SACRAMENTO MUNICIPAL UTILITY DISTRICT
UPPER AMERICAN RIVER PROJECT
(FERC NO. 2101)

CAMINO REACH WHITEWATER BOATING FLOW STUDY TECHNICAL REPORT

Prepared by:

Devine Tarbell & Associates, Inc.
Sacramento, California

The Louis Berger Group
Oakhurst, California

Prepared for:

Sacramento Municipal Utility District
Sacramento, California

MARCH 2005

TABLE OF CONTENTS

Section & Description **Page**

TABLE OF CONTENTS

Section & Description **Page**

LIST OF TABLES

Table No. & Description **Page**

LIST OF FIGURES

Figures No. & Description **Page**

LIST OF APPENDICES

Appendix & Description

LIST OF APPLICABLE STUDY PLANS

Description

- Camino Whitewater Boating Study Plan
- Camino Dam Whitewater Boating Flow Biological Study Plan

8.11 Camino Whitewater Boating Study

8.11.1 Pertinent Issue Questions

The Camino Whitewater Boating Study addresses the following recreational resource questions:

6. What maximum and minimum flow regimes are required for whitewater boating in the stream reaches affected by the Project, including Upper Rubicon River
19. Can there be a flow management hydrology model (unimpaired hydrograph) built with a whitewater filter that estimates flows assuming UARP/Chili Bar presence and absence?
68. What is the need for, and feasibility of, whitewater boating in the reaches below Project dams?

8.11.2 Background

The objectives of the Whitewater Boating Feasibility Study (see *Technical Report on Whitewater Boating Feasibility, February 2004*) included:

- Identify and describe reaches where there are existing or potential whitewater opportunities
- Quantify how the Project affects these opportunities (i.e., flows, boatable days, season of use, access)
- Characterize whitewater opportunities affected by Project operations based on physical characteristics, existing information and interviews (e.g., gradient, length, access, channel characteristics, flows, reservoir storage and diversion capacity)
- Determine current and future demand for whitewater boating on Project reaches
- Develop a range of possible flows to provide other TWGs before conducting additional studies
- Describe and assess the adequacy and availability of existing flow information
- Recommend additional studies needed for whitewater resources (e.g., Single Flow Feasibility Study or Controlled Flow Study)

Reconnaissance conducted as part of the Whitewater Boating Feasibility Study was completed in 2002 and a presentation of the methods and results was made to the Recreation TWG on January 22, 2003. Subsequent documentation of the reconnaissance was presented to the Recreation TWG on February 5, 2003. Helicopter reconnaissance of South Fork Silver Creek below Ice House Reservoir and Silver Creek below Camino Reservoir was conducted on December 18th, 2003. The *Technical Report for the Whitewater Feasibility Study* was distributed to the TWG's in February 2004. Based on the report findings the TWG participants did not determine that further studies were not warranted, and further studies were considered. The need for a controlled flow study on the Camino Reach was discussed at Recreation TWG meetings on April 28th, 2004 and at an Internal Focus Group (IFG) on May 10th, 2004. During these meetings the representatives from the Forest Service, El Dorado County, American Whitewater along with Bill Center, expressed their concern that additional information was needed on the Camino Reach to determine the relative quality of this reach and range of acceptable flows. Based on their recommendations a single flow study was proposed to be conducted in the Fall 2004.

8.11.3 Study Objectives

The objectives of this study include:

- Identify current and potential boating opportunities on the Camino reach. Opportunities may vary by craft, skill level, or preferences for different types of whitewater conditions.
- Identify flow-related attributes for each of those opportunities, including a description and classification of key rapids.
- Develop relationships between flow levels and quality of whitewater experience for the Camino Reach. Resulting "flow evaluation curves" will identify minimum and maximum acceptable flows and optimum flow ranges for each reach for a variety of watercraft.
- Determine the whitewater difficulty using the International Scale of Whitewater Difficulty (American Whitewater 1963) for the reach within the range of test flows.

- Determine what types of watercraft are suited for the reach within the range of test flows.
- Characterize the whitewater resource in the reach in terms of quality of the opportunity and suitability for whitewater boating.
- Determine what operational challenges may exist in providing flows in the boatable range.
- Quantify how the Project has affected the frequency and timing of boatable days available in this reach.

8.11.4 Study Area and Sampling Locations

The study area is defined as the Project reach directly downstream of Camino Dam (between Camino Dam and Slab Creek Reservoir).

8.11.5 Information Needed From and Coordination with Other Studies

Hydrology data to determine the annual number of days and timing of boatable flows that occur under regulated and unimpaired conditions in this reach. Channel morphology and habitat mapping information may be useful to review in the analysis.

Provide timing, duration and magnitude of test flows as soon as practical to other TWGs. The Aquatics TWG will develop a set of concurrent studies that will focus on aquatic resources that could potentially be affected by the study flows.

8.11.6 Study Methods And Schedule

The Camino Whitewater Boating Study requires that a team of boaters paddle a given stream at the specified flow. Although SMUD will assist with the shuttle, participants will travel the entire shuttle route as if they were unassisted to evaluate shuttle as a component of the overall run. The group of participants will then individually complete a single flow survey questionnaire querying them on a number of whitewater and non-whitewater characteristics specific to the run. Participants will also complete a survey questionnaire asking them to make judgments on a range of flows for this reach. A video taped group discussion structured with specific questions will be conducted at the conclusion of the run. This group discussion is designed to allow participants to comment on characteristics and observations that may not have been captured in the survey questionnaire.

The methodology to complete the Camino Whitewater Boating Study will include an organized boating trip on the Project reach at **600 cfs**. Boating teams of between six to 12 kayaks and other crafts suitable for small creek type of boating on the Camino Reach will be organized to run the reach.

The existing information about the whitewater resource on the Camino Reach indicates that current boating opportunities are constrained by the Project diversions around the reach. The target flow for this run was selected anticipating that study participants will be able to provide information about a range of boatable flows.

The boating team members will have the skills necessary to boat the reach. Boating participants will be selected by interested TWG participants. Each boater will sign a waiver of liability prior to participating in the study. The primary data for this study will consist of the boaters' responses to questionnaires that they will complete at the conclusion of each run. The questionnaire will include a section to gather data for a comparative flow evaluation for the reach. A draft of the questionnaire has been prepared and is attached to this study plan. Comments and changes to the questionnaire will be incorporated prior to initiating the study. The type of data to be collected include: 1) boatability, 2) quality of the reach, 3) suitability of the run for different crafts and boater skill levels, 3) quality of the put-in/take-out locations, 4) boater's opinion of the class of difficulty of the run, 5) quality and length of the shuttle, 6) any safety concerns or hazards, 7) scenic quality, 8) number and difficulty of portages, 9) availability of play areas, 10) length and difficulty of the shuttle, and 11) boater's opinion of the flows that would represent the general paddling public preference.

If practical, the locations of any significant boating hazards or log jams in the reach will be made using GPS equipment during the study flow.

The study methods will include videotaped recordings and/or photographs taken at key locations on the run. The post-run discussion among the boaters (after the team has completed the questionnaires) will also be recorded on videotape. The post run group discussion, will include identifying suitable locations in the reach for lunch or break stops, possible overnight use locations, access and potential for commercial boating use in the reach as well as discussing other general aspects of the reach. The questions for the group discussion will be developed with interested TWG participants during the process of reviewing and finalizing the questionnaires that will be used in the study.

The schedule for conducting the Camino Whitewater Boating Study is listed below:

Camino Reach: September 15, 2004

Although the Licensee has every intention of completing this study in September 2004, this study plan needs to include a contingency for unforeseen power generation needs or because of biological concerns raised by the Aquatics TWG.

8.11.7 Analysis

The information developed in this study will be used to describe the whitewater boating opportunities on this reach, quality of the run, ease of the shuttle (in terms of time, distance, quality of route), access at both put-ins and take-outs, scenic quality, class of difficulty and boatability. The data collected will be summarized and analyzed for frequencies of responses and general trends that may exist in the data. The questionnaire responses will be used to estimate by watercraft type, the minimum and maximum acceptable boating flows and optimum boating flow for the reach that is within the normal peaks of the natural hydrograph. These definitions (Whittaker et al. 1993) are:

- Minimum Acceptable Flow: the lowest flow at which 50% of the survey respondents will return to paddle.
- Maximum Acceptable Flow: the highest flow at which 50% of the survey respondents will return to paddle.
- Optimum Flow: The flow level that provides the best combination of flow conditions for a whitewater opportunity. The optimum flow is the peak of the flow preference curve.
- Flow Preference Curve: the graphic relationship between flow (vertical axis) and survey responses (horizontal axis).

Hydrology data for the period of record (1975 to 2001) will be analyzed to display how often boatable flows, as identified by the boaters, including optimum flows, have occurred under unimpaired and regulated conditions. The analysis will also identify when these flows have occurred over the period of record (number of days with boatable days per month and water year type) under unimpaired and regulated conditions. Hourly data will be used, where available or where it can be synthesized. Information about the hydrologic conditions as they relate to the contribution of the flows to the reach from the SFAR will also be presented.

Other hydrologic factors that may affect boating opportunities will also be analyzed. These will include how quickly typical spill flows move through the boatable range and whether there are other flow fluctuations that make it difficult to boat this reach under current operations.

8.11.8 Study Output

A written report will be prepared to include documentation of survey findings with presentation in graphical and discussion format in a manner which appropriately answers issue questions. The study output will include a USGS quad map showing basic information about the runs including the location of the put-ins and take-outs, potential break or lunch stop locations, portages, locations of barriers/log jams, areas with safety concerns, shuttle route, and locations of photographs or videotape recordings taken during the study. The study output will also include the summarized responses to the questionnaires, flow preference curves, photographs showing portions of the runs, put-ins and take-outs, and edited videotape of the run and post-run group discussion. The edited video will capture watercraft at selected rapids. The output will also include graphical and tabular data to compare the number and timing of boatable days that occur under unimpaired and regulated conditions in this reach. Operational aspects of the Project such as the low level outlet valve and the minimum instream flow requirements will be presented in the report.

8.11.9 Recreation and Aesthetic TWG Endorsement

This study plan was approved on June 23, 2004 by the following entities of the TWG: Eldorado National Forest, American River Recreation Association/Camp Lotus, National Park Service, El Dorado County Parks and Recreation, El Dorado County Water Agency, PG&E and SMUD. The Plenary Group approved this plan on September 1, 2004. None of the participants at the meeting said they could not "live with" this study plan.

8.11.10 Literature Cited

American Whitewater, 1963. International Scale of Whitewater Difficulty.

Whittaker et al. 1993. Instream Flows for Recreation: A Handbook on Concepts and Research Methods. U.S. Department of the Interior.

8.11 Camino Dam Whitewater Boating Flow Biological Study Plan

8.11.1 Pertinent Issues

This study, performed in conjunction with the Camino Dam Reach Whitewater Boating Test Flow Study, is designed to address the effects of a release of a whitewater boating flow on aquatic resources in the Camino Dam Reach. This study plan is specific to this particular whitewater test flow event, currently scheduled for September 15, 2004, and additional studies may be necessary for whitewater boating flow releases at other times. In particular, additional biological studies are expected for any springtime flow events.

In general, the study plan is comprised of five separate investigations, each focused on the effect of the whitewater flow on different components of the aquatic environment. These are listed below and described in greater detail further in this study plan:

- Continuously monitoring of water temperature, total suspended solids, turbidity, and dissolved oxygen at three different sites in the affected reach before, during, and after the boating release.
- Qualitative evaluation of changes in FYLF distribution or presence/absence before and after the boating release.
- Documentation of changes in river stage, and by inference amphibian habitat, during the boating release at known areas of foothill yellow-legged frog (FYLF) presence.
- Sampling of the of the benthic macroinvertebrate (BMI) community at two sites in the affected reach and at a single control site in the South Fork American River before and after the boating release.
- .Evaluation of bed mobility at sites of documented FYLF populations.

8.11.2 Background

The Camino Dam Reach Whitewater Boating Test Flow Study will involve the release of water from the Camino Reservoir. The increase of flow through the Camino Dam Reach will be performed on a single day in order to determine the feasibility of whitewater boating within this particular reach. The flow single flow that will be released for these purposes is 600 cfs. This flow will be released on September 15, 2004.

Flows will be ramped up to and down from the 600 cfs test flow. Flows will be ramped from the current minimum flow at a rate of one foot per hour.

8.11.3 Study Objectives

The primary objectives of the water quality and biological monitoring are: 1) monitor the temperature, turbidity, total suspended solids, dissolved oxygen and flow stage during the whitewater flow release from the Camino Dam, 2) identify the change in the BMI community resulting from the release, and 3) measure changes in river stage at FYLF sites during the course of the whitewater flow.

8.11.4 Study Area

The study area will include the Camino Dam Reach of Silver Creek. The Camino Dam Reach includes Silver Creek from immediately below Camino Dam downstream to the confluence with the South Fork American River. An additional study area for the BMI investigation will include a control site that has been previously used as a reference site for the Camino Dam Reach – the South Fork American River at Ice House Road.

8.11.5 Study Methods and Schedule

Water Quality

The purpose of the water quality investigation is to evaluate the magnitude and duration of changes in specific water quality parameters before, during, and after the boating flow release. Four components will be monitored: (1) water temperature (°C), (2) turbidity (NTU), (3) dissolved oxygen (mg/L) and (4) total suspended solids (TSS). The first three parameters will be continuously monitored using temporarily installed instrumentation at three locations: 1) directly below Camino Dam; 2) approximately midway through the bypass reach, adjacent to the Camino Tunnel Adit spoil pile; and 3) at the mouth of Silver Creek. The instrument used to gather data on these parameters will be a Troll XP MPT 9000 *in situ* sampler, which will be programmed to record information every 15 minutes. The sampling instruments will be installed approximately one week prior to the release date and will be removed approximately one week after the release. Water quality parameters will be recorded beginning at least 48 hours before the test flow, and continuing at least 48 hours after the end of the test flow.

Total suspended solids, which cannot be monitored with the Troll XP MPT 9000 instrument, will be monitored by hand regularly during the boating release event. Sampling will consist of filing a 500ml polyethylene bottle every 1.5 or 2 hours during the course of the boating release event. Filled sample bottles will be chilled either in river water or in an ice bath and transported to a laboratory for analysis (EPA 160.2). TSS sampling will be performed below Camino Dam and adjacent to the spoil pile. TSS sampling will not be performed at the mouth of Silver Creek for logistical and safety reasons (see more detailed discussion of safety constraints in FYLF investigation).

Foothill Yellow-legged Frog

The purpose of the FYLF investigation is to qualitatively evaluate changes in FYLF distribution or abundance at previously surveyed sites in the Camino Dam Reach (Camino Tunnel Adit Site, and Silver Creek Confluence Site). Visual encounter surveys (VES) will be performed within a week prior to and 1-2 weeks after the boating release to: 1) verify the continued presence of FYLF at these sites, and 2) qualitatively evaluate changes in distribution or abundance of FYLF resulting from the test flow. The VES effort will cover the same areas and use the same methods as the previous VES.

In addition to the VES, a pair of amphibian specialists will be onsite at the Camino Tunnel Adit spoil pile study site during the flow release on September 15, in a safe and secure location along the river margin prior to the release. During the release, observations will be made of changes in habitat and hydraulic conditions in areas previously studied during the Amphibian Habitat Flow Study. These areas include polygons delineated during the prior study, as well as any known locations of egg deposition, tadpole observations, etc. Where safely feasible along the margin of the river, additional hydraulic measurements (depth and velocity) will be made to quantify changes in habitat during the high-test flow.

Flow and Stage Changes

The purpose of the flow and stage (water surface elevation) change task is to monitor stage changes at known FYLF sites during the test flow event, in order to help quantify the extent of habitat changes for FYLF. This task will be accomplished by regularly monitoring the stage of Silver Creek at known areas of FYLF use during the course of the boating flow passing through the bypass reach. At the Camino Tunnel Adit spoil pile study site, this will be accomplished by having the amphibian specialists monitoring a temporary staff gage every 15 minutes during the course of their other work for the FYLF habitat evaluation (described above). The staff gage will be digitally photographed at each 15-minute interval, to provide a visual record of the stage height and surrounding hydraulic conditions.

At the Silver Creek confluence site, the study area is not safely accessible during high flow events. Stage changes will be recorded by installing a digital water surface elevation logger (level loggers) (Levellogger model 3001, Solinst Canada Ltd.). Level loggers measure relative changes in river stage height to the nearest 0.01 ft (at 15 minute intervals) by measuring changes in total pressure, which includes both water and atmospheric pressure. To correct for changes in atmospheric pressure, one level logger will be placed on the shore in a sheltered open-air location as a control. The instream level logger will be placed in a pool or backwater at least 2-3 ft deep and sheltered from high velocities and turbulence. Level loggers will be housed in metal casings and cabled to the stream bank. The loggers will be deployed in the week preceding the flow event, and removed after the flow event is complete.

Benthic Macroinvertebrates

The purpose of the BMI investigation is to evaluate changes to the BMI community associated with the whitewater boating release. The basic design of the investigation is a sequential pre- and post-boating release sampling effort. The BMI investigation will be performed at three sampling locations, two in the Camino Dam bypass reach, which will demonstrate the change in the BMI community between the pre- and post-sampling periods, and a third location that will serve as a control site. The control site will be located on the South Fork American River at Ice House Road, the same site that was used in the UARP BMI study as a reference. This site will serve as a control site, demonstrating changes in BMI communities occurring naturally between the pre- and post- sampling period. Natural changes in the BMI community may result from changes in water temperature among other factors.

The same field sampling procedure and laboratory processing protocol used in the previous BMI study of the UARP relicensing will be applied to this investigation. The same riffles will be selected for sampling at CD-I1, CD-I2, and SFAR in 2003. The BMI samples collected post-boating flow release will be collected along transects in the same riffles as pre-boating release samples, in an area just upstream of the previous sampling transect. A metal square or similar device will be used to more consistently delineate the sampling area that is disturbed upstream of the net.

The pre-boating release sampling effort will be performed approximately one week in advance of the September 15. The post-boating release sampling effort will be performed approximately 30 days after boating release, with a goal of detecting whether any substantial disruption of the BMI community is detectable 30 days after the test flow event. Changes in the BMI community of Silver Creek between the pre- and post-boating releases will be analyzed with respect to changes at the control site. Information from the previous years of sampling in the Camino Dam Reach will also be compared to the results of this investigation.

Streambed Mobility

The purpose of the streambed mobility task is to document whether the boating test flow results in mobilization or scouring of the streambed, resulting in potential effects on habitat for aquatic species. Prior to the boating test flow, a series of rocks in a line along the stream bottom will be marked *in-situ* with waterproof paint. The number of marked rocks, their approximate size distribution, and the endpoints of the survey line will be recorded. The sampling area will be photographed. Following the test flow, the area will be revisited and changes in the number and distribution of the marked rocks will be measured (e.g., number of rocks missing, displacement distance of rocks, size of displaced rocks, etc.) to provide an indication of bedload movement during the event.

8.11.6 Study Output

The final study output will be a written report that includes the issues addressed, objectives, study area, methods, analysis and results.

CAMINO REACH WHITEWATER BOATING FLOW STUDY TECHNICAL REPORT

SUMMARY

SMUD primarily investigated the feasibility of whitewater boating on the Upper American River Project (UARP or Project) Reaches in the Whitewater Boating Feasibility Study. Based on the findings in the study, it was determined that there was not enough existing information about the Camino Reach of Silver Creek to assess the effects of the Project on whitewater boating opportunities. Specifically, the class of difficulty, boating suitability and the range of boatable flows could not be accurately determined from existing information. SMUD developed the Camino Whitewater Boating Study to collect this information to use in characterizing the Project effects on boating opportunities.

This study included a team of kayakers and rafters who boated the Camino Reach at a target flow of 600 cfs. The actual flow measured during the study was 650 cfs. The study was conducted on September 15, 2004. Upon completion of the run, boaters completed evaluation forms that provided information about various reach characteristics including class of difficulty and the desirability of a various flow levels. Participants also participated in a focus group discussion in order to obtain additional information on the run.

The difficulty class for the entire reach was rated class V, and is most suited for boaters with advanced skills or better. The time taken to complete the run was seven hours and twenty minutes. The paddling team described three distinct sections on the run. The boaters reported that the reach is aesthetically pleasing with a very remote feel to the run. The paddlers reported between 3 and 13 portages on the reach. The portage routes were generally considered slightly difficult. Participants felt that the rapids on this run were less clean than other comparable runs. Most of the paddlers stated that they would not return to do this run at the test flow level (650 cfs). The shuttle on this run was considered to be rather long at approximately one hour and fifteen minutes, one way.

The study results provided a basis to determine a range of acceptable and optimal flows. The evaluation responses indicate that the minimum navigable flow for the reach is approximately 600 cfs. Most boaters felt that flows between 650 cfs and 830 cfs would provide the optimal range of boating flows. The acceptable boating range was determined to be between 600 and 1,100 cfs. There was less variation on boaters' responses about minimum flows than their responses about maximum flows.

In addition, SMUD characterized the boating opportunities that existed with the current UARP operations over the past 25 years, and the boating opportunities that might have existed over that same period if there were no developments upstream of Camino Reach. This analysis was done using water year types recommended by the UARP Relicensing Water Year Type Subgroup. The analysis showed that, on average, there would have been fewer boatable days in all water year types, generally between March and June, with the UARP in place than might have occurred if no water developments had been in place during this 25-year period. Analyzing the synthesized unimpaired flow data, flows in the boatable range did not usually extend beyond June except in Above Normal or Wet water year types.

1.0 INTRODUCTION

This technical report is one in a series of reports prepared by Devine Tarbell & Associates, Inc., (DTA) and The Louis Berger Group, Inc. for the Sacramento Municipal Utility District (SMUD) as an appendix to SMUD's application to the Federal Energy Regulatory Commission (FERC) for a new license for the Upper American River Project (UARP or Project). This technical report focuses on the whitewater boating resources, which were evaluated under a controlled flow study, in the 9-mile-long-section of Silver Creek between Camino Dam and Slab Creek Reservoir (Camino Reach). This report includes the following sections:

- **BACKGROUND** – Includes when the applicable study plan was approved by the UARP Relicensing Plenary Group; a brief description of the issue questions addressed, in part, by the study plan; the objectives of the study plan; and the study area. In addition, requests by resource agencies for additions to this technical report are described in this section.
- **METHODS** – A description of the methods used in the study, including a listing of study sites.
- **RESULTS** – A description of the salient data results. Raw data where copious and detailed model results are provided by request in a separate compact disc (CD) for additional data analysis and review by interested parties.
- **ANALYSIS** – An analysis of the results, where appropriate.
- **FINDINGS** – A broad statement of study findings
- **LITERATURE CITED** – A listing of all literature cited in the report.

This technical report does not include a detailed description of the UARP Alternative Licensing Process (ALP) or the UARP, which can be found in the following sections of SMUD's application for a new license: The UARP Relicensing Process, Exhibit A (Project Description), Exhibit B (Project Operations), and Exhibit C (Construction).

Also, this technical report does not include a discussion regarding the effects of the UARP on whitewater boating or associated environmental resources, nor does the report include a discussion of appropriate protection, mitigation and enhancement measures. A discussion regarding resource impacts associated with the UARP is included in the applicant-prepared preliminary draft environmental assessment (PDEA) document, which is part of SMUD's application for a new license. Development of resource measures will occur in settlement discussions, and will be reported on in the PDEA.

2.0 BACKGROUND

The UARP Recreation and Aesthetics Technical Working Group (Recreation TWG) developed a total of eight recreation studies to collect information to answer the issue questions relating to recreation resources associated with the UARP. One of these studies, the Whitewater Feasibility Study, revealed that the Camino Reach had only been run twice, once in 1983 and once in 1998. It was determined that there was insufficient information regarding the whitewater resources related to the Camino Reach (See *Whitewater Feasibility Technical Report*). Subsequent documentation of the reconnaissance was presented to the Recreation TWG on February 5, 2003. Helicopter reconnaissance of Silver Creek below Camino Reservoir was conducted on December 18, 2003. The need for a controlled flow study on the Camino Reach was discussed at Recreation TWG meetings on April 28, 2004 and at an IFG meeting on May 10, 2004. During these meetings the representatives from the Eldorado National Forest, El Dorado County, American Whitewater along with Bill Center, expressed their concern that additional information was needed on the Camino Reach to determine the relative quality of this reach and range of boatable flows. Based on their recommendations a single flow study was planned and conducted in the fall of 2004.

Consequently, the Camino Whitewater Boating Study was developed to provide additional information and this report contains the results of the study.

2.1 Camino Whitewater Boating Study Plan

On September 1, 2004 the UARP Relicensing Plenary Group approved the Camino Whitewater Boating Study Plan. The study plan was designed to address, in part, the following issues questions developed by the UARP Relicensing Plenary Group:

Issue Question 1a	Is it possible to have consistent and regular releases that support boating in the reach between Camino Dam and Chili Bar Reservoir?
Issue Question 3a	What are the effects of potential boating flows on water levels of Project reservoirs?
Issue Question 6	What maximum and minimum flow regimes are required for whitewater boating in stream reaches affected by the Project, including upper Rubicon River?
Issue Question 19	Can there be a flow management hydrology model (unimpaired hydrograph) built with a whitewater filter that estimates flows assuming UARP/Chili Bar presence and absence?
Issue Question 68	What is the need for, and feasibility of, whitewater boating in the reaches below Project dams?

Specifically, the objectives of the study plan were to:

- Identify current and potential boating opportunities in the Camino Reach. Opportunities may vary by craft, skill level, or preferences for different types of whitewater conditions.
- Identify flow-related attributes for each of those opportunities, including a description and classification of key rapids.
- Develop relationships between flow levels and quality of whitewater experience for the Camino Reach. Resulting “flow evaluation curves” would identify minimum and maximum acceptable flows and optimum flow ranges for a variety of watercraft.
- Determine the whitewater difficulty using the International Scale of Whitewater Difficulty (American Whitewater 1963) for the reach within the range of test flows.
- Determine what types of watercraft are suited for the reach within the range of test flows. (Note: this study was designed as a single flow study.)
- Characterize the whitewater resource in the reach in terms of quality of the opportunity and suitability for whitewater boating.

- Determine what operational challenges may exist in providing flows in the boatable range.
- Quantify how the Project has affected the frequency and timing of boatable days available in this reach.

As discussed above, this *Camino Whitewater Boating Study Technical Report* does not address UARP impacts or protection, mitigation or enhancement measures. Therefore, this report does not address Issue Questions 1a, 3a, 19 and 68 or the study objective relating to operational challenges to providing flows in the boatable range. Note that Issue Questions 3a and 19 may be addressed using the UARP CHEOPS Water Balance Model.

2.1.1 Whitewater Boating Flow Ecological Study Plan for Camino Reach

On September 1, 2004 the Aquatic/Water Quality/Geomorphology/Hydrology Resources Technical Working Group approved the Whitewater Boating Flow Ecological Study Plan. The primary objective of the study is to determine if high flows released from Camino Dam for purposes of whitewater boating will adversely affect the water quality in Silver Creek. Secondary objectives include documenting changes of bed form features associated with aquatic habitat resulting from inundation as well as potential for fish stranding as water levels recede. Results from this study are provided in Appendix G of this report.

2.2 Water Year Types

The information in this subsection is provided for informational purposes, as requested by agencies. The UARP Relicensing Water Balance Model Subcommittee established five water year types to be applied to all preliminary analysis with the understanding that the UARP Relicensing Plenary Group, with cause, may modify the current water year types in the future.

The five current water year types are triggered by the February 1, March 1, April 1 and May California Department of Water Resources (CDWR) forecast for total water year unimpaired inflow into Folsom Reservoir. An additional trigger is CDWR's October 1 estimate of the actual total water year unimpaired inflow into Folsom Reservoir. The February 1 forecast determines the water year type applied for the period from February 10 through March 9: the March 1 forecast the period from March 10 through April 9; the April 1 forecast the period from April 10 through May 9; the May 1 forecast the period from May 10 through October 9; and the October 1 estimate the period from October 10 through February 9. The inflow levels area:

- Critically Dry (CD) Water Year — Less than 900,000 acre-feet
- Dry (D) Water Year — From 900,001 to 1,700,000 acre-feet
- Below Normal (BN) Water Year — From 1,700,001 to 2,600,000 acre-feet
- Above Normal (AN) Water Year — From 2,600,001 to 3,500,000 acre-feet
- Wet (W) Water Year: — More Than 3,500,000 acre-feet

The study described in this Technical Report covers the period of record. For this period, the water year types by month are shown in Table 2.2-1.

Table 2.2-1. Application of UARP Relicensing Plenary Group water year types for the period from Calendar Year 1975 through 2001.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1975	W	D	BN	BN	AN	AN	AN	AN	AN	AN	AN	AN
1976	AN	D	D	CD	CD	CD	CD	CD	CD	CD	CD	CD
1977	CD	CD	CD	CD	CD	CD	CD	CD	CD	CD	CD	CD
1978	CD	AN	AN	AN	W	W	W	W	W	AN	AN	AN
1979	AN	D	BN	BN	BN	BN	BN	BN	BN	BN	BN	BN
1980	BN	AN	W	W	W	W	W	W	W	W	W	W
1981	W	D	D	D	D	D	D	D	D	D	D	D
1982	D	W	W	W	W	W	W	W	W	W	W	W
1983	W	W	W	W	W	W	W	W	W	W	W	W
1984	W	W	W	W	W	W	W	W	W	W	W	W
1985	W	BN	BN	BN	D	D	D	D	D	D	D	D
1986	D	BN	W	W	W	W	W	W	W	W	W	W
1987	W	D	D	D	CD	CD	CD	CD	CD	CD	CD	CD
1988	CD	BN	D	CD	CD	CD	CD	CD	CD	CD	CD	CD
1989	CD	D	D	BN	BN	BN	BN	BN	BN	BN	BN	BN
1990	BN	D	D	D	D	D	D	D	D	D	D	D
1991	D	CD	CD	D	D	D	D	D	D	D	D	D
1992	D	D	D	D	D	D	D	D	D	CD	CD	CD
1993	CD	AN	AN	AN	AN	AN	AN	AN	AN	AN	AN	AN
1994	AN	D	D	D	CD	CD	CD	CD	CD	CD	CD	CD
1995	CD	W	AN	W	W	W	W	W	W	W	W	W
1996	W	BN	AN	AN	AN	AN	AN	AN	AN	W	W	W
1997	W	W	W	W	W	W	W	W	W	W	W	W
1998	W	AN	W	W	W	W	W	W	W	W	W	W
1999	W	AN	W	AN	AN	AN	AN	AN	AN	AN	AN	AN
2000	AN	BN	AN	AN	AN	AN	AN	AN	AN	AN	AN	AN
2001	AN	D	D	D	D	D	D	D	D	D	D	D

2.3 Agency Requested Information

In a letter dated December 17, 2003 to SMUD, the agencies requested that SMUD provide specific information in various technical reports. The Camino Whitewater Boating Study was developed after this letter was provided to SMUD. Consequently the agencies' letter does not include any specific requests for information to be provided in this technical report.

3.0 METHODS

The study methods conformed to those approved by the UARP Relicensing Plenary Group. The study required a team of boaters to paddle the Camino Reach at a single flow of approximately 600 cfs. Then, each participant individually completed a questionnaire that queried the participant about a number of whitewater characteristics specific to this flow. Participants were also asked to complete a comparative evaluation form that provided an appraisal of a range of potential flows for this reach. Following completion of the questionnaires, a post-run group discussion was conducted and videotaped. Portions of the run during the study were also recorded on videotape.

3.1 Target Flows and Schedule

The target flow used in this study was developed using the following resources:

- Interview responses collected as part of the Whitewater Feasibility Study (see *Whitewater Feasibility Technical Report*)
- Video photography of the Project Reach taken from low-flight helicopter
- USGS quadrangle maps

The Recreation TWG participants evaluated this information and agreed upon the target flow for the study. Based on the previously mentioned resources the target flow for the Camino Whitewater Boating Study was 600 cfs.

The study was conducted, as scheduled, on September 15, 2004.

3.2 Boating Participants

Given the perceived difficulty and length of the Camino reach a small group of nine participants was selected for the study. Selecting a small group size would improve the group's ability to move quickly and efficiently down the 9-mile reach. The participants were selected based on several criteria. Boaters needed to have the skills necessary to boat rivers of class V difficulty. There was also a desire to have paddlers that had participated in the Slab Creek Whitewater Boating Study, which was conducted in 2003. Six of the nine paddlers had participated in the Slab Creek Whitewater Boating Study; all but two of the boaters had previous experience with whitewater boating studies so most of the participants had some experience with the process. In addition to meeting these criteria all participants were recommended to participate in the study by members of stakeholder groups participating in the UARP relicensing effort.

3.3 UARP Operations During the Study

The flows for the study were provided in the reach by spilling water through the spill gates at the top of Camino Dam. Several operational challenges had to be overcome in order to provide stable flows at the target flow of 600 cfs below the Camino Dam. To ensure the water kept flowing during the study and for a quick response if there were any problems with the upstream plants supplying the water for the study, hydro operators were stationed at Union Valley Powerhouse, Jaybird Powerhouse and Camino Powerhouse. Even though Camino Powerhouse was downstream of the reach it was operated to keep the elevation at Camino Reservoir constant. There was one hydrographer and one weather shop employee at the Camino Dam site to monitor the instrumentation and provide information needed by SMUD's PSO (power systems operations) to hold the flow at a constant flow during the study. The flows were measured every 15 minutes using a staff gauge that is located approximately one-half mile down stream from the dam and applying a stage-discharge relationship to determine the flow. The test flow was ramped at a rate of one foot per hour and the flow was achieved as follows:

Table 3.3-1. Flows during the Camino Whitewater Boating Study at 15 minute intervals.

Ramp up		Test Flow				Ramp Down	
Time	Flow (cfs)	Time	Flow (cfs)	Time	Flow (cfs)	Time	Flow (cfs)
6:31	19	9:16	544	12:01	639	14:46	466
6:46	44	9:31	590	12:16	649	15:01	470
7:01	54	9:46	659	12:31	654	15:16	462
7:16	61	10:01	654	12:46	649	15:31	466
7:31	143	10:16	644	13:01	649	15:46	213
7:46	167	10:31	649	13:16	649	16:01	203
8:01	199	10:46	649	13:31	634	16:16	203
8:16	199	11:01	634	13:46	634	16:31	199
8:31	363	11:16	659	14:01	654	16:46	130
8:46	418	11:31	654	14:16	654	17:01	67
9:01	522	11:46	639	14:31	629	17:16	61

Figure 3.3-1. Camino Dam spilling during flow study.

3.4 Data Collection

There were many tools used to obtain data for the whitewater flow study. A general information form, a single-flow evaluation form, as well as a comparative-flow evaluation form was given to the participants after the run was completed. Video recordings and photographs of portions of the runs at the test flow, and video recordings of the post-run group discussions were also used in the data collection.

The flow evaluation forms were prepared by SMUD and presented to the Recreation TWG for review and comment. SMUD incorporated the suggested changes made by this group. The forms were approved by the Recreation TWG following the revisions. The evaluation forms included questions about: 1) boatability; 2) quality of the reach; 3) suitability of the run for different crafts and boater skill levels; 4) quality of the put-in/take-out locations; 5) boater's opinion of the class of difficulty of the run; 6) boater's opinion of the acceptability of this run at different flows; 7) any safety concerns or hazards; 8) scenic quality; 9) number and difficulty of portages; 10) availability of play areas; and 11) boater's opinion of the flows that would represent the general paddling public preference. Copies of the evaluation forms are included in Appendix A of this report.

SMUD's staff was available to clarify questions for the participants while they were filling out the questionnaires at the conclusion of the test flow however, the staff did not interpret the evaluation questions for the participants. The completed evaluation forms were checked by SMUD's staff for legibility, incomplete responses and for responses that were not provided consistent with the directions on the forms. The study staff directed the participants to correct any of these deficiencies on their evaluation forms before they departed for the day.

After the evaluations were completed, a group discussion took place. The post-run group discussion topics included: 1) access at the put-in/take-out location; 2) shuttle; 3) suitability of the run for commercial use; 4) the time of year when boaters would be likely to boat the reach; 5) names of rapids; 6) class of difficulty; 7) suitability for different crafts; 8) safety concerns; 9) alternate locations for take-outs; and 10) availability of lunch or break stops in the run. SMUD compiled a videotape of pertinent recordings made during the study, which is made part of this report.

4.0 RESULTS

4.1 Study Participants

A list of all of the study participants is included in Appendix B. There were nine boaters who participated in the study. Seven of the participants paddled the reach in hard-shell kayaks. Two of the participants paddled a 12-foot raft. All participants were considered expert boaters and had an average of thirteen years of experience boating at this level. All but one of the paddlers had some commercial experience. Only one of the participants had completed this run in the past. This was not surprising since only two known runs had been recorded in the previous investigation (see *Whitewater Feasibility Technical Report*). Most of the participants reside within one to two hours of driving time of this run. The group consisted of 9 men between 31 and 46 years of age, an average age of 39 years. Participants were asked to respond to a series of questions about their boating preferences. In general, responses to the boating profile revealed that the group generally had more of an affinity for steep technical class IV/V rivers than for whitewater playboating. Members of the group generally felt confident to rate rivers for people with different skill levels. A summary of all of the evaluation data is included in Appendix C.

Figure 4.1-1. Boating team member Louis DeBret contacting SMUD staff during study.

4.2 Run Description

Prior to the run, the boaters met near the Camino Powerhouse where they assembled their gear and boarded a shuttle bus that was provided by SMUD. A safety briefing and orientation to the types of information that they would be asked to provide at the end of their run was conducted during the drive to the put-in. All nine of the boaters who began the run at Camino Dam completed the run down to the Camino Powerhouse. The group put on the river below Camino Dam at 10:40 A.M. and took off at the Forebay Road bridge, located directly upstream of Slab Creek Reservoir, at 6:00 P.M, completing the run in seven hours and twenty minutes. The group stopped for only one 20-minute break during the run. Considerable time on the run was taken for scouting and portaging, on average approximately an hour and forty minutes during the run. Figure 4.2-1 shows the study reach and locations of the rapids.

The put-in is located approximately 200 yards below the dam. To get to the put-in it is necessary to take a short hike across the Camino Dam to a trail leading to the river. In the first mile the river drops 171 feet and contains several class V rapids. At river mile 0.25 the team encountered the first rapid that required scouting. The next significant rapid, later named Powel's Pyramid, was only run by the boating team in the 12-foot raft, all other boaters portaged this rapid. At river mile 0.92 the team scouted a rapid that was run through a slot on the far left bank. This rapid, later named the Spout, was run by all members of the team. The next rapid that was portaged by the group, with the exception of the raft, aptly named Rafter's Only was at river mile 1.31. This rapid consists of a jumble pile of large boulders with no obvious kayak line through the rapid.

After almost two hours on the river the team took a lunch break at river mile 1.76. In the next mile the canyon becomes quite narrow, and the gradient eases slightly. A ten-foot-tall bedrock fall at river mile 2.62, Whimper Falls, was only one of two rapids on the run that was portaged by all members of the boating team. At river mile 3.24 there is a 12-foot drop with a difficult landing. One kayaker swam after running this drop and another kayaker ran the drop successfully, the other five kayakers portaged this rapid. Just upstream from the adit spoil pile, there is a river-wide ledge, which is very sticky. After the first member of the team swam out of this hole, the remaining kayakers portaged this rapid. The raft had a successful run on the right side of the ledge. The group later named this rapid Lowhead (Figure 4.2-2). The longest and most difficult rapid on the run is at river mile 4.0. The rapid consists of a long lead-in with a number of diagonal waves and several sizable holes. At the mid point in the rapid there is a river wide ledge with a very retentive hole. The rapid finishes with the river running through a ten-foot-wide slot that had a menacing looking wall on the right side. This rapid was portaged by all members of the team with the exception of one kayaker who ran the top half and the rafting team who ran the entire rapid.

The rapids over the next several miles become increasingly junky, because of many loose boulders and more vegetation in the channel. At river mile 5.53 the raft flipped and became rapped on a large boulder. It took approximately 30 minutes to extricate the raft. The confluence with the South Fork American River is at river mile 6.13, after which the river channel becomes much wider and many of the rapids were boney or rocky at this flow. The last significant rapid on the run is a fifteen-foot-high falls known as F-111. This rapid is in the section of the reach that is part of the Golden Gate Run. The team reached the take-out at Forebay Road bridge, which is at the upstream end of Slab Creek Reservoir, at 6:00 P.M. The total length of the run was 9.09 miles.

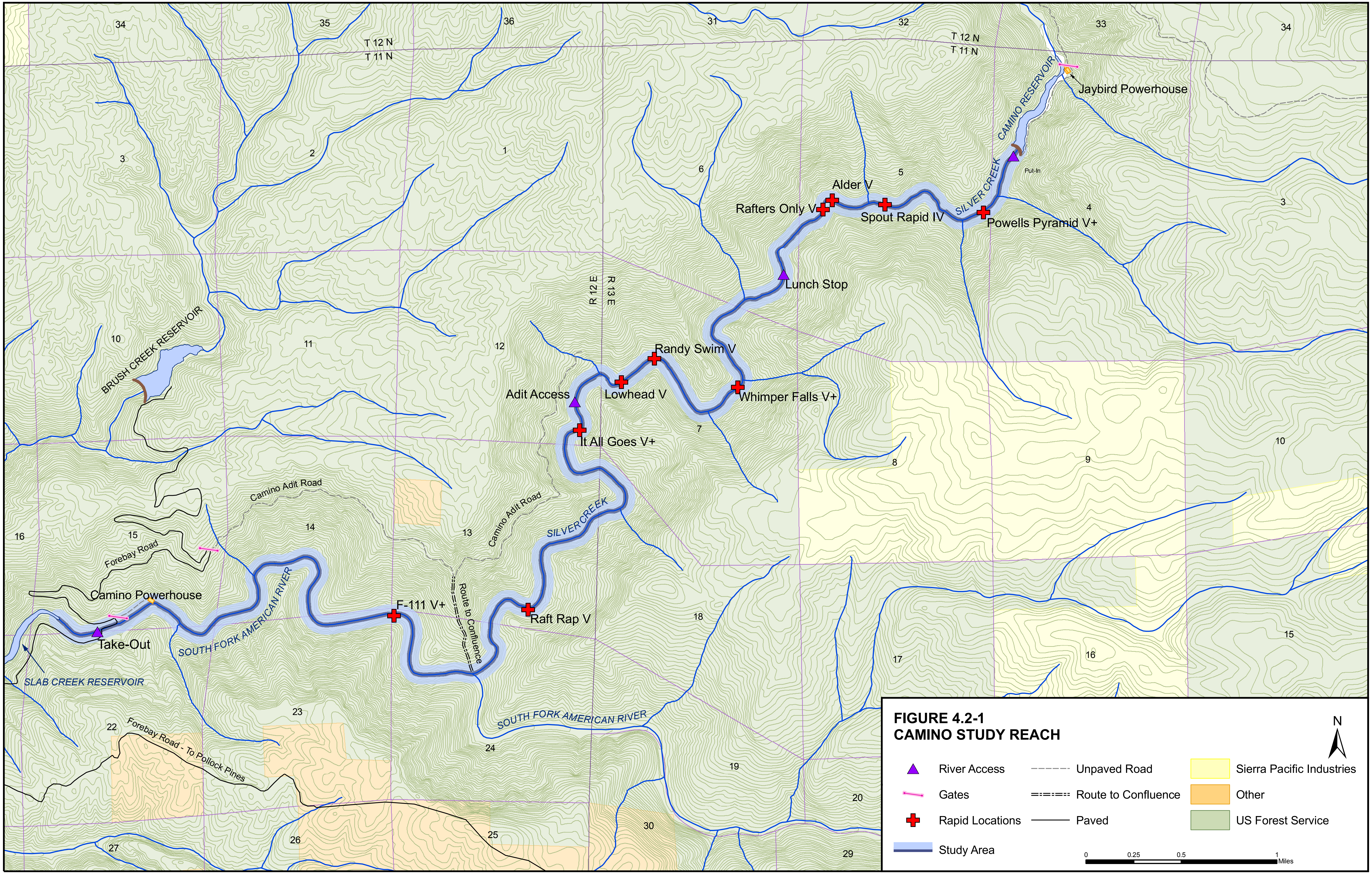


FIGURE 4.2-1
CAMINO STUDY REACH

Figure 4.2-2. Boaters scouting Lowhead rapid.

