KILARC-COW CREEK PROJECT

FERC NO. 606

REVISED STUDY PLANS

Pacific Gas and Electric Company

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INTRODUCTION

Pacific Gas and Electric (PG&E) is pleased to present the following detailed Study Plans for the Kilarc-Cow Creek Project (FERC Project No. 606). The detailed Study Plans represent the technical approach deemed necessary to gather information that will be used to assess the environmental effects of relicensing PG&Es Kilarc-Cow Creek Hydroelectric Project.

This document contains twenty study plans and one Appendix. Studies 1 through 20 address the aquatic and biological studies to be completed for the relicensing process. The information collected from implementation and completion of Studies 1 through 20 is critical to understanding the potential Project effects on the watershed and identifying potential protection, mitigation and enhancement measures. Appendix A provides a preliminary draft of the estimation of unimpaired flow for the Cow Creek watershed. This information will be modified pending the results of Studies 1 and 2.

Studies 21 through 28 focus on recreational, archaeological, land management and aesthetic resources. The content of Studies 21 through 28 has not changed from those presented in Appendix C of the First Stage Consultation Document, submitted June 2002 for the Kilarc-Cow Creek Project and therefore, have not been included in this package.

For the purposes of this document, the following definitions apply unless otherwise specified:

"Project Area" is the area within the FERC Project Boundary.

"Project Vicinity" is the area extending to about 10 miles out from Project features.

"Project Region" is an area on the order of County or National Forest size.

"Immediate Project Vicinity" is the area extending to about one mile out from Project features.

Study 1

Stream Flow Monitoring
KILARC-COW CREEK PROJECT
FERC NO. 606

Study Plan Title: Stream Flow Monitoring

Objective of Study: To collect data to simulate the hydrologic record under the current Project operation at selected points in the watershed and establish long-term flow monitoring.

Study Methods: The streamflow records for the Cow Creek Watershed will be summarized based on a common time scale and missing records or changes in the gages will be noted. Daily data collected by PG&E at the head and end of the Kilarc and South Cow Creek Canals will be evaluated for adequacy and will be used to assess the historic diversions. A preliminary draft of the simulated hydrologic record prepared from data collected to date is provided as Appendix A.

In addition, two temporary, continuous, flow-monitoring stations will be established and monitored in the Kilarc-Cow Creek Project Area in 2003. One station will be located on Old Cow Creek near the Kilarc Powerhouse and the second station will be located on South Cow Creek upstream of the South Cow Diversion Dam near the wet crossing. The specific location of each monitoring station will be based on site reconnaissance, actual channel characteristics, and hydraulic conditions. The locations of the continuous flow monitoring stations will be recorded by GPS and plotted on a diagram of the Project Area. In addition to the two continuous flow monitoring stations, biweekly (once every two weeks) discharge measurements and flow calculations will be performed at Kilarc Diversion (Old Cow Creek) and Mill Creek Diversion (Tributary to South Cow Creek). Calculations of flow in Old Cow Creek upstream of the Kilarc Diversion Dam will be attempted by measuring discharge over the diversion dam and calculating additional flow past the overpour section at the head of the canal. Biweekly discharge measurements will also be performed in Mill Creek Canal and in the Mill Creek bypass reach. The discharge

measurements and data collection at these sites will be coordinated with the data collection efforts at the continuous monitoring points. The locations of these monitoring points will also be recorded by GPS and plotted on a diagram of the Project Area.

Each of the temporary, continuous, flow-monitoring stations will consist of a Campbell CR510 digital recorder, associated Druck 5-psi pressure transducer, and a stage gage (reference pin or staff gage). The stage gage and pressure transducers will be placed in-stream, while the digital recorders will be located on the stream bank in locked enclosures. A typical transducer installation will consist of a mounting stake driven into the substrate. A transducer-mounting block (aluminum pinch block) will be used to attach the transducer to the stake. All equipment installations will be camouflaged to lessen the likelihood of vandalism.

The digital recorders will be set to record instantaneous readings every 15 minutes, and store this data as hourly, average, transducer values. All data will be stored in non-volatile memory. During monthly site visits, stored, hourly, average transducer data will be downloaded to a computer for offsite processing. Personnel from PG&E's Technical and Ecological Services (TES) Land and Water Unit will conduct instrument installation, monthly data retrieval, and data processing.

During all routine site visits, stream stage (gage height) readings will be collected (time and instantaneous stage readings recorded). A simple linear regression will be used to define the relationship between transducer readings and stream stage at each station. Average hourly transducer readings will then be converted to average hourly stream stage using the resultant equation.

Stream flow measurements will be made at each station based on stage/flow conditions. Measurements will typically be more frequent during runoff periods and less frequent during base flow periods. The primary objective of the routine flow measurements will be to cover the range of observed flows in order to develop a stage-flow rating equation. A PG&E Hydrographer will collect biweekly measurements. Measurements will be made using USGS-approved, stream-flow measurement techniques (Buchanan 1980).

Measurements will be made at wade-able transects using a Price Current Meter or similar flow measurement device, and top-setting wading rod. The error range associated with these measurements is estimated at 5 to 15% depending on the amount of large substrate and/or emergent vegetation in the channel.

Calculations of flow in Old Cow Creek upstream of the Kilarc Diversion Dam will be based on measurements of flow over the dam, as well as flow past the over-pour section of Kilarc Canal. The calculations of flow in the over-pour section will be performed by applying appropriate coefficients to standard weir equations (King *et al* 1963). These measurements will be performed on a biweekly basis throughout the spring runoff season, as opportunities to measure unimpaired flow arise.

The relationship of stream stage to stream flow (stage-flow rating) will be developed using flow measurements and the associated stage gage (staff/pin measurements) collected during routine measurements. A PG&E Hydrographer will be responsible for generating the stage-discharge ratings. The rating curve will be applicable to the defined range of stage, and may be subject to temporary shifts caused by changes in the hydraulic control (debris movement). These shifts may not be captured by the routine flow measurements if multiple shifts occur between measurements.

The resultant stage-discharge rating will be used to convert the average hourly stage readings into average hourly flow; the hourly data will be used to generate daily and monthly statistics. The entire data package will be provided to the study team in support of the various resource analyses at the end of the monitoring program.

