource areas in the Pit 1 Project that could be affected by whitewater boating flows.

Resource Area	Type of Information	Suitability of Information	Sufficiency of Information	Need for Additional Studies (basis) and Type of Study
Northwestern Pond Turtles (NWPT)	Site specific NWPT surveys; results from other turtle studies available.	Yes • 5-year NWPT Protection Plan calls for habitat mapping and FYLF surveys in Pit 1 Project area through 2008; only first year results available; • Life history and distribution information summarized in BPA report (Holland 1994); • Southwestern pond turtle study on Lower Kern assessing response to boating activity.	Yes • First year surveys of Protection Plan found NWPT present throughout the Pit 1 Project study area; • Majority of NWPT found in Fall River Pond and Big Eddy pools: slower water habitats; • Lower densities in Pit 1 Project area consistent with NWPT densities in other large Pacific NW rivers; • Life history indicates that NWPT nest in upland habitats from April – July; hatchlings remain in nest over the winter; • Adult NWPT typically leave water by September to overwinter in upland areas; • Turtles acclimate to human recreational activities.	No • Annual and summary reports generated by the NWPT Protection Plan should be adequate to address any potential effects that whitewater boating flow may or may not have on this species; • Timing of ovipositing and overwintering behaviors place NWPT in more terrestrial habitat during the proposed period of whitewater boating flow release.

Table A-1. Summary of the Phase 1 Interim report's information reviewed and recommendations for further study for resource areas in the Pit 1 Project that could be affected by whitewater boating flows.

Resource Area	Type of Information	Suitability of Information	Sufficiency of Information	Need for Additional Studies (basis) and Type of Study
Riparian Vegetation	Site specific observations during flushing flows; habitat study in other Pit River projects.	Yes • Before, during, and after photographs of the August 2005 flushing flows were taken at 24 observation points throughout the Pit 1 bypass reach; • Riparian vegetation in the photographs were assessed for damage/negative impacts as a result of the flow release; • Results consistent with previous study (DeVries et al. 2003) of riparian zone inundation in Pit 3, 4, and 5 reaches during 2002 high test flow releases.	Yes • A stage increase of 1.2-1.6 ft was estimated for sites within the Pit Rive canyon during the August 2005 flushing flows; • Approximately 50% of *Carex* (sedge) clumps would be inundated by the estimated stage increase; • Review of the August 2005 photographic time series did not show any significant impact to sedge clumps; • Test flow releases of 1,250 to 1,750 cfs in Pit 3, 4, and 5 reaches resulted in little effect on riparian vegetation.	No • A two-day whitewater flow pulse would not be expected to significantly and adversely affect the riparian vegetation community in the Pit 1 bypass section.

Table A-1. Summary of the Phase 1 Interim report's information reviewed and recommendations for further study for resource areas in the Pit 1 Project that could be affected by whitewater boating flows.

Resource Area	Type of Information	Suitability of Information	Sufficiency of Information	Need for Additional Studies (basis) and Type of Study
Wildlife – Bald Eagles	Site specific Bald Eagle Monitoring	Yes • Extensive eagle monitoring studies from pre-relicensing effort (PG&E 1993a); • 5-year Bald Eagle Compliance Monitoring Plan calls for year-round monitoring of bald eagle use of Pit 1 Project area, and annual monitoring of bald eagle productivity; only first year (2004) results available; • Bald eagle life history information available in plans and studies.	Yes • Three nesting surveys conducted to assess nesting success in 2004; • Ten bi-weekly helicopter surveys used to assess foraging habitat usage in 2004; • Radio telemetry of 1 adult female used to assess foraging habitat use in 2004; • Life history information indicates that September/October period is well past the breeding season, and juvenile eagles migrate north during this period.	No • First year surveys indicate bald eagles are successfully breeding, in the Pit 1 Project area, as well as hunting and foraging in the bypass reach; • Annual and summary reports generated by the BECM Plan should be adequate to address any potential effects that whitewater boating flow may or may not have on this species.

Table A-1. Summary of the Phase 1 Interim report's information reviewed and recommendations for further study for resource areas in the Pit 1 Project that could be affected by whitewater boating flows.

Resource Area	Type of Information	Suitability of Information	Sufficiency of Information	Need for Additional Studies (basis) and Type of Study
Cultural Resources	Limited	No • Several cultural resources studies conducted as part of relicensing process, but not in bypass reach; • Archaeological surveys in bypass reach completed in 2004, along with additional 2005 survey to confirm site-specific conditions and erosion potential; • Cultural Resources Management Plan (CRMP) in development, but not complete; • Annual CRMP Status reports available for 2004 and 2005.	N/A • Archaeological survey results of available for review as of January 2006, due to issues of resource confidentiality and security. • Preliminary results of the 2005 survey suggest that flows and stage increases of the whitewater flow release do not compare to those produced by natural flow events. • Any impacts to cultural resources would be likely caused by natural flow events than by Project operations.	No • Information should adequately address whitewater flow impacts if the report of the 2005 cultural resource survey results is completed according to the Whitewater Flow Impacts Study Plan, and the additional proposed observations during whitewater test flow releases are conducted.

APPENDIX B

Whitewater Boater Study Report

APPENDIX C

Agency and Stakeholder Consultations