4.3 Reach Characteristics

The boaters were asked to evaluate the whitewater characteristics of the Camino Reach by indicating the degree to which they agreed or disagreed with a series of statements. The responses to these statements are summarized in Figure 4.3-1.

In general the boaters indicated that the Camino reach has a number of favorable characteristics at 650 cfs. These included: good technically challenging whitewater with nice water features, nice aesthetics and nice places to stop for breaks or lunch. Boaters did not feel that the run has particularly nice play spots. Several member of the boating team did feel that the run was somewhat long. This was true from both the focus group interview and average rating of 3.5 on the 5-point scale in the evaluation. The boaters also indicated that that portages were somewhat of a problem during the run. The number of portages ranges from 3 portages, for the rafting team, to between 6 and 13 portages for the kayakers. The number of hits on the run, indicating the number of times a participants craft struck a rock or other obstacle, averaged 57.8 occurrences for the group. The number of times participants were stopped by obstacles was far lower, ranging from zero to ten occurrences for the group. The number of times participants had to drag their boats off of obstacles was lower still, averaging 2.8 occurrences for the group.

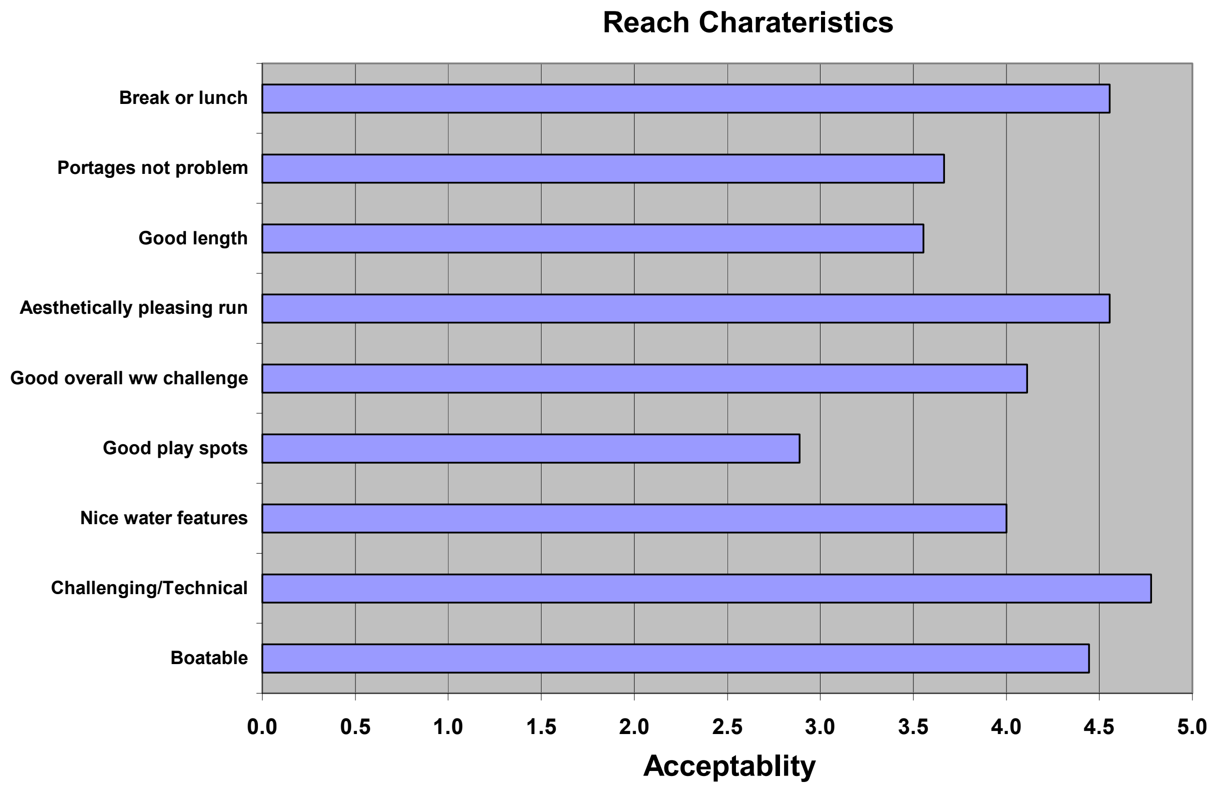


Figure 4.3-1. Boater responses (averaged) regarding the whitewater characteristics of the Camino Run at 650 cfs. (Source: Data from the Single Flow Evaluation Form at 650cfs.)

4.4 Flow Assessment

To determine what flows would be acceptable to provide whitewater boating opportunities on the Camino Reach, the participants were asked to provide their opinions on the acceptability of the run at various flow intervals between 200 and 2,400 cfs. Although the participants had only boated the reach at 650 cfs, they were asked to speculate about the range of flows to the degree that they felt confident in their ability to do so. All of the boaters provided information for the entire range of flows provided in the comparative evaluation. A summary of this information is provided in Figure 4.4-1 below.

The flow preference graph, Figure 4.4-1, provides a basis to evaluate how acceptable various flows would be for the Camino Reach. Assuming that boaters would return for a flow rated ‘Marginal’, ‘Acceptable’ or ‘Totally Acceptable’, the averaged responses provided on the comparative flow evaluations indicate a range of acceptable flows from approximately 600 cfs to 1,200 cfs. When asked specifically about the minimum flow that would offer a quality technical boating experience, the average response from the boating team was 583 cfs. This response was very consistent with a standard deviation of only 35 cfs. The average response for the highest safe flow was 1,037 cfs but participants were less consistent with their responses to this question, which had a standard deviation of 377 cfs. The safety issue of the flow on the South Fork American River (SFAR) below the confluence with Silver Creek was raised in the *Whitewater Feasibility Technical Report*. Under unimpaired conditions, the flows on Silver Creek constitute about 40 percent of the flow below the confluence. During the flow study the SFAR was flowing at 49 cfs and had little effect on the total flow. This portion of the run, from the confluence to the Forebay Road bridge, was noted to be at a low flow level and had several shallow rapids. One rapid, F-111 (see Figure 4.4-2), which is also part of the Golden Gate run, was determined to have too little flow and was portaged by all of the participants. In general participants felt that flows in the 2,000 to 3,000 cfs range would be acceptable on this section of river.

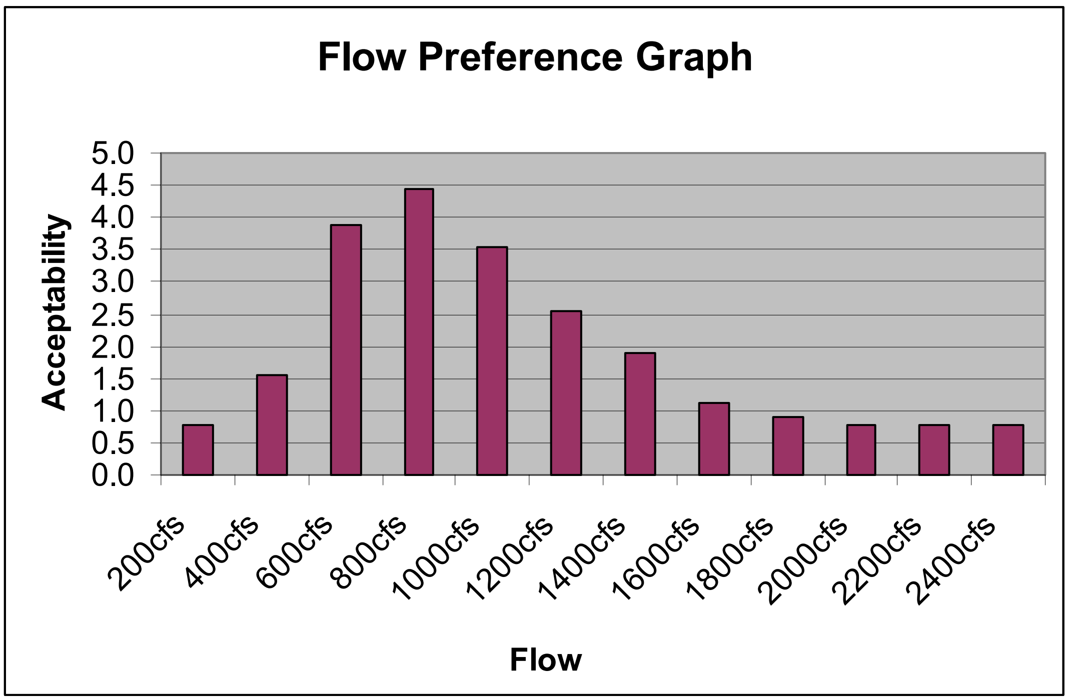


Figure 4.4-1. Average boater acceptability of flows.
(Scale: 1=Totally Unacceptable, 2=Unacceptable, 3=Marginal, 4=Acceptable, 5=Totally Acceptable)
(Source: Data from the Comparative Evaluation Form)

Figure 4.4-2. Scouting F-111 on the SFAR.

4.4.1 Range of Optimum Flows

To further examine the whitewater boating opportunities at various flows, the boaters were asked to suggest the optimum range of flows that would provide the best whitewater characteristics for the run. Boater evaluation responses, which are shown graphically in Figure 4.4-1, indicate that the boater's optimum range of flows is between 656 and 828 cfs. This information is consistent with the post run focus group discussion. In looking at the individual responses, the participants provided an optimal range of flows that were fairly consistent with a standard deviation of 68 and 87 cfs for the low and high end of the optimal range, respectively.

4.4.2 Boatability

The responses of the boating team in regard to the overall quality of the run at 650 cfs were mixed. The evaluation results showed that 33 percent of the paddlers responded that they would definitely return at this flow, 33 percent said they would probably return at this flow, and 33 percent stated they would possibly return at this flow. During the focus group most of the participants indicated that they would not return at 650 cfs or that they would return very infrequently. The participants generally indicated that their opinion of the reach would improve with a higher flow in the reach. All of the boaters rated the difficulty of the Camino Reach to be class V on the International Scale of River Difficulty (see Appendix D).

4.4.3 Craft Types

Seven of the participants were paddling hardshell kayaks during the study, two other participants were paddling a twelve foot raft. The participants had the breadth of boating experience necessary to make recommendations on the suitability of the Camino Reach for a number of other craft types. Participants were asked to rate the suitability of the Camino Reach for different craft types and, if suitable, to specify at what flow levels. Participants were asked if different crafts would be suitable at flows that are: much higher, higher, lower, much lower, or the same as the test flow, or not appropriate for this reach at any flow. The participants who responded to this question, agreed that the reach is suitable for rafts at a flow higher than the 650 cfs test flow. The members of the rafting team agreed that generally rafts up to 14 foot in length with very experienced crews, would be suitable for this run. The participants felt that catarafts would not be suitable on this run due to the narrow nature of many of the rapids. Open canoes would not be appropriate for this run according to the three participants that had knowledge of this craft type. At 650 cfs, the test flow level, or lower flows inflatable kayaks could also be acceptable crafts for this run.

4.5 Access

The shuttle, put-in and take-out locations and access are discussed in the following section. A map is provided in Figure 4.5-2 for reference.

4.5.1 Camino Dam

The comparative flow evaluation included questions about river access for whitewater boating. Boaters agreed with the statement that the access at the put-in used during the study was good. However, the study team was driven through a gate at the Jaybird Powerhouse that is typically locked. The distance from this gate to Camino Dam, where the shuttle terminated at the put-in, is 0.6 mile. To reach the river from this point, it is a short hike across Camino Dam and down a primitive foot trail (see Figure 4.5-1) to the waters edge, approximately 200 yards downstream from the dam. General comments from the focus group and evaluation responses indicated that the access to the put-in from the dam is adequate; one participant did feel strongly that the put-in should not be improved in any way. Most of the participants agreed that access past the gate at the Jaybird Powerhouse would be important for boaters doing this run.

Figure 4.5-1. Trail below Camino Dam.

4.5.2 Forebay Road Bridge

The take-out location for the study was just downstream of the Forebay Road Bridge, which crosses the SFAR. There is ample parking along an unpaved access road that parallels the north side of the river for approximately one-quarter to one-half a mile below the bridge (see Figure 4.5-3), which terminates at the upper end of Slab Creek Reservoir. Resource damage that was observed at this site included fire rings and vehicle use occurring too close to the shoreline, deep ruts caused by OHV or 4-wheel drive vehicles on steep slopes, user-created pit toilet at the waters edge, graffiti, trash, and damage to riparian vegetation. Visitors have repeatedly used one area for target practice as evidenced by an accumulation of shell casings and various targets including an old microwave and a computer terminal. General comments from the focus group and evaluation responses indicated that the access at the take out was good, as it offered calm water and an easy walk from the river up to the parking area.

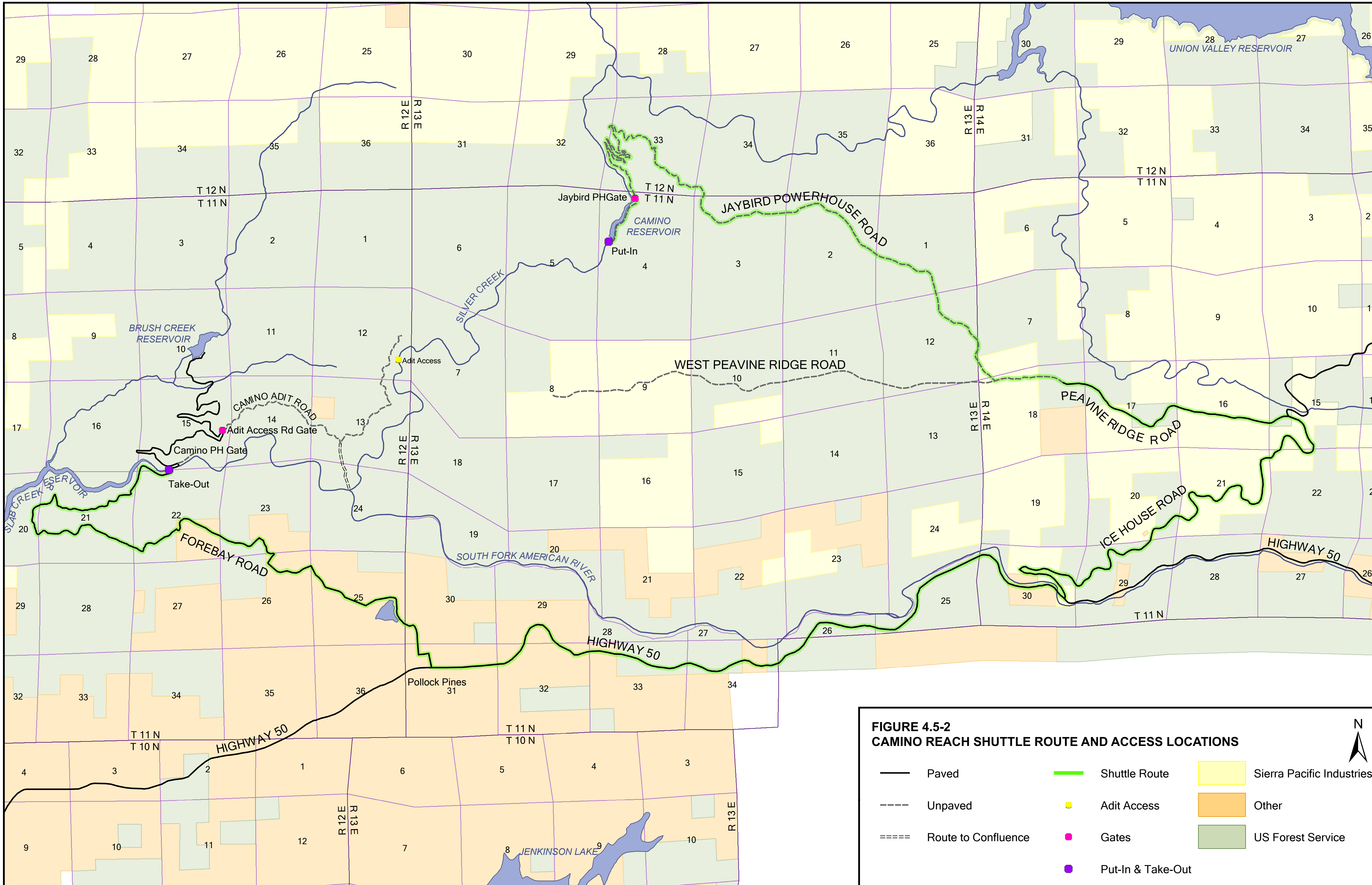


FIGURE 4.5-2
CAMINO REACH SHUTTLE ROUTE AND ACCESS LOCATIONS

Figure 4.5-3. View of take-out location from Forebay Road.

4.5.3 Other Access

The Camino Reach is very remote with steep canyon walls. Between the put-in and take-out there are no roads leading to the river however there are a few locations that could provide egress from the canyon. One possible egress location is at the end of the Camino Adit Road, which begins at Forebay Road 1.6 miles north of the Forebay Road Bridge over the SFAR. This is a Project road and it is gated at Forebay Road by the Licensee. The road extends 3.1 miles, between Forebay Road and its terminus, the Camino Adit spoil pile. This location would provide access at approximately river mile 4 and it is a very steep climb from the river to the road. Since this road is gated, it would then be necessary to walk 3.1 miles to reach the Forebay Road. Teams conducting aquatics studies during the flow study used this location as a monitoring site.

It could be possible to access the river from other points along the Camino Adit Road. One individual who was observing the boating study, hiked to the confluence of Silver Creek and SFAR from the Camino Adit Road. Using this location as an egress point would require hiking half a mile out of the canyon and then 1.5 miles on the Camino Adit Road back to Forebay Road.

4.5.4 Shuttle

The length of the shuttle from the take-out to the put-in is 35 miles. Access to the take-out from Pollock Pines is by way of Forebay Road to the upper end of Slab Creek Reservoir (approximately 20 minutes). From the take out, access to the put-in is by returning to Pollock Pines via Forebay Road, then traveling west on Highway 50 to Ice House Road. The drive beyond this intersection to Camino Reservoir is slow and winding, up Ice House Road to the top of Peavine Ridge and then down Peavine Ridge Road to Camino Reservoir. During the study, the team took almost two hours to travel from the take-out to the put-in location. The group did make several stops along the way, which added approximately 30 minutes to the total shuttle time. Even without these stops, one-way shuttle time on this run would range from one hour to one and one-half hours. In the evaluation responses all but one of the participants disagreed with the statement that the length of the shuttle was not a problem. The group was mixed as to whether this run has a good shuttle to boating ratio, four of the participants agreed with this statement, four participants disagreed with this statement and one was neutral.

4.6 Regional Opportunities

4.6.1 Nearby Population Centers

The communities where boaters live who may use this run and that are within a reasonable driving distance of the Camino Reach put-in are listed below in Table 4.6-1.

Table 4.6-1. Distance and driving time to Camino Reach put-in from nearby population centers.

Location	Distance (miles)	Driving Time to Camino Reach
Placerville, CA	39.9	70 minutes
Coloma, CA	48.3	80 minutes
Sacramento, CA	85.0	2.0 Hours
San Francisco, CA	168.5	3.3 Hours
Redding, CA	245.3	4.5 Hours
Reno, NV	116.2	3.0 Hours

4.6.2 Whitewater Boating Opportunities in the American River and Cosumnes River Watersheds

A review of *California Whitewater: A Guide to the Rivers* (Cassady and Calhoun, 1995), *California Creekin: A Whitewater and Touring Guide to California* (Tuthill 2004), *The Best Whitewater in California: The Guide to 180 Runs* (Holbek and Stanley 1998) and *California Boating and Water Sports* (Stienstra 1996) identifies 20 runs in the American and Cosumnes River (including the Rubicon River) watersheds with a total distance of over 178 miles. Information about the other whitewater boating opportunities in the area is listed in Table 4.6-2 below.

Table 4.6-2. Whitewater boating opportunities in the American River watershed.

Name of Run	Put-In & Take Out	Length (miles)	Gradient (feet per mile)	Class	Boating Range[1] and (Optimum Flow)	Boating Season
Cosumnes River						
Camp Creek	Fleming Meadows to Happy Valley Road bridge	10.1	113	IV+	200-400[2]	Winter, Early Spring
North Fork American River						
Generation Gap	Tadpole Creek to Colfax-Foresthill Rd.	12.3	75	IV-V 0 portages	600-2,000 (1,200)	Spring
Giant Gap	Euchre Bar to Colfax-Iowa Hill Rd.	14.5	54	IV-V 0 portages	600-2,500 (1,000)	Winter, Spring
Chamberlain Falls	Colfax-Iowa Hill Rd. to Colfax-Foresthill Rd.	4.8	44	III-IV+ 0 portages	800-2,500 (1,500)	Winter, Spring
Ponderosa Way	Colfax- Foresthill Bridge to Ponderosa Way Bridge	5	21	II+ to III 0 portages	500-1,500 > 1,500 (1,200)	Spring
Middle Fork American River						
No. Middle Fk. American River	Last Chance Bridge to Middle Fk. American	12.9	129	V 7 portages	600-800 (600)	Winter, Spring
Tunnel Run	Ralston Afterbay to Spring Garden Rd.	17	23	IV 1 portage	800-1,500 (1,200)	Spring, Summer
Rubicon River						
Lower Run	Ellicott Bridge to Ralston Afterbay	20.3	108	V- to V 2 portages	500-1,000 1,000-2,000 (1,200)	Spring
South Fork American River						
Lovers Leap	Strawberry to Kyburz	9.6	171	V 3 portages	500-1,200 (1,000)	Spring
Dugald Bremner	Upper Bridge to Girard Cr.	3.5	191	V 1 portage	300-800 (500)	Winter, Spring
Lower Run	China Flat to So. Fk. American	3.3	236	V+ 2 portages	350-550 (400)	Spring, Summer
Kyburz to Riverton	Kyburz to Route 50 Bridge	9.6	90	III-IV+ IV-V 2 portages	700-1,200 1,200-1,300 (1,200)	Spring
Riverton to Peavine	Route 50 Bridge to Peavine Ridge Rd.	3.5	69	III-IV 0 portages	700-4,000 (1,500)	Spring
Golden Gate	Peavine Ridge Rd. to Forebay Rd.	9.4	117	V+ 5 portages	700-1,500 (1,000)	Spring
Silver Creek	Camino Reservoir to SFAR	9.2	119	V 8 portages	600-800 (600)	Spring
Camino	Slab Cr. Dam to White Rock PH	7	89	V 1 portage	500-2,000 (1500)	Spring
Rock Creek	Near Dutch Cyn to Rock Cr. Rd.	6.3	110	IV+ 2 portages	300-800 (600)	Winter, Spring

Table 4.6-2. Whitewater boating opportunities in the American River watershed.

Name of Run	Put-In & Take Out	Length (miles)	Gradient (feet per mile)	Class	Boating Range[1] and (Optimum Flow)	Boating Season
South Fork American River						
Chili Bar	Route 193 to Coloma	5.8	31	III+ III-IV 0 portages	700 –1,500 1,500-10,000 (2,000)	Year-round
Coloma to Lotus	Coloma Park to Lotus Campground	3	24	II II+ III 0 portages	500-1,500 1,500-3,000 >3,000 (1,500)	Spring, Summer
The Gorge	Lotus Campground to Folsom Lake	11.2	21	III+ III-IV 0 portages	800-2,000 2000-10,000 (2,000)	Year-round

[1] Boatable range and optimum flow from Holbek and Stanley (1995) except as otherwise noted.
[2] Boatable range of flows from Tuthill (2004).

4.6.3 Comparison to Other Runs in California

The study participants most frequently compared the Camino Reach to the Slab Creek run on the SFAR and the Camp Creek run below Jenkinson Lake. Generally, the boaters felt that the Camino Reach was of lower quality than either of these other two runs. Other similar runs listed included, the North Fork Trinity, the Middle Fork American River, North Fork American River and the Clavey River.

4.7 Impacts to UARP Reservoirs

In response to Issue Question 3a the analysis of the impact of whitewater releases on reservoir elevation was quantified during the study. The forebay reservoirs, Camino and Junction, did not experience fluctuations that were different from normal daily operations during the study. As per the direction of the Recreation TWG, only the impact of the whitewater release on the storage reservoir that was immediately upstream of the study reach was evaluated. The volume of water used for the whitewater flow study was 360 acre-feet. This equated to a drop in the Union Valley Reservoir elevation from 0.17 feet with the reservoir level staring at 4832.95 feet. Only Union Valley Reservoir was analyzed which is consistent with the Recreation TWG direction to analyze reservoir elevations of the primary storage reservoir upstream of the Camino Reach.

4.8 Hydrology

The SFAR is a watershed with a classic Sierra snowmelt drainage pattern. As such, a typical unimpaired hydrograph for the reach shows a number of storm events during the winter with elevated flows, a spring runoff period with high flows, and summer and fall seasons with fairly stable and low flows. Of course there are variations to this pattern but, in general, the storm events occur in the winter months and the highest flows are associated with the spring runoff. Figure 4.8-1 below shows the hydrograph that occurred in 1974-75 that reflects this general flow pattern.

The UARP modifies the magnitude and frequency of the flows in the UARP reach. Figure 4.8-2 shows a flow pattern that occurred in 1999 in the SFAR. This regulated hydrograph shows stable low flows and infrequent spill events. It should be noted that there is an extreme variability in the flow patterns from one year to the next in regard to either the regulated or the unimpaired flow patterns.

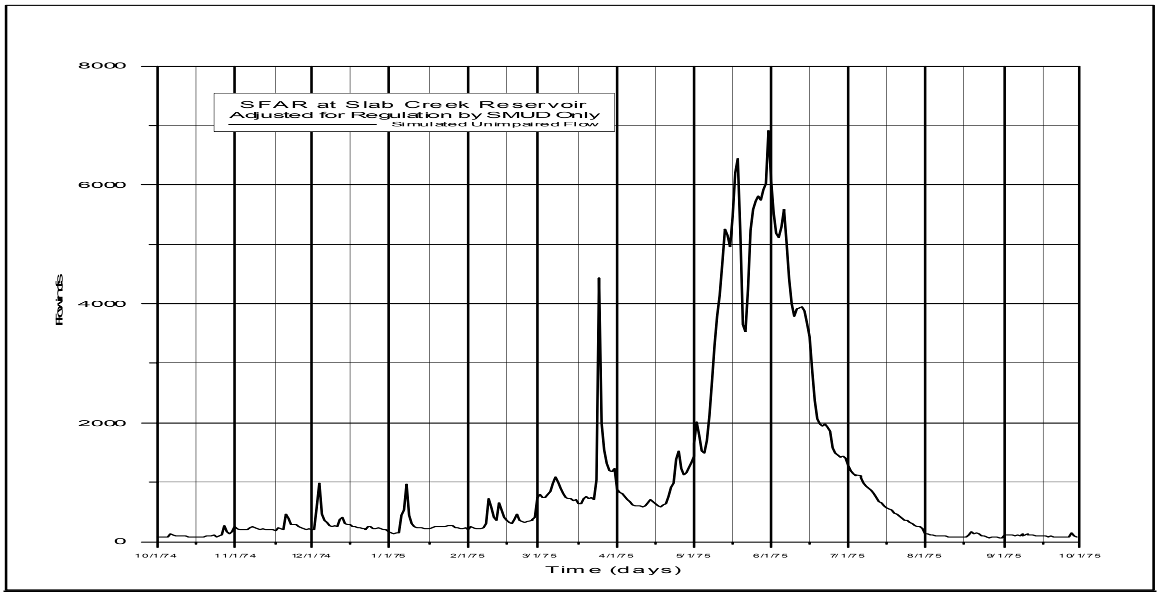


Figure 4.8-1. Synthesized unimpaired hydrograph for the SFAR October 1974 through September 1975.

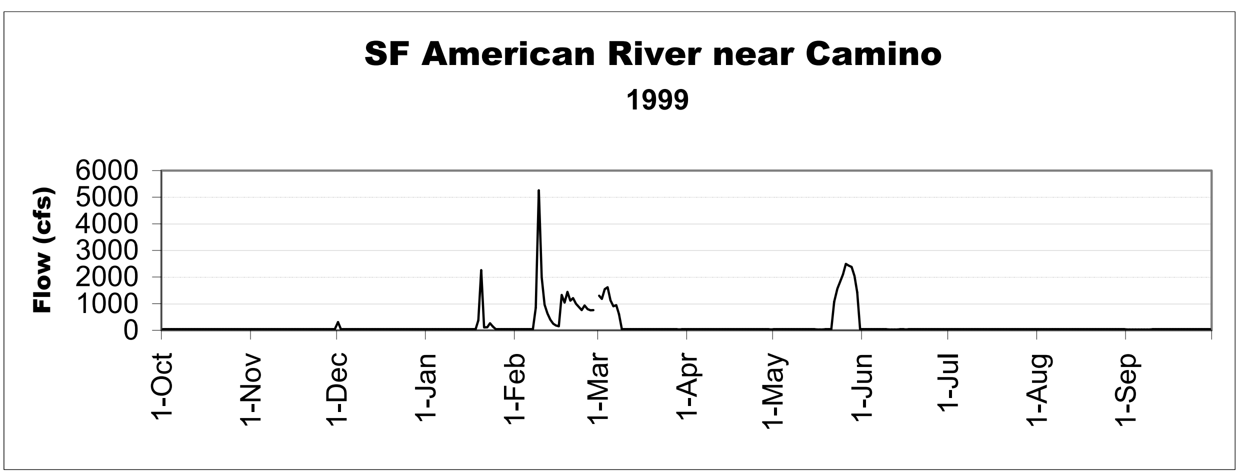


Figure 4.8-2. Regulated hydrograph for the SFAR, October 1998 through September 1999.

SMUD summarized the measured regulated and synthesized unimpaired flow information for the reach. These data can be used to characterize the boating opportunities that existed with the current UARP operations from Water Year 1975 through 2000, and the boating opportunities that might have existed over that same period without the UARP. Hydrologic data were analyzed using two methods; histograms based on boatable days and flow exceedance curves. Analysis of these two data sources is provided in section 5.3. Exceedance curves and histograms are provided in Appendix E.

4.9 Videotape

The reader is also referred to Appendix F that includes the video prepared by SMUD as part of this study. This video shows the participants boating various rapids in the Camino Reach at the different test flows and excerpts from the post-run group discussions with the study participants.

5.0 ANALYSIS

5.1 Minimum Acceptable Flows

Two methods were used to determine minimum acceptable flows. First, the minimum acceptable flow, as defined in the study plan, is the lowest flow at which 50 percent of the survey respondents would return to paddle the reach. The evaluation form used a five-point scale of: Totally Unacceptable, Unacceptable, Marginal, Acceptable and Totally Acceptable. Assuming that boaters would return for a flow rated 'Marginal', 'Acceptable' or 'Totally Acceptable', the averaged responses show the minimum acceptable flow to be between 400 and 600 cfs. Figure 4.4-1 provides a graphical representation of the evaluation responses for the minimum acceptable flow for the Camino reach. The second method was to have the participants respond to two questions concerning the minimum flow for this reach. The first question that boaters were asked was, 'What is the minimum flow that would allow boaters to simply get down the river?' and second, 'What is the lowest flow that provides a quality technical boating experience for this reach?' Based on the boaters' averaged responses, the minimum flow that would allow boaters to simply get down the river is 488 cfs. The lowest quality technical flow that boaters identified, averages 583 cfs. Based on these results the minimum acceptable flow for the Camino reach is approximately 600 cfs. It should be noted however, that during the focus group discussion most of the group indicated that they would not return at this flow. This inconsistency may be more statement of the general quality of the run than the unacceptability of this particular flow.

5.2 Optimal Range of Flows

The optimum flow, as defined in the study plan, is the peak of the flow preference curve and represents the flow level that provides the best combination of flow conditions for a whitewater opportunity. Figure 4.4-1 provides a graphic representation of the average acceptability of a range of flows from the comparative flow evaluation data. This information reveals that the optimum range of flows is approximately between 600 and 900 cfs. Analysis of the responses of the comparative flow evaluation gives a narrower optimal range of flows. The averaged responses from the participants suggest an optimal range of boating flows between 655 and 827 cfs. In looking at the individual responses, the participants provided an optimal range of flows that was very consistent and there were no significant outliers within the group. During the focus group interview the participants felt fairly confident in speculating on this range of optimum flows based upon their one run at 650 cfs. Some of the participants commented during the focus group discussion that they felt that this run has a rather narrow range of optimal flows.

Figure 5.2-1. Boaters scouting a rapid portaged by all participants except the rafters at 650 cfs.

5.3 Craft Types

During the study, seven of the participants were paddling hardshell kayaks and two participants paddled a twelve-foot raft. The group felt confident about making recommendations on the suitability of the Camino reach for a number of other craft types. The group was in agreement that the reach is suitable for rafts and kayaks. Slightly higher flows than the 650 cfs test flow would improve this run for both craft types but this is particularly true for rafts. The rafting team stated that they would be willing to take a fourteen-foot raft with skilled paddlers down this reach at a flow of 800 cfs. The participants felt that catarafts would not work well on this run due to the numerous narrow slots in many of the rapids. Inflatable kayaks with class V-skilled boaters, were also judged to be acceptable for this run. The participants also agreed that flows lower than the 650 cfs test flow would be acceptable for inflatable kayaks.

5.4 Commercial Use

In the boater evaluation question regarding commercial use, none of the participants recommended commercial use on this run. One of the members of the rafting team stated that the run could be feasible for commercial outfitters with slightly higher flows and elite rafting crews. This was consistent with the focus group discussion on this topic. The difficulty, length, and remote nature of the run were cited as potential problems for commercial outfitters.

5.5 Hydrology Analysis

SMUD summarized the measured regulated and synthesized unimpaired flow information for the reach. These data can be used to characterize the boating opportunities that existed with the current UARP operations from Water Year 1975 through 2000, and the boating opportunities that might have existed over that same period without the UARP. Hydrologic data were analyzed using two methods; histograms based on boatable days and flow exceedance curves.

Histograms developed for the study show the number of boatable days that exist in the Camino Reach under regulated conditions and the number of boatable days that might have existed if the UARP were not in place. To make this analysis, SMUD relied on a range of boatable flows as revealed by responses to the boater evaluations relating to the acceptability of different flows. This information indicated that flows between 600 and 1,100 cfs would be a reasonable range of flows to use to in this evaluation. This flow range would be acceptable for most craft types and ability levels. However, the lowest flows in this range would not be acceptable for large rafts and the high end of the range would not be suitable for less skilled boaters. This rather narrow acceptable flow range could make this run rather difficult for boaters to use this reach on an opportunistic basis in either an impaired or unimpaired condition. Based on the averaged hydrologic data for each of the five water year types (see section 2.2), the average number of days in each month is shown on a graph for each water year type that existed under regulated (with the project in place) and synthesized unimpaired conditions. The histograms shown in Figure 5.5-1 shows that boating opportunities would have existed in the unimpaired condition in the winter and spring months. With the UARP in place some opportunities do occur in wet years during the winter and spring.

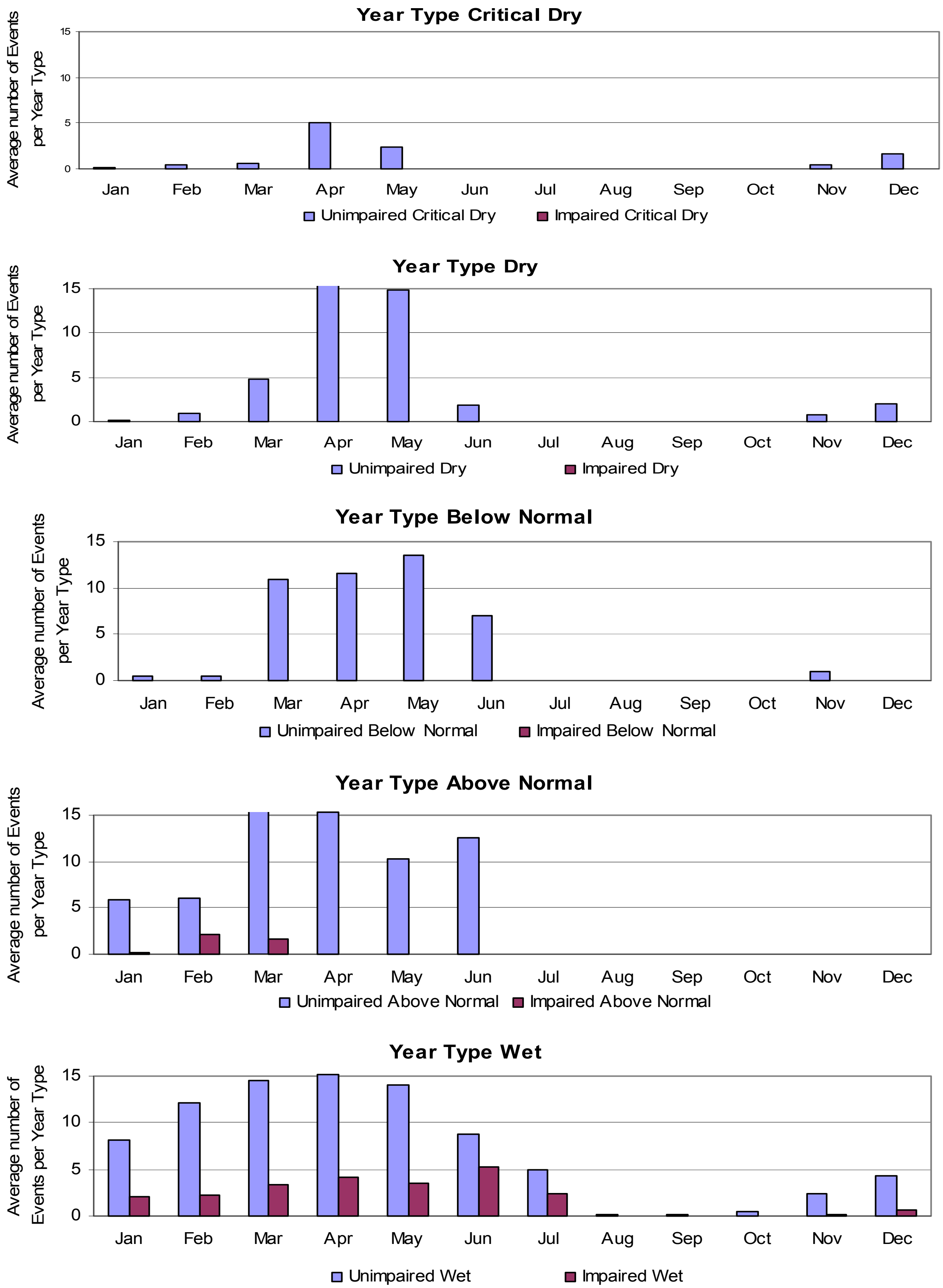


Figure 5.5-1. Number of 1-day events between mean daily flow of 600 cfs and 1,100 cfs in the Camino Reach (WY 1975-2000).

Hydrologic information was also evaluated based on exceedance curves for each of the respective months within each type of the five water year types. The data were combined and averaged to develop monthly flow exceedance curves for each type of water year. The graphs show the probability for exceeding flows between 0 and 10,000 cfs in the Camino reach under the regulated and unimpaired conditions.

The acceptable flows as determined by the evaluation responses collected for the controlled flow study for the Camino Reach are between 600 cfs and 1,100 cfs. The months April through November were chosen to reflect months in which there is enough daylight to reasonably complete the run. The exceedance curves for the five different water year types from April through November are provided in Appendix E. An example of a probability exceedance curves as shown in Figure 5.5-2 show how likely these flows would be to occur in the wet water years in the month of June. A review of the synthesized unimpaired flow information indicates that flows between 600 and 1,100 cfs, shown as the two horizontal lines on the exceedance curves, might have occurred in most winter and spring months in all but Critically Dry water years. In Wet water year types, flows in the boatable range would occur on a limited basis, less that 25 percent of the time, in the month of July. The impaired flow data shows that the UARP typically only spills in Wet water year types. While these spill events provided some opportunity, it is less than what would occur if no developments were on the watershed. Flow information would improve the ability of boaters to use this reach on an opportunistic basis.

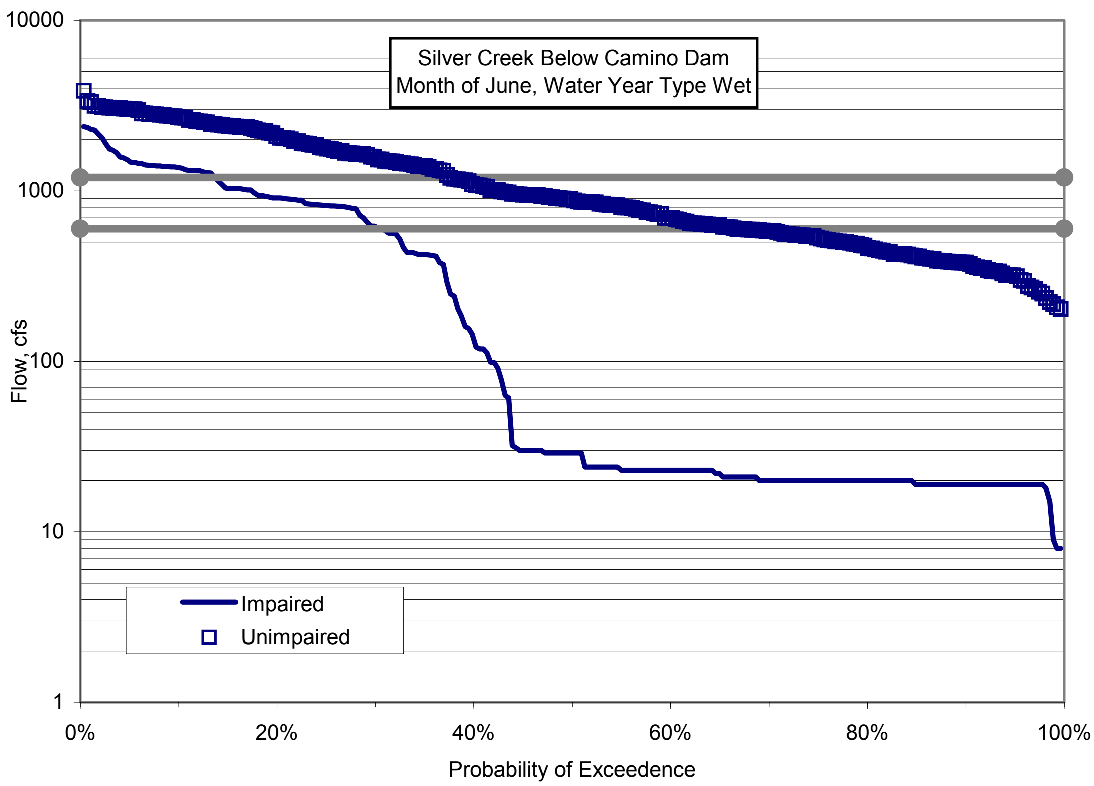


Figure 5.5-2. Example of the probability of exceedance curve for Camino Reach in June in a wet water year type.

6.0 FINDINGS

The Camino Whitewater Boating Study had a number of significant findings, specifically, the class of difficulty, boating suitability including craft types and the range of boatable flows. The difficulty class for the entire reach was rated class V, and is most suited for boaters with advanced skills or better. The run is best suited for hard shell kayaks however it is also suitable for small rafts (14' or less) and inflatable kayaks, depending on the level of flow. The paddlers reported between 3 and 13 portages on the reach. The portage routes were generally considered slightly difficult. The participants felt that the rapids on this run were less clean than other comparable runs. Most of the paddlers stated that they would not return to do this run at the test flow. The time to complete the run was seven hours and twenty minutes. This was a considerable amount of time to complete this nine-mile run. Considerable time on the run was taken for scouting and portaging, on average approximately an hour and forty minutes during the run. It is likely that as boaters would become more familiar with this run the time to complete the run could be reduced. However, this run, particularly when combined with the long shuttle, will always require a very long day.

The study was able to determine a range of acceptable and optimal flows. The evaluation responses indicate that the minimum navigable flow for the reach is approximately 600 cfs. Most boaters felt that flows between 650 cfs and 830 cfs would provide the optimal range of boating flows. The acceptable boating range was determined to be between 600 and 1,100 cfs. There was less variation on boaters' responses about minimum flows than their responses about maximum flows.