The 1965 adjudication study included spot flow measurements taken at different locations in the Project Area. These data provide greater spatial coverage of flow measurements than currently exist with the long-term flow recording stations. The adjudication flow records will be supplemented with new flow records collected bimonthly in 2003. The purpose of these flow records is to assess the change in streamflow within the watershed and the influence of accretions and depletions. The streamflow measurements will be collected with a Price Current Meter or similar flow

measurement device at selected locations. The locations will be chosen to characterize the flow levels upstream of the diversion, in the bypass reach, and downstream of the tailrace.

Products from Study: The primary product of this study will be flow data that will be reviewed and presented in relation to Study 2. PG&E will provide the flow data and ENTRIX will summarize and analyze the data against the simulated hydrograph. Information will be presented in graphic and/or tabular form as appropriate. This information will be presented in the Exhibit E of the FERC license application.

Study Schedule: Continuous flow monitoring instrumentation will be installed in both Cow and South Cow Creeks during the month of April. Monitoring will be performed throughout 2003 for as long as feasible.

References:

Buchanan, T.J., and W.P. Somers. 1980. *Discharge Measurements at Gaging Stations*. Technical Water Resources Investigations. Book 3, Chapter A8.

King, H. W. and Brater, E. F., 1963, Handbook of Hydraulics [5th ed.]: New York, McGraw-Hill, 1373 p.

Rantz, S. E., *et al*, 1982, Measurement and Computation of Streamflow: Volume 2. Computation of Discharge, USGS Water-Supply Paper 2175 (available online at http://water.usgs.gov/pubs/wsp/wsp2175/index.html)

Study 2

Estimate Available Flow
KILARC-COW CREEK PROJECT
FERC 606

Study Plan Title: Estimate Available Flow

Objective of Study: To estimate the available streamflow at the Cow Creek and Kilarc Diversion Dams. Once this flow has been determined, PG&E's ability to manage the resource within the bypass reach can be assessed.

Study Methods: The assessment process is outlined below.

1. Selected points along the watercourses will be used to develop available flow estimates. Based on the need to directly assess the effects of Project diversions, these points would include Old Cow Creek at Kilarc Diversion, South Cow Creek at South Cow Creek Diversion, and Cow Creek at Millville. The measured flow records at these points include the partial records at Old Cow Creek at Kilarc Diversion and South Cow Creek at South Cow Creek Diversion, plus the full flow records at Cow Creek at Millville.
2. The major diversions in the watershed will be identified and aggregated to represent the total diversion (both Project and non-Project) for a reach of river. The reaches will be structured to accommodate the estimate of available flow and identify Project and non-Project influences on flow.
3. The magnitude and season of non-Project diversions will be evaluated from data collected for the adjudication, during 2003 surveys, and discussions with local landowners. A long-term diversion record will be developed that matches the available flow record based on these data and professional judgement.
4. The estimated diversion record and the measured flow will be used to estimate the available flow for the watershed and sub-watersheds where historic data exists.
5. The flow for the reach will be divided by the area of the contributing watershed to estimate a flow-per-unit-area. These data will be evaluated relative to precipitation

data to assess if there are changes in the unit runoff because of seasonal influence. Seasonal flow-per-unit-area estimates will be developed, if appropriate.

6. These subwatershed estimates will be compared with the estimate developed for Cow Creek at Millville. Relationships between the Cow Creek at Millville estimate and the subwatershed estimates will be developed. Using the relationships, the flow record for the selected points of interest (described in #1 above) will be extended to match the Millville period of record. Because these records are incomplete and may not match the period of records for other stations, the records will be lengthened and placed on a similar time scale.
7. These synthesized records for available flow will be compared with the actual measured flows. PG&E will assess the appropriateness of the estimated flows with a mass balance using the assumed diversions.

The approach to computing unimpaired flow will be patterned after the flow-per-unit-area approach advocated by the State Water Resources Control Board. Flow-per-unit-area (the unit flow) involves relating the measured flow at a gage to the total area tributary to that gage. For this watershed, the method will use the unit flow of Cow Creek at Millville as the dependent variable to estimate the unit flow elsewhere in the watershed. With the Millville gage as the dependant variable, the unit flow at other locations can be estimated for the 1949-to-present period of record. In this way, the limited flow records at other locations in the watershed are extended to the entire period.

In addition, the continuous flow monitoring data to be collected in Old Cow and South Cow Creeks throughout 2003 will be used to validate the model.

Products of Study: The product of this study will be the estimated available flow at Cow Creek and Kilarc Diversion Dams. Historical flow data, and the continuous flow information acquired from Study 1 will be used to validate the simulated hydrograph developed with Study 2. A preliminary draft of the simulated hydrograph is provided as Appendix A. Assumptions and limitations of the model under impaired and unimpaired scenarios will be discussed and information will be presented in graphic and/or tabular

form as appropriate. The hydrologic time series of the available flow at PG&E's diversions will be used in the analysis of impacts for the Exhibit E.

Study Schedule: Data will be collected throughout 2003 and the study will be completed by December 2003.

Study 3

Water Quality Monitoring Study
KILARC-COW CREEK PROJECT
FERC 606

Study Plan Title: Water Quality Monitoring Study

Objective of Study: A water quality monitoring study will be performed to determine water quality conditions in the Kilarc-Cow Creek Project Area under existing operational, hydrological, and meteorological conditions. These water quality conditions will then be compared to Basin Plan standards to verify that the project conforms to the beneficial uses identified by the California Regional Water Quality Control Board – Central Valley Region (CRWQCB-CVR) in the Basin Plan.

Study Methods: Water samples will be collected from twelve locations throughout the Project Area. One sample will be collected in North Canyon Creek (NC1) above the Project diversion, two samples will be collected in South Canyon Creek (CC1 and CC2), three samples in Old Cow Creek (OC1, OC3, and OC4), one sample in Kilarc Forebay (KF1), one sample in Mill Creek (MC1), three samples in South Cow Creek (SC1, SC4, and SC5), and one sample in Cow Creek Forebay (CCF1). Monitoring will be conducted twice, once during the winter (March) and once during the summer (September/October). Water quality parameters will include general chemical, mineral, trace metals, nutrients, and coliform bacteria. Table 1 presents a list of sampling locations and the rationale for their selection. The spatial locations of the sampling sites are presented in Figure 1. A list of sampling parameters and their rationale are presented in Table 2.

Water samples will be collected for analysis of inorganic chemical parameters, metals, and nutrients at the California Department of Fish and Game water quality laboratories in Rancho Cordova and Moss Landing, California, and coliform bacteria will be analyzed at Basic Laboratories in Redding, California. All samples analyzed for trace metal concentrations will be collected as grab samples using U.S. EPA method 1669, *Sampling Ambient Water for Trace Metals at EPA Water Quality Criteria.* All other constituents of

interest will be sampled in a manner similar to U.S. EPA 1669 ultra clean sampling methodology. All appropriate preservation and analytical methods will be utilized during sample collections.

In addition to samples collected for analytical analysis, *in-situ* parameters (water temperature, pH, specific conductance, dissolved oxygen, total dissolved solids, and turbidity) will be measured at each location on a monthly basis between May and September/October. All instrumentation will be maintained and calibrated according to manufacturer's specifications.

Personnel from PG&E's TES Land and Water Quality Resources Unit will be responsible for development and implementation of the water quality monitoring program.

Products of Study: The results of this study will be used to evaluate the impacts, if any, of on-going Project operations and maintenance activities on water quality and beneficial uses within the Project Area. Information collected during completion of the water quality monitoring program will be included as part of the Exhibit E for the FERC license application. The report will include all data collected during the monitoring program, an analysis of the data with regard to existing resource conditions, and a comparison with available historical data, as well as with current regulatory statutes. The water quality data will also be used in conjunction with the results of the other resource investigations (fisheries, botany, and wildlife) to determine if there is an overall effect of project operations on the environmental resources of the Project Area. The results of this evaluation will be presented in the Exhibit E of the FERC license application.

Study Schedule: The water quality monitoring program will be conducted during 2003 and will include two sampling efforts. Sampling will be conducted in March and September/October 2003.

030406/Kilarc-Cow Creek Stations

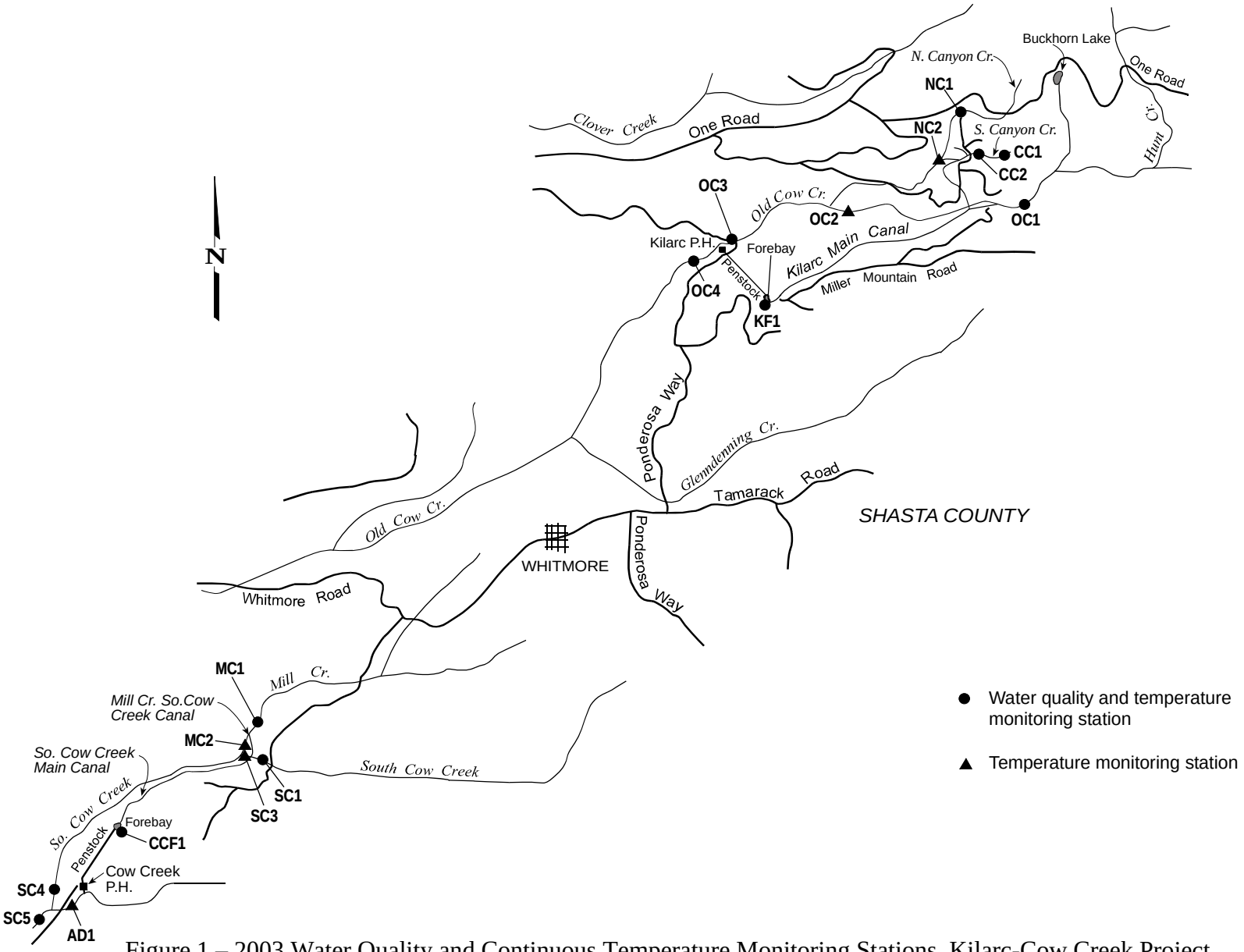


Figure 1 – 2003 Water Quality and Continuous Temperature Monitoring Stations, Kilarc-Cow Creek Project