In addition, SMUD characterized the boating opportunities that existed with the current UARP operations over the past 25 years, and the boating opportunities that might have existed over that same period if there were no developments upstream of Camino Reach. This analysis was done using water year types recommended by the UARP Relicensing Water Year Type Subgroup. The analysis showed that, on average, there would have been fewer boatable days in all water year types, generally between March and June, with the UARP in place than might have occurred if no water developments had been in place during this 25-year period. Analyzing the synthesized unimpaired flow data, flows in the boatable range did not usually extend beyond June except in Wet water years.

7.0 LITERATURE CITED

American Whitewater 1998. Information provided on website: www.americanwhitewater.org Site accessed on June 3, 2003.

Cassidy, J. and F. Calhoun 1995. California Whitewater: A Guide to the Rivers. North Fork Press, Berkeley, CA.

Holbeck, L. and C. Stanley. 1998. The Best Whitewater in California: The Guide to 180 Runs. Watershed Books, Coloma, California.

Steinstra, T. 1996. California Boating and Water Sports. Foghorn Press, Emeryville, CA.

Tuthill, Bill 2004. Website: http://creekin.net *California Creekin: A Whitewater and Touring Guide to California,* Site accessed on 12/28/2004.

USDI, Geological Service quadrangle map (Pollock Pines) as revised 1973.

APPENDIX A

BOATER EVALUATION FORM
CAMINO RUN

Camino Reach
(Camino Dam to Slab Creek Reservoir)
WHITEWATER BOATING FLOW STUDY,
September 15, 2004

BOATER EVALUATION FORM

This questionnaire is organized in three sections. Section 1—Contact information and characterization of your boating skills/experience. Section 2—Questions regarding your experience on today's run. Section 3—A comparative evaluation of different flows.

SECTION 1--BOATER BACKGROUND INFORMATION—*(COMPLETE THIS SECTION ONLY ONCE)*

1. Name ____ 2. Affiliation _________________________________

3. Home Address ____________________________________ 4. Telephone _________________________________

5. E-Mail Address ___________________________________ 6. Preferred Craft ____________________________

7. What is your age? ___________________________ years 8. Gender (circle one): Male Female

9. Please indicate your current boating skill level below. *(Circle one)*

   a) Novice
   b) Intermediate
   c) Advanced
   d) Expert
   e) Elite

10. How many years have you been boating at this level? ___________

11. Do you have any commercial guiding experience? ___________ In what craft types? Raft Kayak Other_______

12. In the past 3 years, how many days a month do you boat? _________________

13. Have you ever participated in a hydro relicensing whitewater boating study before? _________________________

14. If yes, how many, when and for which hydro projects? ____________________________________-________________

15. How many times have you boated this run before today? _______

If you have boated this run before (Leave blank if you have not boated the run before today.):

15a. what were the flows? _____________________________ cfs

15b. what type of craft(s) did you use?
____

16. How long does it take you to get to this reach from your home? ________hrs___________min

17. Please respond to each of the following statements about your river-running preferences.

Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I prefer running rivers with difficult rapids (Class IV and V).	1	2	3	4	5
Running challenging whitewater is the most important part of my boating trips.	1	2	3	4	5
I often boat short river segments (under 4 miles) to take advantage of whitewater play areas.	1	2	3	4	5
I often boat short river segments to experience a unique and interesting place.	1	2	3	4	5
I often boat short river segments to run challenging rapids.	1	2	3	4	5
Good whitewater play areas are more important than challenging rapids.	1	2	3	4	5
I am willing to tolerate difficult put-ins and portages in order to run interesting reaches of whitewater.	1	2	3	4	5
I prefer boating rivers that feature large waves and powerful hydraulics.	1	2	3	4	5
I prefer boating steep, technical rivers.	1	2	3	4	5
I enjoy boating both technical and big water rivers.	1	2	3	4	5
I feel able to evaluate rivers for boater of different skill level than my own.	1	2	3	4	5

SECTION 2-- BOATER POST-RUN EVALUATION FORM

Date of run: **September 15, 2004**

Reach: **Camino**

1. What was the target flow on this run? **600 cfs** as measured at **base of Camino Dam**.

2. What type of craft did you use for this run *(Circle one)*?

   1. Hard shell kayak
   2. Inflatable kayak
   3. Closed deck canoe
   4. Open canoe with floatation
   5. Cataraft (please indicate length: _____)
   6. Raft (please indicate length: _____)
   7. No craft: I road/trail-scouted this run
   8. Other: (please explain) ______________________

3. Please identify the put-in and take-out locations you used and estimate the time you put-in and took out on this run.

   Put-in location: **Camino Dam** Time: _______

   Take-out location: **Camino PH** Time: _______

4. About how many times did you stop and get out of your boat for breaks, or for scouting and portaging?

   About _____ times for breaks.

   About _____ times for scouting or portaging.

5. Please estimate the total amount of time you spent out of your boat for breaks, or for scouting and portaging.

   About _____ minutes for breaks.

   About _____ minutes for scouting or portaging.

6. Please estimate the number of **hits**, **stops**, **boat drags**, and **portages** you had on this run.

   I **hit** rocks or other obstacles (but did not stop) about ____ times.

   I was **stopped** after hitting rocks or other obstacles about _____ times (but did not have to get out of my boat to continue downstream).

   I had to get out to **drag or pull my boat** off rocks or other obstacles about _____ times.

   I chose to **portage** around rapids, or other sections about _____ times.

7. In general, how would you rate the whitewater difficulty on this reach at this flow? (Use the International Whitewater Scale that ranges from Class I to Class VI)._____

8. In your opinion, would a boater looking for an experience of this difficulty be likely to return for future boating if today's flow were to be provided? (circle one)
   a) Definitely No b) Possibly c) Probably d) Definitely Yes

9. Relative to today's flow would you prefer a flow that was higher or lower or was this optimum flow?
a) Much Lower b) Lower c) Higher d) Much Higher e) Optimum

10. Please respond to each of the following statements about the characteristics of this run at today's flow.

Statement	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
This reach is boatable at these flows.	1	2	3	4	5
This reach offers challenging and technical boating.	1	2	3	4	5
This reach has nice water features such as waves and holes.	1	2	3	4	5
This reach has good play spots.	1	2	3	4	5
This run offers good overall whitewater challenge.	1	2	3	4	5
This is an aesthetically pleasing run.	1	2	3	4	5
This run is a good length.	1	2	3	4	5
The portages on this run are not a problem.	1	2	3	4	5
There are enough places to take a break or have lunch on this run.	1	2	3	4	5

11. Please identify particularly challenging rapids or sections and rate their difficulty at this flow (using the International Whitewater Scale). Also note if you portaged any of these rapids.

Location (Name or site)	**Rating (Whitewater Scale of Difficulty)**	**Portage? (Yes or No)**

12. If you portaged any rapids on the run, please identify rapids you chose to portage and rate the **<u>difficulty of those portages</u>** (using your type of craft at this flow level).

Location	**Not at all difficult**	**Slightly difficult**	**Moderately difficult**	**Extremely difficult**
	1	2	3	4
	1	2	3	4
	1	2	3	4
	1	2	3	4
	1	2	3	4
	1	2	3	4

13. Did you observe or experience any significant safety issues on your run today (swims, pins, wrapped boats, man-made or natural river features etc…)? Please explain.

_____

_____

_____

_____

_____

14. If you feel qualified to offer an opinion of the boatability of this run at today's flow using different types of crafts, please respond to the following statements. Leave blank if you do not have experience with a particular type of craft. (Circle one number for each type of craft)

This run would be acceptable for the following craft types at flow levels that are:	Much Higher	Higher	The Same as Today's Flow	Lower	Much Lower	Not appropriate for this Craft Type
Kayaks	5	4	3	2	1	0
Rafts	5	4	3	2	1	0
Catarafts	5	4	3	2	1	0
Open Canoes	5	4	3	2	1	0
Inflatable Kayaks	5	4	3	2	1	0

15. If you feel qualified to offer an opinion of the commercial suitability of this run using different types of crafts, please respond in the space provided below.

____

____

____

____

____

____

SECTION 3—Comparative Evaluation Form

1. Please evaluate the following flows for your craft and skill level (please circle one in each column). In making your evaluations, please consider all the flow-dependent characteristics that contribute to a high quality trip (e.g., boatability, whitewater challenge, safety, availability of surfing or other play areas, aesthetics, and rate of travel).

Camino	200 cfs	400 cfs	600 cfs	800 cfs	1000 cfs	1200 cfs	1400 cfs	1600 cfs	1800 cfs	2000 cfs	2200 cfs	2400 cfs
Totally acceptable	5	5	5	5	5	5	5	5	5	5	5	5
Acceptable	4	4	4	4	4	4	4	4	4	4	4	4
Marginal	3	3	3	3	3	3	3	3	3	3	3	3
Unacceptable	2	2	2	2	2	2	2	2	2	2	2	2
Totally Unacceptable	1	1	1	1	1	1	1	1	1	1	1	1

2. Based on your boating trips on this reach, please answer the following questions. *(Note: you can specify flows that you have not seen, but which you would predict based on your experience.)*

	Flow in cfs
What is the lowest flow you need to simply get down the river in your craft?	________________
What is the lowest flow that provides a quality technical boating experience for this reach?	________________
What is the optimal range of flows that provides the best whitewater characteristics for this run?	________ to ________
What do you feel the highest safe flow for your craft and skill level?	________________

3. In your experience, what whitewater runs in California do you believe offer a whitewater experience similar to this one at the optimum flow for this reach? Also list how often you boat these reaches and how long it takes you to travel to the run from your home.

a) ____

Trips per year on this reach (circle one) 0-3 4-8 9-15 15+

Travel Time: _______hours What months do you usually boat this run?____________________

b) ____

Trips per year on this reach (circle one) 0-3 4-8 9-15 15+

Travel Time: _______hours What months do you usually boat this run?____________________

c) ____

Trips per year on this reach (circle one) 0-3 4-8 9-15 15+

Travel Time: _______hours What months do you usually boat this run?____________________

d) ____

Trips per year on this reach (circle one) 0-3 4-8 9-15 15+

Travel Time: _______hours What months do you usually boat this run?____________________

4. Compared to the runs you listed above, how would you rate boating opportunities on the Camino Reach. *(Circle one number for each; if you are unsure about a comparison, leave that item blank).*

Compared to:	Much Worse	Worse	About the Same	Better	Much Better
________	1	2	3	4	5
________	1	2	3	4	5
________	1	2	3	4	5
________	1	2	3	4	5

5. Please respond to the following statements about the non-whitewater characteristics of this run.

Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Length of shuttle is not a problem.	1	2	3	4	5
The put -in for this run is good.	1	2	3	4	5
The take-out for this run is good.	1	2	3	4	5
The total shuttle to boating ratio on this run is good.	1	2	3	4	5

6. If you have any suggestions for improving the access or other attributes for this run please describe these improvements below.

7. Please use the space below to provide any comments about your overall boating experience on the Camino run.

APPENDIX B

LIST OF STUDY TEAM PARTICIPANTS

List of Boating Study Participants
Camino Whitewater Boating Study
September 15, 2004

Name	Affiliation (If provided)	Craft	Age	Gender (M-Male F-Female)	Skill Level[1] (N/I/A/X/E)
Dave Steindorf	The Louis Berger Group	kayak	44	M	X
Eric Magneson	American Whitewater	kayak	45	M	X
Erik Powell	Beyond Limits Adventures	raft	36	M	X
Jeff Alkena	Beyond Limits Adventures	raft	35	M	X
Justin States	AWA/private	kayak	31	M	X
Kary Danielson		kayak	37	M	X
Louis Debret	private	kayak	46	M	X
Randy Calvin		kayak	41	M	A
Todd Stanley		kayak	34	M	X

[1] N-Novice; I-Intermediate; A-Advance; X-Expert; E-Elite

APPENDIX C

SUMMARIZED RESPONSES OF BOATER EVALUATIONS

	0	1	2	6	7	8	9	10	11a	11b	12
Flow	ID	Name	Affiliation	Preferred Craft	Age	Gender	Skill Level (N/I/A/X/E)	Years Boating @ this Level	Comercial Experience	Craft	boat days/month (last 3 yrs)
600	1	Dave Steindorf	The Louis Berger Group	kayak	44	M	X	6	yes	Kayak	4
600	2	Eric Magneson	AWA	kayak	45	M	X	20	yes	Raft/Kayak	4
600	3	Erik Powell	Beyond Limits Adventures	Raft	36	M	X	12	yes	Raft	4
600	4	Jeff Alkena	Beyond Limits Adventures	Raft	35	M	X	15	yes	Raft/Kayak	17
600	5	Justin States	AWA/private	kayak	31	M	X	4	No		4
600	6	Kary Danielson		Raft	37	M	X	7	yes	Raft	3
600	7	Louis Debret	private	kayak	46	M	X	23	yes	Raft	2
600	8	Randy Calvin		kayak	41	M	X	20	yes	Raft/Kayak	4
	9	Todd Stanley		kayak	34	M	X	10	yes	Raft	5

	1	2	6	7	8	9	10	11		12
ID	Name	Affiliation	Preferred Craft	Age	Gender	Skill Level	Years Boating @ this Level	Comercial Experience		boat days/month (last 3 yrs)
				9		0	9	9		9
				39			13.0	89%		5.2

Male	9	100%	9
Female	0	0%	9

Novice (N)	0	0%	9
Intermediate (I)	0	0%	9
Advanced (A)	0	0%	9
Expert (X)	9	100%	9
Elite (E)	0	0%	9

	0	1	13		14			15	15a	15b	16
Flow	ID	Name	ww boating study before YES	WW boating study before NO	How many?	When?	Which?	Number of times boated this run	What flow (cfs)	Type of craft	Time to this reach (minutes)
600	1	Dave Steindorf	1		12	1998		0			180
600	2	Eric Magneson	1		2	2003	RCC - NFFR Slab Creek	0			60
600	3	Erik Powell	1		1	2003	Slab Creek	0			30
600	4	Jeff Alkena	1		2	1999	Tiger Creek, N. Feather	0			90
600	5	Justin States	1		2	2003	Slab Creek, Ice House	0			150
600	6	Kary Danielson		1				0			60
600	7	Louis Debret	1		3	2003	Florence Lake, San Joaquin, Slab Creek	1	500-1000	kayak	90
600	8	Randy Calvin	1		2	2003	South Fork San Juanquin, Slab Creek	0			120
	9	Todd Stanley		1				0			60

	1	13		14			15	15a	15b	16
ID	Name	ww boating study before YES	ww boating study before NO	how many?	when?	which?	Number of times boated this run	What flow (cfs)	Type of craft	Time to this reach (minutes)
		7	2	7	1		9	0		9
		78%	22%	3.4			0.1	500-1000	kayak	93

kayak	1
raft	0
kayak, raft	0

	0	1	17										
Flow	ID	Name	Class IV/V rapids	Challenging whitewater	Short river ww play areas	Short river exp new/int place	Short river challenging rapids	WW play > challenging rapids	Tolerate difficult faccess or good ww	Large waves/ hydraulics	Steep, technical rivers	Both technical, big water rivers	Evaluate for other skill level
600	1	Dave Steindorf	4	4	3	5	4	2	4	3	4	4	5
600	2	Eric Magneson	5	4	3	3	4	3	3	3	5	3	4
600	3	Erik Powell	5	5	3	4	5	2	4	4	5	4	4
600	4	Jeff Alkena	3	2	2	2	2	2	4	3	4	4	5
600	5	Justin States	4	3	2	5	4	2	4	1	5	3	4
600	6	Kary Danielson	4	3	2	5	5	2	5	3	4	4	4
600	7	Louis Debret	5	4	4	2	4	2	4	3	5	4	4
600	8	Randy Calvin	4	3	4	5	4	2	5	4	4	4	4
	9	Todd Stanley	5	3	5	4	5	2	5	5	5	5	5

ID	1	17										
	Name	Class IV/V rapids	Challenging whitewater	Short river ww play areas	Short river exp new/int place	Short river challenging rapids	WW play > challenging rapids	Tolerate difficult faccess or good ww	Large waves/ hydraulics	Steep, technical rivers	Both technical, big water rivers	Evaluate for other skill level
		9	9	9	9	9	9	9	9	9	9	9
		4	3.4	3.1	3.9	4.1	2.1	4.2	3.2	4.6	3.9	4.3

	0	1	0	1	2	3					4		5	
Flow	ID	Name	Date of Run	Target Flow	Craft	Put-in	Takeout	Start Time	End Time	Trip Time	Number of Breaks	Number of scout/ portage	Breaks (minutes)	Scout/ portage (minutes)
600	1	Dave Steindorf	15-Sep	600	KAYAK	CAM	CPH	10:40	18:00	7:20	1	20	20	90
600	2	Eric Magneson	15-Sep	600	KAYAK	CAM	CPH	10:40	18:00	7:20	1	10	20	75
600	3	Erik Powell	15-Sep	600	RAFT (11')	CAM	CPH	10:40	18:00	7:20	1	10	15	110
600	4	Jeff Alkena	15-Sep	600	RAFT (11')	CAM	CPH	10:40	18:00	7:20	1	10	15	120
600	5	Justin States	15-Sep	600	KAYAK	CAM	CPH	10:40	18:00	7:20	2	23	40	120
600	6	Kary Danielson	15-Sep	600	KAYAK	CAM	CPH	10:40	18:00	7:20	1	22	20	120
600	7	Louis Debret	15-Sep	600	KAYAK	CAM	CPH	10:40	18:00	7:20	1	25	20	120
600	8	Randy Calvin	15-Sep	600	KAYAK	CAM	CPH	10:40	18:00	7:20	2	15	15	120
	9	Todd Stanley	15-Sep	600	KAYAK	CAM	CPH	10:40	18:00	7:20	1	10	15	60
										0:00				

ID	1	0	1	2	3					4		5	
	Name	Date of Run	Target Flow	Craft	Put-in	Takeout	Start Time	End Time	Trip Time	Number of Breaks	Number of scout/ portage	Breaks (minutes)	Scout/ portage (minutes)
		9	9		0		9	9	9	9	9	9	9
			600		scd		10:40	18:00	7:20	1.2	16.1	20	104

KAYAK		WRPH	0	18:00
7		Mosquito Bridge	0	18:00
RAFT (11')			0	0
2				
RAFT (14')				
0				

	0	1	6				7	8				9				
Flow	ID	Name	Hits	Stops	Drags	Portages	WW Scale (Class I-VI)	No	Possibly	Probably	Yes	Much lower	Lower	Higher	Much higher	Optimum
600	1	Dave Steindorf	60	10	2	10	V		1					1		
600	2	Eric Magneson	30	3	3	8	V				1			1		
600	3	Erik Powell	45	10	4.5	3	V			1				1		
600	4	Jeff Alkena	50	10	4.5	3	V			1				1		
600	5	Justin States	60	2	5	13	V		1					1		
600	6	Kary Danielson	15	0	0	8	V				1					1
600	7	Louis Debret	80	0	0	9	V			1				1		
600	8	Randy Calvin	100	1	0	9	V				1			1		
	9	Todd Stanley	80	2	6	6	V		1					1		

	1	6				7	8				9				
ID	Name	Hits	Stops	Drags	Portages	WW Scale (Class I-VI)	No	Possibly	Probably	Yes	Much lower	Lower	Higher	Much higher	Optimum
		9	9	9	9	0	0	3	3	3	0	0	8	0	1
		57.8	4.2	2.8	7.7	V	0%	33%	33%	33%	0%	0%	89%	0%	11%

IV/V	0	0%
IV+	0	0%
IV+/V-	0	0%
IV+/V	0	0%
V-	0	0%
V	9	100%
V-/V	0	0%

Flow	0	1	10									11.1		
	ID	Name	Boatable	Challenging/Technical	Nice water features	Good play spots	Good overall ww challenge	Aesthetically pleasing run	Good length	Portages not problem	Break or lunch	Chall. Rapid Location/ Name	WW Scale	Portage?
600	1	Dave Steindorf	4	5	4	3	4	5	2	2	4	Powels Pyramid	VI	yes
600	2	Eric Magneson	4	5	4	3	4	4	3	3	4	Powels Pyramid	VI	yes
600	3	Erik Powell	5	5	4	5	5	5	4	4	5	Powels Pyramid	V	no
600	4	Jeff Alkena	4	4	4	4	4	4	4	4	4	Powels Pyramid	V	no
600	5	Justin States	4	5	3	2	4	4	3	3	4			
600	6	Kary Danielson	5	5	5	3	5	5	5	5	5	Powels Pyramid	V	yes
600	7	Louis Debret	5	5	5	3	4	5	4	4	5	Powels Pyramid	V	yes
600	8	Randy Calvin	5	5	3	2	4	4	4	4	5	Powels Rapid	V+	yes
	9	Todd Stanley	4	4	4	1	3	5	3	4	5			

ID	1	10									11.1		
	Name	Boatable	Challenging/Technical	nice water features	good play spots	good overall ww challenge	aesthetically pleasing run	good length	portages not problem	break or lunch	Chall. Rapid Location/ Name	WW Scale	Portage?
		9	9	9	9	9	9	9	9	9	0		
		4.4	4.8	4.0	2.9	4.1	4.6	3.6	3.7	4.6			

	0	1	11.2			11.3			11.4			11.5		
Flow	ID	Name	Chall. Rapid Location/ Name	WW Scale	Portage?	Chall. Rapid Location/ Name	WW Scale	Portage?	Chall. Rapid Location/ Name	WW Scale	Portage?	Chall. Rapid Location/ Name	WW Scale	Portage?
600	1	Dave Steindorf	Whimper Falls	VI	yes	Randy's Swim	V	yes						
600	2	Eric Magneson	Whimper Falls	VI	yes				Bear Hug	IV	no			
600	3	Erik Powell	Whimper Falls	V+	yes	No Swimming Here	V	..Swam thou	Rafters Only/It all	V	no	F-111	V+	yes
600	4	Jeff Alkena	Whimper Falls	V+	yes	Rafters Only/It all G	V	no	F-111	V+	yes	No Swimmin' Her	V+	no
600	5	Justin States	Whimper Falls	V+	yes	Low Head	V	yes	IGOB	V	yes			
600	6	Kary Danielson	Whimper Falls	V	yes	Low Head	V	yes	Powels Pyramid	V		Blowin Out Botto	V	no
600	7	Louis Debret	Whimper Falls	VI	yes	Low Head	V	yes	It all Goes	V	yes			
600	8	Randy Calvin				Low Head	V+	yes				Spickett Falls	V	np
	9	Todd Stanley	Whimper Falls	V+	yes									

ID	1	11.2			11.3			11.4			11.5		
	Name	Chall. Rapid Location/ Name	WW Scale	Portage?	Chall. Rapid Location/ Name	WW Scale	Portage?	Chall. Rapid Location/ Name	WW Scale	Portage?	Chall. Rapid Location/ Name	WW Scale	Portage?

	0	1	12.1				12.2			12.3			12.4		
Flow	ID	Name	Portage Rapid Location		1. Easy 2. Slightly 3. Moderat 4. Extreme		Portage Rapid Location		1. Easy 2. Slightly 3. Moderat 4. Extreme	Portage Rapid Location		1. Easy 2. Slightly 3. Moderat 4. Extreme	Portage Rapid Location		1. Easy 2. Slightly 3. Moderat 4. Extreme
600	1	Dave Steindorf	Mother Lode Falls		3										
600	2	Eric Magneson	Powels Pyramid		2		Randy's Swim		1	Whimper Falls		1	Rafters Only		3
600	3	Erik Powell	Whimper Falls		2		Tight Squeeze/		1	F-111		1			
600	4	Jeff Alkena	Whimper Falls		2		F-111		2	Tight Squeeze/Ski Jump		1			
600	5	Justin States	Whimper Falls		1		IGOB		2	Low Head		1			
600	6	Kary Danielson	Whimper Falls		2		Low Head		2	Powels Pyramid		3	Blowin Out Bottom		3
600	7	Louis Debret	Powels Pyramid		2		Whimper Falls		2	Low Head		2	6		2
600	8	Randy Calvin	Powels Pyramid		2		Low Head		2	Whimper Falls		2	It All Goes		2
	9	Todd Stanley	It All Goes		1										

ID	1	12.1				12.2			12.3			12.4		
	Name	Portage Rapid Location	0	1. Easy 2. Slightly 3. Moderat 4. Extreme	0	Portage Rapid Location	0	1. Easy 2. Slightly 3. Moderat 4. Extreme	Portage Rapid Location	0	1. Easy 2. Slightly 3. Moderat 4. Extreme	Portage Rapid Location	0	1. Easy 2. Slightly 3. Moderat 4. Extreme

	0	1	12.5			12.6				13
Flow	**ID**	Name	Portage Rapid Location		1. Easy 2. Slightly 3. Moderat 4. Extreme	Portage Rapid Location		1. Easy 2. Slightly 3. Moderat 4. Extreme		Safety-related - comments
600	**1**	Dave Steindorf								One swim and one pin.
600	**2**	Eric Magneson	F1-111		2					A raft high isded in a sticky spot whre a swim
600	**3**	Erik Powell								There were 2 kayak swims that were picked
600	**4**	Jeff Alkena								1 brief kayak surf resulted in a swim. 1
600	**5**	Justin States								Two swims, kayak. One raft-wrapped boat. One
600	**6**	Kary Danielson	No Swimming Here		2					One short pin, 2 swims after attempting t run
600	**7**	Louis Debret	6		2	6		2		2 swims(kayak), 1 wrap (raft), 1 swim (raft)
600	**8**	Randy Calvin	F1-111		2					Swim at Low Head very bad place to be!!! I
	9	Todd Stanley								Yes, I swam out of a huge hole that resembles

ID	1	12.5			12.6			0	13
	Name	Portage Rapid Location	0	1. Easy 2. Slightly 3. Moderat 4. Extreme	Portage Rapid Location	0	1. Easy 2. Slightly 3. Moderat 4. Extreme	0	Safety-related - comments

	0	1	14					15
Flow	ID	Name	kayaks	rafts	catarafts	open canoes	IK	Commericial suitabitliy Comments
600	1	Dave Steindorf	4	4		0	2	Not Suitable for Kayaks
600	2	Eric Magneson	4	4				
600	3	Erik Powell	4	4			3	The run at this flow is not suited to
600	4	Jeff Alkena	4	4				Not suitable for commerical raft rips
600	5	Justin States	4				2	
600	6	Kary Danielson	3	4	4	0	0	The commerical suitability is nill, too
600	7	Louis Debret	4	4				
600	8	Randy Calvin	4	4				
	9	Todd Stanley	4	4	4	0	3	

	1	14					15
ID	Name	kayaks	rafts	catarafts	open canoes	IK	Commericial suitabitliy Comments

				1. Evaluate the following flows for your **craft** and skill **level**												2. Answer following questions based on trips on Ice House				
ID	Name	**Skill Level**	**Kayak OR Raft**	200cfs	400cfs	600cfs	800cfs	1000cfs	1200cfs	1400cfs	1600cfs	1800cfs	2000cfs	2200cfs	2400cfs	Lowest flow get down	lowest flow technica	optimal range		highest safe flow
1	Dave Steindorf	X	K	1	2	4	4	3	2	1						400	500	600	750	800
2	Eric Magneson	X	K		1	3	5	4	3	2						400	600	700	900	1800
3	Erik Powell	X	R	1	1	4	5	4	3	3	2	1	1	1	1	500	600	700	800	900-1000
4	Jeff Alkena	X	R	1	2	3	5	4	3	2	1	1	1	1	1	500	600	750	850	1000
5	Justin States	X	K		2	4	4	2								600	600	600	800	700
6	Kary Danielson	X	K	1	2	5	4	3	2	1	1	1	1	1	1	500	550	550	650	600
7	Louis Debret	X	K	1	2	5	5	4	3	2	2	2	1	1	1	500	600	700	900	1000
8	Randy Calvin	X	K	1	1	4	4	3	3	2	2	1	1	1	1	400	600	600	900	1200
9	Todd Stanley	X	K	1	1	3	4	5	4	4	2	2	2	2	2	600	600	700	900	1200

	1. Evaluate the following flows for your **craft** and skill **level**																
	200cfs	400cfs	600cfs	800cfs	1000cfs	1200cfs	1400cfs	1600cfs	1800cfs	2000cfs	2200cfs	2400cfs	flow get down	flow technica	optimal range		highest safe flow
Count	7	9	9	9	9	8	8	6	6	6	6	6	5	5	5	5	4
Average	0.8	1.6	3.9	4.4	3.6	2.6	1.9	1.1	0.9	0.8	0.8	0.8	488.9	583.3	655.6	827.8	1037.5
													78.1736	35.355	68.211	87.003	377.7281713

				3. What CA whitewater runs are similar to Camino Reach at optimal flow?																				
				A							B							C						
ID	Name	Skill Level	Kayak OR Raft	Name of Run	0-3	4-8	9-15	15+	Travel Time	Boatable Months	Name of Run	0-3	4-8	9-15	15+	Travel Time	Boatable Months	Name of Run	0-3	4-8	9-15	15+	Travel Time	Boatable Months
1	Dave Steindorf	X	K	Slab Creek	1					March-May	None							None						
2	Eric Magneson	X	K	Slab Creek	1				1	March-May	North Fork Feathe	1				2	April							
3	Erik Powell	X	R	Slab Creek		1			0.5	Spring	North Staninslaus		1			2.5	Spring-Summ	Upper Cosumns	1				1	May-June
4	Jeff Alkena	X	R	Slab Creek	1				1.5	May-June	Upper Cosumnes	1				1	May-June							
5	Justin States	X	K	Lower NFMF America	1				1.5	April-May	Sierra City	1				1.5	April-May							
6	Kary Danielson	X	K	Lower Webber Creek	1				3	Winter	Camp Creek	1				6	Spring	Lower Silver Fork	1				6	
7	Louis Debret	X	K	North Trintiy	1				8	March-April														
8	Randy Calvin	X	K	Camp Creek	1				1.5	Feb. & March														
9	Todd Stanley	X	K	Camp Creek	1				0.5	When they release														

	3. What CA whitewater runs are similar to Ice House at optimal flow?																					
	A							B							C							
	Name of Run	0-3	4-8	9-15	15+			Name of Run	0-3	4-8	9-15	15+			Name of Run	0-3	4-8	9-15	15+			
Count																						
Average																						

				4. Compared to runs listed above, how would you rate boating on the Camino Reach?						5. Non Whitewater characteristics				6. Suggestions for access/shuttle improvements	7. Other comments
				A		B		A							
ID	Name	Skill Level	Kayak OR Raft	Name of Run	Scale 1 to 5	Name of Run	Scale 1 to 5	Name of Run	Scale 1 to 5	Length of Shuttle	Put-in	Take-out	Shuttle: Boating Ratio		
1	Dave Steindorf	X	K	Slab Creek	2	None		None	2	2	4	4	2		
2	Eric Magneson	X	K	Slab Creek	2	NFMF American	4	Lower Clavey	3	2	3	4	4	More frequent releases would clean out loose debris (logs etc.)	about this run and am glad to finally get the opportunity to runit. Interesting geogolgy and variable rapid
3	Erik Powell	X	R	Slab Creek	2	North Staninslaus	2	Upper Cosumns	3	3	4	5	4	Move or remove locked gates to allow access right to the rivers edge.	extremely scenic and remote offering challenging rapids in an expert only or advanced boater venue. Thanks to
4	Jeff Alkena	X	R	Slab Creek	2	Upper Cosumnes	4			2	4	5	4	A high flow release would help to clean-up in channel debris and bush.	clean up the run, and cover up a lot of the rocks that were obstructing the channels and make a less bumpy
5	Justin States	X	K	Lower NFMF American	4	Sierra City				2	3	4	3	Improve trail at put-in, regular flows to keep brush/trees to a minimum.	2. Middle, nice drops, and granite 3. Lower, gorilla boating 4. G Gate, fun with some junk. Overall this
6	Kary Danielson	X	K	Webber	4	Camp Creek	4	Lower Silver Fork	4	2	4	4	2	None	to compare this run to any single run I've experienced. It's really an anonomly of many different rocky runs.
7	Louis Debret	X	K	North Trintiy	3					2	4	4	2	Gate open at put-in.	The rapids for the most part were not that clean (blocked chutes, boulders, etc.)
8	Randy Calvin	X	K	Camp Creek	2					2	4	4	2	none	Would go back and do it again. Would rate it as a premium run.
9	Todd Stanley	X	K	Camp Creek	2					5	5	5	4	tired of those blaktop type accesses. I prefer the natural state. If you are prepared to boat	I thoroughly enjoyed the day! Thanks for the experience.

	4. Compared to runs listed above, how would you rate boating on the Ice House Reach?						5. Non-Whitewater characteristics			
	A		B		A					
	Name of Run	1 to 5	Name of Run	1 to 5	Name of Run	Scale 1 to 5	Length of Shuttle	Put-in Good	Take-out Good	Boating Ratio Good
Count							6	6	6	6
Average							2.4	3.9	4.3	3.0

APPENDIX D

INTERNATIONAL SCALE OF RIVER DIFFICULTY

(AS REVISED BY AMERICAN WHITEWATER, 1998)

Appendix D

International scale of river difficulty (as revised by American Whitewater, 1998)

this is the American version of a rating system used to compare river difficulty throughout the world. this system is not exact; rivers do not always fit easily into one category, and regional or individual interpretations may cause misunderstandings. it is no substitute for a guidebook or accurate first-hand descriptions of a run.

The six difficulty classes:

class i: easy. fast moving water with riffles and small waves. few obstructions, all obvious and easily missed with little training. risk to swimmers is slight; self-rescue is easy.

class ii: novice. straightforward rapids with wide, clear channels which are evident without scouting. occasional maneuvering may be required, but rocks and medium sized waves are easily missed by trained paddlers. swimmers are seldom injured and group assistance, while helpful, is seldom needed. rapids that are at the upper end of this difficulty range are designated "class ii+".

class iii: intermediate. rapids with moderate, irregular waves which may be difficult to avoid and which can swamp an open canoe. complex maneuvers in fast current and good boat control in tight passages or around ledges are often required; large waves or strainers may be present but are easily avoided. strong eddies and powerful current effects can be found, particularly on large-volume rivers. scouting is advisable for inexperienced parties. injuries while swimming are rare; self-rescue is usually easy but group assistance may be required to avoid long swims. rapids that are at the lower or upper end of this difficulty range are designated "class iii-" or "class iii+" respectively.

class iv: advanced. intense, powerful but predictable rapids requiring precise boat handling in turbulent water. depending on the character of the river, it may feature large, unavoidable waves and holes or constricted passages demanding fast maneuvers under pressure. a fast, reliable eddy turn may be needed to initiate maneuvers, scout rapids, or rest. rapids may require must make moves above dangerous hazards. scouting may be necessary the first time down. risk of injury to swimmers is moderate to high, and water conditions may make self-rescue difficult. group assistance for rescue is often essential but requires practiced skills. a strong eskimo roll is highly recommended. rapids that are at the upper end of this difficulty range are designated "class iv-" or "class iv+" respectively.

class v: expert. extremely long, obstructed, or very violent rapids which expose a paddler to added risk. drops may contain large, unavoidable waves and holes or steep, congested chutes with complex, demanding routes. rapids may continue for long distances between pools, demanding a high level of fitness. what eddies exist may be small, turbulent, or difficult to reach. at the high end of the scale, several of these factors may be combined. scouting is recommended but may be difficult. swims are dangerous, and rescue is often difficult even for experts. a very reliable eskimo roll, proper equipment, extensive experience, and practiced rescue skills are essential. because of the large range of difficulty that exists beyond class iv, class 5 is an open ended, multiple level scale designated by class 5.0, 5.1, 5.2, etc... each of these levels is an order of magnitude more difficult than the last. example: increasing difficulty from class 5.0 to class 5.1 is a similar order of magnitude as increasing from class iv to class 5.0.

class vi: extreme and exploratory. these runs have almost never been attempted and often exemplify the extremes of difficulty, unpredictability and danger. the consequences of errors are very severe and rescue may be impossible. for teams of experts only, at favorable water levels, after close personal inspection and taking all precautions. after a class vi rapids has been run many times, it's rating may be changed to an appropriate class 5.x rating.

APPENDIX E

FLOW EXCEEDANCE GRAPHS

Appendix E
Flow Exceedance Graphs

The following pages show graphs of mean daily flow, grouped by month and then by water year type. Months April through November are included. Flow values are ranked by magnitude and plotted using Weibull plotting positions. On each graph are both impaired and unimpaired flow data.

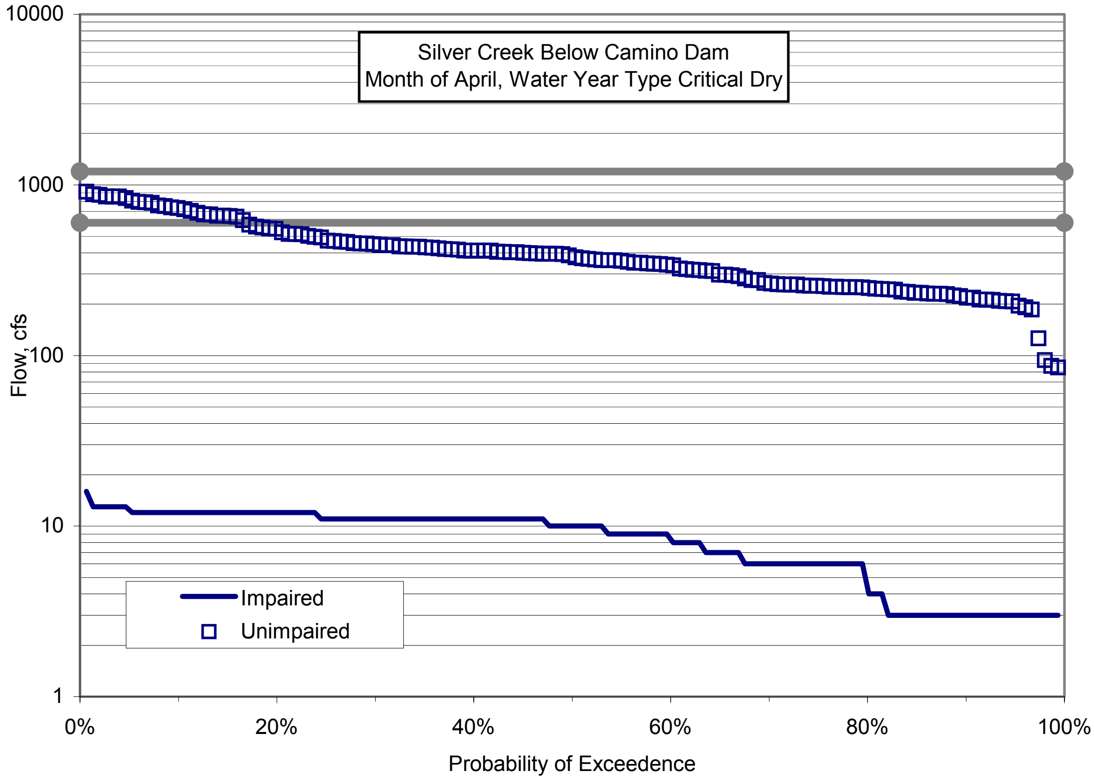
Each graph does not have the same number of data points. This is because each of the five water year types is not uniformly represented in the period of record, water years 1975–2000. Table E1 lists the number of years included in each water year type.

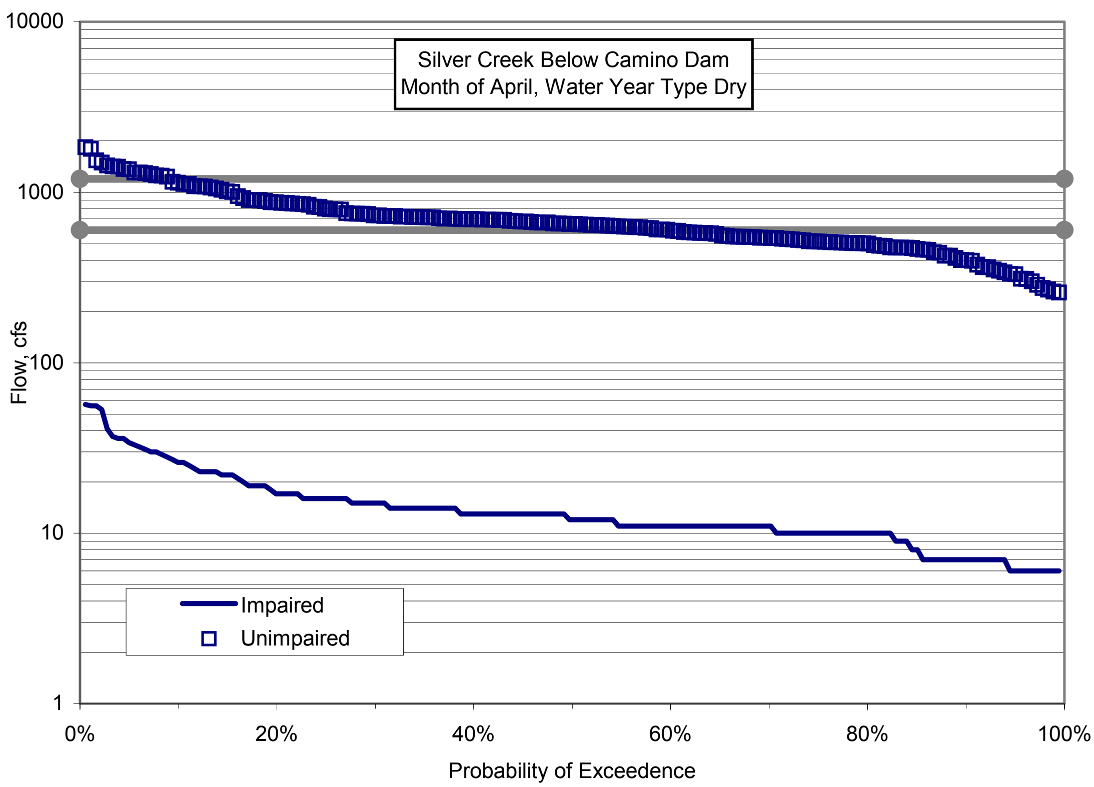
Caution: Months October and November are at the beginning of the water year. There is no significant correlation between runoff in these months and future precipitation. There is some correlation with antecedent snowmelt in above normal and wet years. Therefore, the prior water year's water year type was used to classify flow data for October and November.

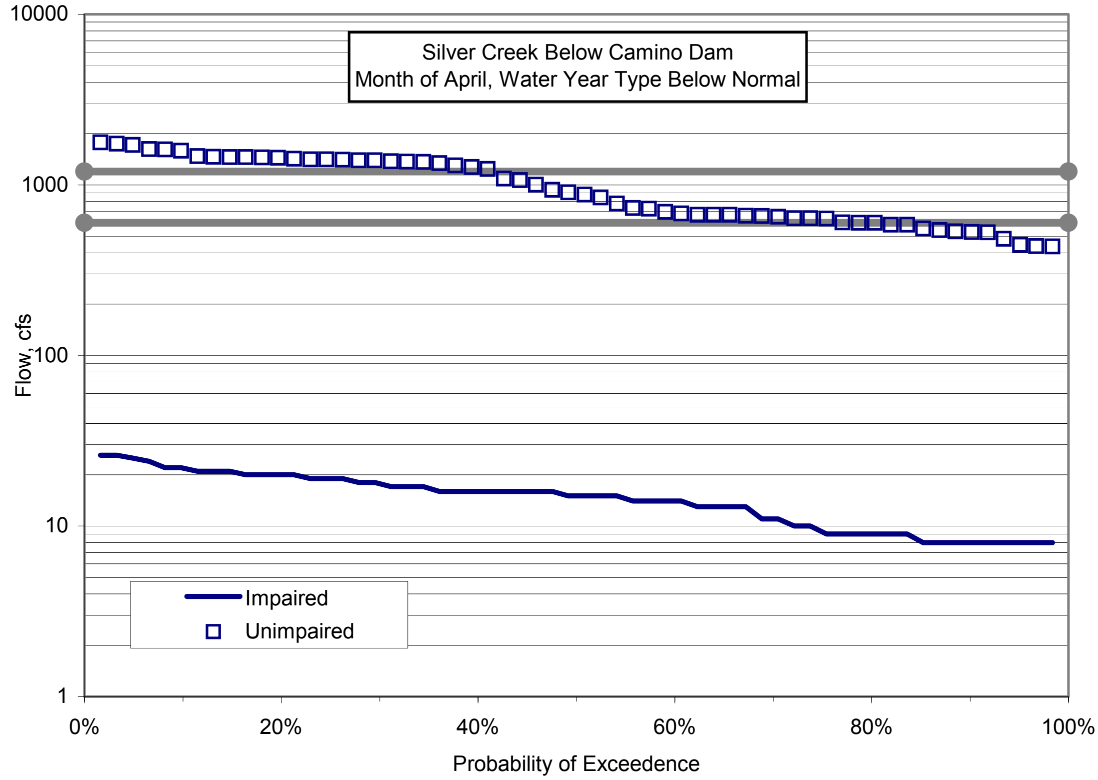
Impaired data were obtained from official USGS records for gage number 11441900. Unimpaired data were taken from the *Hydrology Technical Report*. The flow values 600 and 1200 are highlighted.