Table 1

2003 Water Quality Sampling Location Stations, Kilarc-Cow Creek Project

	Station ID	Station Location	Monitoring Activity	Rationale
1	NC1	North Canyon Creek above North Canyon Creek Canal	TR[1], IS[2], WQ[3]	Defines initial water Quality in North Canyon Creek
2	NC2	North Canyon Creek above South Canyon Creek	TR, IS	Defines water quality before the confluence of North Canyon Creek and South Canyon Creek
3	CC1	South Canyon Creek above Toscher Diversion	TR, IS, WQ	Defines initial water quality in South Canyon Creek
4	CC2	South Canyon Creek above North Canyon Creek	TR, IS, WQ	Defines water quality before in South Canyon Creek before confluence with North Canyon Creek
5	OC1	Old Cow Creek above Kilarc Main Canal	TR, IS, WQ	Defines initial water quality in Old Cow Creek
6	OC2	Old Cow Creek above confluence with North Canyon Creek	TR, IS	Defines water quality in Old Cow Creek before confluence with North Canyon Creek
7	OC3	Old Cow Creek above Kilarc Powerhouse	TR, IS, WQ	Defines water quality in Old Cow Creek before the Kilarc Powerhouse
8	OC4	Old Cow Creek below Kilarc Powerhouse	TR, IS, WQ	Defines water quality in Old Cow Creek after the Kilarc Powerhouse
9	KF1	Kilarc Forebay	TR, IS, WQ	Defines water quality in Kilarc Forebay
10	MC1	Mill Creek above Mill Creek-South Cow Creek Canal	TR, IS, WQ	Defines initial water quality in Mill Creek
11	MC2	Mill Creek above confluence with south Cow Creek	TR, IS	Defines water quality in Mill Creek before the confluence with South Cow Creek
12	SC1	South Cow Creek above Mill Creek-South Cow Creek Canal	TR, IS, WQ	Defines initial water quality in South Cow Creek
13	SC3	South Cow Creek above confluence with Mill Creek	TR, IS	Defines water quality in South Cow Creek above the confluence with Mill Creek
14	SC4	South Cow Creek above confluence with Hooten Gulch	TR, IS, WQ	Defines water quality in South Cow Creek above the confluence with Cow Creek Powerhouse Tailrace water
15	SC5	South Cow Creek below confluence with Hooten Gulch and Cow Creek Powerhouse Tailrace Main Canal	TR, IS, WQ	Defines water quality in South Cow Creek below the confluence with Hooten Gulch and Cow Creek Powerhouse Tailrace
16	CCF1	Cow Creek Forebay above Cow Creek Powerhouse	TR, IS, WQ	Defines water quality in Cow Creek Forebay before the Cow Creek Powerhouse
17	AD1	Hooten Gulch below Cow Creek Powerhouse above Abbott Diversion	TR, IS	Defines water quality from Cow Creek Forebay after passage through the Cow Creek Powerhouse and above the Abbott Diversion

[1] TR = Temperature Recorder
[2] IS = In-situ parameter monitoring
[3] WQ = Analytical parameter

Table 2. 2003 Sampling Parameters for the Kilarc-Cow Creek Project Water Quality Monitoring Program

Parameter	Units	Detection Limits	Analysis Location	Rationale
		Analytical Parameters		
General mineral (calcium, sodium, magnesium, chloride, fluoride, carbonate, phosphorus, alkalinity, TDS, hardness)	mg/l	Various depending on parameter	Certified Laboratory	Indicators of basic water chemistry
Trace metals (arsenic, barium, cadmium, copper, cyanide, iron, lead, manganese, mercury, molybdenum, silver, zinc)	µg/l	Various depending on parameter	Certified Laboratory	Indicators of basic water chemistry
Nitrate	mg as N/l	0.02	Certified Laboratory	Indicator of nutrient loading
Ammonia	mg as N/l	0.2	Certified Laboratory	Indicator of nutrient loading
Total phosphate	mg as P/l	0.01	Certified Laboratory	Indicator of nutrient loading
Ortho-phosphate	mg as P/l	0.04	Certified Laboratory	Indicator of nutrient loading
Boron-Total	mg/l			Indicator of basic water chemistry
PCB			Certified Laboratory	Indicator of water contamination
Total suspended solids	mg/l	1	Certified Laboratory	Indicator of sediment loading
Total Coliform	MPN/100ml	2	Certified Laboratory	Indicator of waste contamination
Fecal Coliform	MPN/100ml	2	Certified Laboratory	Indicator of waste contamination
		***In situ* Parameters**		
Synoptic temperature	degrees C	0.1	In-situ instrumentation	Indicator of basic water chemistry
Dissolved oxygen	mg/l	0.1	In-situ instrumentation	Indicator of basic water chemistry
pH	units	0.1	In-situ instrumentation	Indicator of basic water chemistry
Specific conductance	µmhos/cm	1	In-situ instrumentation	Indicator of basic water chemistry
Turbidity	NTU	0.2	In-situ instrumentation	Indicator of basic water chemistry

Study 4

Water Temperature Monitoring Study
KILARC-COW CREEK PROJECT
FERC 606

Study Plan Title: Water Temperature Monitoring Study

Objectives of Study: The water temperature monitoring study will evaluate water temperature during the warmer months, characterize water temperatures along bypass reaches for aquatic organisms, and characterize the ability of the Project to affect water temperatures in bypass reaches and reaches downstream of Project tailraces.

Study Methods: In order to determine whether water temperatures meet the Regional Water Quality Control Board (RWQCB) Water Quality Objectives, PG&E proposes to monitor stream temperatures in the Project bypass reaches. In general, the sampling approach to meet this objective will involve operating a water temperature recorder in the upstream and downstream end of each Project bypass reach. Water temperatures will be monitored during the period beginning on June 1 and extending until September 30.

Stream temperatures will be automatically measured *in situ* at 20-minute intervals using VEMCO MiniLog 12 TR digital thermographs at fifteen stations throughout the Project Area to determine hourly and daily maximum, minimum, and mean water temperatures. Water temperature monitoring locations are presented on Figure 1. Two recorders will be installed in North Canyon Creek (NC1 and NC2), two in South Canyon Creek (CC1 and CC2), four in Old Cow Creek (OC1, OC2, OC3, and OC4), one in Kilarc Forebay (KF1), two in Mill Creek (MC1 and MC2), four in South Cow Creek (SC1, SC3, SC4, and SC5), one in Cow Creek Forebay (CCF1), and one above the Abbott Diversion (AD1) in Hooten Gulch below Cow Creek Powerhouse. The MiniLog 12 TR is a miniature, microprocessor-controlled temperature logger that stores data in non-volatile memory. The MiniLog 12 TR has an accuracy of 0.1°C between 5 and 40°C. Data will be downloaded to a laboratory computer and stored to disk at monthly intervals.