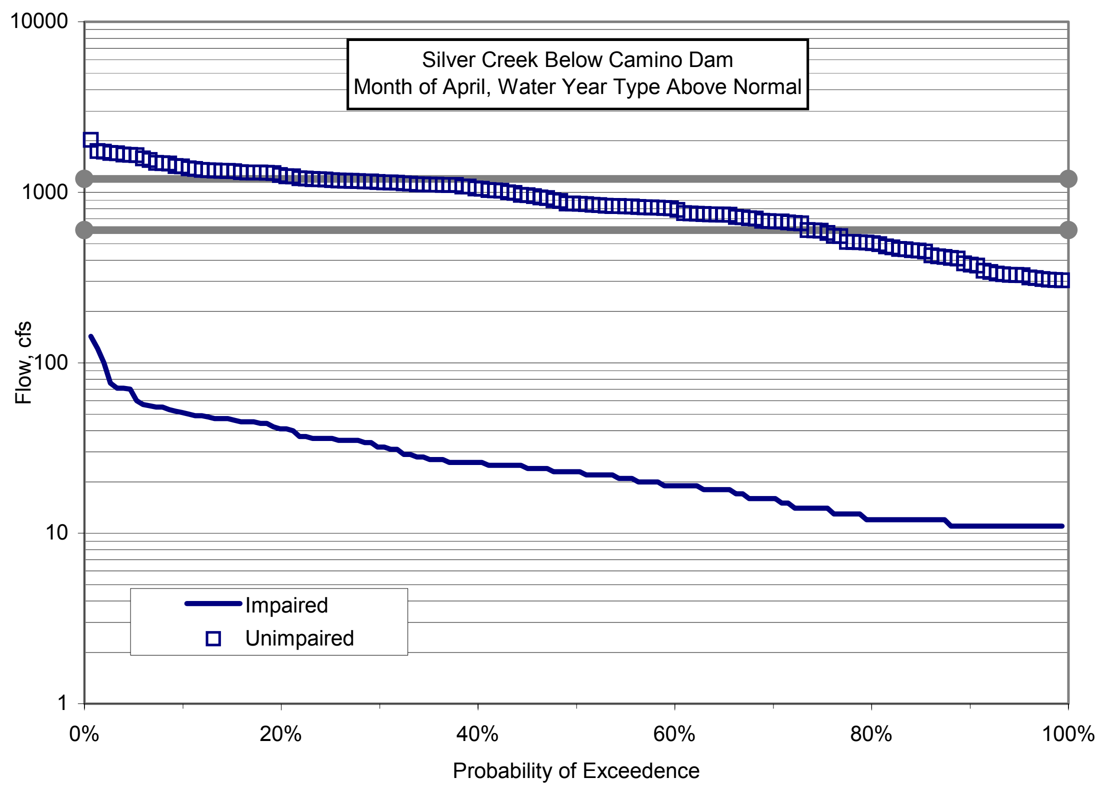
Table E1. Number of years represented by each water year type, 1975–2000.

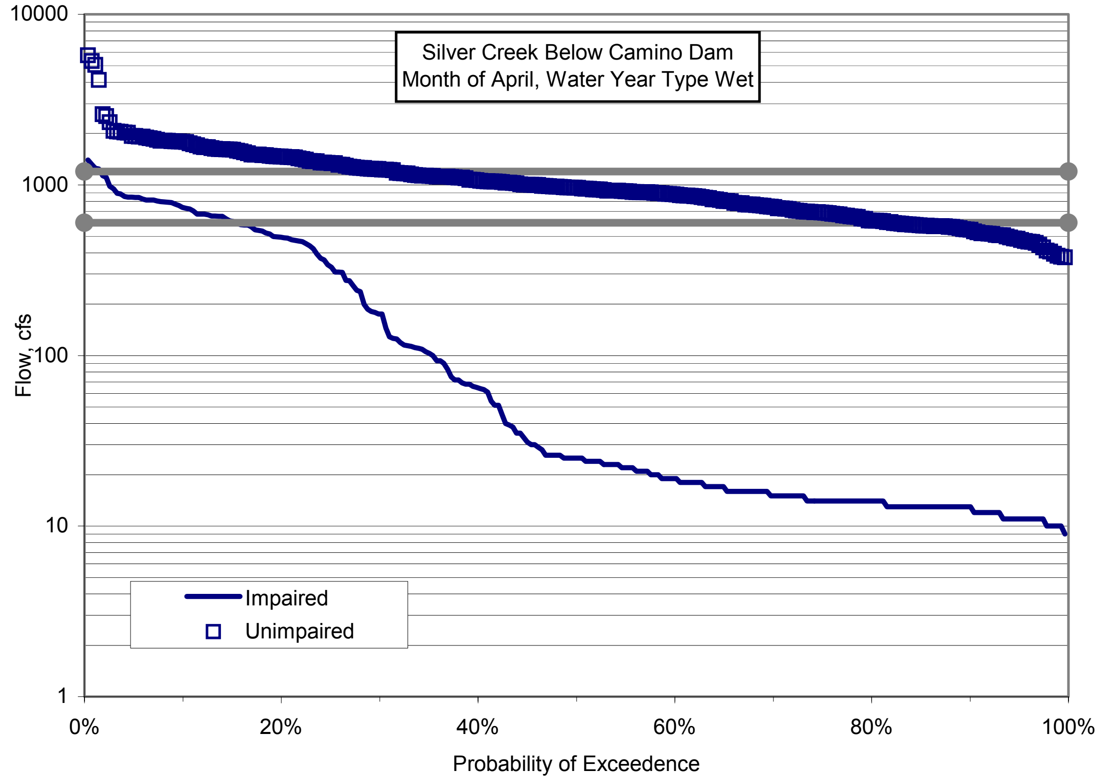
Water year type	Number of years
Critically Dry	5
Dry	5
Below Normal	2
Above Normal	5
Wet	9
Total	26

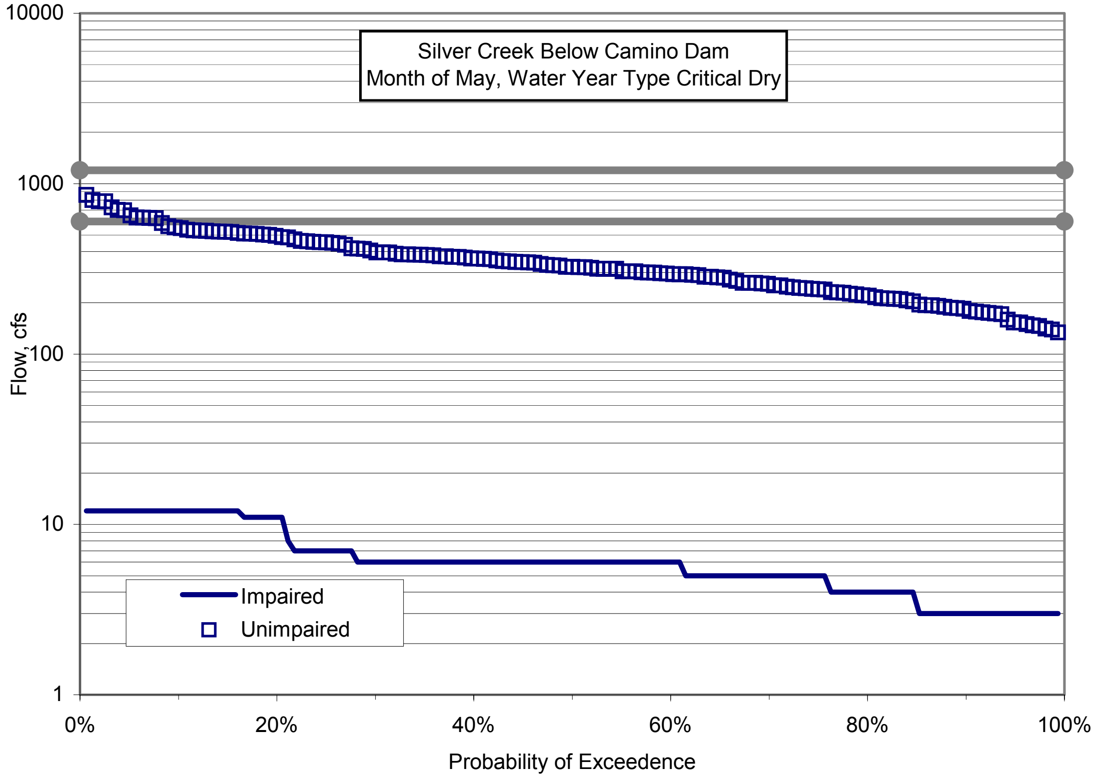

Silver Creek Below Camino Dam
Month of April, Water Year Type Critical Dry
10000
1000
100
10
1
Flow, cfs
0%
20%
40%
60%
80%
100%
Probability of Exceedence
Impaired
Unimpaired

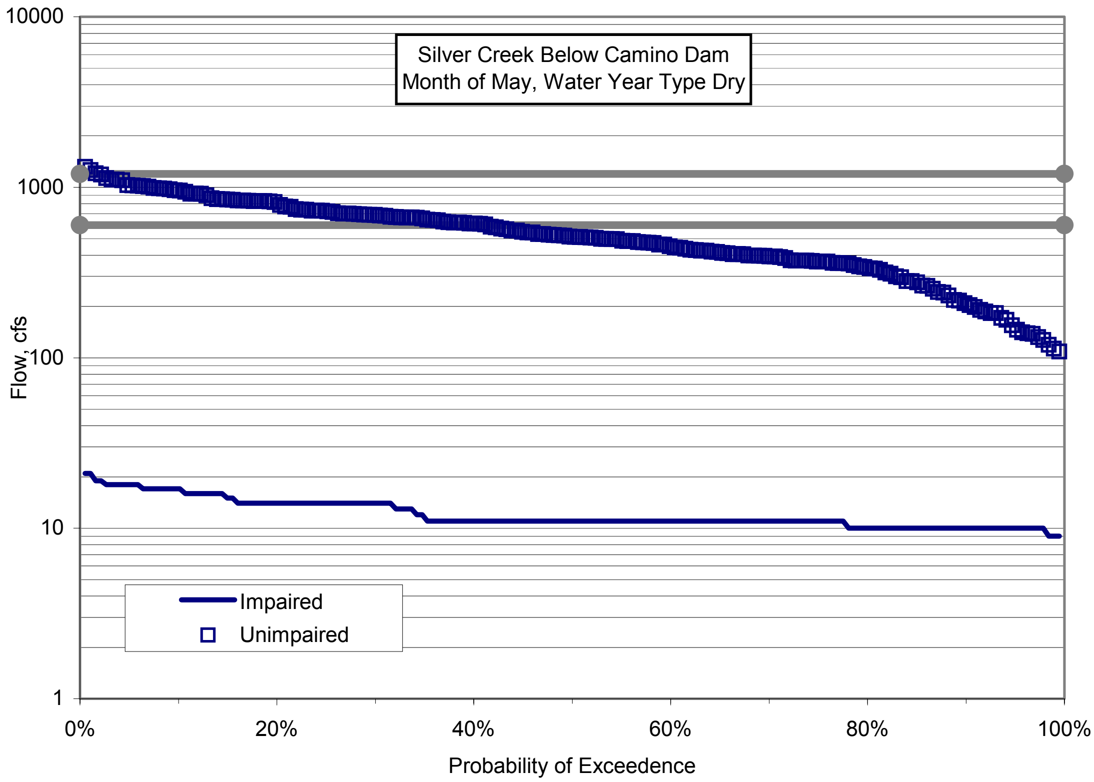

Silver Creek Below Camino Dam
Month of April, Water Year Type Dry
10000
1000
100
10
1
Flow, cfs
0%
20%
40%
60%
80%
100%
Probability of Exceedence
Impaired
Unimpaired

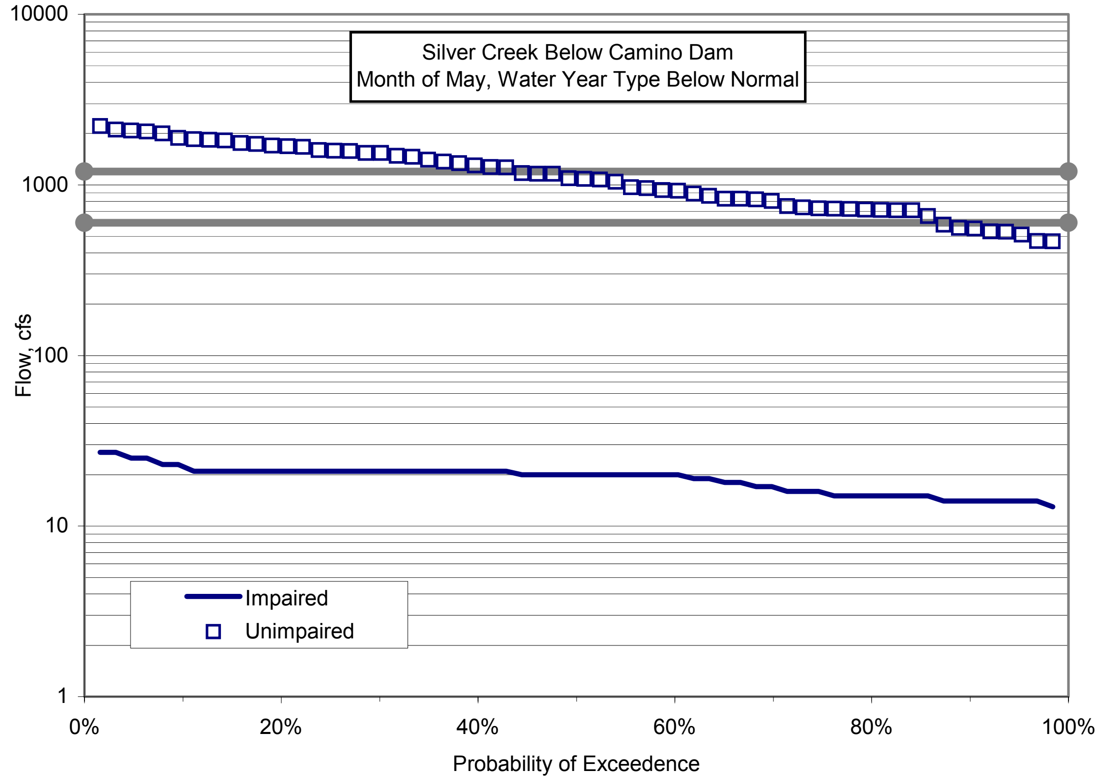

Silver Creek Below Camino Dam
Month of April, Water Year Type Below Normal
Flow, cfs
10000
1000
100
10
1
0%
20%
40%
60%
80%
100%
Probability of Exceedence
Impaired
Unimpaired

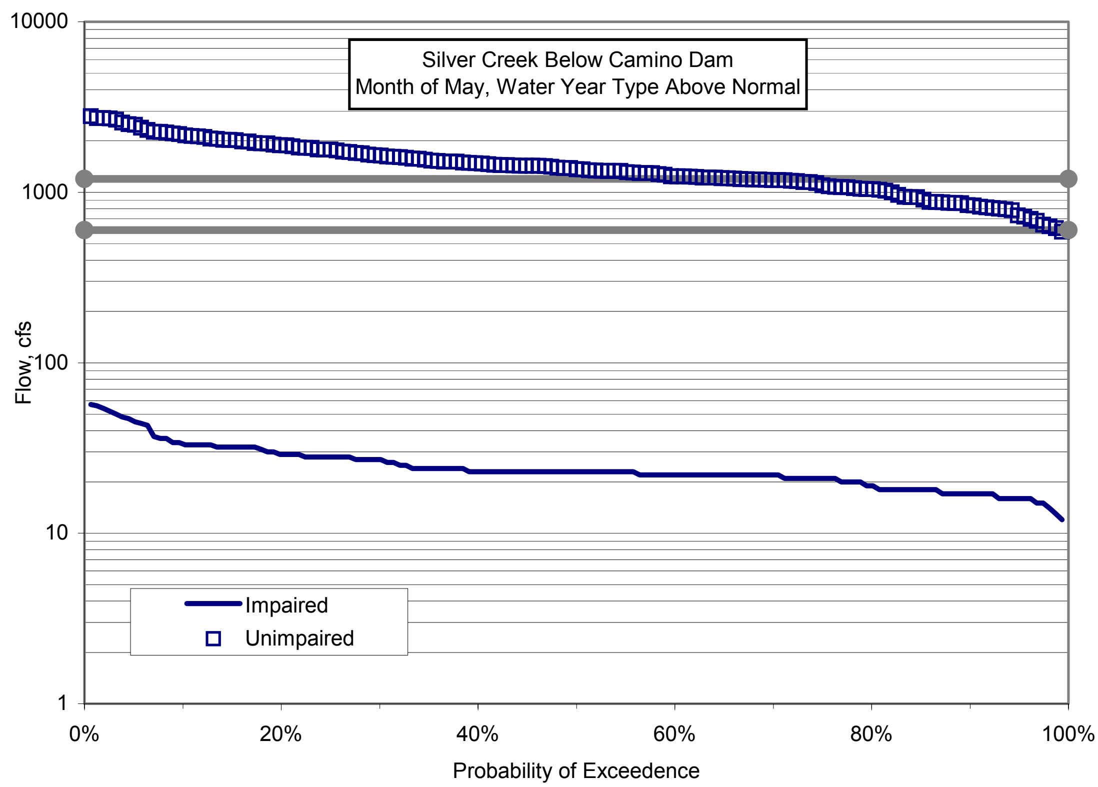

Silver Creek Below Camino Dam
Month of April, Water Year Type Above Normal
Flow, cfs
10000
1000
100
10
1
0%
20%
40%
60%
80%
100%
Probability of Exceedence
Impaired
Unimpaired

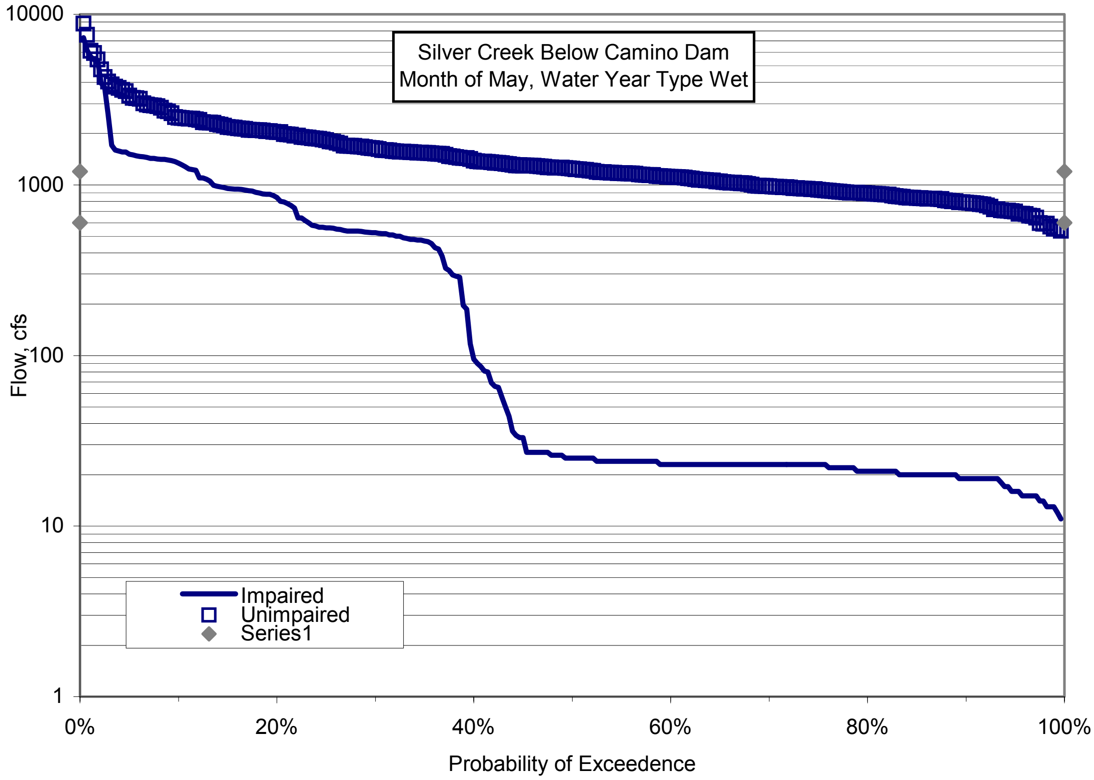

Silver Creek Below Camino Dam
Month of April, Water Year Type Wet
10000
1000
100
10
1
Flow, cfs
0%
20%
40%
60%
80%
100%
Probability of Exceedence
Impaired
Unimpaired

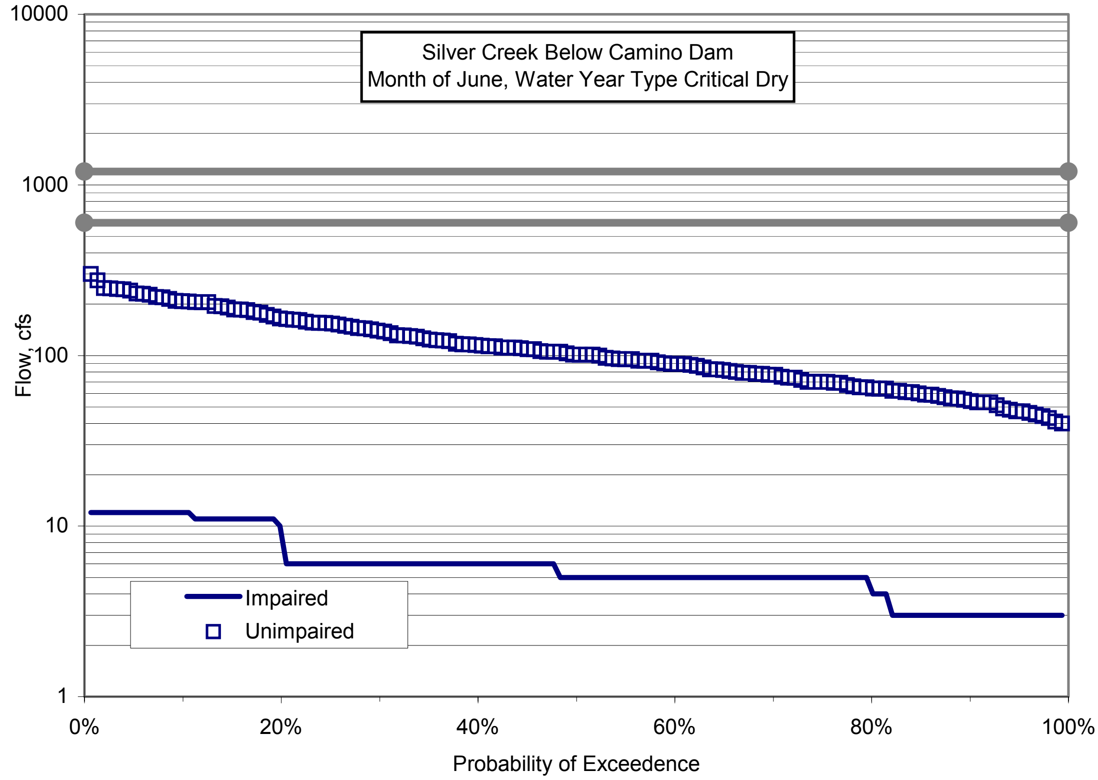

Silver Creek Below Camino Dam
Month of May, Water Year Type Critical Dry
10000
1000
100
10
1
Flow, cfs
0%
20%
40%
60%
80%
100%
Probability of Exceedence
Impaired
Unimpaired

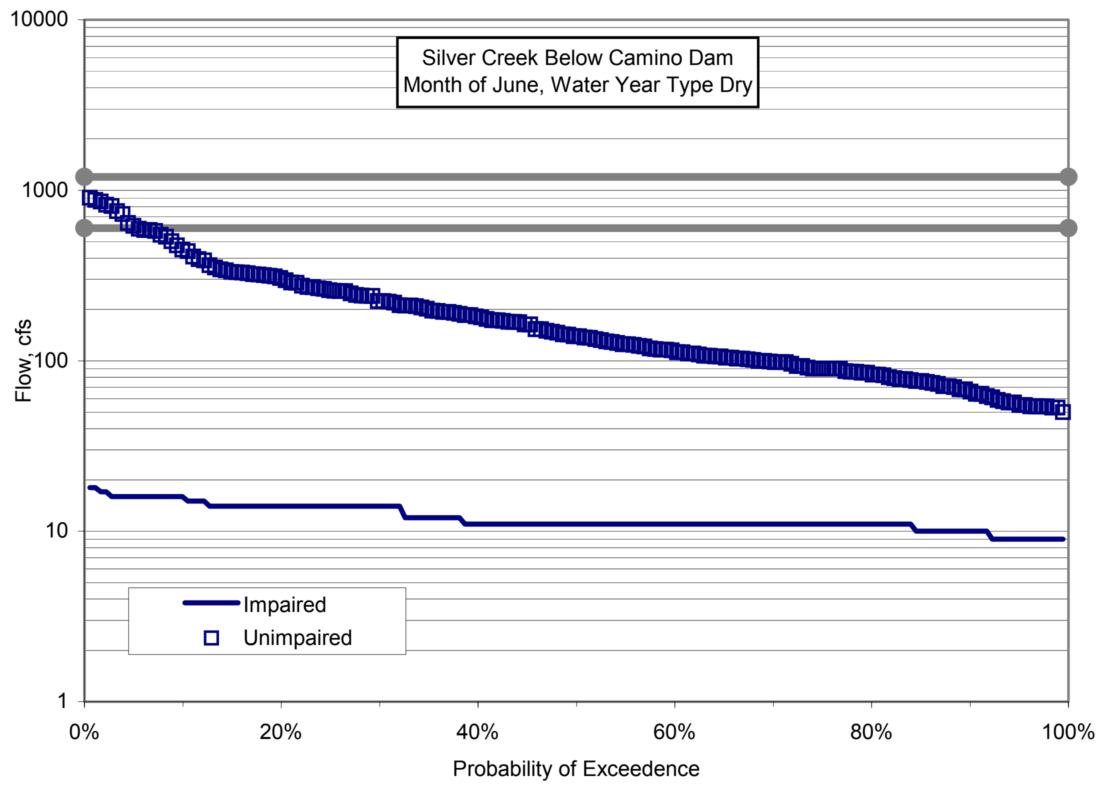

Silver Creek Below Camino Dam
Month of May, Water Year Type Dry
10000
1000
100
10
1
Flow, cfs
0%
20%
40%
60%
80%
100%
Probability of Exceedence
Impaired
Unimpaired

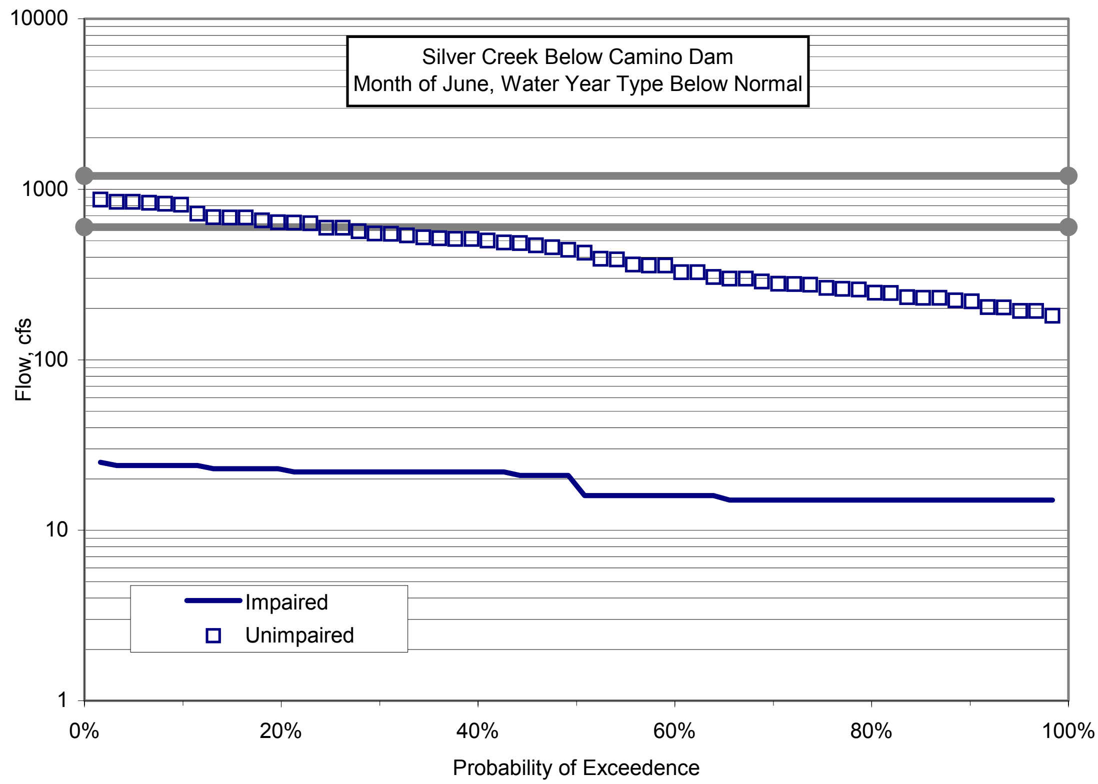

Silver Creek Below Camino Dam
Month of May, Water Year Type Below Normal
10000
1000
100
10
1
Flow, cfs
Impaired
Unimpaired
0%
20%
40%
60%
80%
100%
Probability of Exceedence

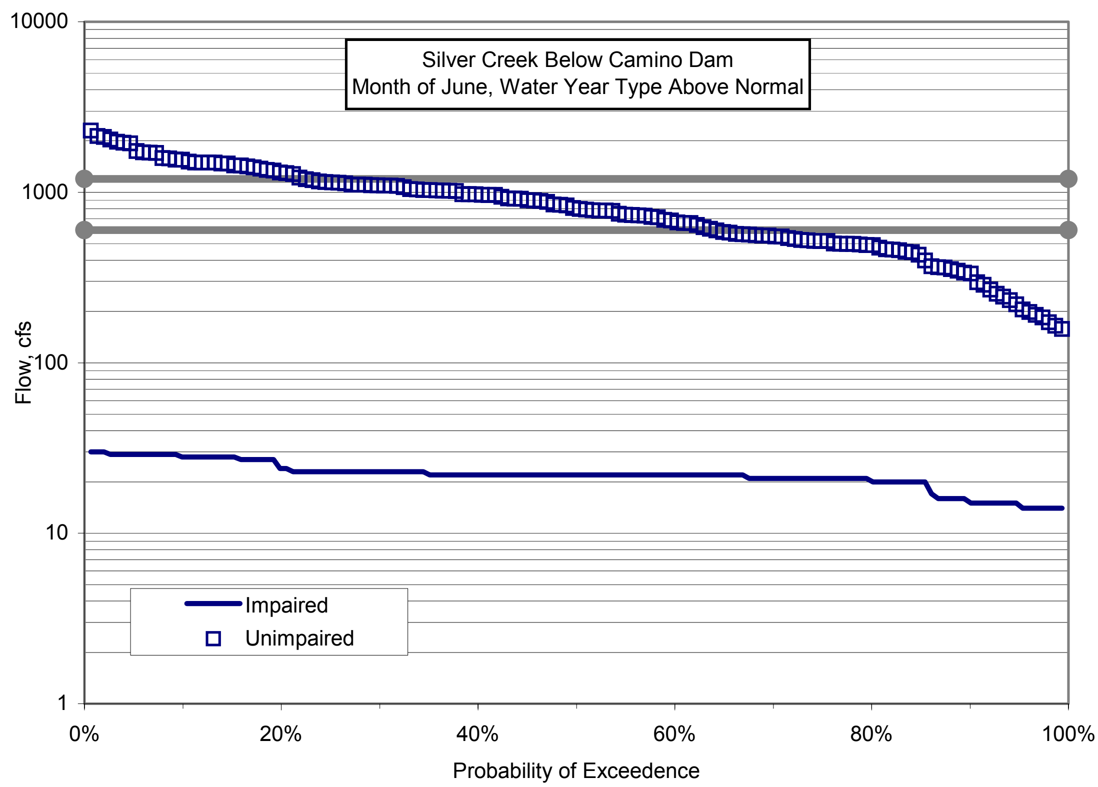

Silver Creek Below Camino Dam
Month of May, Water Year Type Above Normal
10000
1000
100
10
1
Flow, cfs
Impaired
Unimpaired
0%
20%
40%
60%
80%
100%
Probability of Exceedence

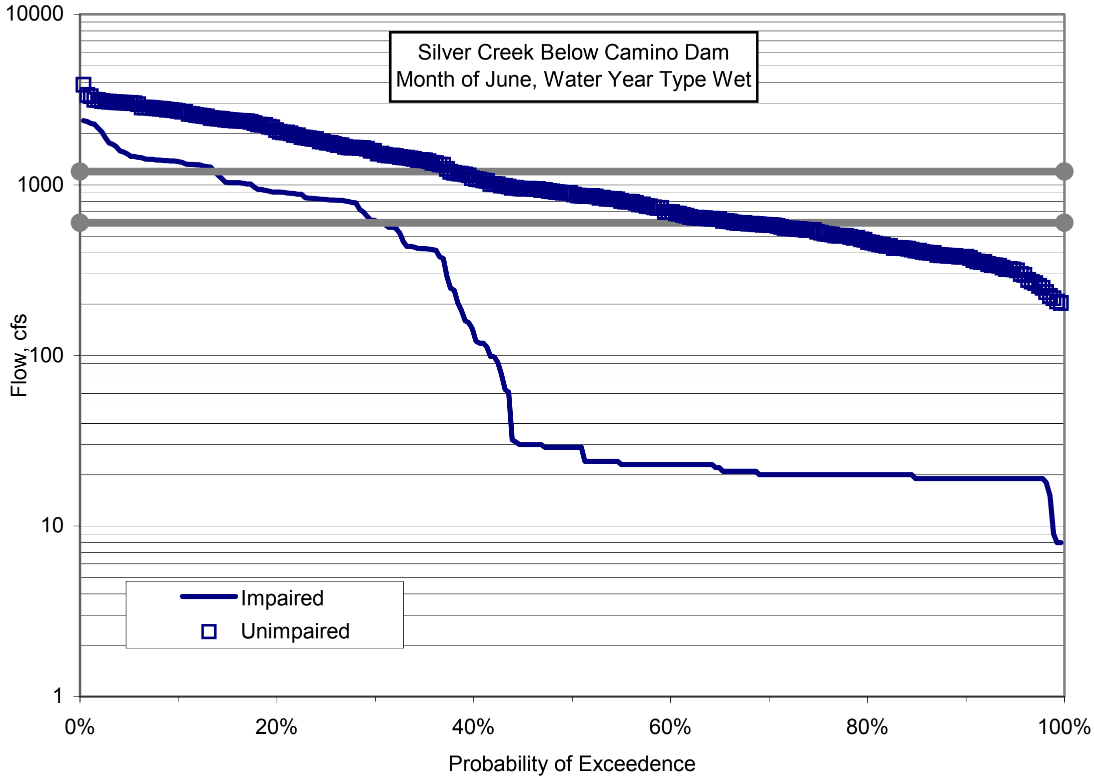

Silver Creek Below Camino Dam
Month of May, Water Year Type Wet
10000
1000
100
10
1
Flow, cfs
0%
20%
40%
60%
80%
100%
Probability of Exceedence
Impaired
Unimpaired
Series1

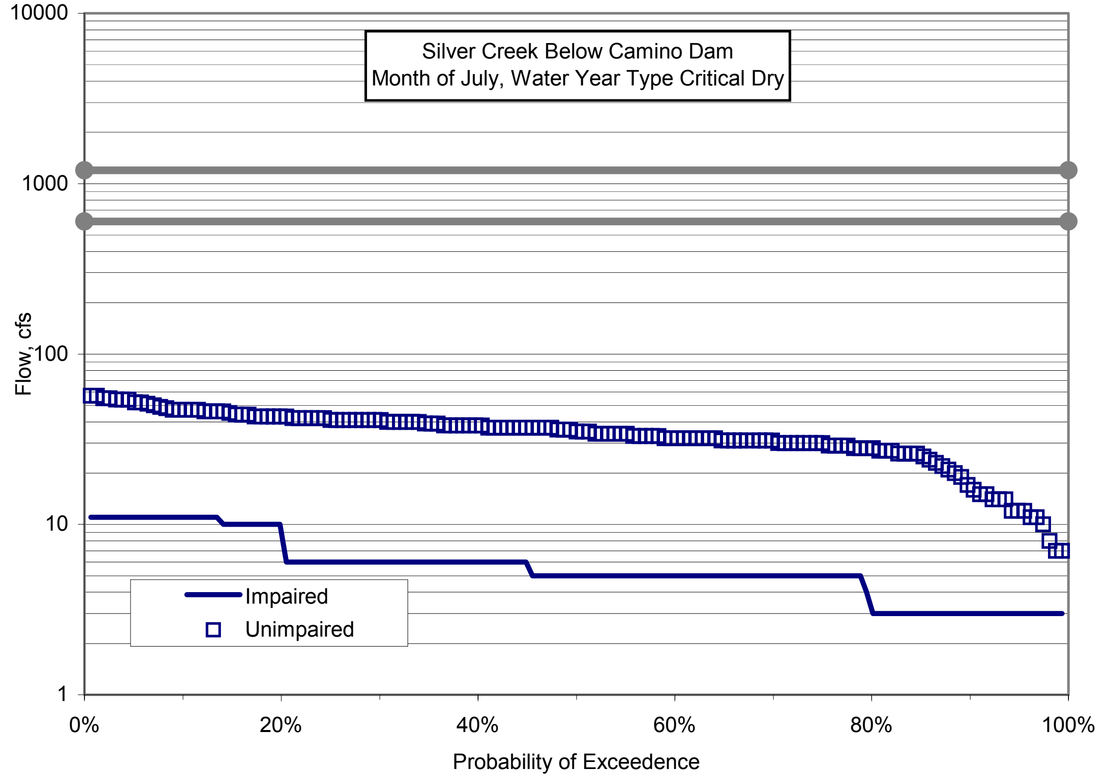

Silver Creek Below Camino Dam
Month of June, Water Year Type Critical Dry
10000
1000
100
10
1
Flow, cfs
0%
20%
40%
60%
80%
100%
Probability of Exceedence
Impaired
Unimpaired

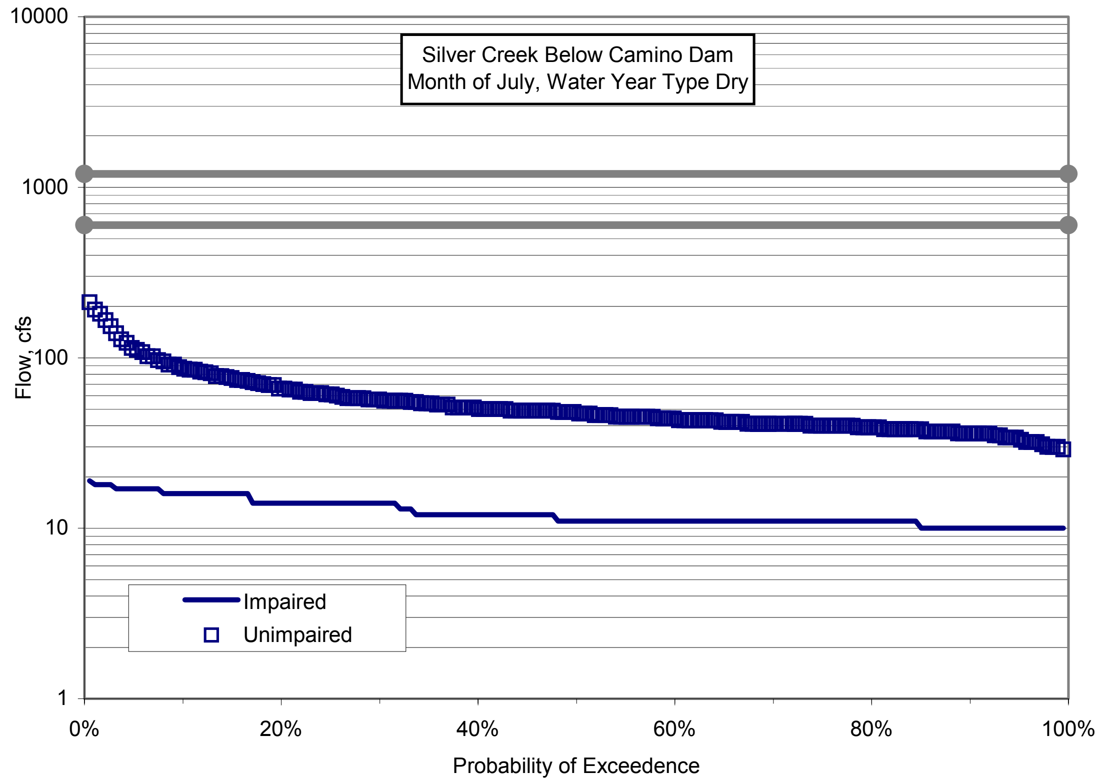

Silver Creek Below Camino Dam
Month of June, Water Year Type Dry
10000
1000
100
10
1
Flow, cfs
0%
20%
40%
60%
80%
100%
Probability of Exceedence
Impaired
Unimpaired

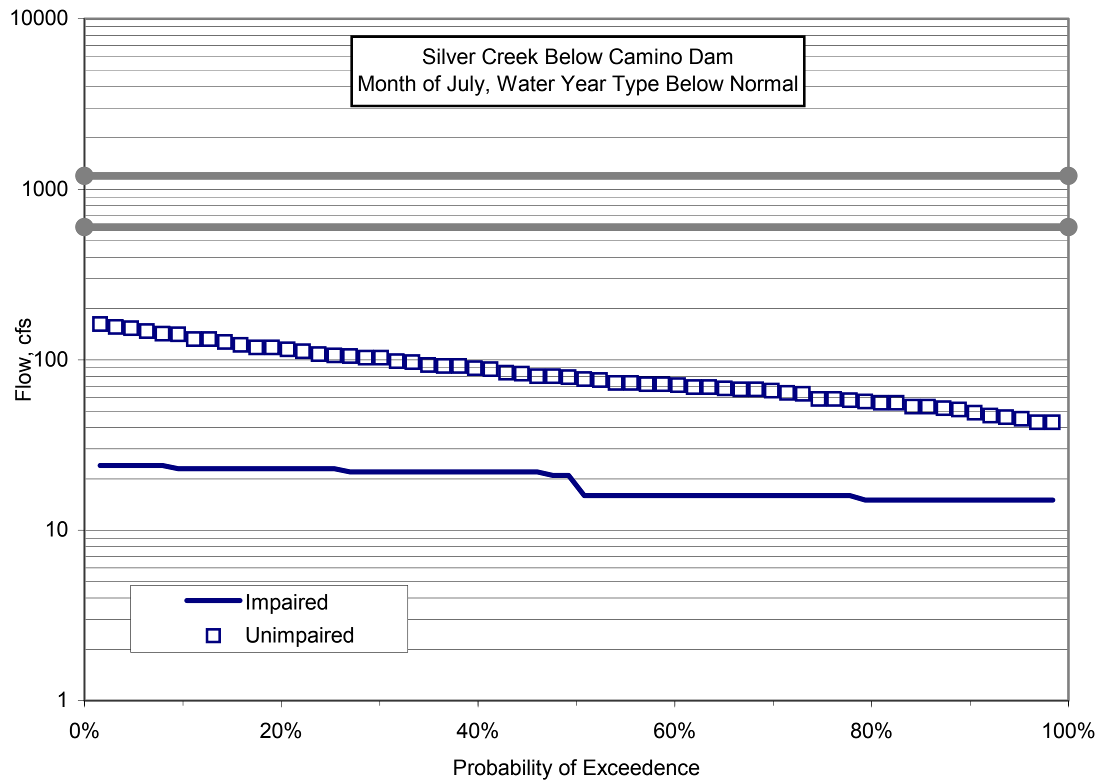

Silver Creek Below Camino Dam
Month of June, Water Year Type Below Normal
10000
1000
100
10
1
Flow, cfs
0%
20%
40%
60%
80%
100%
Probability of Exceedence
Impaired
Unimpaired