When installed, each temperature recorder will be secured and well hidden in remote locations to avoid vandalism. Each recorder will be checked for proper function prior to being placed in operation or upon having been reset. Each unit will be checked monthly. A calibration hack will be made during this operations check. A calibration hack consists of measuring the water temperature at the location of the instrument transducer with a calibrated thermometer whose calibration is traceable to a recognized standard; the date, time, and temperature is then recorded and compared to the corresponding temperature measured by the electronic recorder. Temperature values are recorded no less than hourly throughout the day. Data will be downloaded monthly from the field electronic data loggers; standard field procedures will be followed to minimize data losses (for example, during trips to download data, each instrument is examined for tampering and a calibration check is made). The data collected from these units will be downloaded from the electronic storage into a database.

Concurrent meteorological data will be collected at the Kilarc and Cow Creek Powerhouses. These stations will collect wind speed and solar radiation, air temperature, and relative humidity data. These data are necessary, if stream temperatures are to be simulated. Relationships of local air temperatures to those of stations with long periods of record will be used to define the historical exceedances that allow PG&E to characterize the observed water temperatures as resulting from cold, normal, or hot climatic conditions. This ranking is important to the interpretation the temperature data collected.

Information about stream structure, which influences stream temperatures, will also be collected during Study 9 (*Aquatic Habitat Survey*) and Study 8 (*Riparian Surveys*). Variables such as stream slope, stream bearing, topographic, and vegetative shading have a significant influence on stream temperatures.

Stream temperature data will be tabulated and plotted to display the results of temperature monitoring. The results of water temperature monitoring will be evaluated to determine if temperature increases appear to be to in compliance with the temperature

objectives in the Basin Plan. For those reaches for which Project water temperature impacts are identified, PG&E will evaluate potential mitigation measures.

Products of Study: Daily mean, minimum, and maximum stream temperature values will be calculated from the data collected at each water temperature monitoring location. PG&E will provide temperature information that ENTRIX will present in tabulated and graphic formats as necessary. Average, minimum, and maximum monthly temperatures for each unit will be presented in addition to diurnal fluctuations, variances between upstream and downstream measurements, and other relevant temperature indices. Temperature information will be compared and contrasted to the channel profile and the different measuring locations, with a limited discussion of the relation between temperature and flow. Additionally, temperature data at the measurement stations will be compared to thermal criteria for fish populations. If temperatures are determined to be a limiting factor in fish populations within the Project Area based on this comparison, then the value of temperature modeling will be evaluated collaboratively with the resource agencies. The results of this evaluation will be presented in the Exhibit E of the FERC license application.

Study Schedule: The water temperature monitoring study will take place in June, July, August, and September of 2003.

030406/Kilarc-Cow Creek Stations

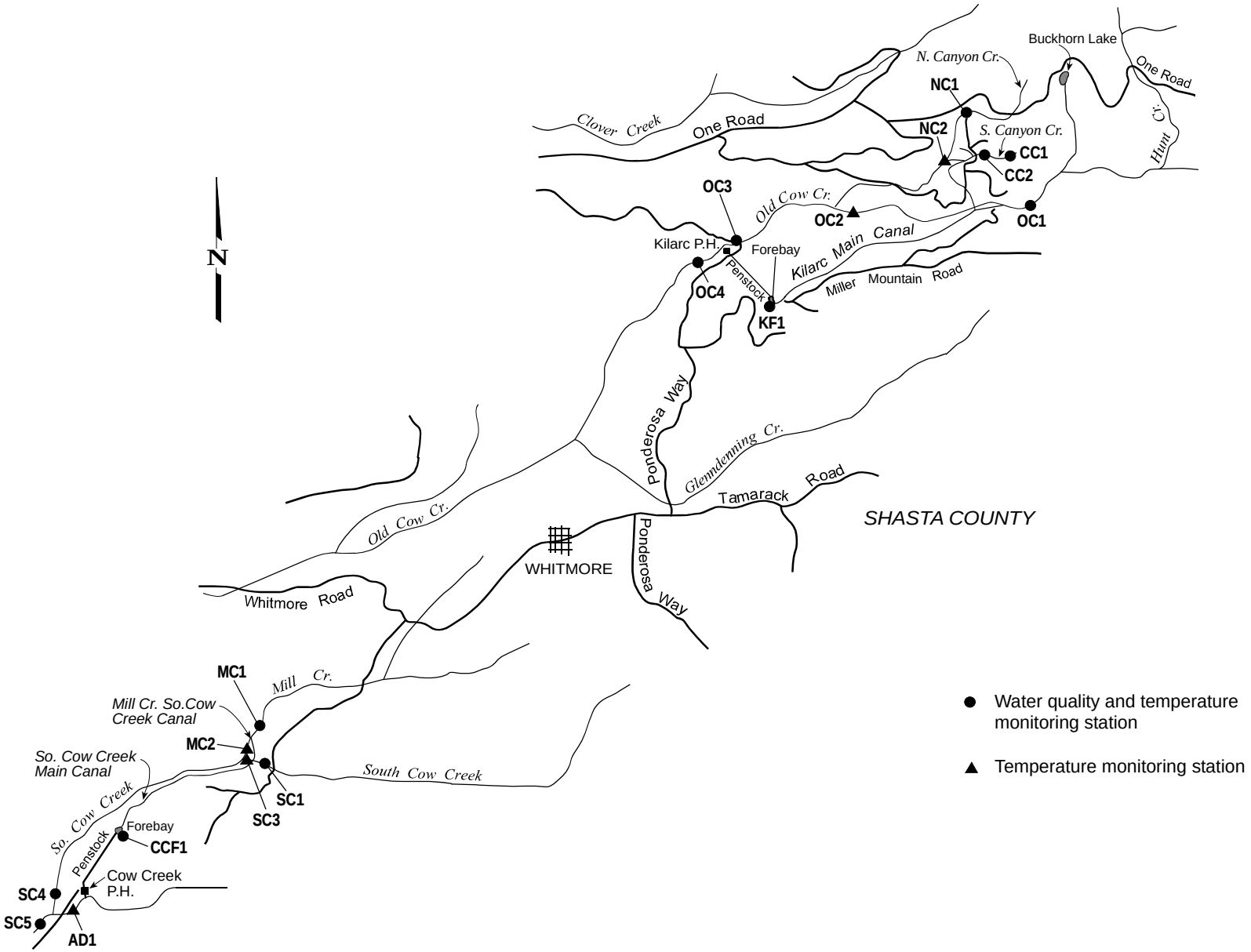


Figure 1. 2003 water quality and continous temperature monitoring stations, Kilarc-Cow Creek Project.