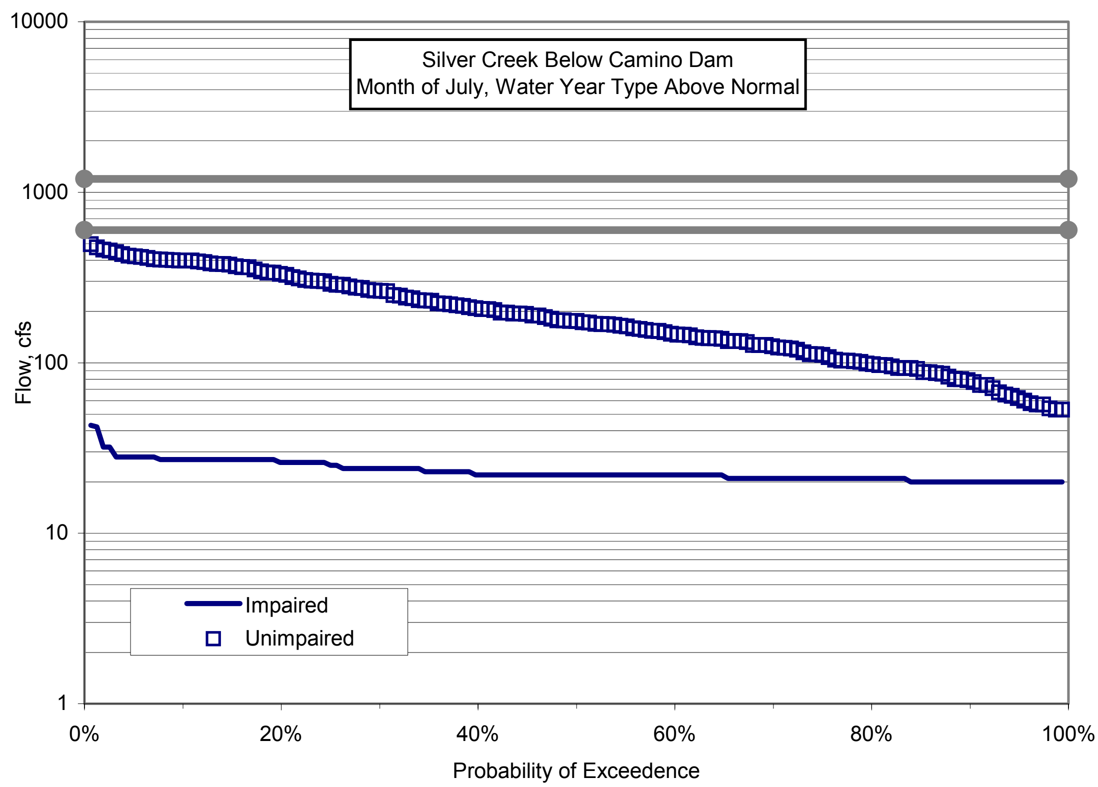

Silver Creek Below Camino Dam
Month of June, Water Year Type Above Normal
10000
1000
100
10
1
Flow, cfs
0%
20%
40%
60%
80%
100%
Probability of Exceedence
Impaired
Unimpaired

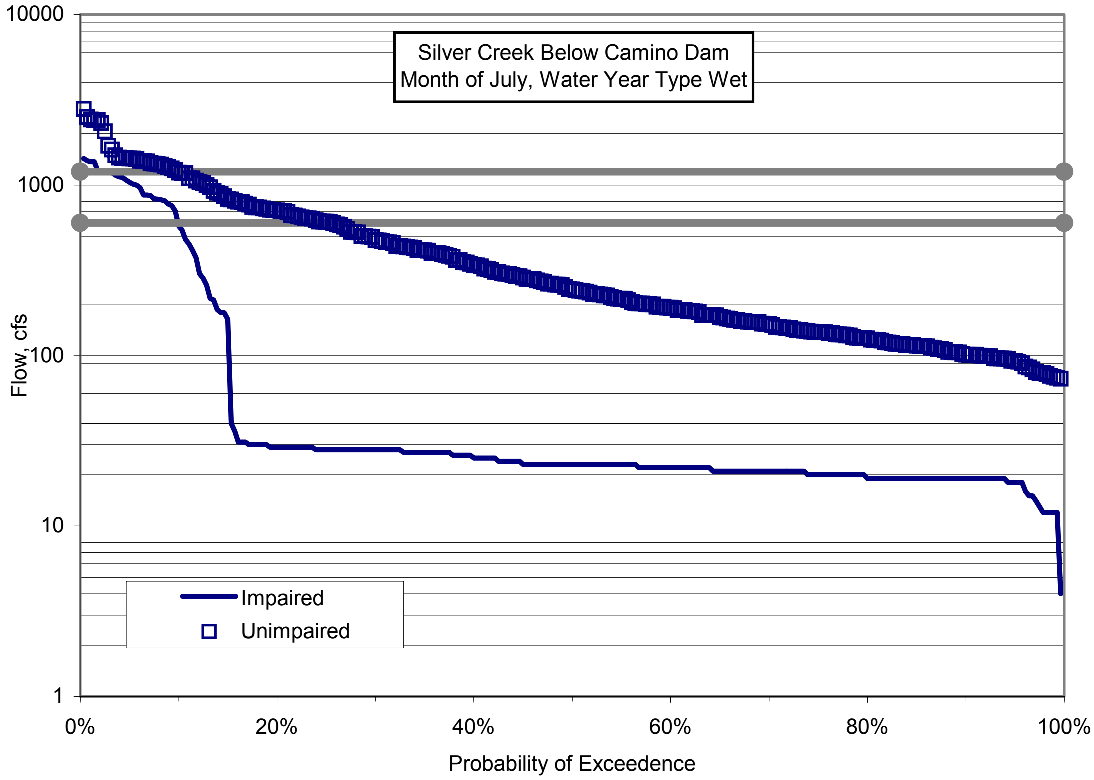

Silver Creek Below Camino Dam
Month of June, Water Year Type Wet
10000
1000
100
10
1
Flow, cfs
0%
20%
40%
60%
80%
100%
Probability of Exceedence
Impaired
Unimpaired

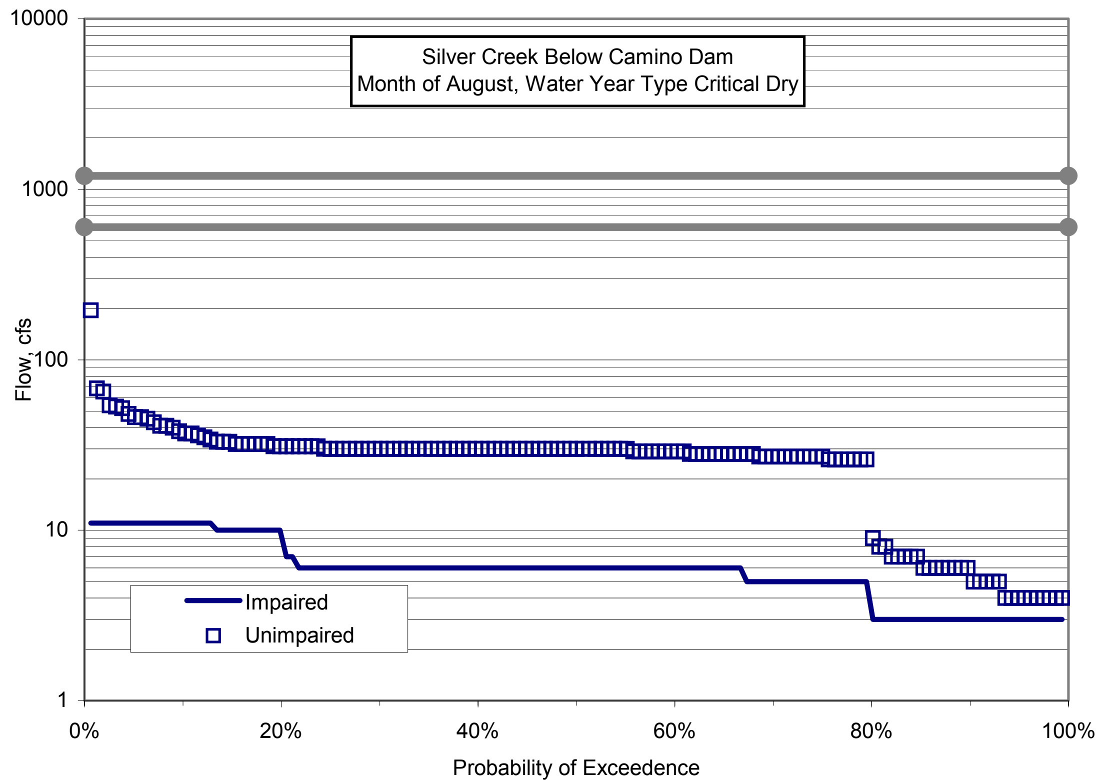

Silver Creek Below Camino Dam
Month of July, Water Year Type Critical Dry
Flow, cfs
10000
1000
100
10
1
0%
20%
40%
60%
80%
100%
Probability of Exceedence
Impaired
Unimpaired

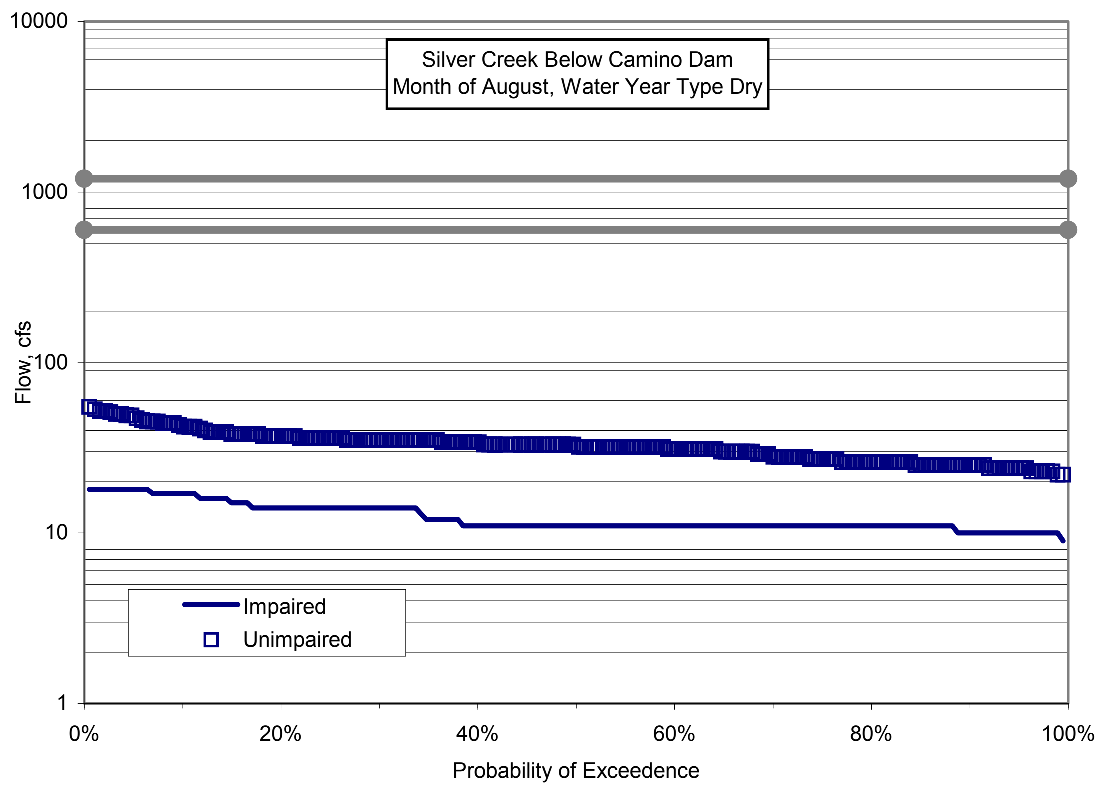

Silver Creek Below Camino Dam
Month of July, Water Year Type Dry
Flow, cfs
10000
1000
100
10
1
0%
20%
40%
60%
80%
100%
Probability of Exceedence
Impaired
Unimpaired

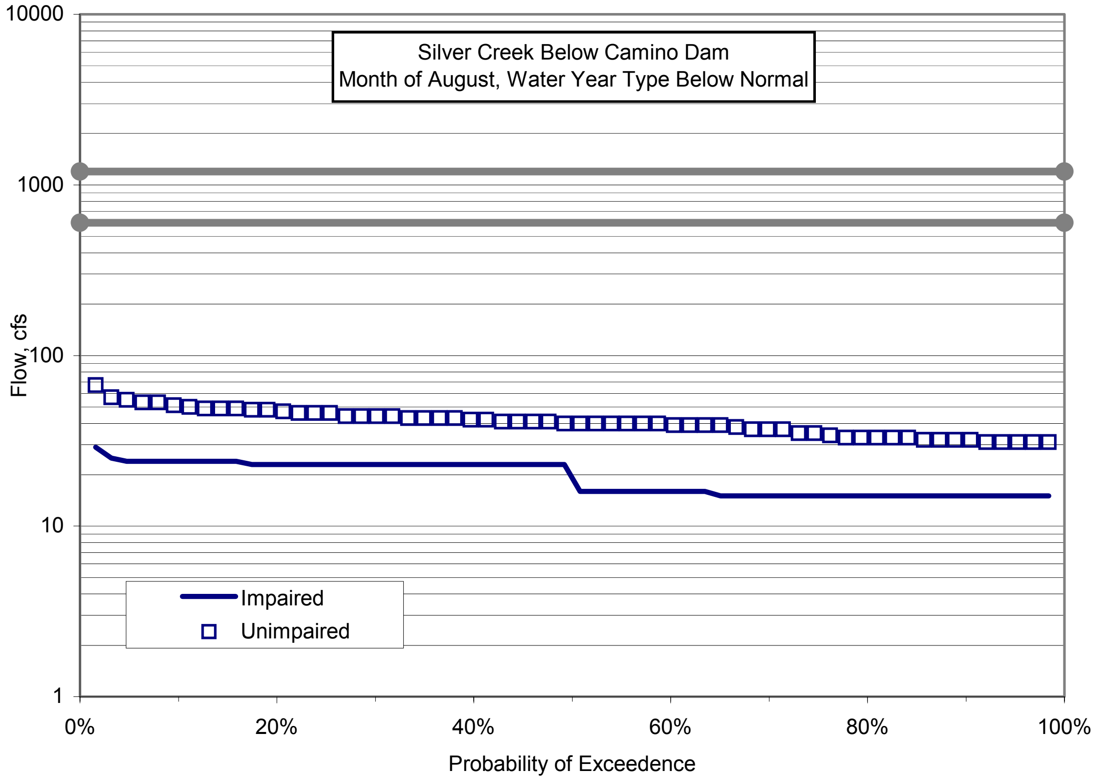

Silver Creek Below Camino Dam
Month of July, Water Year Type Below Normal
Flow, cfs
10000
1000
100
10
1
0%
20%
40%
60%
80%
100%
Probability of Exceedence
Impaired
Unimpaired

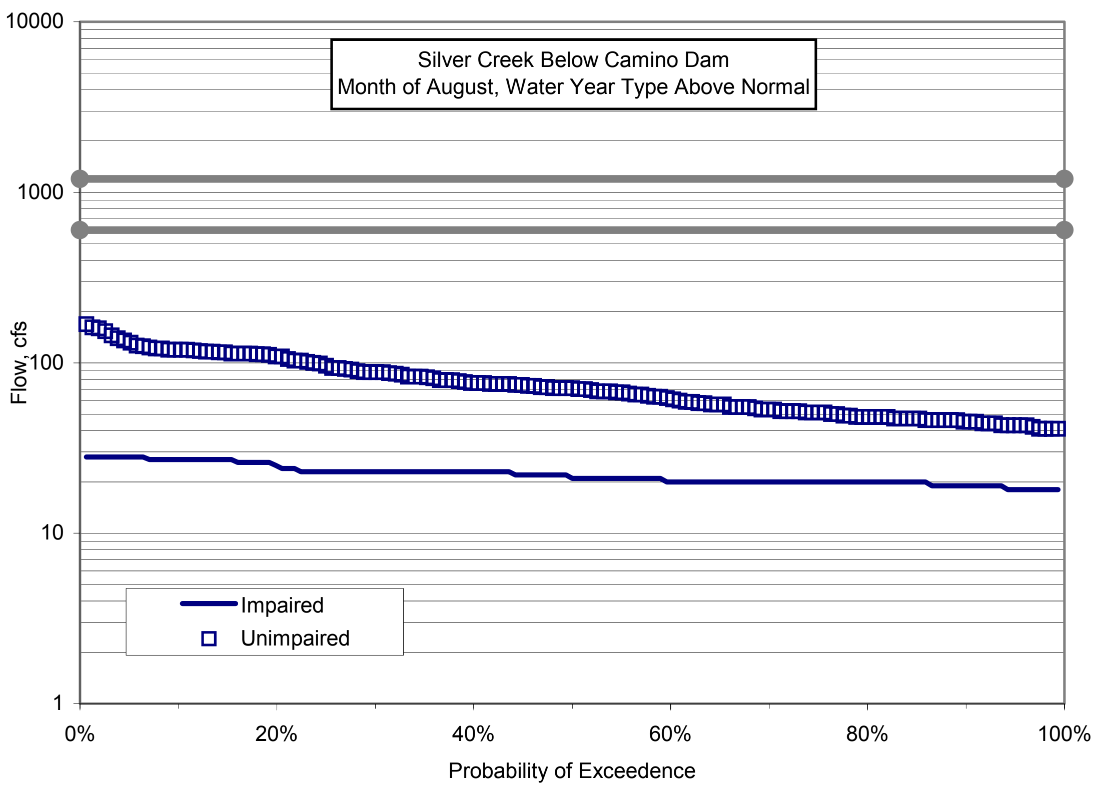

Silver Creek Below Camino Dam
Month of July, Water Year Type Above Normal
Flow, cfs
10000
1000
100
10
1
0%
20%
40%
60%
80%
100%
Probability of Exceedence
Impaired
Unimpaired

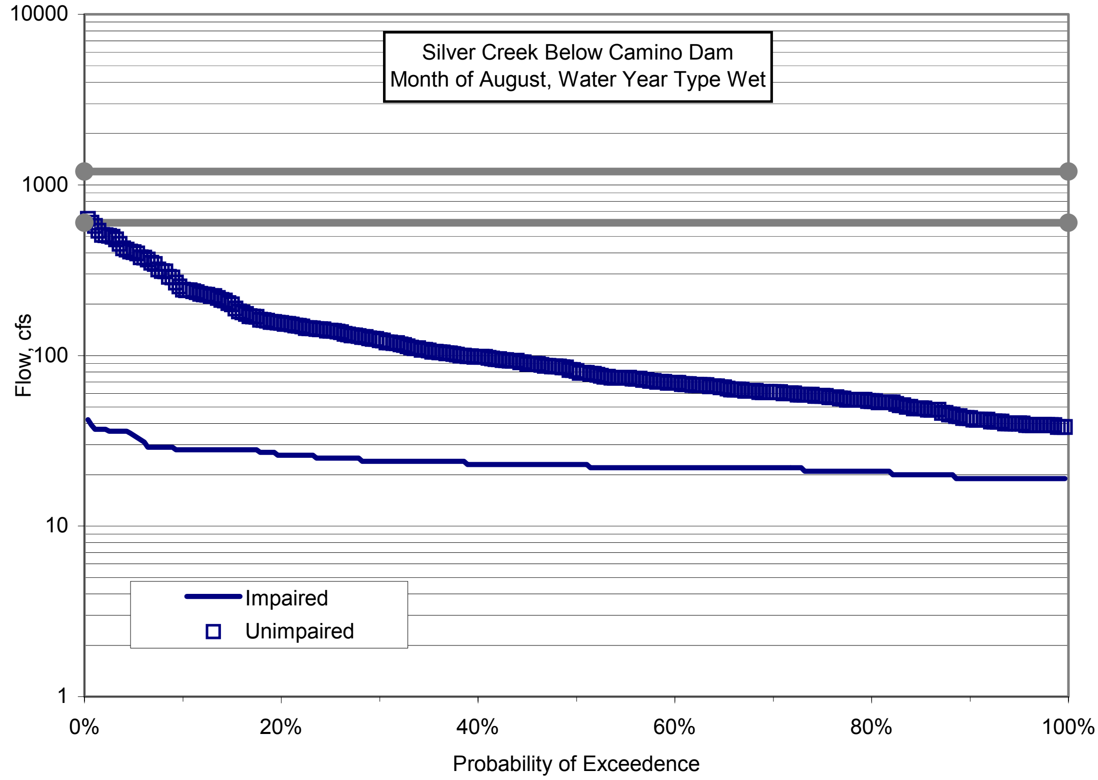

Silver Creek Below Camino Dam
Month of July, Water Year Type Wet
10000
1000
100
10
1
Flow, cfs
0%
20%
40%
60%
80%
100%
Probability of Exceedence
Impaired
Unimpaired

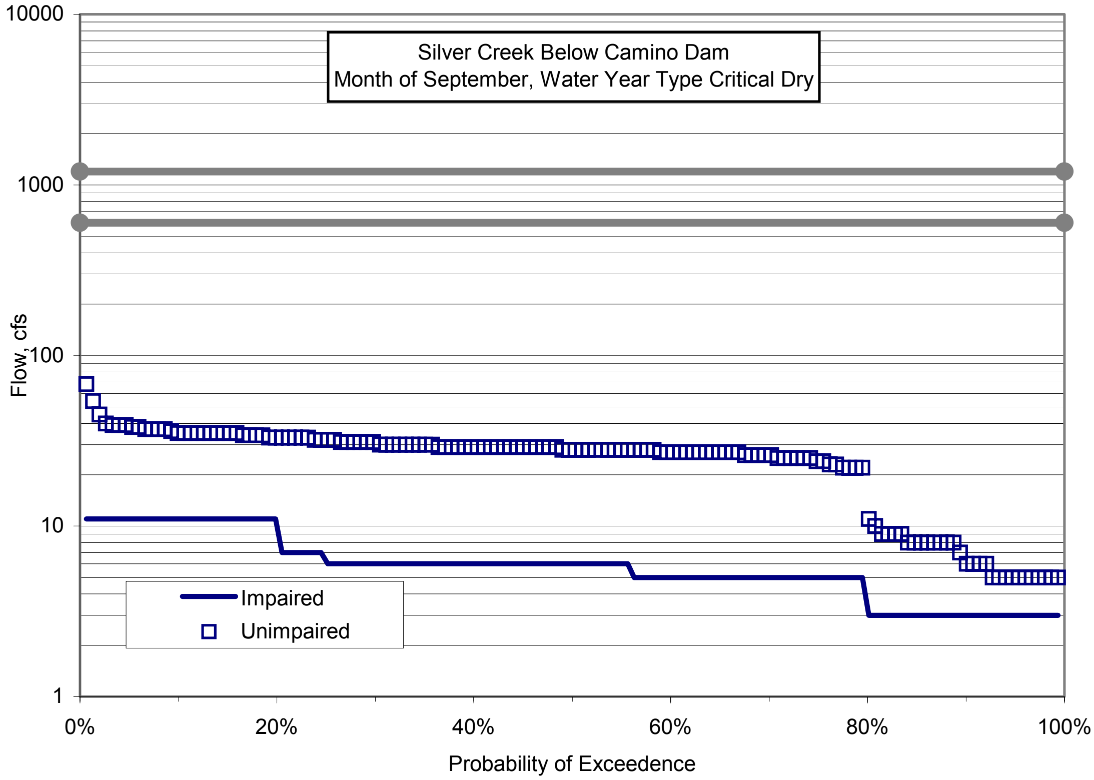

Silver Creek Below Camino Dam
Month of August, Water Year Type Critical Dry
10000
1000
100
10
1
Flow, cfs
Impaired
Unimpaired
0%
20%
40%
60%
80%
100%
Probability of Exceedence

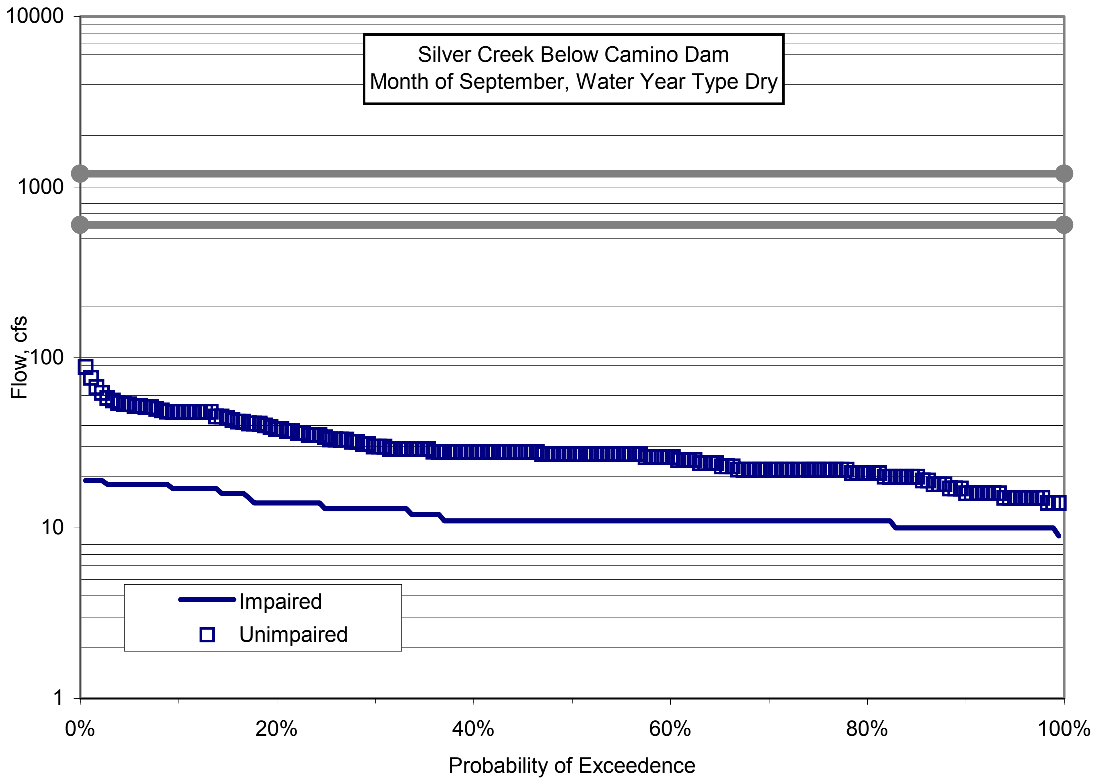

Silver Creek Below Camino Dam
Month of August, Water Year Type Dry
10000
1000
100
10
1
Flow, cfs
Impaired
Unimpaired
0%
20%
40%
60%
80%
100%
Probability of Exceedence

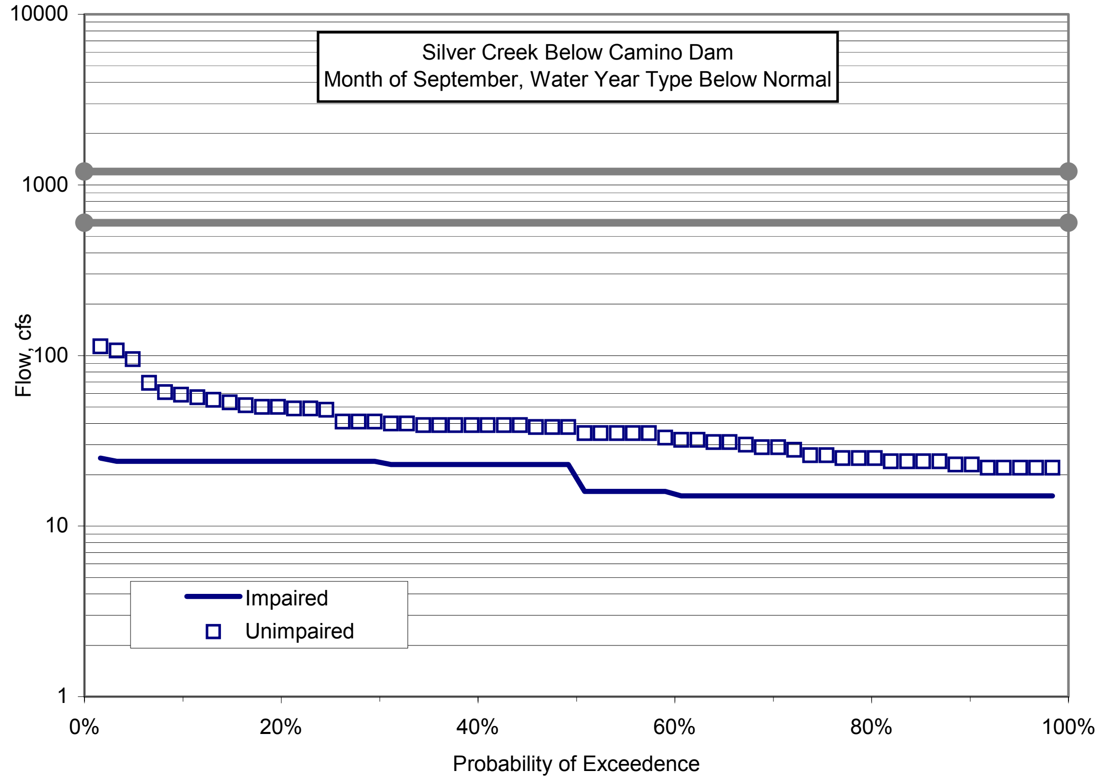

Silver Creek Below Camino Dam
Month of August, Water Year Type Below Normal
10000
1000
100
10
1
Flow, cfs
0%
20%
40%
60%
80%
100%
Probability of Exceedence
Impaired
Unimpaired

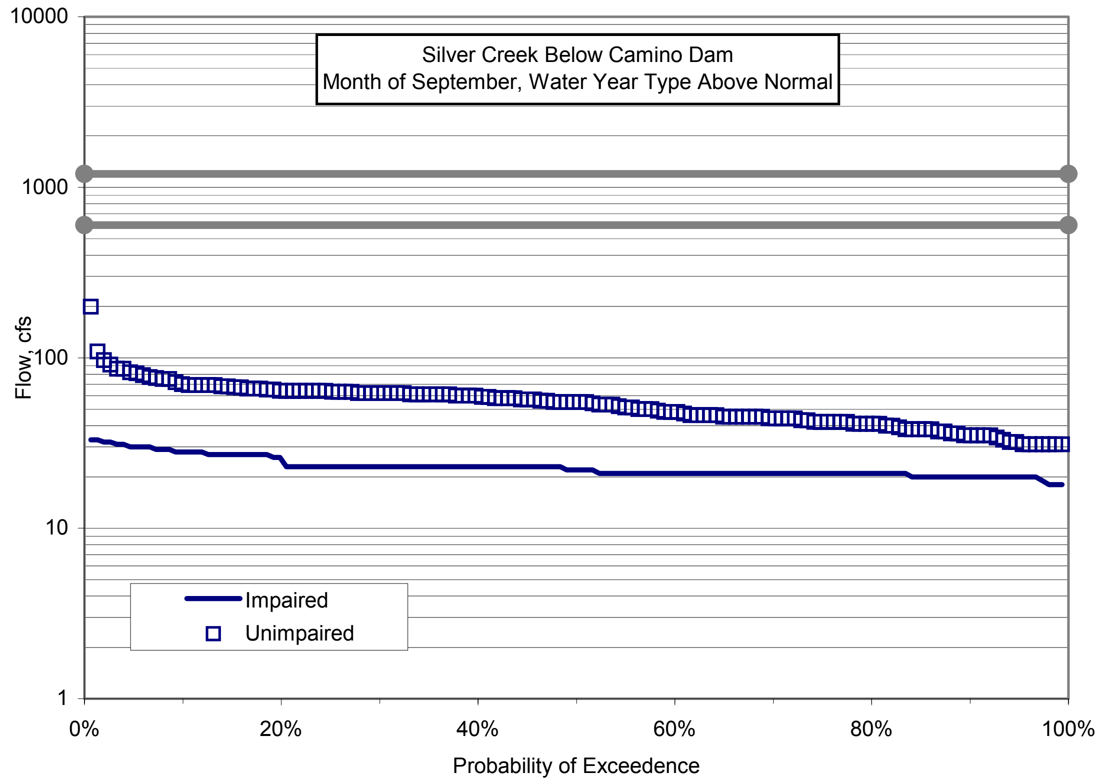

Silver Creek Below Camino Dam
Month of August, Water Year Type Above Normal
10000
1000
100
10
1
Flow, cfs
0%
20%
40%
60%
80%
100%
Probability of Exceedence
Impaired
Unimpaired

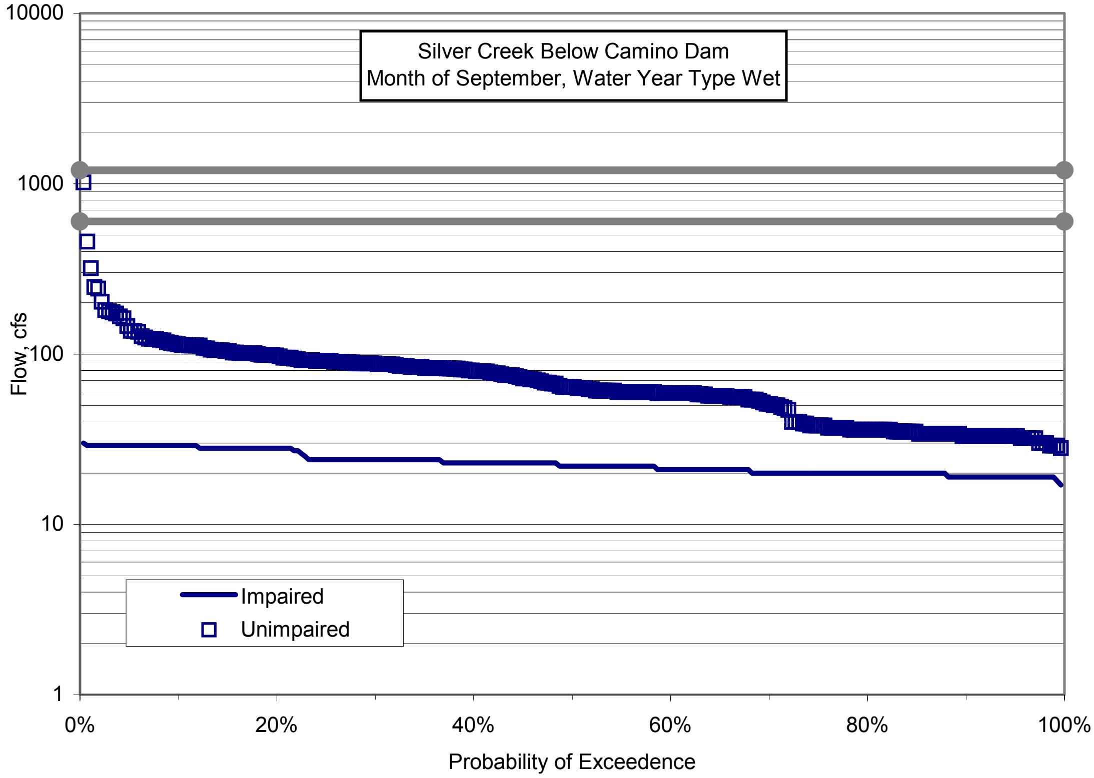

Silver Creek Below Camino Dam
Month of August, Water Year Type Wet
10000
1000
100
10
1
Flow, cfs
0%
20%
40%
60%
80%
100%
Probability of Exceedence
Impaired
Unimpaired

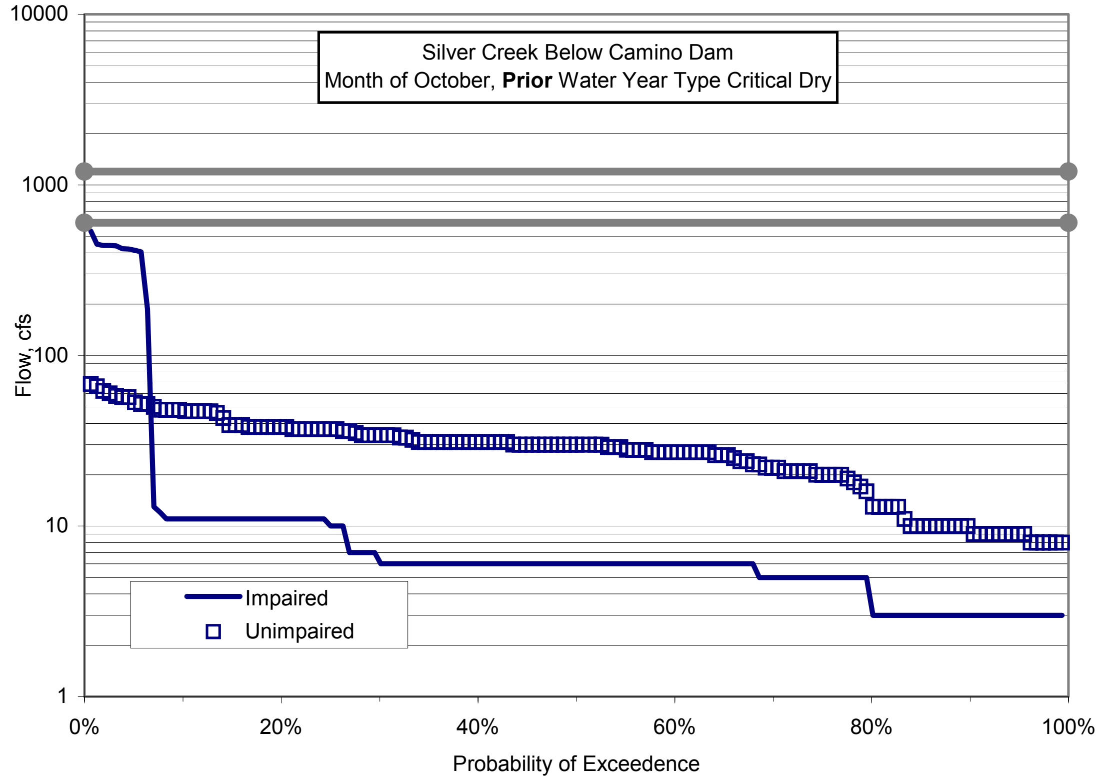

Silver Creek Below Camino Dam
Month of September, Water Year Type Critical Dry
Flow, cfs
10000
1000
100
10
1
0%
20%
40%
60%
80%
100%
Probability of Exceedence
Impaired
Unimpaired

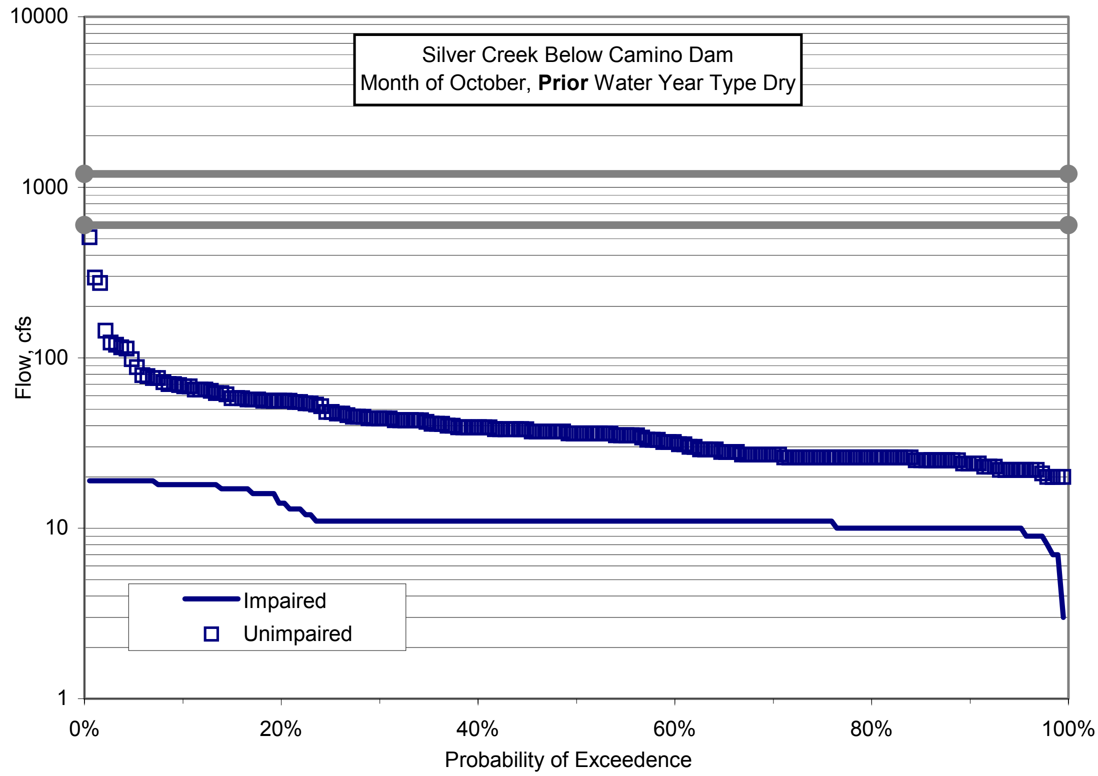

Silver Creek Below Camino Dam
Month of September, Water Year Type Dry
Flow, cfs
10000
1000
100
10
1
0%
20%
40%
60%
80%
100%
Probability of Exceedence
Impaired
Unimpaired

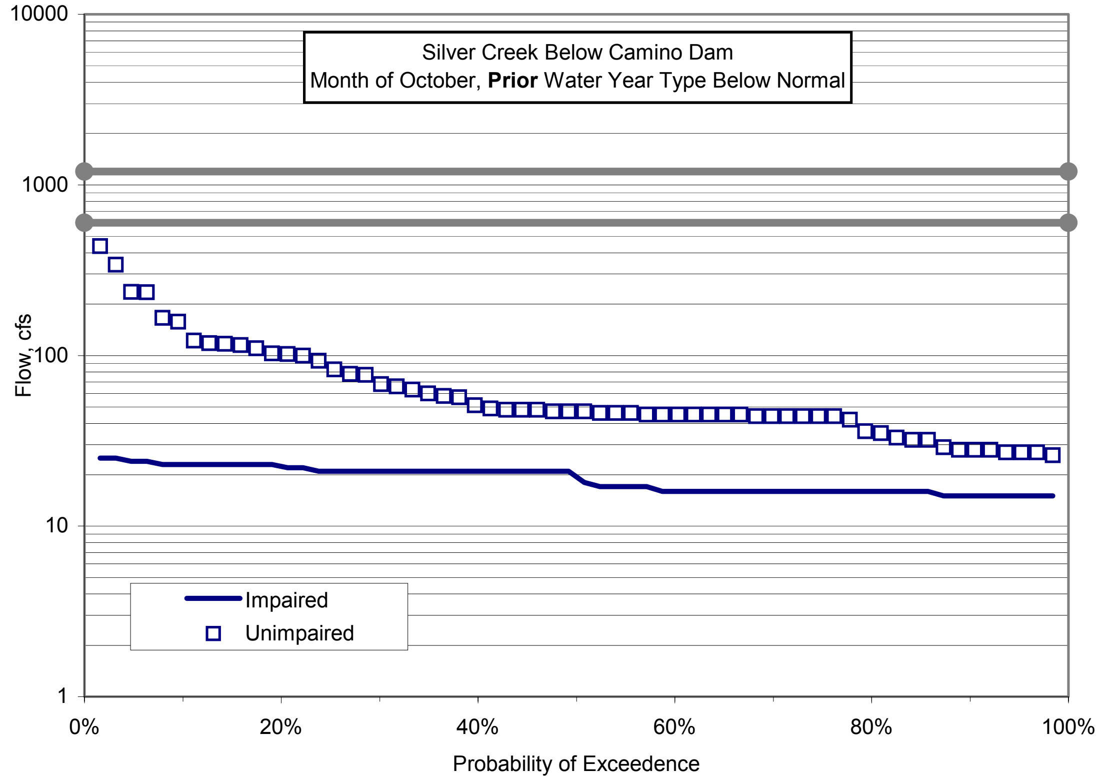

Silver Creek Below Camino Dam
Month of September, Water Year Type Below Normal
Flow, cfs
10000
1000
100
10
1
0%
20%
40%
60%
80%
100%
Probability of Exceedence
Impaired
Unimpaired

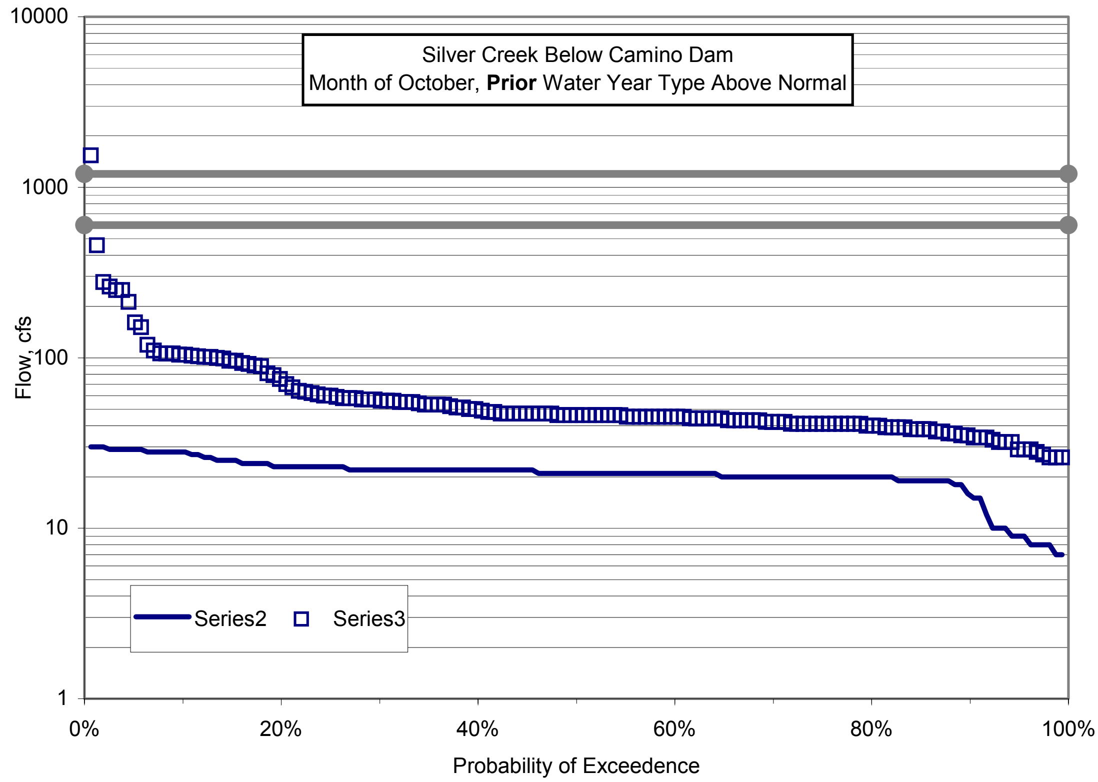

Silver Creek Below Camino Dam
Month of September, Water Year Type Above Normal
Flow, cfs
10000
1000
100
10
1
0%
20%
40%
60%
80%
100%
Probability of Exceedence
Impaired
Unimpaired

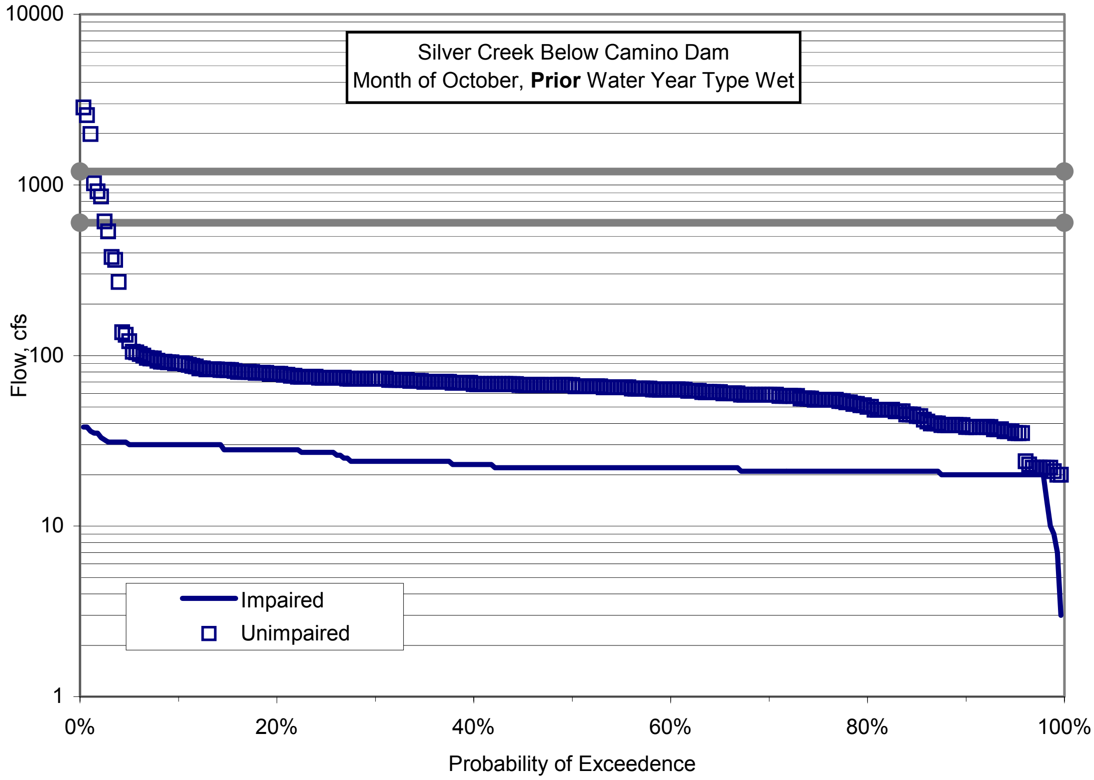

Silver Creek Below Camino Dam
Month of September, Water Year Type Wet
10000
1000
100
10
1
Flow, cfs
0%
20%
40%
60%
80%
100%
Probability of Exceedence
Impaired
Unimpaired

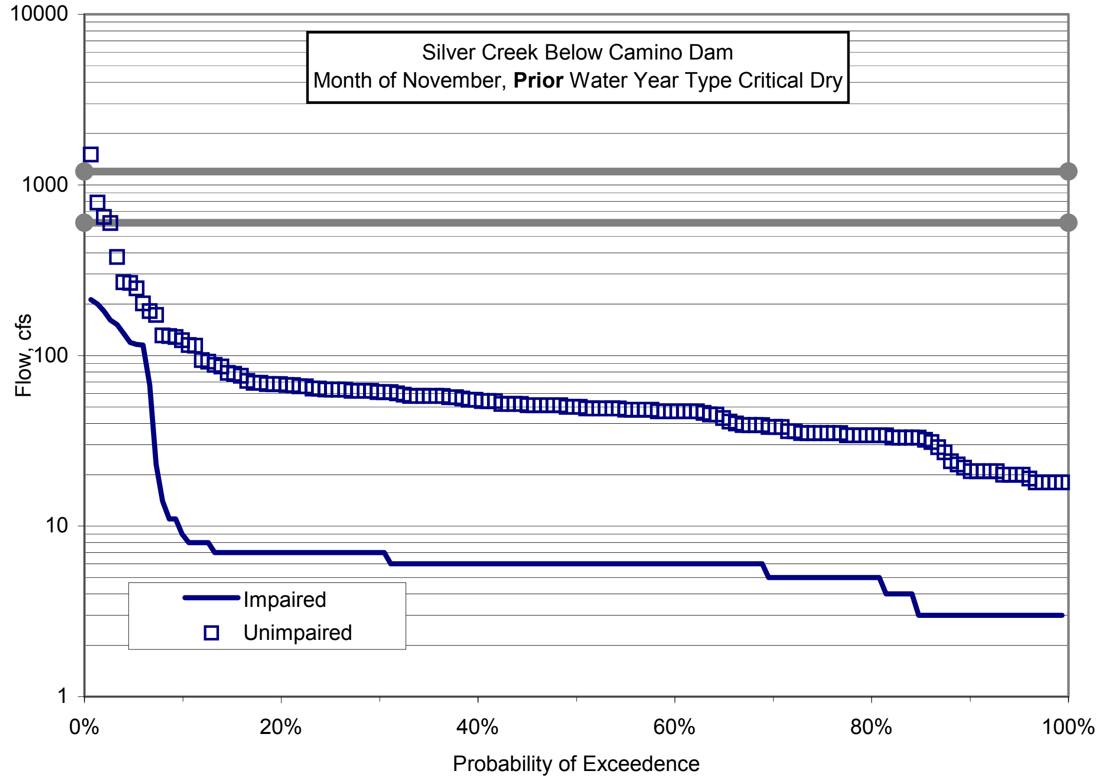

Silver Creek Below Camino Dam
Month of October, **Prior** Water Year Type Critical Dry
Flow, cfs
10000
1000
100
10
1
0%
20%
40%
60%
80%
100%
Probability of Exceedence
Impaired
Unimpaired

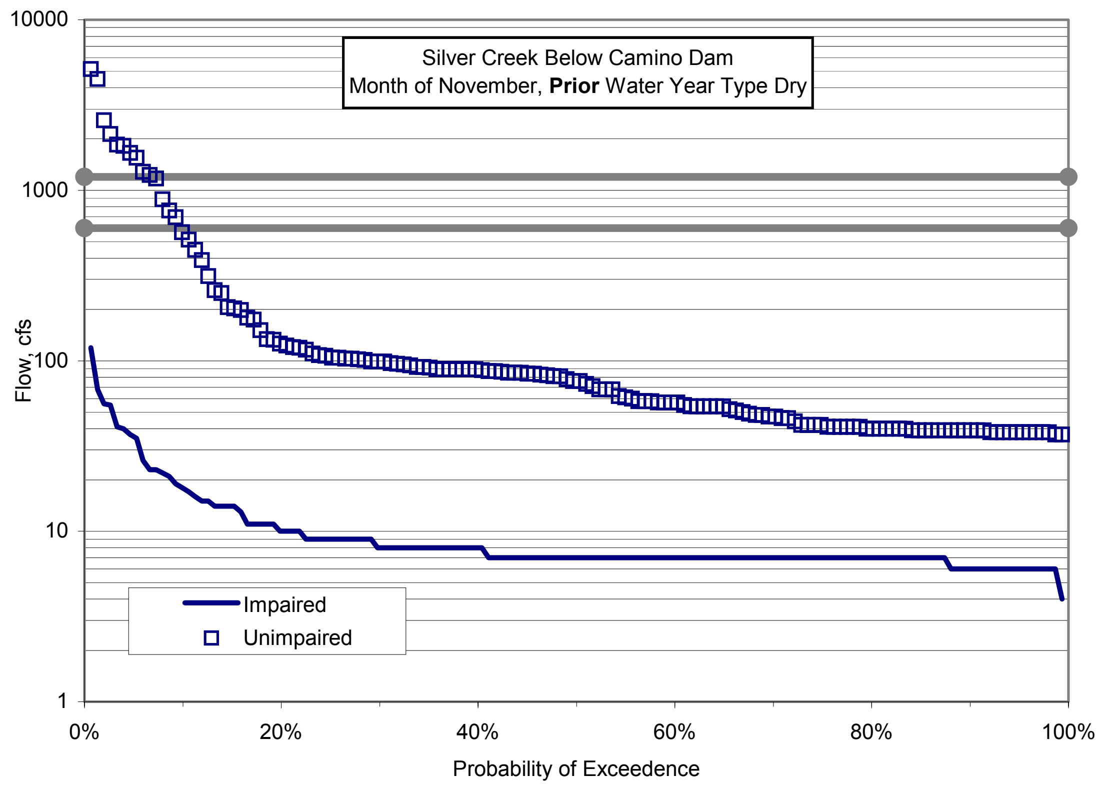

Silver Creek Below Camino Dam
Month of October, **Prior** Water Year Type Dry
Flow, cfs
10000
1000
100
10
1
0%
20%
40%
60%
80%
100%
Probability of Exceedence
Impaired
Unimpaired

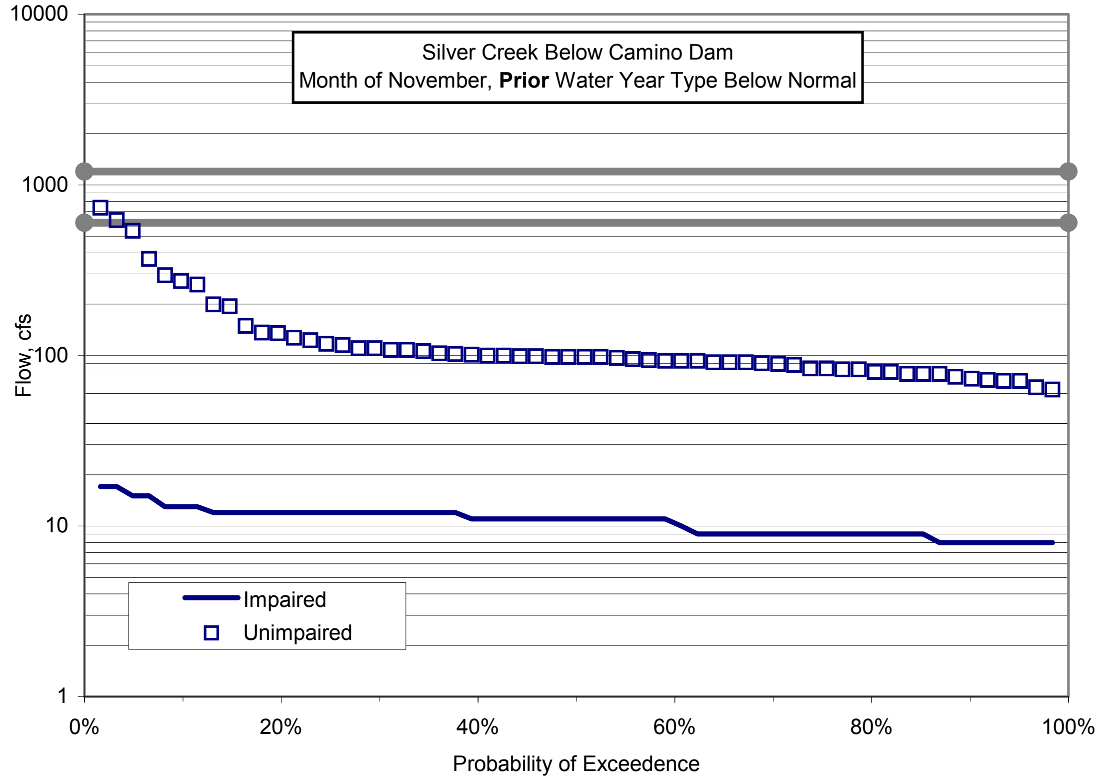

Silver Creek Below Camino Dam
Month of October, Prior Water Year Type Below Normal
10000
1000
100
10
1
Flow, cfs
Impaired
Unimpaired
0%
20%
40%
60%
80%
100%
Probability of Exceedence

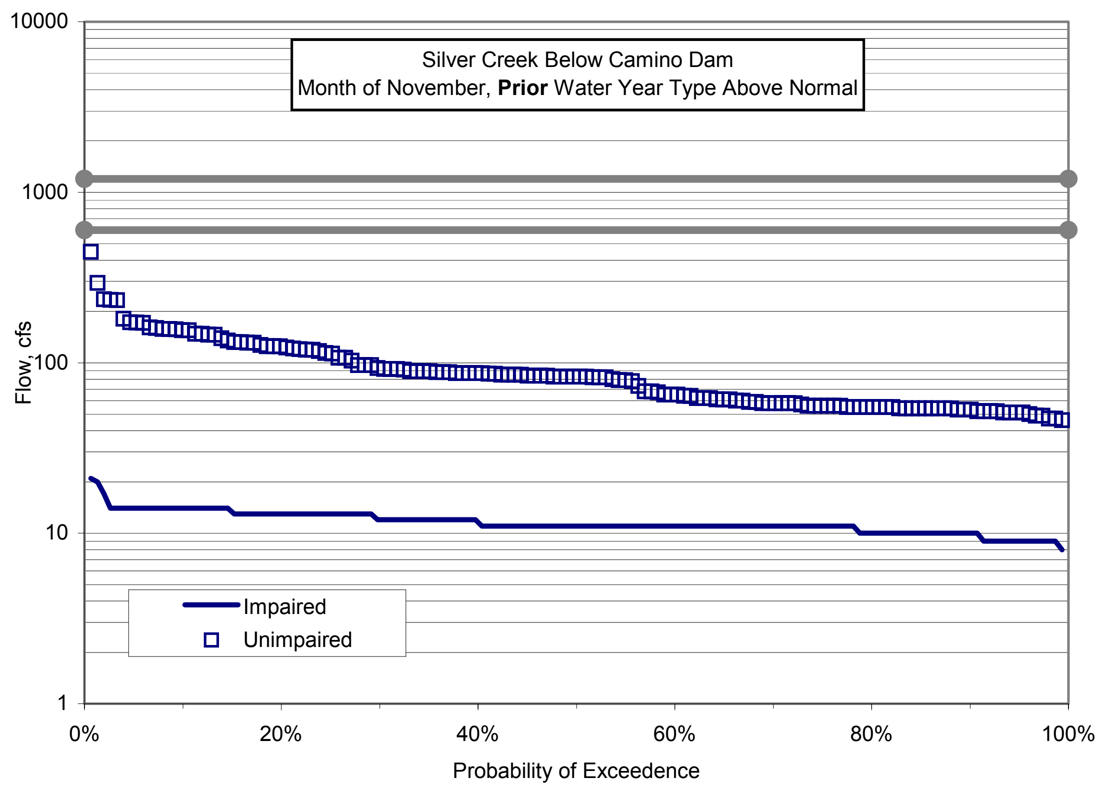

Silver Creek Below Camino Dam
Month of October, Prior Water Year Type Above Normal
10000
1000
100
10
1
Flow, cfs
Series2
Series3
0%
20%
40%
60%
80%
100%
Probability of Exceedence

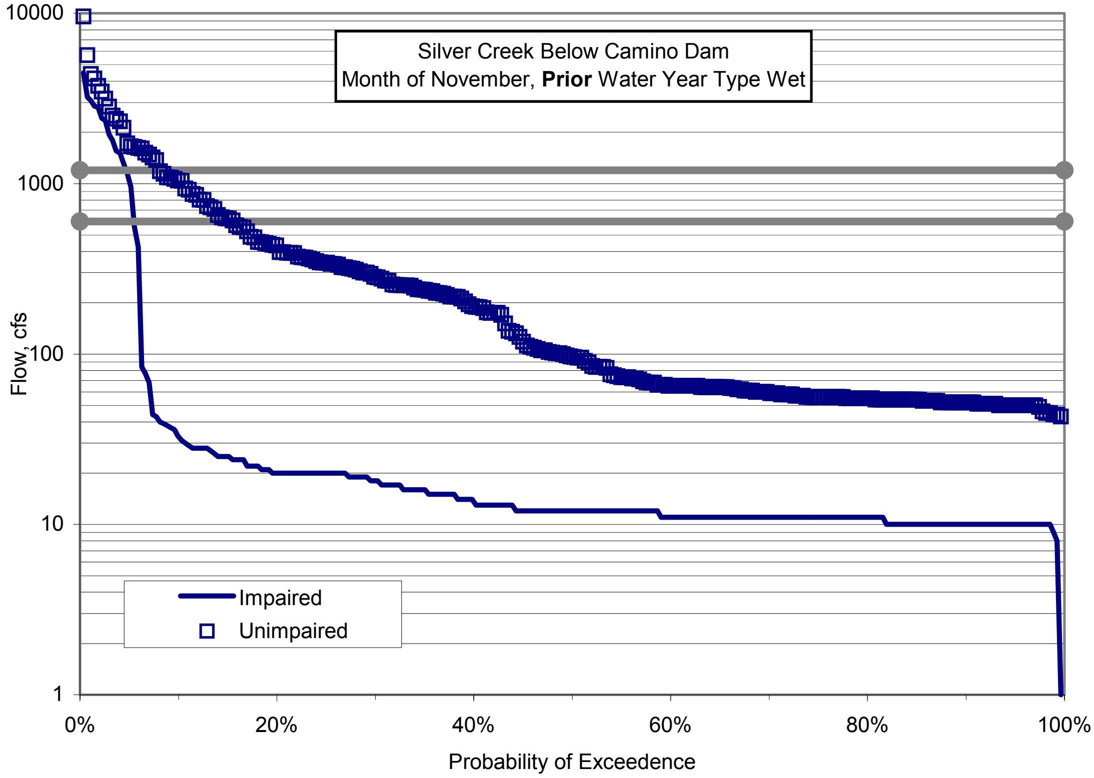

Silver Creek Below Camino Dam
Month of October, **Prior** Water Year Type Wet
Flow, cfs
10000
1000
100
10
1
Impaired
Unimpaired
0%
20%
40%
60%
80%
100%
Probability of Exceedence


Silver Creek Below Camino Dam
Month of November, **Prior** Water Year Type Critical Dry
Flow, cfs
10000
1000
100
10
1
0%
20%
40%
60%
80%
100%
Probability of Exceedence
Impaired
Unimpaired


Silver Creek Below Camino Dam
Month of November, **Prior** Water Year Type Dry
Flow, cfs
10000
1000
100
10
1
0%
20%
40%
60%
80%
100%
Probability of Exceedence
Impaired
Unimpaired


Silver Creek Below Camino Dam
Month of November, **Prior** Water Year Type Below Normal
10000
1000
100
10
1
Flow, cfs
0%
20%
40%
60%
80%
100%
Probability of Exceedence
Impaired
Unimpaired


Silver Creek Below Camino Dam
Month of November, **Prior** Water Year Type Above Normal
10000
1000
100
10
1
Flow, cfs
0%
20%
40%
60%
80%
100%
Probability of Exceedence
Impaired
Unimpaired


Silver Creek Below Camino Dam
Month of November, **Prior** Water Year Type Wet
10000
1000
100
10
1
Flow, cfs
0%
20%
40%
60%
80%
100%
Probability of Exceedence
Impaired
Unimpaired

APPENDIX F

VIDEO FOR CAMINO STUDY VARIOUS RAPIDS AND POST-RUN GROUP DISCUSSION

(DVD by Request)

APPENDIX G

ECOLOGICAL MONITORING STUDY

TABLE OF CONTENTS

Section & Description **Page**

LIST OF TABLES

Table No. & Description **Page**

LIST OF FIGURES

Figure No. & Description **Page**

LIST OF FIGURES

Figure No. & Description **Page**

LIST OF ATTACHMENTS

Attachment & Description **Page**

APPENDIX G
CAMINO WHITEWATER BOATING TEST FLOW BIOLOGICAL STUDY

SUMMARY

This study describes the potential biological effects of a whitewater boating flow release in the Camino Dam Reach of Silver Creek from immediately below Camino Dam to the confluence with the South Fork American River.

The goals of the study were identified by the Aquatic TWG and UARP Relicensing Plenary Group in the Camino Dam Whitewater Boating Flow Biological Study Plan, and included assessing potential biological impacts to the habitat and/or the aquatic community as a result of the boating flow. The study results presented here reflect a data collection effort in 2004, including five areas of study—water quality, foothill yellow-legged frog habitat distribution and abundance, flow and stage changes, benthic macroinvertebrates, and streambed mobility.

Water quality investigations monitored water temperature, turbidity, dissolved oxygen, and total suspended solids at several sites in the reach. The water quality monitoring started at least five days prior to the September 15, 2004 Camino Dam Whitewater Boating Flow Study and continued until five days after the boating flow study. Three of the four parameters (turbidity, dissolved oxygen and total suspended solids) increased, while water temperature decreased during the September 15th pulse flow.

Foothill yellow-legged frog habitat, distribution, and abundance were monitored by visual encounter surveys (VES). Pre- and post-flow surveys documented relatively similar distribution and abundance of subadult and adult frogs, indicating the availability of high-flow refuges, at least during short-duration, pulse flow releases in the fall. Flows were not released when tadpoles were expected to be present, and it is unclear whether tadpoles could have found cover during the pulse flow.

Stage change was monitored every 15 minutes on the day of the release to quantify the extent of habitat changes caused by the boating flow, either by photo documentation or by a water level logger. Although the flow release from Camino Dam occurred over approximately 3 hours, the greatest stage change of 90–100 cm at either of the two study sites was observed within a 30-minute period.

Benthic macroinvertebrates (BMI) were sampled one week prior to the flow release and one month following the flow release with a goal of detecting any substantial disruption in the BMI community. While some decreases in taxonomic richness and diversity were seen in post-flow samples, similar decreases were documented at the control site where a flow pulse did not occur. Thus, temporal factors likely contributed to this difference in taxonomic composition, and not effects of the flow pulse. Mean BMI abundance was significantly lower when the pre-flow pulse samples were compared with samples that received a flow pulse.

Finally, because foothill yellow-legged frogs within this reach typically lay their eggs on cobbles and boulders, streambed mobility was measured during the boating flow to assess potential impacts that could occur if the flow was released during the breeding season. Results from painted rock studies indicate that there is no significant movement of particles at flows of 600 cfs.

This study is specific to this particular flow and reach, and additional biological studies may be necessary for releases during other seasons, particularly in the spring.

G1.0 BACKGROUND

The UARP Aquatic Technical Working Group (TWG) was interested in understanding the potential biological impacts of a whitewater boating flow release in the Camino Dam Reach. This study, performed in conjunction with the Camino Dam Reach Whitewater Boating Test Flow Study, was designed to address the effects of a release of a whitewater boating flow on aquatic resources in the Camino Dam Reach. This study plan is specific to this particular whitewater test flow event, and additional studies may be necessary for whitewater boating flow releases during other seasons. In particular, additional biological studies are expected for any springtime flow events.

The Camino Dam Reach Whitewater Boating Test Flow Study involved the release of water from Camino Reservoir. The release of 600 cfs was made on a single day (September 15, 2004) in order to determine the feasibility of whitewater boating within this particular reach. Flow was ramped up from the current discharge of 15 cfs over a 3 to 4 hour period, with river stage rate of change not to exceed 1 ft/hr in accordance with FERC guidelines.

G1.1 Camino Dam Whitewater Boating Flow Biological Study Plan

On September 1, 2004, the UARP Relicensing Plenary Group approved a Camino Dam Whitewater Boating Flow Biological Study Plan that was developed and approved by the Aquatic TWG on August 25, 2004. In general, the objectives of the study were to evaluate the effect of the whitewater flow on different components of the aquatic environment, including:

- Measuring water temperature, total suspended solids, turbidity, and dissolved oxygen before, during, and after the boating release.
- Documenting FYLF distribution or presence/absence before and after the boating release.
- Identifying and documenting changes in river stage, and by inference amphibian habitat, during the boating release at known areas of FYLF presence.
- Identifying changes in benthic macroinvertebrate (BMI) community characteristics before and after the boating release.
- Assessing potential for bed mobility at areas of documented FYLF populations.

The study area includes the Camino Dam Reach of Silver Creek. The Camino Dam Reach includes Silver Creek from immediately below Camino Dam downstream to the confluence with the South Fork American River. An additional study area for the BMI investigation included a control site that had been previously used as a reference site for the Camino Dam Reach – the South Fork American River at Ice House Road.

G2.0 METHODS

There are three accessible site locations along the Camino Dam Reach that were sampled for the various aquatic environment components. These are: 1) directly below Camino Dam ("Dam Site"); 2) approximately midway through the bypass reach, adjacent to the Camino Tunnel Adit spoil pile ("Adit Site"); and 3) at the mouth of Silver Creek ("Confluence Site"). Photographs of the monitoring locations are provided in Attachment A.

G2.1 Water Quality

The purpose of the water quality investigation was to evaluate the magnitude and duration of changes in specific water quality parameters before, during, and after the boating flow release. Four parameters were monitored:

- water temperature (°C),
- turbidity (NTU),
- dissolved oxygen (mg/L), and
- total suspended solids (TSS).

The first three parameters were continuously monitored using instrumentation installed at three locations: Dam Site, Adit Site, and Confluence Site. The instrument used to gather these data were Troll XP MPT 9000 *in situ* samplers, which was programmed to record information every 15 minutes. The sampling instruments were installed approximately one week prior to the release date and were removed approximately one week after the release. Water quality parameters were recorded beginning at least 5 days before the test flow, and continued approximately 5 days after the end of the test flow.

Total suspended solids (TSS), which cannot be monitored with the Troll XP MPT 9000 instrument, were monitored by hand regularly during the flow release event on September 15, 2004. TSS samples were collected every two hours in 500mL poly plastic bottles and stored at 4ºC until delivery to a certified laboratory and analyzed according to EPA Method 160.2. TSS sampling was performed at the Dam Site and Adit Site. TSS sampling was not performed at the Confluence Site for logistical and safety reasons (see more detailed discussion of safety constraints in subsequent sections).

G2.2 Foothill Yellow-Legged Frog Habitat, Distribution, and Abundance

Foothill yellow-legged frog habitat, distribution, and abundance were documented at two previously surveyed sites in the Camino Dam Reach (Adit Site and Confluence Site [referred to as Site C-3 and Site SFA-4, respectively, in the *Amphibian and Aquatic Reptiles Technical Report*]). Visual encounter surveys (VES) were performed one week prior to and one week after the boating release to: 1) verify the continued presence of FYLF at these sites; and 2) qualitatively evaluate changes in distribution or abundance of FYLF resulting from the boating flow. The VES used the same methods described in the *Amphibian and Aquatic Reptiles Technical Report.*

In addition to the VES, amphibian biologists were present at the Adit Site during the flow release on September 15. During the release, observations were made of changes in habitat and hydraulic conditions in areas previously studied during the Amphibian Habitat Flow Study. These areas include polygons delineated during the prior study, as well as any known locations of egg deposition and tadpole observations. Additional hydraulic measurements were not feasible during the high flows experienced during this study and only qualitative assessments were made.

G2.3 Flow and Stage Changes

The purpose of the flow and stage (water surface elevation) change task was to monitor stage changes at known FYLF sites during the test flow event, in order to help quantify the extent of habitat changes for FYLF. This task included regularly monitoring the stage of Silver Creek at known areas of FYLF use during the course of the boating flow passing through the bypass reach. At the Adit Site, this was accomplished by having the amphibian biologists monitoring a temporary staff gauge every 15 minutes during the course of their other work for the FYLF habitat evaluation (described above). The staff gauge was digitally photographed at each 15-minute interval, to provide a visual record of the stage height and surrounding hydraulic conditions. Because this site was intensively studied during the Channel Morphology Study, a qualitative comparison of the boating flow release with bankfull and floodprone discharges was also conducted.

At the Confluence Site, the study area is not safely accessible during high flow events. Stage changes were recorded by installing a digital water surface elevation logger (level logger) (Levellogger model 3001, Solinst Canada Ltd.). Level loggers measure relative changes in river stage height to the nearest 0.01 ft (at 15 minute intervals) by measuring changes in total pressure, which includes both water and atmospheric pressure. To correct for changes in atmospheric pressure, one level logger was placed on the shore in a sheltered open-air location as a control. The instream level logger was placed in a pool at the mouth of Silver Creek. The loggers were deployed in the week preceding the flow event, and removed 5 days after the flow event was complete.

G2.4 Benthic Macroinvertebrates

Benthic macroinvertebrates were sampled at two locations in the Camino Dam Reach (Adit Site [CD-I2] and Confluence Site [CD-I3]), as well as a third location on the South Fork American River at Ice House Road (SFAR), which served as a reference site. Site SFAR was used as a reference site for the Upper American River Project bioassessment, which is described in the *Aquatic Bioassessment Technical Report*. The reference site provided information on changes in BMI assemblages occurring naturally between the pre- and post-flow sampling periods. Natural changes in the BMI assemblage may result from changes in water temperature and season, among other factors.

This study used the California Stream Bioassessment Procedure for field sampling and laboratory processing, which was the same protocol used for the UARP bioassessment, described in the *Aquatic Bioassessment Technical Report*. The same riffles sampled for the UARP sites in years 2002 and 2003 were sampled for this study at the Adit, Confluence, and SFAR sites.

The pre-boating release sampling effort was performed approximately one week in advance of the boating flow release. The post-boating release sampling effort was performed approximately

30 days after boating release, with a goal of detecting whether any substantial disruption of the BMI assemblage was detectable 30 days after the test flow event. Changes in the BMI assemblage of Silver Creek between the pre- and post-boating releases were analyzed with respect to changes at the reference site. Information from the previous years (2002 and 2003) of sampling in the Camino Dam Reach and the SFAR reference site was used for this study for additional perspective.

Three components of the BMI assemblage were evaluated for differences during the pre- and post- boating flow events:

1. Taxonomic composition
2. Metrics describing characteristics of BMI assemblages
3. Abundance of BMI expressed as number per m^2

Taxonomic composition was analyzed using cluster analysis and Multi-Response Permutation Procedure (MRPP). MRPP is a non-parametric method for testing the hypothesis of no significant difference in taxonomic composition between two or more groups (McCune and Mefford 1999). For this study, MRPP was used to supplement the cluster analysis by determining significance of differences in taxonomic composition of test site samples and reference site samples before and after the boating flow event.

Composite metric scores were used to assess differences in BMI assemblage quality. The same composite metrics and their calculation are described in the *Aquatic Bioassessment Technical Report* with two exceptions. The insect orders **E**phemeroptera, **P**lecoptera and **T**richoptera were combined into the EPT Taxa metric and a Coleoptera Taxa metric was added. These changes resulted in a total of nine metrics used in the composite metric score calculation. Additionally, cumulative site EPT Taxa was plotted on a secondary y-axis of the composite metric score plot for additional perspective. As described in the *Aquatic Bioassessment Technical Report*, the EPT Taxa metric was highly correlated with composite metric scores and Coleoptera taxa were found to be potentially responsive to river regulation due to their absence immediately downstream of the project reservoirs.

BMI abundance was also evaluated for differences before and after the boating flow event. The first step used for the abundance analysis was to optimize statistical power by evaluating abundance data for the previous two years and combine data sets (samples) when appropriate. The Kolmogorov-Smirnov test was used to test the assumption that the abundance data were normally distributed. WinSTAT® and Systat 11® were used for statistical analyses including t-tests, statistical power and estimating critical effect size.

G2.5 Streambed Mobility

Because FYLF typically lay their eggs on boulders and cobbles within this reach, the streambed mobility component of this study focused on the potential for movement at a 600-cfs flow. Prior to the boating test flow, a series of rocks in a transect perpendicular to flow along the stream bottom were marked *in-situ* with white waterproof paint. The painted rocks were located along the semi-permanent cross-section established at the Adit Site during the geomorphological studies reported in the *Channel Morphology Technical Report*. The number of marked rocks, their approximate size distribution (based on *in-situ* measurements that did not dislodge the particles), and the endpoints of the survey line were recorded and photographed. Following the test flow, the area was revisited and changes in the number and distribution of the marked rocks was measured (e.g., number of rocks missing, displacement distance of rocks, size of displaced rocks, etc.) to provide an indication of bedload movement during the event. A total of 15 particles (rocks) were painted. These represented the natural particle size distribution within the reach, as documented in the *Channel Morphology Technical Report*.

G3.0 RESULTS

G3.1 Water Quality

Results from water quality monitoring, before, during, and after the flow release for water temperature, turbidity, dissolved oxygen, and TSS taken at each of the three sample locations are provided in Table G3.1.-1 (see Attachment B for raw data). The release of water from the radial gates at Camino Dam began at 06:15 and continued at a rate of 1 foot per hour (as measured at the SMUD gaging station downstream of Camino Dam), and continued for 4 hours. This translates into an increase of 231 cfs per hour for a maximum flow of 659 cfs (average flow of 647 cfs). The release remained at 647 cfs until approximately 02:00, at which time the flows were decreased at a rate of 1 foot per hour until 18:00.

Table G3.1-1. Water quality parameters sampled before, during, and after the whitewater boating flow study.

Location	Temperature (ºF)	Turbidity (NTU)	Dissolved Oxygen (mg/L)	TSS (mg/L)
Dam Site				
Before Flow [a]				
Average	50.26	1.04	10.63	NA
Maximum	53.78	2.50	10.98	NA
Minimum	48.03	0.70	10.18	NA
During Flow [b]				
Average	50.44	4.56	10.43	NA**
Maximum	51.34	28.1	10.97	13
Minimum	49.41	1.20	9.37	< 5.0mg/L
Post Flow [c]				
Average	50.48	1.59	10.47	NA
Maximum	54.46	7.40	10.99	NA
Minimum	47.95	0.90	9.69	NA
Adit Site				
Before Flow [a]				
Average	57.68	3.42	8.56	NA
Maximum	61.35	32.30	9.24	NA
Minimum	55.62	1.70	7.99	NA
During Flow [b]				
Average	53.42	21.17	9.48	NA**
Maximum	56.11	273.6	10.63	190

Table G3.1-1. Water quality parameters sampled before, during, and after the whitewater boating flow study.

Location	Temperature (ºF)	Turbidity (NTU)	Dissolved Oxygen (mg/L)	TSS (mg/L)
Minimum	51.86	0.7	8.34	< 5.0mg/L
Post Flow [c]				
Average	56.69	2.83	8.61	NA
Maximum	59.99	1063*	9.21	NA
Minimum	49.79	0.10	8.01	NA
Confluence Site				
Before Flow [a]				
Average	61.67	0.34	11.68	NA
Maximum	66.72	1.00	12.41	NA
Minimum	57.88	0.00	10.80	NA
During Flow [b]				
Average	55.16	19.06	12.79	NA
Maximum	58.47	189.9	13.53	NA
Minimum	57.88	0.20	12.31	NA
Post Flow [c]				
Average	57.08	0.64	12.16	NA
Maximum	62.29	1.50	13.07	NA
Minimum	53.71	0.20	11.39	NA

[a] Before Flow refers to the value(s) recorded during the period of time between Troll deployment (September 8th) and 06:00 on September 15 (15 minutes prior to the start of the flow release).
[b] During Flow refers to the value(s) recorded by the Troll units during the flow release, from 06:00 on September 15th to 06:15 on September 16th.
[c] Post Flow refers to the value(s) recorded from 06:15 on September 16th through removal of the Troll units from the sampling sites.
* One single 15-minute recording not related to flow event. See Analysis of Turbidity in Section 5.1.2.
** Average not calculated because minimum values for TSS are <5.00mg/L (concentrations below 5.00mg/L are not precise because reporting limits are set at >5.00mg/L).

G3.2 Foothill Yellow-Legged Frog Habitat, Distribution, and Abundance

Surveys for FYLF were conducted on September 8-10, 2004 and September 20-22, 2004, for the pre- and post-flow analysis at the Adit Site and the Confluence Site. Table G3.2-1 summarizes the number of individuals observed during each of the site visits.

Table G3.2-1. Number of foothill yellow-legged frogs observed, by life history stage, at Adit and Confluence sites.

Site	Site visit	Date	Tadpoles	Juveniles	Adults
Adit	Pre-flow	9/10/04	0	4	4
	Post-flow	9/22/04	0	2	2
Confluence	Pre-flow	9/08/04	0	26	1
	Post-flow	9/20/04	0	37	1

Frogs were typically found sitting or basking along the water's edge. As in previous years' surveys, no frogs were observed along the left bank of the Adit Site. Juveniles and adults at the Adit Site were clumped in their distribution, and most were found in a single sub-site, near the flow and stage change monitoring site. Significantly more juveniles were observed at the Confluence Site. These juveniles were evenly distributed throughout the site. No tadpoles were expected at either site because it was so late in the season.

Spot water temperatures taken during both visits at each site indicate lower temperatures during the second site visit than the first. Edgewater temperatures dropped from approximately 15.5°C to 12°C at the Adit Site. Edgewater temperatures dropped from 16°C to 10°C at the Confluence Site. Juveniles found at the Adit Site were subadult, with many still having tail remnants. Juveniles at the Confluence Site were completely metamorphosed and averaged 19 mm snout-to-vent length (SVL).

G3.3 Flow and Stage Changes

Stage change at the Adit Site was documented using a staff gage and recording stage height at 15-minute intervals throughout the duration of the flow. The interval photographs are shown in Attachment B. Stage height began to change at this site at approximately 9:30 a.m. (Figure G3.3-1). A stage change of 100 cm was recorded by 10:30 a.m., and the stage remained at this level until approximately 2:30 p.m., when flows began to drop off. At the Confluence Site, where a continuous data logger had been placed, the stage change of approximately 90 cm occurred over a half-hour period; stage height began to increase at approximately 10:50 a.m. and the maximum stage change was recorded at 11:20 a.m. (Figure G3.3-1) Stage height began to drop at approximately 4:10 p.m. at this site.

Because the Adit Site was a semi-permanent cross-section established during the Channel Morphology Study conducted in 2003, flow and stage height data were applied to previously determined water surface elevations under base flow conditions, to qualitatively compare effect on habitat. Figure G3.3-2 shows that at 600 cfs and an approximate stage height change of 100 cm, flows completely inundate the channel and are nearly equivalent to the bankfull water surface elevation.

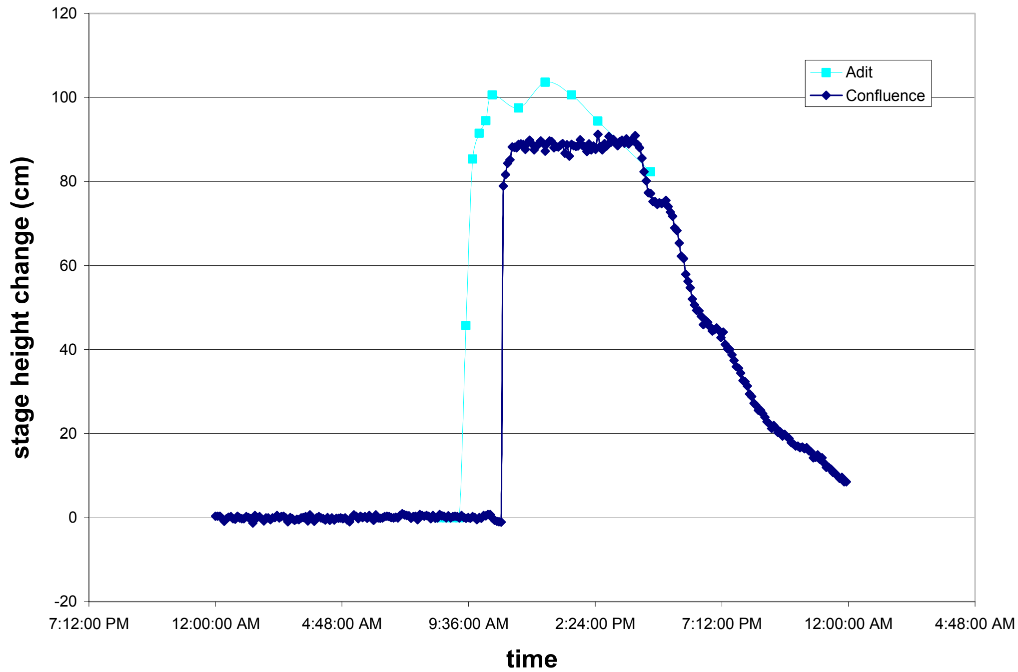


Figure G3.3-1. Change in stage height at the Adit and Confluence sites on Silver Creek on September 15, 2004. Flows of 600 cfs were released from Camino Dam at approximately 6:10 a.m.