Study 5

Sediment Study
KILARC-COW CREEK PROJECT
FERC 606

Study Plan Title: Sediment Study

Objectives of Study: Determine whether Project operations adversely affect sediment transport characteristics and stream stability of the bypassed reaches of the Old Cow and South Cow creeks.

Study Methods: The study will involve a review of existing information pertaining to geology and soils, hydrology, Project operations, and a review of aerial photographs in the Immediate Project Vicinity. The study will identify and evaluate the Project's influence on the timing and duration of channel maintenance flows. Geologic controls, sediment sources and characteristics, sediment transport characteristics, sediment deposits, and channel stability will be evaluated.

Existing hydrology data and synthesized hydrology (Studies 1 and 2) will be reviewed to characterize flow regimes. From the available data, streamflows that are geomorphically significant in the bypass reaches will be estimated.

Aerial photographs of the watershed provided by PG&E will be reviewed. If the scale of photography is suitable, large-scale erosion features will be identified and channel sinuosity and drainage areas will be calculated.

Topographic, geologic, and soils maps will be reviewed. Drainage area and plot channel gradients will be calculated. Based on the available data, preliminary determinations of Rosgen Level 1 channel types will be made along the Project stream reaches.

Project-affected bypass reaches will be field inspected along their entire length to characterize geomorphic conditions. Channel segments upstream of the bypass reaches (approximately ½-mile upstream) will also be inspected and characterized for comparison

to project-affected reaches. The field survey work is based primarily on qualitative visual assessment procedures. Geomorphic conditions to be described will include:

1. Rosgen "Level 1.5" Classification. Stream reaches will be classified to "Level 1.5" based on identification of bankfull indicators, measurement with a tape, and/or visual approximation of bankfull width, depth, and estimation of dominant bed particle size. Cross-section surveys and pebble counts will not be performed, as these are required for a Level II classification (Level II would be part of a more rigorous 5A Quantitative Study that would be conducted, if needed, based on the Study 5 findings).
2. Montgomery-Buffington Classification. Stream reaches will also be geomorphically classified based on the channel bedform using the Montgomery-Buffington methodology.
3. Sediment storage conditions. Pool and riffle fine sediment content will be described. Pools will be visually inspected and the percentage of pool surface area covered by fine sediment will be estimated. Percent embeddedness of riffles collected during the habitat survey (Study 9) will be evaluated to assess sediment storage in the channel. Sediment storage sites such as bars will be identified and tallied, and the dominant particle sizes will be recorded. Tributary delta/bar deposits will also be identified.
4. Bank stability and sediment production. Large scale erosion features (landslides, debris flows) identified in the field will be recorded on maps, and their capacity to deliver sediment to the channel will be described. Bank stability will be rated (low, moderate, high) based on presence of active erosion and inactive features that indicate previous historical erosion activity. Stream processes and land-use activities that are clearly linked to erosion and instability will be identified and described.
5. Floodplain areas will be identified if present, and width will be estimated.
6. Indicators of vegetative encroachment will be identified, including the presence of mature vegetation on bars or within the historic bankfull channel elevation.

Field data will be recorded on available topographic maps or aerial photography. As appropriate, the data will be reduced to graphic plots and tabular format.

An impact analysis of on-going Project operations and maintenance activities on water quantity, water quality, and beneficial uses within the Project Area will be conducted. This analysis will include anticipated impacts associated with the continued operation of the Project, including sediment transport, siltation levels, and bank stability.

Products of Study: Channel geomorphic conditions and stream processes will be described, including stream type, sediment transport capacity, sediment storage and sediment supply conditions.

Where applicable (i.e., similar Rosgen and Montgomery-Buffington stream types), project "reference" reaches upstream of diversions will be compared and contrasted with the downstream project-affected reach. If such comparisons are not valid due to fundamental differences in factors controlling channel morphology, then those factors will be discussed.

The project influence on sediment transport and channel maintenance flows will be described. The results of the sediment evaluation will be presented in the Exhibit E of the FERC license application.

Study Schedule: The sediment study will be conducted during the summer low flows (June, July, or August) of 2003.

Study 6

Vegetation Mapping
KILARC-COW CREEK PROJECT
FERC 606

Study Plan Title: Vegetation Mapping

Objective of Study: To provide a detailed map showing the location of all major plant communities occurring within the Project Area.

Study Methods: Six major plant communities were identified in the Project Area, based on the Cow Creek Watershed Assessment prepared by SHN Consulting Engineers & Geologists, Inc., and Vestra Resources, Inc. (SHN 2001).

- Non-native grassland
- Agricultural lands
- Riparian forest (white alder and mixed)
- Blue oak-foothill pine woodland
- Sierran mixed coniferous forest
- Wetlands (freshwater marsh and seeps)

All major plant communities within the Immediate Project Vicinity will be mapped by using existing aerial photographs (Study 6 in Appendix C). Visual coverage by foot and vehicle will be used to field-check the vegetation/cover-type map. Corrections will be mapped on printed copies of the aerial photographs during the field surveys. A description of each cover type will be provided.

Any unique habitats or features, such as springs, caves, cliffs, and rock outcrops not previously identified during the aerial photographic interpretation will be added to the vegetation/cover type map during the field surveys. Any wetland communities identified will be mapped. Descriptions of the type of wetland (e.g., freshwater marsh, seep, etc.), dominant plant species present, and species composition will be provided.

The area of coverage will include the area within 0.25 mile of: (1) the intake areas at the North Canyon Creek, South Canyon Creek, Kilarc, Mill Creek, and South Cow Creek diversion Dams, (2) the Kilarc Forebay and spillways, Kilarc Penstock, Kilarc Powerhouse, Cow Creek Forebay and spillways, Cow Creek Penstock, and Cow Creek Powerhouse, (3) the North Canyon Creek Canal, South Canyon Creek Canal, Kilarc Main Canal, Mill Creek, and the South Cow Creek Main Canal, and (4) the diverted reaches of Old Cow Creek and South Cow Creek.

Field verification (ground-truthing) will be conducted in areas owned by PG&E or for which PG&E has obtained permission for investigators to access private property and that can be safely accessed or viewed. Areas unsafe for access or viewing include steep cliffs and unstable slopes not visible from accessible points.