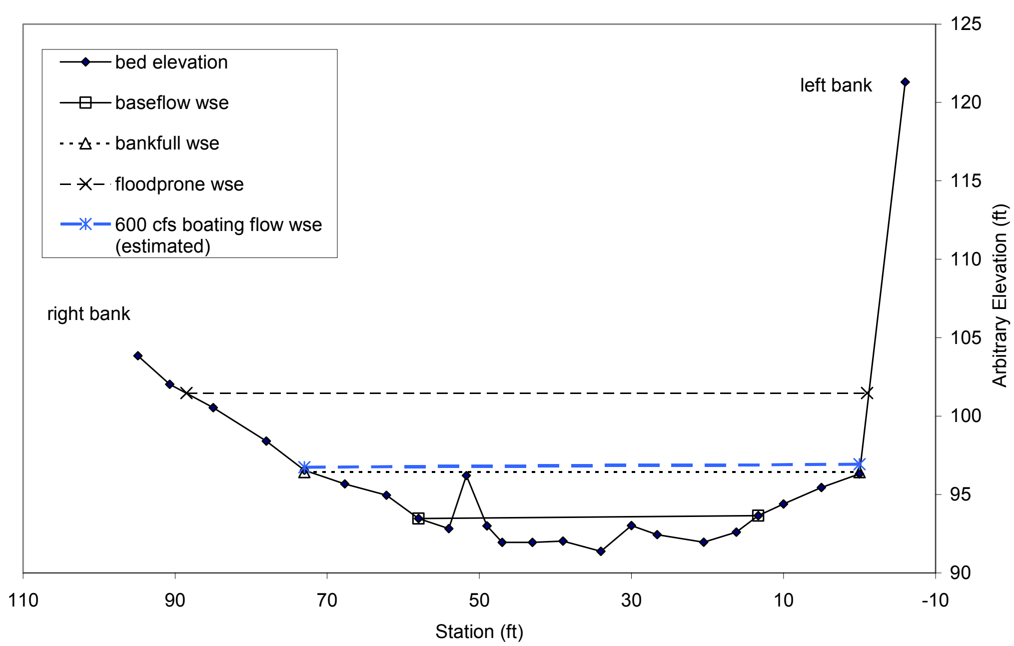


Figure G3.3-2. Estimated water surface elevation, based on estimated stage change, at the Adit Site, Camino Dam Reach. Water surface elevations are further explained in the *Channel Morphology Technical Report*.

G3.4 Benthic Macroinvertebrates

A taxonomic list of BMIs for year 2004 by site and sample for the Camino Dam Reach sites and the reference site is shown in Attachment C, and commonly reported biological metrics including those used for this study are reported by sample and summarized by site in Attachment D. Cumulative site total metric values used in composite metric scores (Section G4.4) by year, site and post-flow sampling event are shown in Table G3.4-1. While some decreases in taxonomic richness and diversity were seen in post-flow samples, similar decreases were documented at the SFAR reference site where a flow pulse did not occur. The differences in metrics and the apparent decrease in abundance at sites receiving the flow pulse are further discussed in section G4.4.

Table G3.4-1. Cumulative site total metric values for pre- and post-flow conditions at the Adit and Confluence sites (within the Camino Dam Reach of the UARP) and the South Fork American River (SFAR) reference site.

	Adit				Confluence				SFAR*			
	Pre-flow			Post-flow	Pre-flow			Post-flow	Pre-flow			Post-flow
Metric	2002	2003	2004	2004	2002	2003	2004	2004	2002	2003	2004	2004
Taxonomic Richness	46	53	50	50	40	44	52	39	50	50	59	43
EPT Taxa	23	23	22	23	17	16	15	13	27	26	30	22
Shannon Diversity	3	3	3	2.7	2.5	2.6	2.8	2.5	2.6	2.9	3.3	2.9
Dominant Taxon (%)	21	16	22	29	21	20	16	18	29	21	13	15
Tolerance Value	4	4	5	4.3	5.1	5.6	5.3	5.7	3.5	3.4	3.9	3.2
Intolerant Organisms (%)	11	15	11	17	2	3	2	2	25	32	22	41
Tolerant Organisms (%)	3	3	3	4.5	6.4	15	4.2	16	0.8	3.2	2.9	2.8
Predator Richness	16	18	22	19	13	14	19	11	15	16	23	16
Coleoptera Richness	5	7	5	3.0	4.0	6.0	8.0	5.0	8.0	9.0	6.0	6.0
Abundance (#/m^2)x1000	4.7	7.0	8.6	5.0	6.1	5.0	5.7	3.0	7.2	8.4	5.5	6.8

* Reference site did not receive a flow pulse.

G3.5 Streambed Mobility

Fifteen particles along one transect at the Adit Site were painted to assess streambed mobility under the 600 cfs flow (Figure G3.5-1). The size distribution of the particles selected was based on the pebble count conducted at this site in 2003. The 15 particles represented the natural distribution of particle sizes within this reach. The median grain size (b-axis) and position along the transect, both pre- and post-flow, are shown in Table G3.5-1.

In general, no movement was recorded based on the 600 cfs boating flow release at the Adit Site. Two of the smaller particles, median axes of 114 mm and 70 mm, did move slightly. Along the right bank, particle #2 moved 9 inches upstream. An upwelling flow may explain this result. Closer to the left bank, particle #12 moved 0.5 ft towards the left bank, but stayed along the transect.

Figure G3.5-1. Painted rocks at Adit Site, view from right bank.

Table G3.5-1. Marked particles and movement recorded pre-flow and post-flow at the Adit Site, Camino Dam Reach.

Survey Point	Short axis (mm)	Long axis (mm)	Median axis (mm)	Location on Transect (ft)		Distance upstream (-) or downstream (+) of transect
				Pre-flow (9/10/04)	Post-flow (9/22/04)	
1	-	-	>4096	36.0	36.0	0
2	30	150	114	54.9	54.9	- 9 inches
3	100	300	155	57.5	57.5	0
4	110	270	256	54.0	54.0	0
5	110	230	180	60.0	60.0	0
6	-	-	>2048	63.5	63.5	0
7	-	-	>4096	66.0	66.0	0
8	90	280	210	73.8	73.8	0
9	40	60	52	73.0	73.0	0
10	126	220	180	74.5	74.5	0
11	20	180	60	77.1	77.1	0
12	50	80	70	77.8	78.3	0
13	40	70	50	81.6	81.6	0
14	75	220	130	89.5	89.5	0
15	35	80	70	89.7	89.7	0

G4.0 ANALYSIS

G4.1 Water Quality

G4.1.1 Temperature

Prior to the boating flow release on September 15th, 2004 in the Camino Dam Reach , water temperatures showed diurnal fluctuation (Figures G4.1-1 through G4.1-3). In general, the maximum daily temperature at each site occurred between 16:00 and 18:00 hours, while the minimum temperatures occurred between 04:15 and 11:00 hours. The average temperatures recorded varied by 11.41ºF among the three sites (Dam Site, 50.26ºF; Adit Site, 57.68ºF; and the Confluence Site, 61.67ºF).

Prior to the flow release (September 8–15 at the Confluence Site and September 10–15 at the Adit Site), average daily water temperatures recorded at the Adit and Confluence sites were 57.34ºF and 61ºF, respectively. During the flow release, the average daily water temperatures decreased dramatically at both sites (to 53.42ºF and 55.16ºF at the Adit and Confluence sites, respectively). Figures G4.1-2 and G4.1-3 illustrate the dip in temperature at these two sites.

In contrast to the Confluence and Adit sites, the temperature change recorded at the Dam Site after the flow release on September 15th did not show a dramatic decrease. Instead, a contraction of daily minimum and maximum water temperatures occurred. Prior to the flow release, the difference between daily maximum and minimum temperatures was, on average, 5.75ºF. During the flow release, the difference between daily maximum and minimum temperatures dropped to an average of 1.93ºF. Despite this contraction, the difference in mean daily water temperatures decreased by only 0.18ºF. Water temperatures recorded immediately downstream of Camino Dam reflect the relatively stable temperature regime of Camino Reservoir, from which flows were released.

Water temperatures resumed a normal diurnal pattern (pattern recorded prior to flow release) 28 hours after the start of the flow release. On September 18th, a rainstorm caused water temperatures to drop approximately 6.3ºF within the reach. The dip in temperatures resulting from the rain is exhibited in Figures G4.1-1 through G4.1-3.

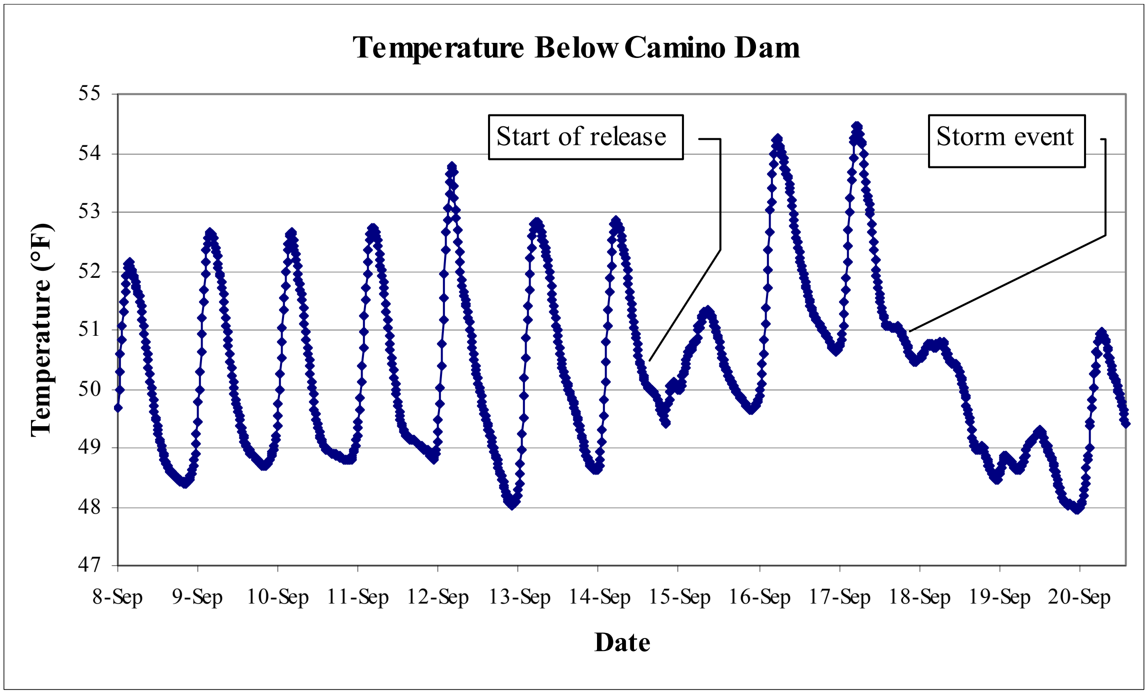


Figure G4.1-1. In-Situ water temperatures recorded at the Dam Site from September 8 through September 20, 2004.

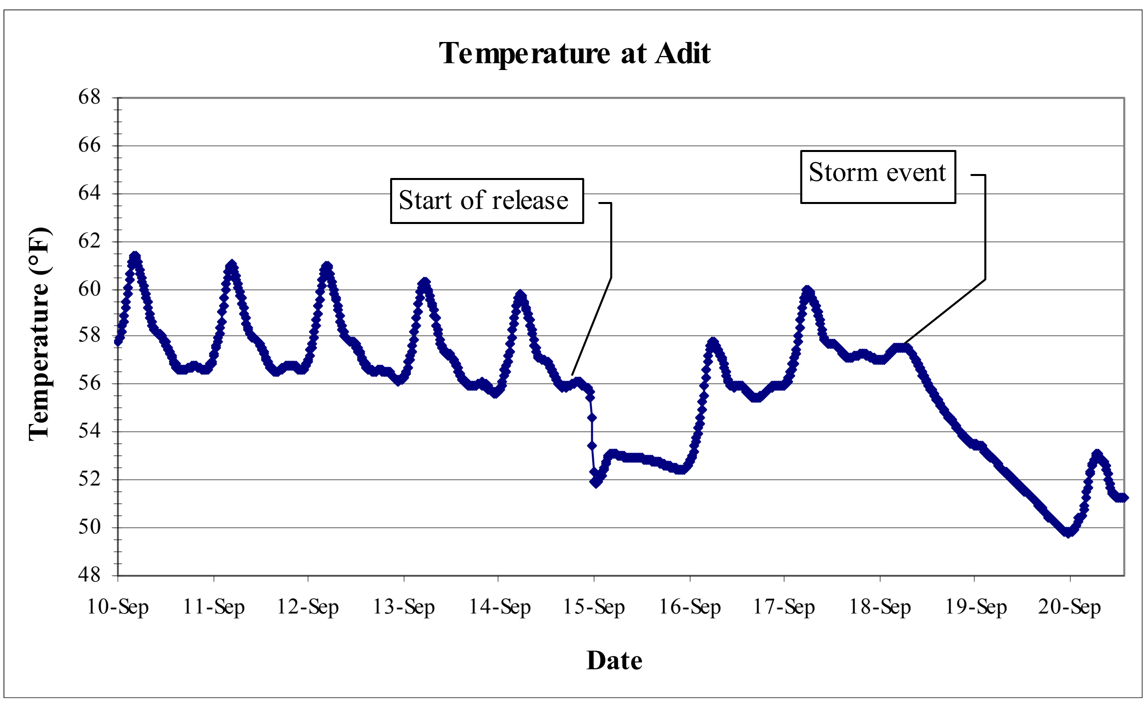


Figure G4.1-2. In-Situ water temperatures recorded at the Adit Site from September 10 through September 20, 2004.

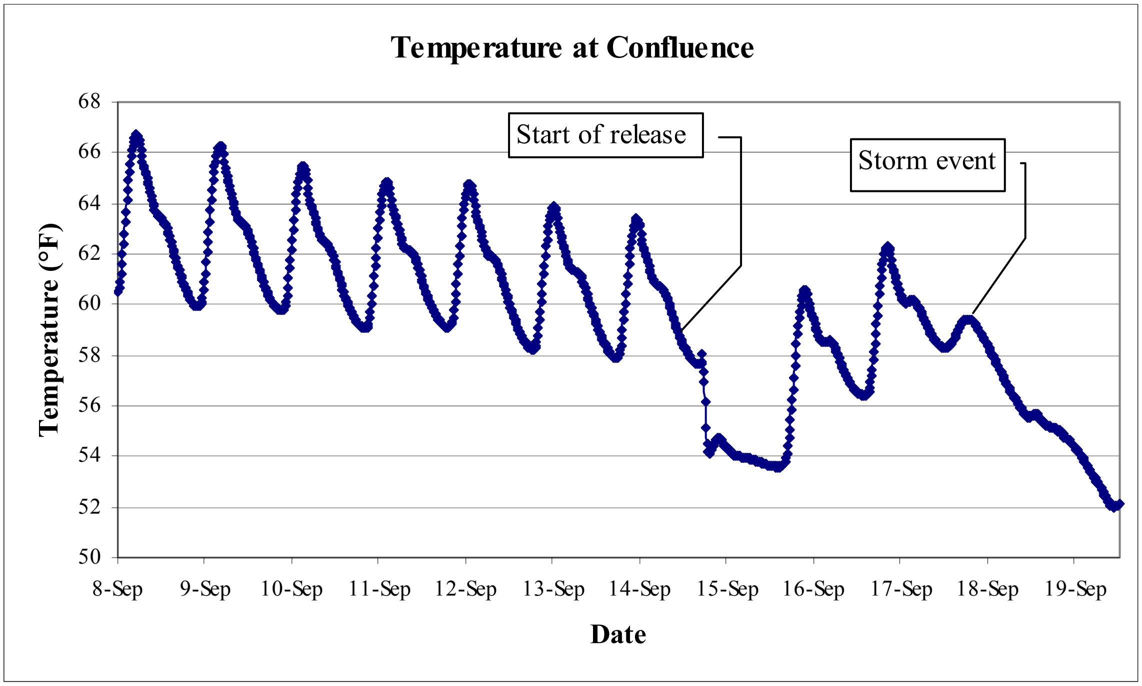


Figure G4.1-3. In-Situ water temperatures recorded at the Confluence Site September 8 through September 20, 2004.

G4.1.2 Turbidity

Turbidity was low prior to the release on September 15, averaging 1.04, 3.42, and 0.34 NTUs at the Dam, Adit, and Confluence sites, respectively.

Turbidity increased throughout the reach following the flow release. At the Dam Site, a maximum NTU of 28.1 was recorded September 15, 2004 at 09:45. At the Adit Site, a maximum NTU of 273 was recorded September 15, 2004 at 11:45, and a maximum of 189.9 NTUs was recorded at the Confluence Site September 15, 2004 at 12:00. Figures G4.1-4 through G4.1-6 indicate that the increase in turbidity at each location was rapid.

At the Dam Site, the highest turbidity level occurred 3.5 hours after the start of the flow release. No change in turbidity was recorded during the first hour (06:16 to 07:15) of the up-ramp, but a small spike was recorded between 07:15 and 07:45 (from 1.2 NTU to 16.3 NTU). From 07:45 to 08:15 water turbidity decreased from 16.3 to 4.6 NTUs. Another increase in turbidity (from 4.6 to 21.9 NTUs) at this site was recorded during the third hour of up-ramp (08:15 to 08:30). From 08:30 to 09:15 the turbidity dropped to 11.3 NTUs. During the fourth and final hour of up-ramp, a maximum turbidity of 28.1 NTU was recorded. The increase and subsequent decrease in turbidity values during each hour suggests that the particulates in the stream between the dam and sample site (approximately 0.10-mile) were moved with the hourly increase in flow and then settled out shortly there after.

At the Adit Site an average of 4.7 NTUs was recorded from 06:15 to 10:30. The following measurement at 10:45 increased to 185.2 NTUs, and a subsequent decrease in turbidity to 121 NTUs at 11:00. Turbidity continued to increase, from 151.8 NTUs at 11:15 to the maximum recorded at this site of 273 NTUs at 11:45. Following the maximum of 273 NTUs, water turbidity at this site dropped rapidly to below 100 NTUs by 12:30. By 19:30, the turbidity dropped below 4.0 NTUs where it remained until the Troll was removed.

An abnormal spike in turbidity (from 1.4 NTUs to 1,063 NTUs) was recorded at the Adit Site at 08:45 on September 16th (one day after the flow release). The subsequent recording at 09:00 indicated that turbidity had returned to its previously low level. The cause of the spike is unknown and may be attributed to a small amount of sediment (sand) or organic matter passing through the sensor cap of the instrument.

At the Confluence Site, turbidity averaged 0.34 NTUs until noon on September 15th. At that time turbidity increased to 189 NTUs. After this increase, turbidity dropped to 111.8 NTUs by 12:45 and then began to rise again. By 13:15 turbidity was recorded at 171.9 NTUs. By 02:00 on the following day (September 16th), turbidity had dropped below 2.0 NTUs, and continued to drop to below 1.0 NTU by 09:00. No significant increase in turbidity was recorded at the Confluence Site during or after the September 18th rain event.

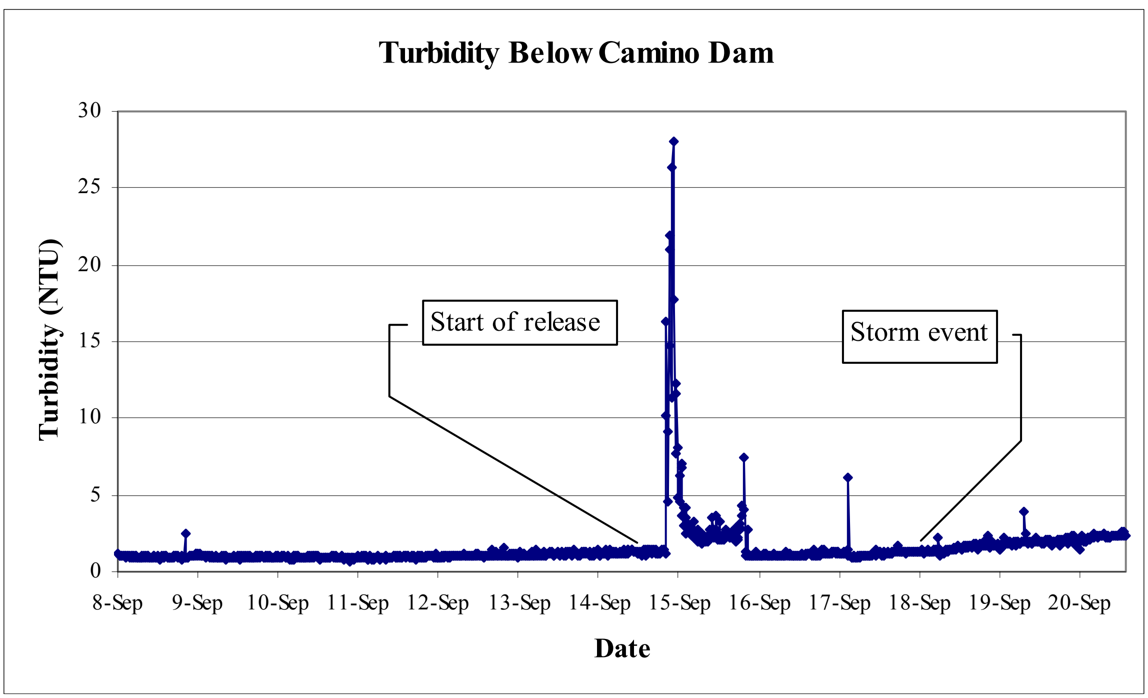


Figure G4.1-4. Turbidity measured at the Dam Site from September 8 through September 20, 2004.

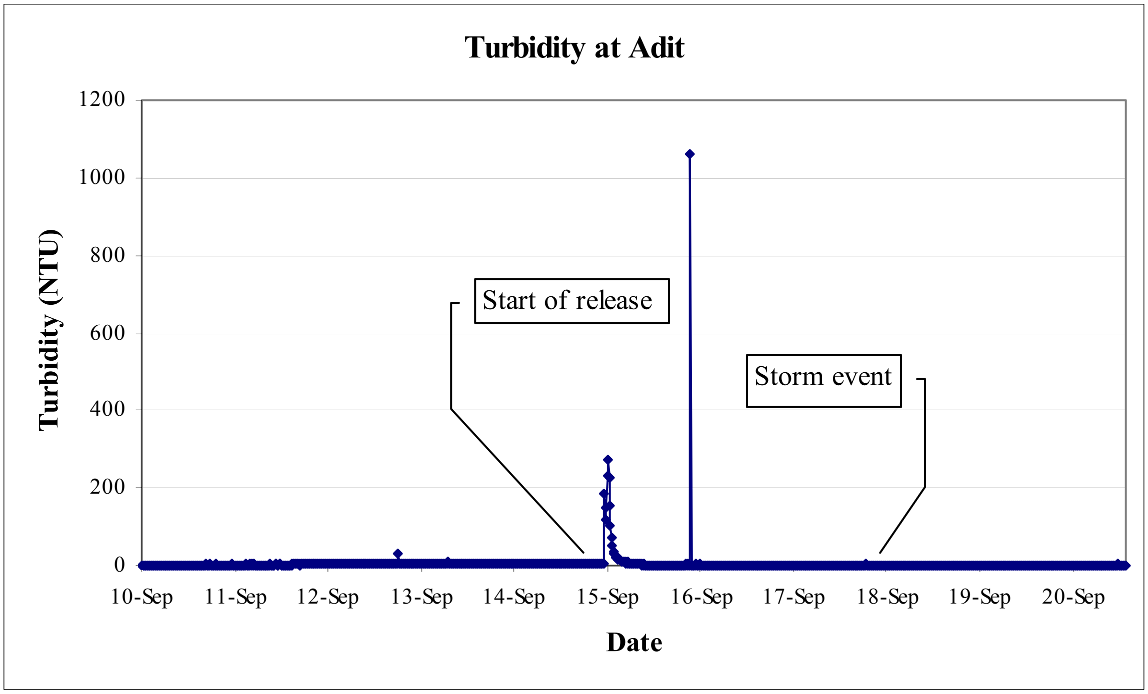


Figure G4.1-5. Turbidity measured at the Adit Site from September 10 through September 20, 2004.

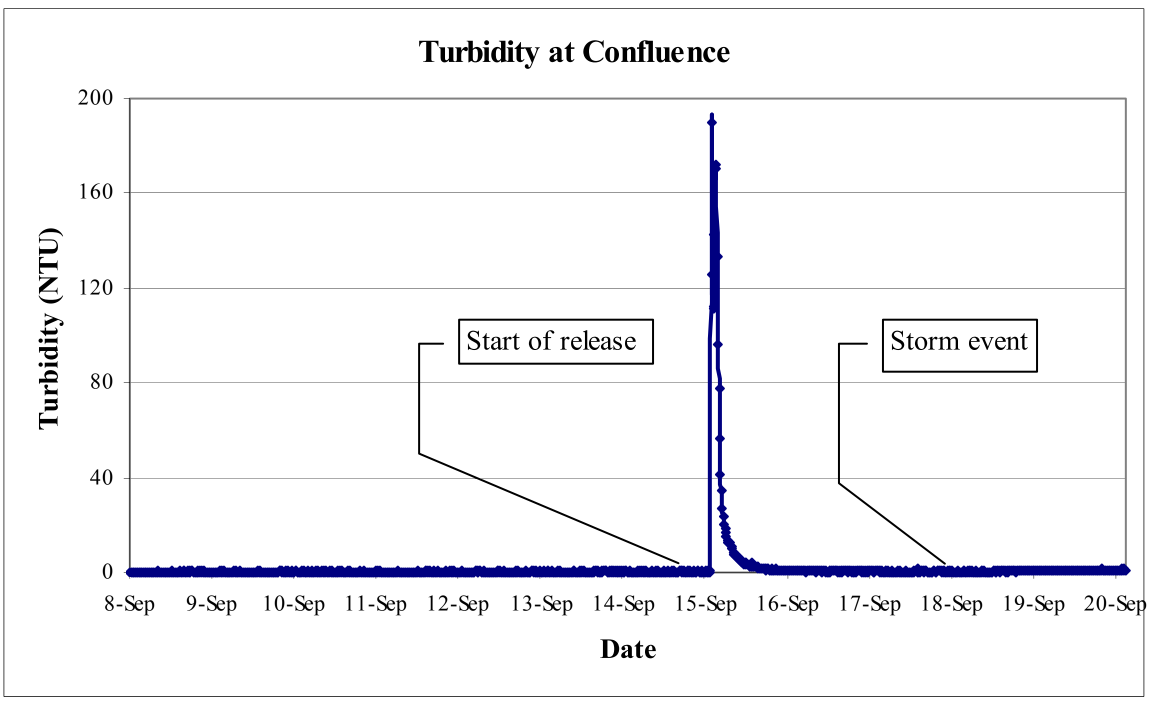


Figure G4.1-6. Turbidity measured at the Confluence Site, from September 8 through September 20, 2004.

G4.1.3 Dissolved Oxygen

The trends in dissolved oxygen (DO) concentrations before, during, and after the flow release are exhibited in Figure G4.1-7. Dissolved oxygen levels within the Camino Dam Reach showed diurnal fluctuations similar to those of water temperature. Indeed, DO concentrations normally fluctuate daily and seasonally in response to temperature (Allen 1996). Additionally, turbulent waters (specifically small rivers and streams such as Silver Creek) typically have relatively high DO concentrations (as compared to large, slow-moving rivers and lakes) because an increased proportion of water is exposed to air per unit time.

Prior to September 15th, DO concentrations at the Dam, Adit, and Confluence sites averaged 10.63mg/L, 8.56mg/L and 11.68mg/L, respectively. Higher concentrations measured at the Dam and Confluence sites are likely due to the increase in turbulence just upstream of the sample sites. Both sites were near or above 100% saturation. The lower DO concentration measured at the Adit Site is likely, in part, a result of lower turbulence levels in the pools that are located just upstream and at the sample site. In addition, decaying organic matter in these pools at the Adit Site likely increases DO consumption.

During the flow release, the DO concentration at the Dam Site fell 0.34 mg/L but remained near 100% saturation. In contrast, DO concentrations the Adit and Confluence sites increased by 2.07 mg/L (19.5%) and 1.85 mg/L (13.7%), respectively.

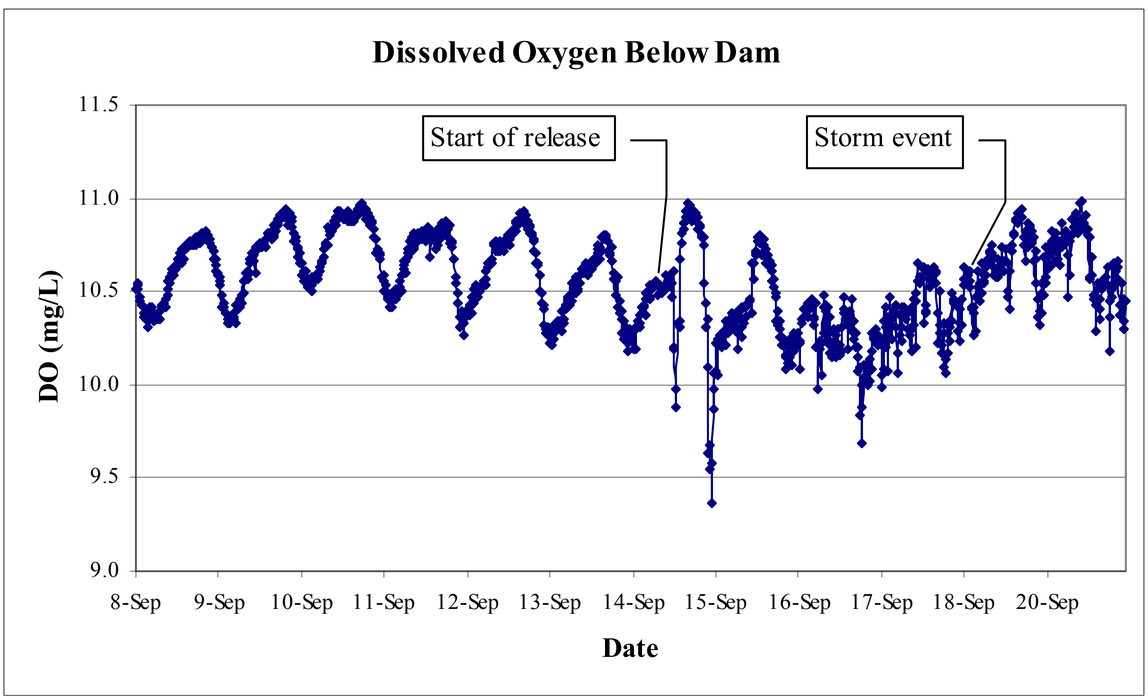


Figure G4.1-7. Dissolved oxygen concentrations measured at the Dam Site from September 8 through September 20, 2004.

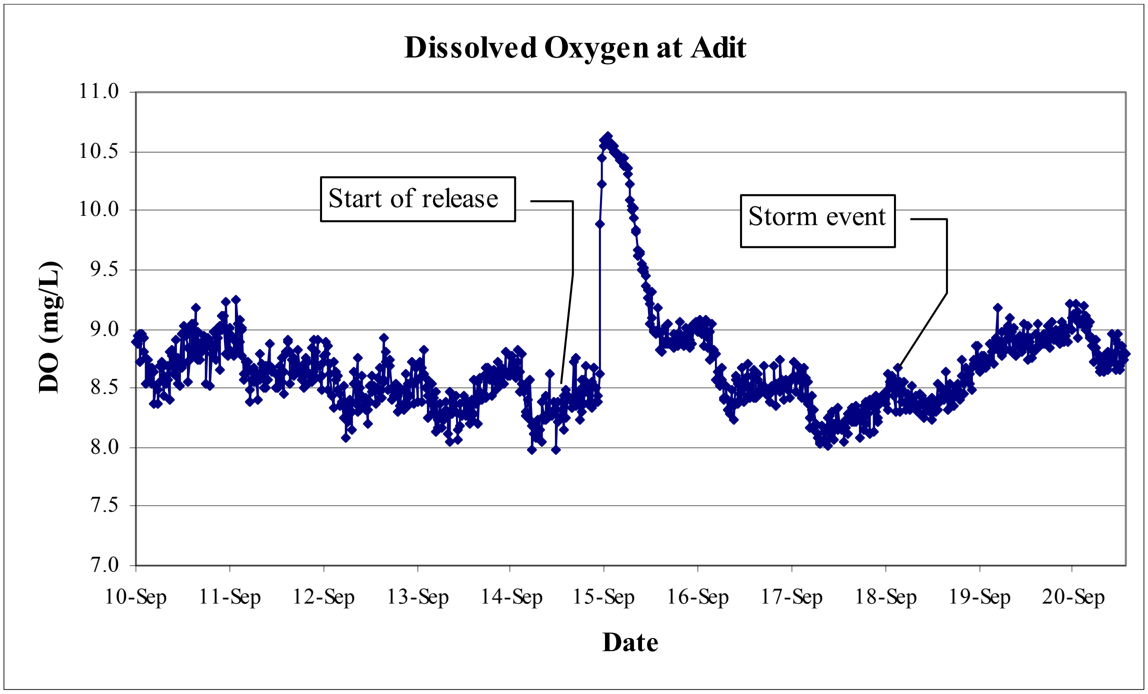


Figure G4.1-8. Dissolved oxygen concentrations measured at the Adit Site from September 10 through September 20, 2004.

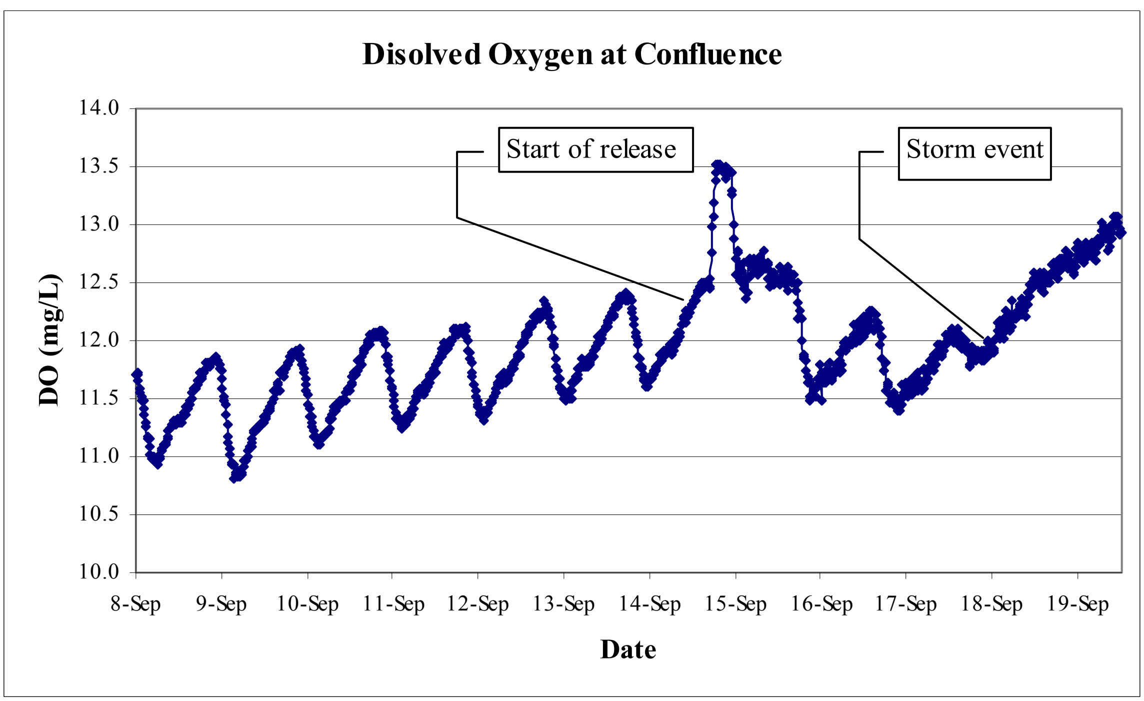


Figure G4.1-9. Dissolved oxygen concentrations measured at the Confluence Site from September 8 through September 20, 2004.

After the flows subsided at each of the sites, the DO concentrations returned to the same ranges as seen prior to the flow release event (see Table G3.1-1 above). However, the rain event of September 18th and 19th increased the DO concentrations at each of the three sites. DO concentrations at the Confluence Site were affected the most by the storm, with concentrations nearing those measured during the flow release on September 15th.

G4.1.4 Total Suspended Solids

TSS levels increased at the Dam Site and at the Adit Site. These increases in TSS can be attributed to the increased flows through the reach that result in the transport of particulates (e.g., organic detritus and sediment) downstream. During the flow release, only one TSS sample at the Dam Site showed a concentration greater than the 5.0mg/L laboratory reporting limit. This sample (TSS of 13mg/L) was collected at 08:15, two hours after the start of the boating flow release. All other samples taken at the Dam Site had a non-detectable level of TSS.

At the Adit Site no TSS values were above the 5.0mg/L laboratory reporting limit until 11:15. The 11:15 sample had a TSS of 119mg/L, with all subsequent samples showing a substantial decrease. The final sample (collected at 17:15) showed a concentration of 12mg/L.

G4.2 Foothill Yellow-Legged Frog Habitat, Distribution, and Abundance

FYLF distribution and abundance remained relatively similar between the pre-flow and post-flow site visits at both sites. It appears that high flow refuges were available for the metamorphosing and recently metamorphosed individuals to withstand a 600 cfs pulse flow. A sustained flow of this magnitude may not have the same result. Also, because no tadpoles were present at this time of the year, either pre- or post-flow, it is unclear what impact such a flow would have on completely aquatic life stages (i.e., tadpoles) of amphibians.

Suitable habitats for foothill yellow-legged frog had been previously identified during VES conducted in spring and summer 2003, and surveys conducted during test flow releases in fall 2003 at both the Adit and Confluence sites.

At the Adit Site, potentially suitable habitats identified at the highest test flow released in 2003 (100 cfs) were completely inundated during the boating flow release of 600 cfs (Figure G3.3-2). Much of the substrate at the Adit Site is bedrock, and the few backwater areas present were located on large slabs of bedrock, that fell steeply into the water. The general channel morphology at this site includes a narrow floodplain width, with little room for water to spread across the channel. Thus, at higher flow conditions, edgewater areas tend to become deeper and faster. Most habitats where subadults were observed during pre-flow surveys, and where egg masses and tadpoles had been documented during surveys conducted in 2003, were completely inundated under this flow, and were unsuitable for FYLF. A backwater along the right bank that remains wetted year-round likely became inundated under the boating flow (it was not safe to access this area to confirm this during the flow release), and may have provided suitable cover and refuge from the high flows. Also, small seeps along the right bank may also have provided some cover during the high flows.

Although no direct observations were conducted at the Confluence site, it is likely that habitat at this site was affected similarly. Results from the Amphibian Flow Study indicated the wetting of backwater and side channel habitat at 100 cfs that was previously dry. Although the boating flow release would also have inundated these areas, the suitability of the habitats created could not be assessed. During the post-flow surveys, the mid-channel island at this site was not dry at its highest point, indicating that flows completely immersed this area. However, post-flow VES documented post-metamorph and adult FYLF occurrence along the edgewaters of this mid-channel island, indicating the availability of suitable cover during the high flow at this site.

G4.3 Flow and Stage Changes

Stage change was rapid during the flow event and the maximum change occurred over a 60-minute time period at the Adit Site. With more precise electronic sampling at the Confluence Site, the results were similar, and maximum stage change occurred there within a 30-minute interval. This suggests that while ramping rates at Camino Dam were set to increase flows gradually over a 3-hour period, stage changes at the downstream sites (and therefore effects on aquatic organisms at these sites) occurred over a more rapid time period. This result is consistent with hydraulic studies elsewhere (e.g., the *Flow and Fluctuation in the Reach Downstream of Chili Bar Technical Report*, and recent studies in the Mokelumne River basin) which document that increased flow releases in steep canyons tend to "catch up" to the leading edge of the flow pulse as the channel is "filled," resulting in more rapid stage increases as you move farther downstream.

G4.4 Benthic Macroinvertebrates

G4.4.1 Taxonomic Composition

The MRPP analysis indicated that BMI taxonomic composition was significantly dissimilar ($p<0.05$) between pre-flow samples and post-flow samples collected at the Camino Dam Reach sites and the SFAR reference site in year 2004 (Figures G4.4-1 and G4.4-2). Since there was no flow pulse through the SFAR reference site between the sampling events, the differences in taxonomic composition at the sites were most likely due to temporal factors not associated with the flow pulse. Or, if the difference in taxonomic composition was due to the flow pulse, it could not be detected due to the concomitant change in taxonomic composition documented at the SFAR reference site.

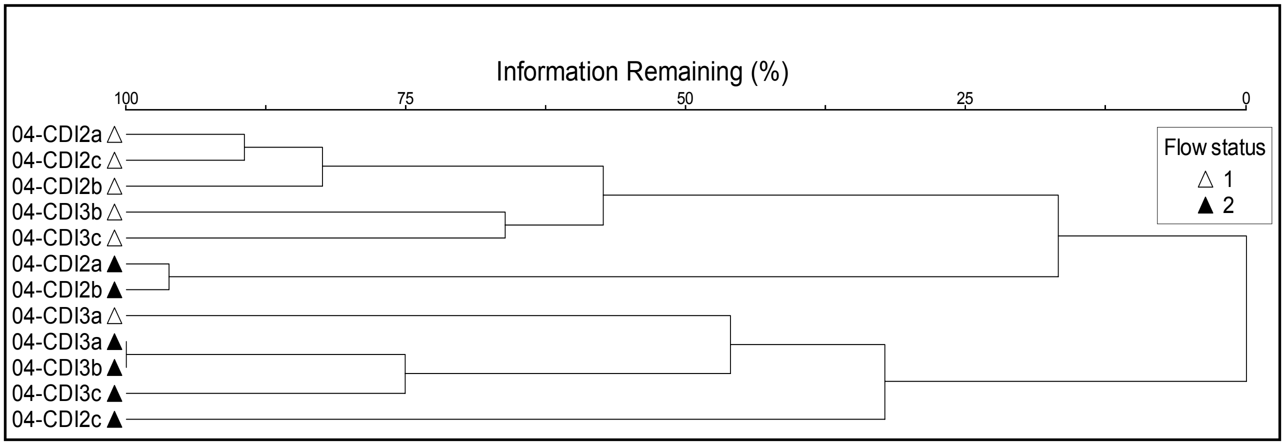


Figure G4.4-1. Cluster dendrogram showing relative similarity of Camino Dam Reach sites and samples (denoted a, b and c) as a function of BMI taxonomic composition. CDI2 is the Adit Site, CDI3 is the Confluence Site. Samples were grouped by sampling event (1 = 9/8/04, 2 = 10/6/04), which correspond to sampling events before and after the boating flow pulse at the Camino Dam Reach sites.

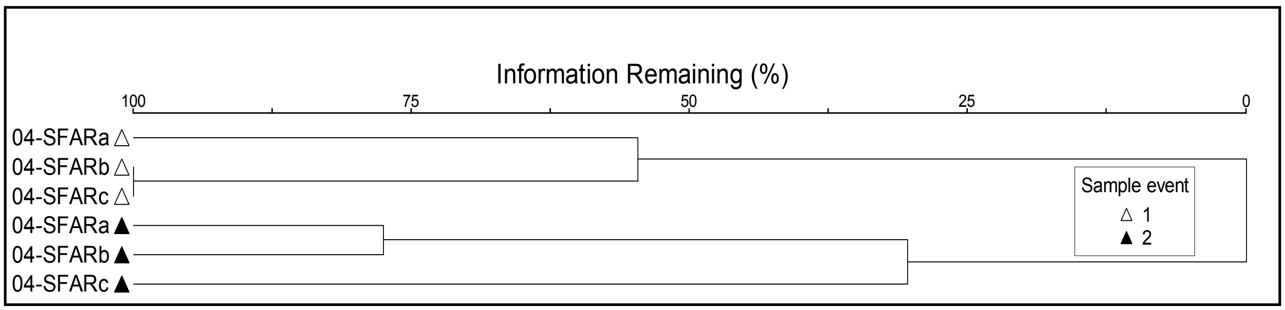


Figure G4.4-2. Cluster dendrogram showing relative similarity of the reference site and samples (denoted a, b and c) as a function of BMI taxonomic composition. Samples were grouped by sampling event (1 = 9/8/04, 2 = 10/6/04), which correspond to sampling events before and after the boating flow pulse at the Camino Dam Reach sites.

G4.4.2 Biological Metrics

Composite metric scores are shown in Figure G4.4-3, which includes the previous two years (2002 and 2003) of data for the Adit, Confluence, and the SFAR reference sites. For additional perspective, cumulative site total EPT Taxa values are shown in Figure G4.4-3 on a secondary y-axis. EPT Taxa is a component metric of the composite metric score and was highly correlated with the composite metric scores described in the *Aquatic Bioassessment Technical Report*. Furthermore, the EPT Taxa metric is commonly reported in the literature and is one of several metrics used in the development of macroinvertebrate-based indices of biotic integrity in regions of California (Ode et al. 2003).

The Adit Site composite metric scores show annual consistency with negligible decreases in scores after the post-flow sampling event; the cumulative EPT Taxa metric also shows high annual consistency with a negligible increase after the post-flow sampling event.

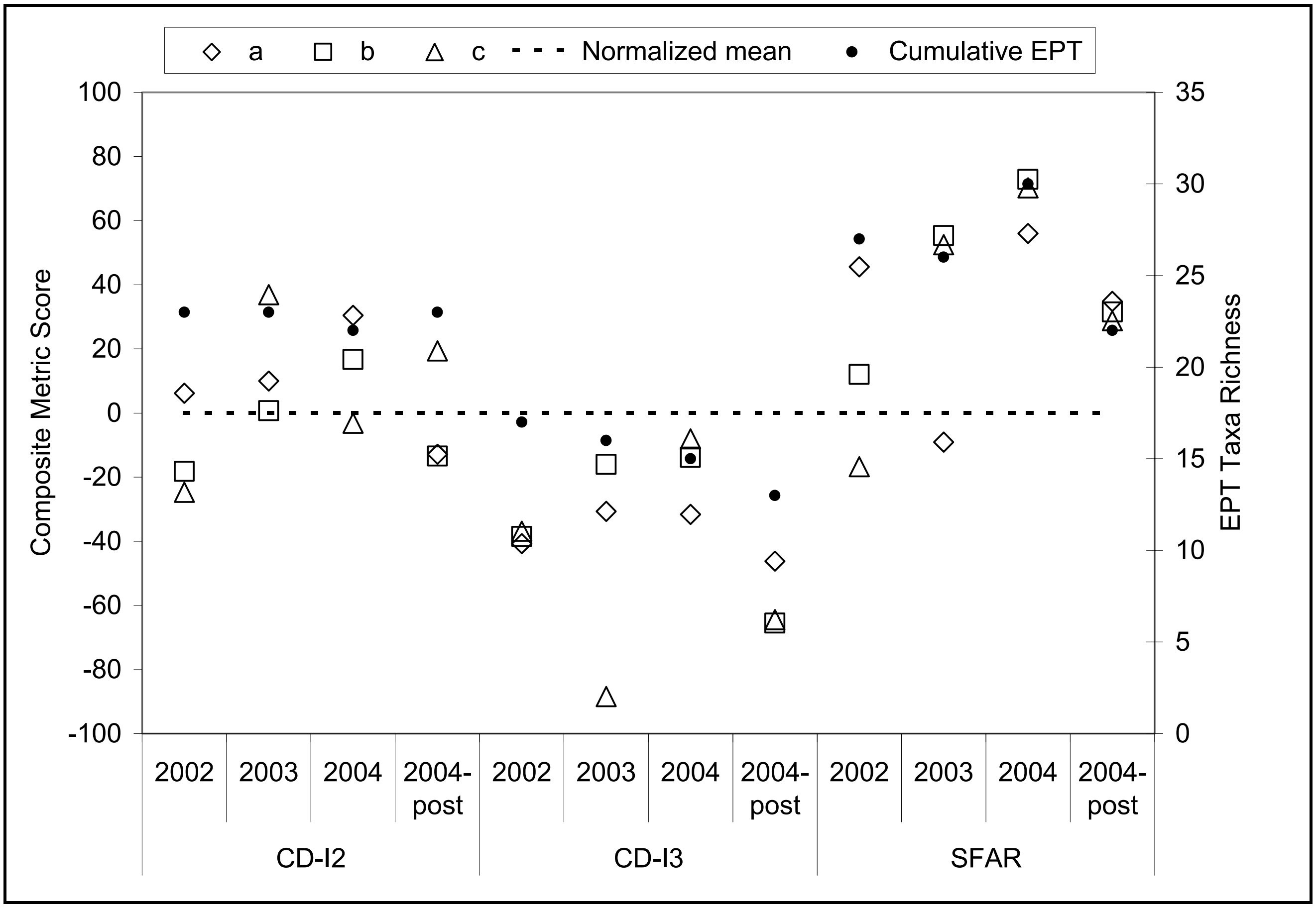


Figure G4.4-3. Composite metric scores for sites and samples (denoted as a, b and c) and cumulative site EPT taxa for benthic macroinvertebrate assemblages sampled from the Camino Dam Reach and the reference site (SFAR) for the fall season of years 2002 to 2004 including pre-flow (pre) and post-flow sampling events of 2004. Note that the reference site did not receive a flow pulse but was sampled concurrently with Camino Dam Reach samples.

The Confluence Site composite metric scores also demonstrated annual consistency with somewhat lower composite metric scores and lower cumulative EPT Taxa for the post-flow sampling event. These minor trends of lower composite metric scores for the Adit and Confluence sites were likely due to temporal effects because the SFAR reference site also showed reductions in composite metric scores and cumulative EPT Taxa during the same sampling period. Figure G4.4-4 shows mean values and 95 percent confidence intervals (CI) for four metrics used in the composite metrics scores. The four metrics represent distinct attributes of BMI assemblages including richness (EPT Taxa), diversity (Shannon Diversity), Tolerance (weighted mean Tolerance Value), and trophic level (Predator Richness). It is not surprising that Figure G4.4-4 supports the general trends shown by the composite metric scores but it also shows the variation around the mean metric values and indicates that the EPT Taxa and Tolerance Value metrics were more responsive at partitioning sites (smaller signal-to-noise ratios).

Note that the ranges in metric values determined for this study in year 2004 are consistent with the results and trends described in the *Aquatic Bioassessment Technical Report* for years 2002 and 2003.

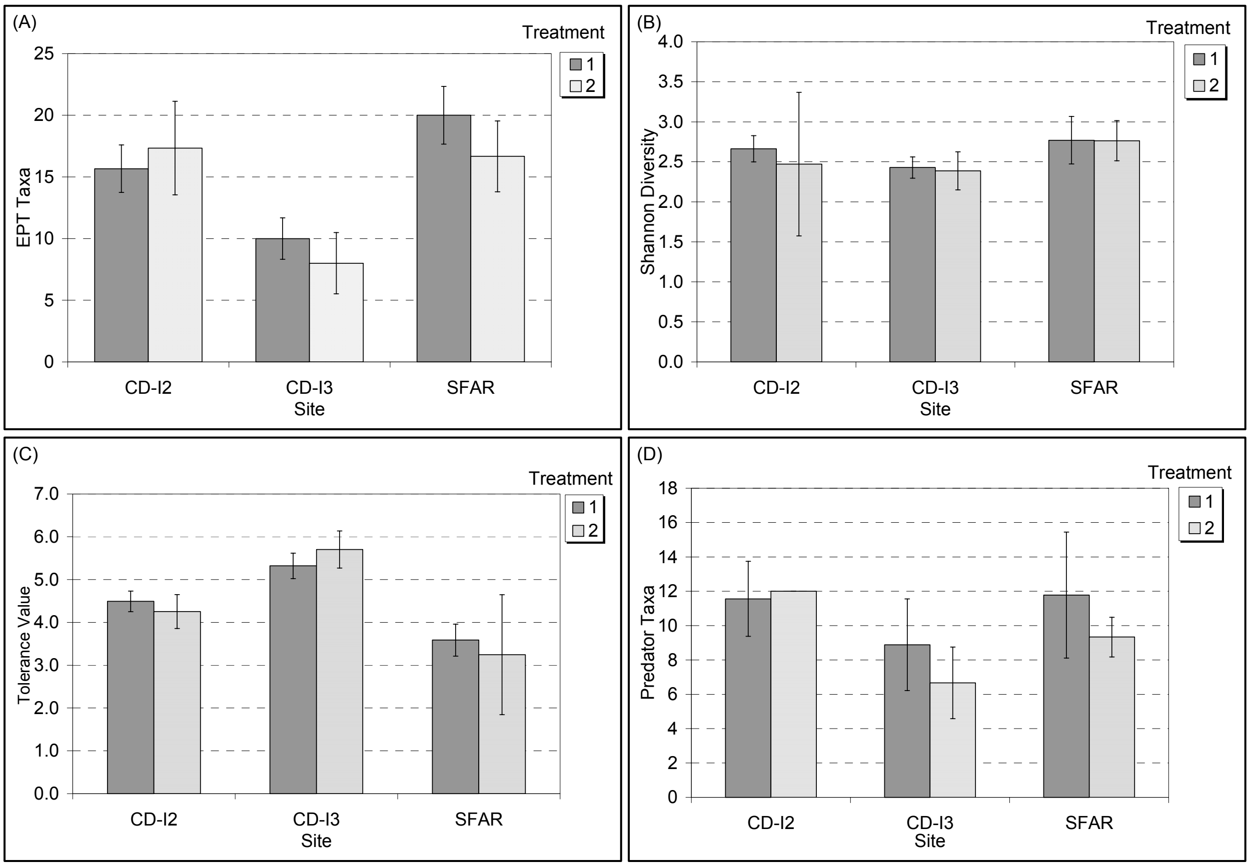


Figure G4.4-4 A-D. Mean values and 95 percent confidence intervals for four metrics and two treatment conditions including pre-flow (1; n=9) and post-flow (2; n=3). CD-I2 is the Adit Site, and CD-I3 is the Confluence Site. There was no flow pulse through the SFAR site but its sampling period was commensurate with the Camino sites. Note that there were 12 Predator Taxa subsampled from all CD-I2 treatment 2 samples.

G4.4.3 Abundance

Figure G4.4-5A demonstrates high BMI abundance variability as defined by high 95 percent CI in pre-flow samples collected at the study sites. BMI abundance is inherently variable due to heterogeneous distributions of organisms in riffles (Allan 1995), laboratory subsampling, and small sample size. Increasing sample size is one way to potentially reduce variability and increase statistical power. Figure G4.4-5B shows a reduction in pre-flow pulse abundance variability after samples were pooled by year, which increased sample size from three per site to nine per site.

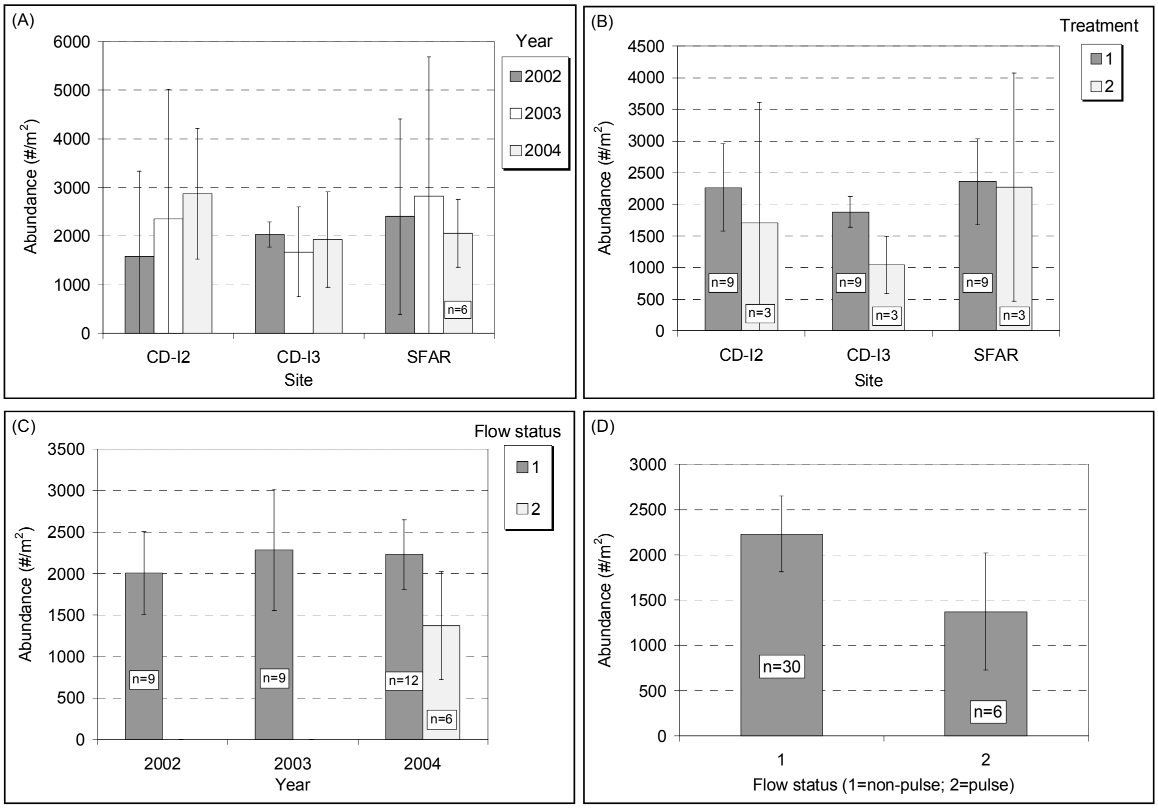


Figure G4.4-5A-D. **Mean abundance values and 95 percent confidence intervals by site and year with no flow pulse (plot A, n=3 except where noted); by site and treatment (plot B) depicting pre-flow (1) and post-flow (2) sampling events (treatment) (Note: CD-I2 is the Adit Site, and CD-I3 is the Confluence Site); by year and flow status (plot C) depicting samples receiving no flow pulse (1) and samples receiving a flow pulse (2); and by flow status only (plot D).**

Pre-flow site mean abundance values shown in Figure G4.4-5B were not significantly different ($p>0.05$; n=9) after data were pooled by year. There was also no significant difference ($p>0.05$; n=9 for 2002 and 2003; n=12 for 2004) in pre-flow yearly mean abundance after the data were pooled by site (Figure G4.4-5C). Figure G4.4-5B shows a trend of lower mean abundance for samples that were exposed to the flow-pulse, but it is only significant at the Confluence Site. Note that the SFAR reference site was sampled during the same time periods as the Camino sites but did not receive a flow pulse.

Figure G4.4-5C shows mean abundance by year and flow status (samples receiving a flow pulse and samples not receiving a flow pulse), which indicated a significant difference ($p<0.05$) in mean abundance when pre-flow pulse samples were compared with samples receiving a flow pulse in year 2004. When samples were grouped by flow status only (Figure G4.4-5D) there was a 40 percent decrease in mean abundance for samples that received the flow pulse, which was statistically significant ($p<0.05$). Note that sample sizes between nine and 12 appear to optimize our ability to detect differences in abundance assuming a critical effect size of minus 30 percent; there was a negligible decrease in CI when all pre-flow samples were pooled to produce a sample size of 30 (Figures G4.4-5C and G4.4-5D).

A power analysis conducted for this abundance data indicated that a sample size of approximately 10 would be required to achieve statistical power of 0.8 with an effect size of minus 30 percent assuming a one-tail t-test with an alpha of 0.05. Statistical power is defined as the probability of rejecting the null hypothesis when it is false and should be rejected.

G4.4.4 Conclusions

1. Taxonomic composition was dissimilar when compared by sampling event (pre-flow pulse vs. post-flow pulse). However, the dissimilarity of the reference site's taxonomic composition during the same time periods indicated that temporal factors, and not the flow pulse, contributed to the differences.

2. Although there were slight decreases in composite metric scores at sites that received the flow pulse, there were similar or greater magnitude differences in metrics documented at the reference site where there was no flow pulse. The metrics generated for this study in year 2004 support the results and trends described in the UARP *Aquatic Bioassessment Technical Report*.

3. Mean BMI abundance was significantly different when the pre-flow pulse samples were compared with samples that received a flow pulse in year 2004. There was also a significant difference in mean abundance when all fall season samples collected for years 2002 to 2004 (two Camino Dam Reach sites in 2002 and 2003 and pre-flow in 2004, and two sampling periods in 2004 at the SFAR reference site; n=30) were compared with mean abundance from fall season samples that received a flow pulse in year 2004 (two Camino Dam Reach sites post-flow 2004; n=6). It is recommended for future evaluations of BMI abundance that a minimum of 10 samples be used for hypothesis testing to detect approximately 30 percent reductions in BMI abundance with statistical power of 0.8.

G4.5 Streambed Mobility

The bed is sufficiently armored and particle sizes are large enough that no significant bed scour was experienced during the brief 600 cfs flow at the cross-section surveyed. Although two small movements were recorded, these were not of sufficient magnitude to suggest potential effects to amphibians or other aquatic organisms due to bed mobility under a flow of this magnitude and duration at this location.

G5.0 LITERATURE CITED

Allan, J. D. 1995. Stream Ecology- Structure and function of running waters. 1st ed. Chapman & Hall. xii, 388pp

McCune, B., and M. J. Mefford. 1999. PC-ORD. Multivariate Analysis of Ecological Data, Version 4. MjM Software Design, Gleneden Beach, Oregon, USA.

Ode, P.R., A.C. Rehn and J.T. May. 2003. A BMI Index of Biotic Integrity for Southern Coastal California. California Department of Fish and Game, Rancho Cordova, CA. Manuscript in review.

Attachment A

Camino Dam Whitewater Boating Flow Biological Study

Site Photographs

Figure A-1a. Confluence Site, Camino Dam Reach, UARP.

Figure A-1b. Water quality and flow/stage change monitoring location at Confluence Site.

Figure A-1c. Foothill yellow-legged frog monitoring at the Confluence Site.

Figure A-1d. Benthic macroinvertebrate monitoring at the Confluence Site.

Figure A-2a. Adit Site, Camino Dam Reach, UARP.

Figure A-2b. Water quality and flow/stage monitoring location at Adit Site.

Figure A-2c. Foothill yellow-legged frog monitoring at the Adit Site.

Figure A-2d. Benthic macroinvertebrate monitoring at the Adit Site.

Figure A-2d. Streambed mobility monitoring at the Adit Site.

Figure A-3. Reference site for BMI on SF American River at Ice House Road (SFAR).

Attachment B

Adit Site During Boating Flow Release
Photos taken 9/15/2004

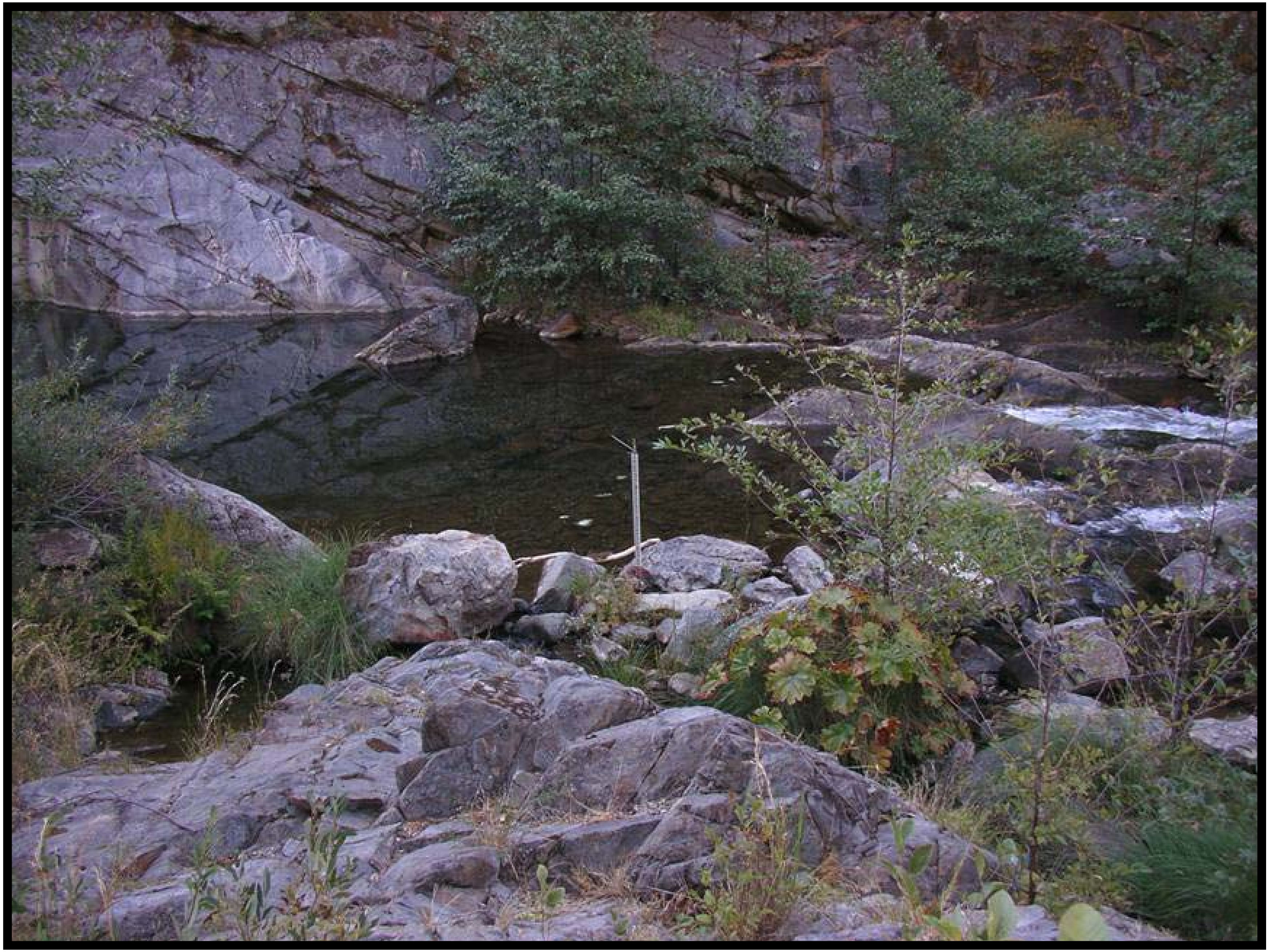


Figure B-1. Staff Gage at 0830.

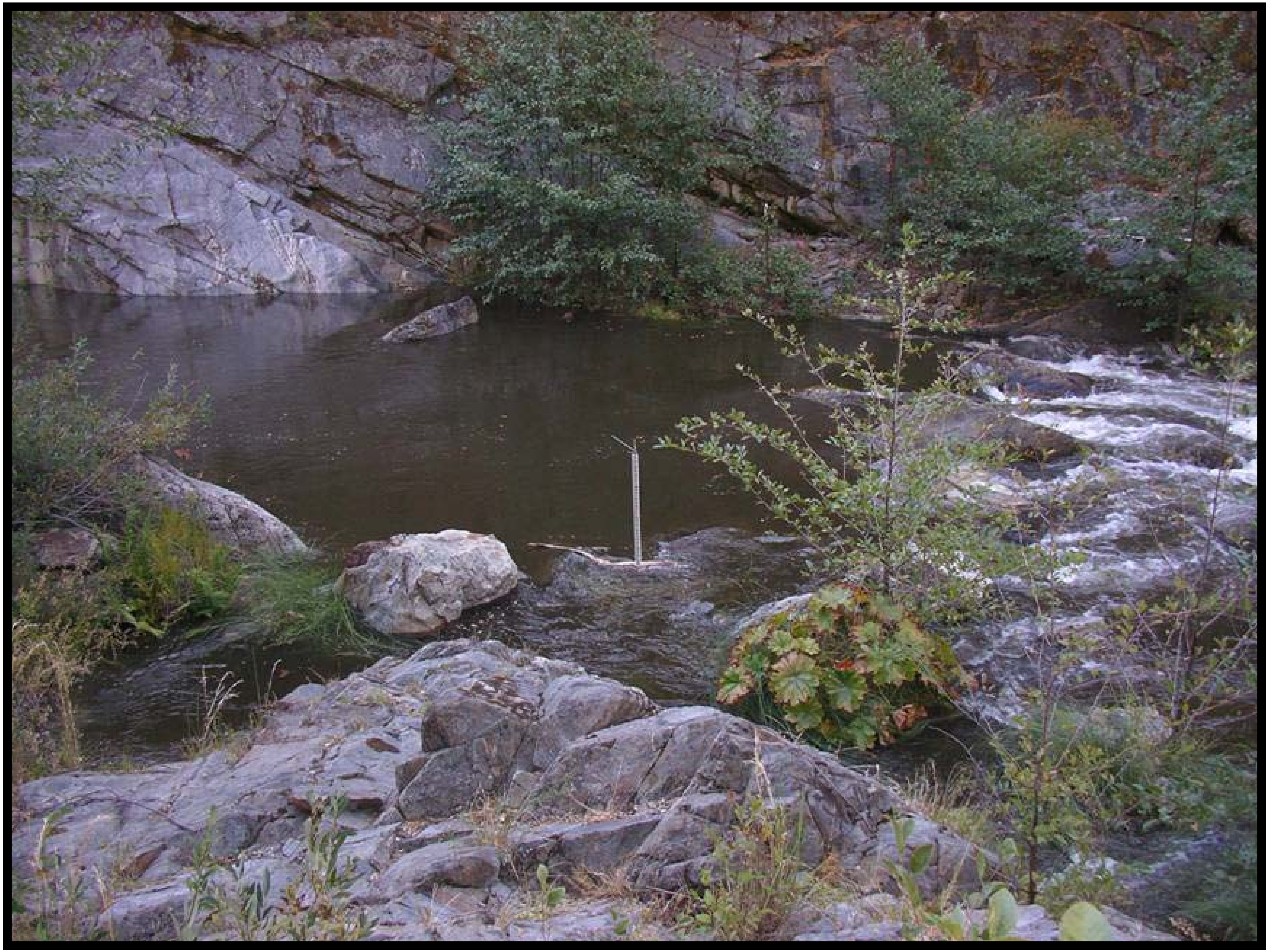


Figure B-2. Staff Gage at 0930.

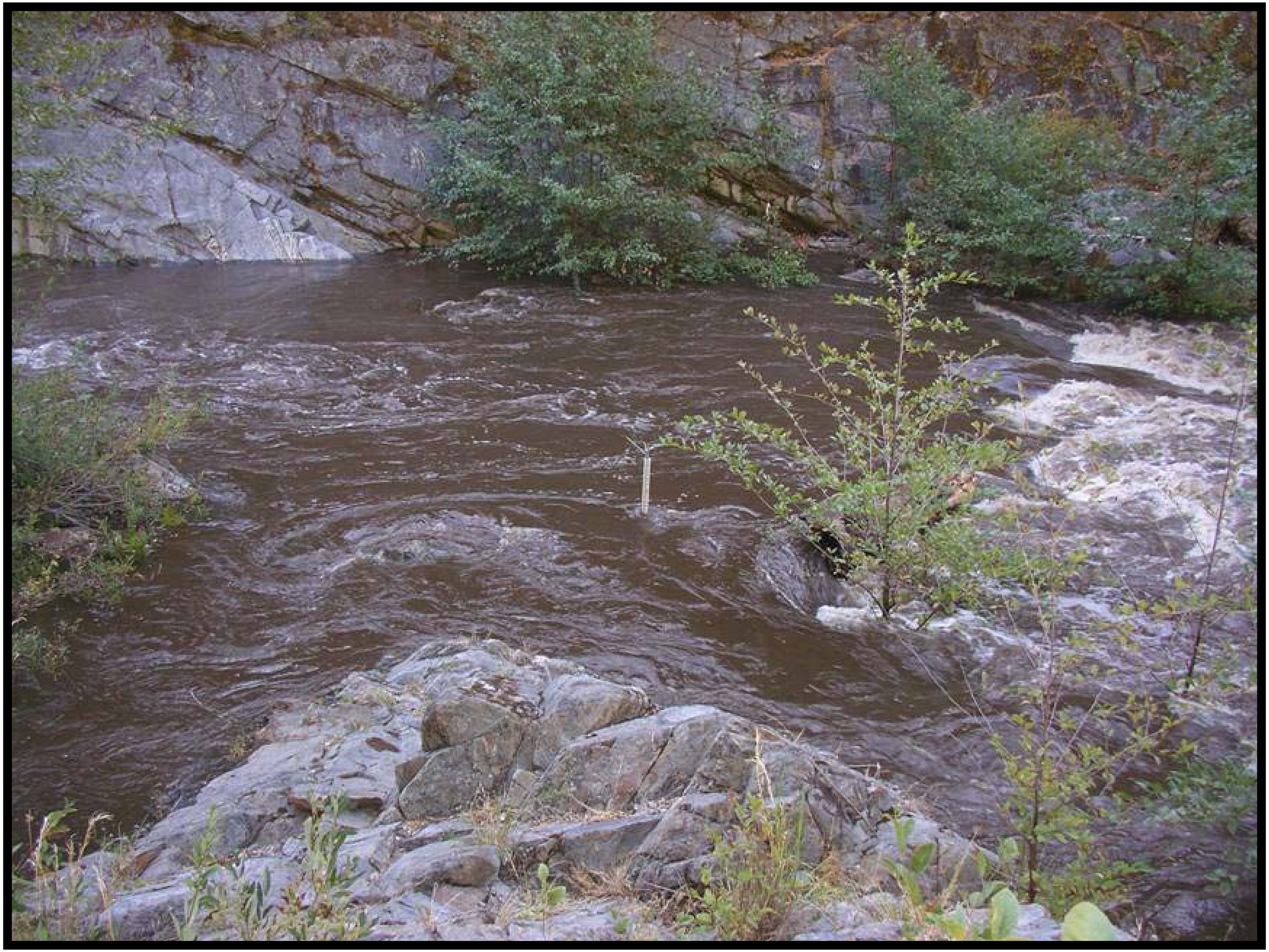


Figure B-3. Staff Gage at 1030.

Fifteen minute intervals shown during rapid ramping period.

Figure B-4a. Staff Gage at 1045.

Figure B4b. Staff Gage at 1100.

Figure B-4c. Staff Gage at 1115.

Figure B-4d. Staff Gage at 1130.

Figure B-5. Staff Gage at 1230.

Figure B-6. Staff Gage at 1330.

Figure B-7. Staff Gage at 1430.

Figure B-8. Staff Gage at 1530.

Figure B-9. Staff Gage at 1630.

ATTACHMENT C

TAXONOMIC LIST OF BENTHIC MACROINVERTEBRATES

		Year/condition	2004/ pre-flow									2004/ post-flow								
		Site:	CD-I2			CD-I3			SFAR			CD-I2			CD-I3			SFAR		
		Sample:	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c
Arthropoda	CTV	FFG																		
Insecta																				
Coleoptera																				
Dryopidae																				
Elmidae																				
Cleptelmis addenda	4	cg													1		1			
Heterelmis	4	cg						1												1
Optioservus	4	sc	2	3	4			3	20	17	19	7	1	1				12	21	25
Optioservus (A)	4	cg	5						4	3	7							1	1	1
Ordobrevia nubifera	4	sc	3	4	6	4	5	9	3	1	1		2	1		1				
Ordobrevia nubifera (A)	4	cg						1												
Zaitzevia	4	sc	13	8	5		4	3	12	10	35	10	16	7		1		6	1	3
Zaitzevia (A)	4	cg	3				1	1	13	7	4				1			1		2
Psephenidae																				
Eubrianax edwardsii	4	sc					1		4	1	1							4	1	1
Ptilodactylidae																				
Stenocolus scutellaris		sh					1								1					
Diptera																				
Athericidae																				
Atherix pachypus	2	p								1	2									1
Ceratopogonidae																				
Atrichopogon	6	cg				1				1										
Bezzia/ Palpomyia	6	p																		
Dasyhelea	6	cg				3									2					
Chironomidae																				
Chironomini	6	cg	10	37	9	1	4	1	8	5	5	1		1						
Diamesinae	2	cg	2	2	3							4	2	8		1	3			
Orthocladiinae	5	cg	13	17	3	25	21	12	9	21	21	22	7	50	37	39	88	6	9	29
Pseudochironomus	5	cg				3									1		1			
Tanypodinae	7	p	2	2	2	3	3		1	1	2	1	1							
Tanytarsini	6	cg	47	55	104	14	50	39	4	18	20	5	1	4	29	20	26	14	19	16
Dixidae																				
Dixa	2	cg															1			
Dolichopodidae																				
Dolichopodidae	4	p				1														

		Year/condition	2004/ pre-flow									2004/ post-flow								
		Site:	CD-I2			CD-I3			SFAR			CD-I2			CD-I3			SFAR		
		Sample:	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c
Empididae	CTV	FFG																		
Chelifera/ Metachela	6	p	2			2	2	3	2	4	4									1
Hemerodromia	6	p	4		2	1	2		1					2		1	12		1	
Trichoclinocera/Clinocera	6	p		1			2	2	2			2	2	1						
Wiedemannia	6	p		4		1		3												
Psychodidae																				
Maruina lanceolata	2	sc				1	2		1	1				1				9	6	6
Simuliidae																				
Simulium	6	cf		4	2	106	9		5	4	3		4	20	65	69	15	3	8	19
Tipulidae																				
Antocha	3	cg	15	2	5	6	15	6	7	5	3		2	8	2	1	12	1		1
Limonia	6	sh				1														
Ephemeroptera																				
Ameletidae																				
Ameletus	0	cg	1		2									2						
Baetidae																				
Acentrella	4	cg					1		9	17	5						1	3	3	6
Baetis	5	cg	24	6	3	11	18	8	23	30	13	13	6	61	43	42	51	20	12	20
Centroptilum	2	cg								1	1									
Diphetor hageni	5	cg	2	4	11	2			4	19	4							1		
Ephemerellidae																				
Drunella	0	cg							2	1	2							2		2
Ephemerella	1	cg								2		3		3			1	14	9	8
Serratella	2	cg							3	5	8									
Heptageniidae																				
Epeorus	0	sc	2	1	2				5	19	7	2	13	6	1	3	3	40	48	4
Ironodes	4	sc	5	5	5	3		1				1	5	7		1				
Leucrocuta/Nixe	1	sc		1	2				1											
Rhithrogena	0	sc	1		1			4	22	17	18	3	1	5		1		8	8	6
Leptophlebiidae																				
Paraleptophlebia	4	cg	19	11	11		1	2				45	37	29	1					
Lepidoptera																				
Pyralidae																				
Petrophila	5	sc	1			1	2	3		1										
Megaloptera																				

Year/condition			2004/ pre-flow									2004/ post-flow								
Site:			CD-I2			CD-I3			SFAR			CD-I2			CD-I3			SFAR		
Sample:			a	b	c	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c
Corydalidae	CTV	FFG																		
Orohermes crepusculus	0	p			1						1	1								
Odonata																				
Aeshnide																				
Aeshna	5	p						1												
Calopterygidae																				
Hetaerina americana	6	p				1														
Coenagrionidae																				
Argia	7	p	1		1	14	22	15					1		15	32	5			
Gomphidae																				
Gomphidae	4	p		1	1							2								
Octogomphus specularis	4	p								1			2		1					
Ophiogomphus	4	p									1									
Plecoptera																				
Chloroperlidae																				
Sweltsa	1	p	1	2						1	1	10	3	5					1	
Nemouridae																				
Malenka	2	sh	21	19	11	1		3		1			2	1	1		1			
Zapada	2	sh		3	1									1						
Perlidae																				
Calineuria californica	1	p	3	8	4				4	2	2	29	14	10				1	3	1
Hesperoperla	2	p	2					1	1		1	1	1	1					1	
Perlodidae																				
Cultus	2	p		1				1	2	3										
Isoperla	2	p							3	3	4	1	1	5				17	13	23
Osobenus yakimae	2	p	1								4	1	1	3					1	2
Perlinodes aureus	2	p							2	1	2							1		4
Skwala parallela	2	p						1	3	1								2		
Taeniopterygidae																				
Taeniopterygidae	2	om											1							
Trichoptera																				
Brachycentridae																				
Amiocentrus aspilus	3	cg								1			1							
Micrasema	1	mh			1				2	8	14			2				16	68	16
Glossosomatidae																				

		Year/condition	2004/ pre-flow									2004/ post-flow								
		Site:	CD-I2			CD-I3			SFAR			CD-I2			CD-I3			SFAR		
		Sample:	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c
Agapetus	0	sc							1		1									
Glossosoma	1	sc							3	4	4							6	5	7
Hydropsychidae																				
Cheumatopsyche	5	cf	52	22	62	5	33	111	62	27	34	121	131	8	8	2	6	50	25	24
Hydropsyche	4	cf	13	28	14	38	40	40	45	23	33	10	22	8	17	35	13	48	31	60
Hydroptilidae																				
Hydroptila	6	ph	15	4	7	29	32	10	1				2	6	10	6	19		1	
Leucotrichia pictipes	6	sc																1		
Neotrichia	4	sc								1										
Lepidostomatidae																				
Lepidostoma	1	sh							1	2	4	1	1					7	2	4
Philopotamidae																				
Chimarra	4	cf										1								
Wormaldia	3	cf	10	27	2	6	16	1	3	4	3				1					
Polycentropodidae																				
Polycentropus	6	p			3															
Rhyacophilidae																				
Rhyacophila	0	p	2	2	1	1	1		1	1		1		3	2			2		1
Arachnoidea																				
Acari																				
Hydryphantidae																				
Protzia	8	p													1					
Hygrobatidae																				
Hygrobates	8	p	5	3	6	1					2			1	4	1	9	2	3	
Lebertiidae																				
Lebertia	8	p	4	2					1		2	1			2		1			1
Sperchontidae																				
Sperchon	8	p	2		2	2		1	2	6	4			7	1			2	2	3
Sperchonopsis	8	p			1	1		1												
Torrenticolidae																				
Torrenticola	5	p	6	5	6	1		4	1		2		2	2			2	1	2	
Annelida																				
Oligochaeta																				
Lumbriculida																				
Lumbriculidae	8	cg										1	2	1						

Year/condition			2004/ pre-flow									2004/ post-flow								
Site:			CD-I2			CD-I3			SFAR			CD-I2			CD-I3			SFAR		
Sample:			a	b	c	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c
Tubificida	CTV	FFG																		
Enchytraeidae																				
Enchytraeidae	8	cg																		1
Naididae																				
Naididae	8	cg		2	1	1	3				1		3	12	33	24	31	2	3	1
Mollusca																				
Bivalvia																				
Pelecypoda																				
Sphaeriidae																				
Pisidium	8	cf										2	7	2						
Gastropoda																				
Prosobranchia																				
Pleuroceridae																				
Juga	7	sc				1	3	1							2		1			
Pulmonata																				
Ancylidae																				
Ferrissia	6	sc										1								
Planorbidae																				
Gyraulus	8	sc				8		5								4				
Nemertea																				
Enopa																				
Tertastemmatidae																				
Prostoma	8	p		1		4	7	4	3	5	1		2		14	10	10		1	5
Platyhelminthes																				
Turbellaria																				
Tricladida																				
Planariidae																				
Planariidae	4	p	3	2			5	2		1	2	2	1	2	1	2				

CTV: California Tolerance Value
FFG: Functional Feeding Group:

cg: collector-gatherer	sh: shredder
cf: collector-filterer	mh: macrophyte herbivore
sc: scraper	om: omnivore
p: predator	ph: piercer herbivore

ATTACHMENT D

BIOLOGICAL METRICS OF BENTHIC MACROINVERTEBRATE ASSEMBLAGES

Macroinvertebrate metric values including mean, standard deviation (SD) and cumulative site totals (CST) for the Camino boating flow study.

	Pre-flow Pulse									Post-flow Pulse								
Site Code:	CD-I2	CD-I2	CD-I2	CD-I3	CD-I3	CD-I3	SFAR	SFAR	SFAR	CD-I2	CD-I2	CD-I2	CD-I3	CD-I3	CD-I3	SFAR	SFAR	SFAR
Sample:	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c
Taxonomic Richness *	37	35	37	36	29	35	43	46	44	31	35	38	28	21	24	32	30	34
Predator Richness *	14	13	12	13	8	13	15	14	17	12	12	12	9	5	6	8	10	10
Coleoptera Richness *	5	3	3	1	5	6	6	6	6	2	3	3	3	2	1	5	4	6
EPT Taxa *	17	16	18	9	8	12	23	25	21	16	17	19	9	7	8	18	16	16
Ephemeroptera Taxa	7	6	8	3	3	4	8	9	8	6	5	7	3	4	4	7	5	6
Plecoptera Taxa	5	5	3	1	0	4	6	7	6	5	7	7	1	0	1	4	5	4
Trichoptera Taxa	5	5	7	5	5	4	9	9	7	5	5	5	5	3	3	7	6	6
Sensitive EPT Index (%)	11	12	8	1	0	3	18	23	24	17	13	16	1	1	2	38	51	26
Shannon Diversity *	3.0	2.9	2.5	2.5	2.7	2.4	3.0	3.2	3.2	2.2	2.3	2.9	2.5	2.3	2.4	2.8	2.7	2.9
Dominant Taxon (%) *	16	18	34	35	16	37	20	10	11	40	44	21	22	23	28	17	22	20
Tolerance Value *	4.6	4.6	5.0	5.5	5.2	5.0	3.9	3.9	3.8	4.1	4.3	4.4	5.9	5.7	5.5	3.1	2.7	3.9
Intolerant Organisms (%) *	11	13	9	1	1	3	19	24	25	19	13	19	1	2	3	41	53	28
Tolerant Organisms (%) *	3.5	2.7	3.3	5.6	3.3	3.6	2.0	3.6	3.2	1.3	4.7	7.7	19	13	16	2.0	2.9	3.6
Collector-Gatherers (%)	44	45	50	22	37	23	28	44	31	31	20	60	51	43	69	21	18	29
Collector-Filterers (%)	24	27	26	51	32	50	38	19	24	44	55	13	31	36	11	33	21	34
Scrapers (%)	9	7	8	6	6	10	24	23	28	8	13	9	1	4	1	28	29	17
Predators (%)	12	11	10	11	14	13	9	10	12	17	10	14	14	16	12	9	9	14
Shredders (%)	6.6	7.4	3.9	0.7	0.3	1.0	0.3	1.0	1.3	0.3	1.0	0.7	0.7	0.0	0.3	2.3	0.6	1.3
Other (%)	4.7	1.3	2.6	9.5	10	3.3	1.0	2.6	4.5	0.0	1.0	2.7	3.4	2.0	6.1	5.3	22	5.2
Abundance (#/m^2) x1000	2.3	2.9	3.4	2.2	2.2	1.5	1.2	1.8	2.5	2.3	1.6	0.99	0.84	1.1	1.2	2.2	3.1	1.6
Site Code:	CD-I2			CD-I3			SFAR			CD-I2			CD-I3			SFAR		
	Mean	SD	CST	Mean	SD	CST	Mean	SD	CST	Mean	SD	CST	Mean	SD	CST	Mean	SD	CST
Taxonomic Richness *	36	1.2	50	33	3.8	52	44	1.5	59	35	3.5	50	24	3.5	39	32	2.0	43
Predator Richness *	13	1.0	22	11	2.9	19	15	1.5	23	12	0.0	19	7	2.1	11	9	1.2	16
Coleoptera Richness *	4	1.2	5	4	2.6	8	6	0.0	6	3	0.6	3	2	1.0	5	5	1.0	6
EPT Taxa *	17	1.0	22	10	2.1	15	23	2.0	30	17	1.5	23	8	1.0	13	17	1.2	22
Ephemeroptera Taxa	7	1.0	8	3	0.6	6	8	0.6	10	6	1.0	7	4	0.6	7	6	1.0	7
Plecoptera Taxa	4	1.2	7	2	2.1	4	6	0.6	9	6	1.2	8	1	0.6	1	4	0.6	7
Trichoptera Taxa	6	1.2	7	5	0.6	5	8	1.2	11	5	0.0	8	4	1.2	5	6	0.6	8
Sensitive EPT Index (%)	10	2.1	10	1	1.6	1	22	3.0	22	15	2.3	15	1	0.1	1	38	12.9	38
Shannon Diversity *	2.8	0.2	3.0	2.5	0.2	2.8	3.1	0.1	3.3	2.5	0.4	2.7	2.4	0.1	2.5	2.8	0.1	2.9
Dominant Taxon (%) *	23	9.6	22	29	11.2	16	14	5.7	13	35	12.4	29	24	3.3	18	19	2.8	15
Tolerance Value *	4.7	0.2	4.7	5.3	0.3	5.3	3.9	0.1	3.9	4.3	0.2	4.3	5.7	0.2	5.7	3.2	0.6	3.2
Intolerant Organisms (%) *	11	1.8	11	1.8	1.3	2	22	3.3	22	17	3.1	17	2.0	0.8	2	41	12.8	41
Tolerant Organisms (%) *	3.1	0.4	3.1	4	1.3	4.2	2.9	0.9	2.9	4.6	3.2	4.5	16	2.7	16	2.8	0.8	2.8
Abundance (#/m^2) x1000	2.9	2.7	8.6	1.9	8.4	5.8	1.8	8.7	5.5	1.6	21	4.9	1.0	13	3.1	2.3	5.5	6.8

* metrics used for composite metric scores

ATTACHMENT E

RAW DATA

(Provided on CD by Request)