Products of Study: As part of the Exhibit E for the FERC license application, each cover type observed within the Immediate Project Vicinity will be included and the vegetation community mapped. The report on botanical resources will include a general description of botanical resources within the Immediate Project Vicinity and a description of plant communities in the Project Area.

Study Schedule: Ground-truthing of vegetation cover maps prepared from aerial photographs is scheduled for spring-summer 2003.

References:

SHN Consulting Engineers & Geologists and Vestra Resources, Inc (SHN). 2001. Cow Creek Watershed Assessment. Prepared for Western Shasta Resource Conservation District and Cow Creek Watershed Management Group.

Study 7

Special-Status Plant Surveys
KILARC-COW CREEK PROJECT
FERC 606

Study Plan Title: Special-Status Plant Surveys

Objective of Study: To identify the locations of endangered, threatened, rare, or other special status plant species within the existing Project Area.

Study Methods: Based on a literature review, a list of special status plant species that could potentially occur within the Project Area was provided in the First Stage Consultation Document. For the purposes of this review, special-status plant species were defined as those species listed, proposed, or under review as rare, threatened, or endangered by the federal government or the State of California and those listed as rare or endangered by the California Native Plant Society (CNPS). These species are shown in the Table below.

Special-Status Plant Species Potentially Occurring in the Kilarc-Cow Creek Project Area

Common Name	Flowering Period	Status
Bogg's Lake Hedge-Hyssop	April - June	California Endangered
Shasta Snow Wreath	May - June	California Rare or Endangered
Four Ankled Spike Rush	May - September	California Rare or Endangered
Ahart's Paronychia	March - June	California Rare or Endangered
Shasta Clarkia	June - August	California Rare or Endangered
Butte County Fritillary	March - May	California Rare or Endangered

Surveys will be conducted within the entire Project Area. Prior to field surveys, herbarium investigations will be conducted to gather information on each species. For some species, field visits may be made to known locations of special-status plant species in the Immediate Project Vicinity to obtain additional morphological and habitat information.

All field surveys will be floristic, and the entire Project Area will be surveyed twice. Multiple surveys will be required to search for all potentially present special status plant species during appropriate seasons. Survey protocols will follow “Guidelines for

Assessing the Effects of Proposed Developments on Rare, Threatened, and Endangered Plants and Natural Communities" (CDFG 2000).

The locations of all special status plant species observed within the Project Area will be mapped (at a scale of 1" = 24,000'). Photographs showing diagnostic floral characteristics will be taken of any special status plant species observed within the Project Area. Voucher specimens will be collected in accordance with government collecting regulations.

Surveys will be conducted in areas owned by PG&E or for which PG&E has obtained permission to access streams from local property owners and that can be accessed safely. Areas unsafe for access include steep cliffs, unstable slopes, and areas bounded by impassable stream conditions.

Products of Study: The results of the special status plant study, identifying the locations of all endangered, threatened, or special status plant species observed within the existing Project Area. Species descriptions will include current status, phenology, habitat requirements, and distributional range.

The locations of all endangered, threatened, or other special-status plant species observed within the Project Area will be included in Exhibit E of the FERC license application.

Study Schedule: Surveys are scheduled for May and June 2003.

References

California Department of Fish and Game (CDFG). 2002a. California Natural Diversity Data Base Rare Find Report for {insert project quad names} quadrangles. CDFG Natural Heritage Division. Rancho Cordova, California.

CDFG, 2002b. State and federally listed endangered, threatened, and rare plants of California. http://www.dfg.ca.gov/whdab/TEPlants.pdf (July, 2002).

CDFG, 2002d. Special vascular plants, bryophytes, and lichens list. http://www.dfg.ca.gov/whdab/spplant.pdf (July, 2002).

California Native Plant Society (CNPS). 2001. Inventory of rare and endangered plants of California (6th edition, electronic version). Rare Plant Scientific Advisory Committee, David P. Tibor, convening editor. Sacramento: California Native Plant Society

Study 8

Riparian Surveys
KILARC-COW CREEK PROJECT
FERC 606

Study Plan Title: Riparian Surveys

Objective of Study: To identify the distribution, community types, and condition of riparian vegetation in the Project Area.

Study Methods: Riparian vegetation in the Project Area will be surveyed in conjunction with other botanical surveys. The riparian vegetation will be described, and its distribution and width will be mapped. Data collected will include the species composition, an estimate of the percent cover, the height of the vegetation, and mortality, if any. Map polygons will be a minimum of 0.25 acre in size. Additionally, the surveyors will record the presence/absence of seedlings and young saplings in polygons with tree species.

Surveys will be conducted in areas that PG&E owns or for which PG&E has obtained permission to access streams from local property owners and that can be accessed safely. Areas unsafe for access include steep cliffs, unstable slopes, and areas bounded by impassable stream conditions

Products of Study: The results of the riparian surveys will identify the distribution, community types, and condition of riparian vegetation observed within the Project Area. Riparian vegetation mapping will include digitized maps prepared at a scale of 1:24,000. The riparian study will identify the distribution, community types, and condition of riparian vegetation observed within the Project Area. Riparian vegetation descriptions will include the species composition, an estimate of the percent cover, the height of the vegetation, mortality (if any), and presence or absence of tree seedlings and young saplings in areas where trees are present. The results will be included in the Exhibit E of the FERC license application.

Study Schedule: Surveys are scheduled for May and June 2003.

Study 9

Aquatic Habitat Study
KILARC-COW CREEK PROJECT
FERC 606

ENTRIX is conducting an aquatic habitat study to characterize the types and calculate the relative proportions of available habitat in streams within the Kilarc-Cow Creek Project Area. This study was started in December 2002 after receiving comments from NOAA Fisheries and CDF&G on the Study plan. Surveys have been completed for most of Old Cow Creek. Rains in December halted the surveys. They are scheduled to resume when flows recede to an appropriate range. The aquatic habitat surveys will:

1. Describe the type and amount of habitat available for fish and other aquatic species in the Project Area;

2. Provide a general description of these habitat types and the Project Area as a whole, including the size of the habitat units, the amount and type of cover available, and the size and location of gravel deposits;

3. Contribute to the analysis of the factors likely limiting salmonid populations in the study area; and

4. Contribute to the assessment of the potential impacts of the Project on the aquatic habitat in the Project Area and the development of appropriate Protection, Mitigation and Enhancement (PME) measures.

5. This study will be conducted in conjunction with the passage barrier analysis (Study 10).

Sampling Locations

The Project Area includes two main streams: Old Cow Creek and South Cow Creek. ENTRIX continue conducting aquatic habitat surveys which when completed will encompass the entire length of the bypass reaches on each stream. On Old Cow Creek, the bypass reach extends from the Kilarc tailrace to the Kilarc Diversion, a distance of just under 4 miles. On South Cow Creek the bypass reach extends from the confluence of Hooten Gulch to the South Cow Diversion, a distance of approximately 3.5 miles.

Study Methods

The two major project streams will be divided into sub-reaches based on differences in gradient, confinement and significant changes in flow. Stream surveys will then locate and identify (type) aquatic mesohabitats (i.e. run, riffle, pool) within each stream sub-reach of the study area. Mesohabitats will be identified using methods described by Hawkins et al. (1993) and USFS R-5's Fish Habitat Relationships Technical Bulletin (McCain et al. 1990). A mesohabitat unit is a hydraulically similar section of stream differentiated from adjoining units by features such as hydraulic controls, gradient, turbulence, etc. These mesohabitat units are used differentially by aquatic organisms for shelter, feeding, spawning, rearing or other activity.

Habitat typing will typically start from the downstream end of the channel and continue upstream. Each sequential mesohabitat unit encountered will be classified as to its mesohabitat type to Level 3 (McCain et al. 1990), measured for length, width, and mean depth, and gradient. Maximum depth will also be measured for pool mesohabitats. Substrate composition will be visually assessed and the percentage of the most prevalent substrate and the second most prevalent substrate type will be estimated tot he nearest 10 percent. The amount and relative quality of spawning gravel for resident trout (0.25 to 2 inch diameter gravel), steelhead (0.25 to 3 inch diameter gravel) and Chinook salmon (0.25 to 6 inch diameter gravel) will be recorded. Spawning quality will be assessed based on levels of embeddedness, position in channel, hydraulics, and level of compaction. Large woody debris (> 6 inches in diameter and more than 6 feet long) will be counted in each unit. Finally cover quantity and composition will be estimated in each unit.

A Geographic Positioning System (GPS) waypoint will be taken at the start of each day, approximately every tenth habitat unit, and at the end of each day. Flow will be estimated at the beginning of each survey day to provide a reference for mesohabitat unit inventory in the different streams.

Access to project streams is subject to obtaining permission of the landowner since most the bypass reaches are privately owned. All survey efforts will be conducted on parcels where the property owner has granted access.

Product of Study

The results of this evaluation will be presented in Exhibit E of the FERC license application. The study will be used to describe the existing physical habitat conditions and to provide information for assessing mesohabitat types present. The report will describe the sub-reach breakouts, and within each sub-reach, the types and proportions of mesohabitats present and the characteristics of these mesohabitat types in terms of the parameters described above.

Study Schedule

This study will be completed in June or July 2003 when flows recede to base flow levels.

References

Hawkins, C., J. Kershener, P. Bisson, M. Bryant, L. Decker, S. Gregory, D. McCullough, C. Overton, G. Reeves, R. Steedman, and M. Young. 1993. A hierarchical approach to classifying habitats in small streams. Fisheries. 18(6): 3-12.

McCain, M. D. Fuller, L. Decker, and K Overton. 1990. Stream habitat classification and inventory procedures for northern California. FHR Currents: R-5's fish habitat relationships technical bulletin. No. 1. US Dept. of Agriculture, Forest Service, Pacific Southwest Region, Arcata, CA. 1990

Study 10

Passage Barrier Survey
KILARC-COW CREEK PROJECT
FERC 606

The is conducting a passage barrier survey to inventory and catalog potential physical structures (i.e. waterfalls and critical riffles) that may obstruct upstream or downstream salmonid migration within the bypass reaches. This study was started in December 2002 after receiving comments from NOAA fisheries and CDF&G on plan for Study 10. Surveys have been completed for most of Old Cow creek. Rains in December halted the surveys. They are scheduled to resume in May in conjunction with the Study 11 the instream flow study to evaluate higher flows, and will be complete in conjunction with Study 9 in June or July. The objectives for the fish passage survey are to:

1. Inventory potential fish passage barriers.
2. Collect measurements describing each barrier, its relative difficulty of passage, and to allow prioritization of these barriers for potential removal.

Sampling Locations

Barriers will be inventoried in the bypass reaches of Old Cow Creek and South Cow Creek. On Old Cow Creek the bypass reach extends from the Kilarc tailrace to the Kilarc Diversion, a distance of just under 4 miles. Surveys have been completed on 3 of the 4 miles. On South Cow Creek the bypass reach extends from the confluence of Hooten Gulch to the South Cow Diversion, a distance of approximately 3.5 miles.

Study Methods

Analysis of fish passage barriers is based on techniques provided by Powers and Orsborn (1985). These techniques utilize barrier geometry and stream hydrology to define the barrier. Fish passage for this study will be defined by the following characteristics:

- Class
- Drop Type
- Degree of Difficulty
- Position

The data on passage characteristics are determined at a given flow, which is used as a hydraulic comparison for future decisions. The flow level when the barrier would functionally impede fish passage will be estimated as low, medium, or high. In addition, the severity of the barrier will be estimated as either partial, or complete relative to the flow level.

The class of the barrier will be cataloged in terms of hydraulic control of fish movement (i.e. critical riffle, single falls, multiple falls). Drop type information refers to the type of restrictions the barrier presents, including: (1) if there is a resting pool present which would determine the amount of energy needed to overcome the barrier; (2) whether it is a combination of a fall and chute which also relates to total energy expended; and (3) if the entrance condition is good or poor which would determine approach options. If a drop pool exists, the size will be evaluated to determine if it would serve as a jump pool providing fish an opportunity to leap the barrier.

Geomorphic measurements will be taken of each barrier at the reference flow during field sampling. Measurements include fall height, critical depth, depth in the plunge pool, the horizontal distance from the crest of the barrier to the standing wave, and length of the barrier's slope. The degree of difficulty is determined through the above analysis on a scale of 1 to 10. Difficulty is a function of geomorphic and hydrologic characteristics.

All potential barriers will be photographed and described. GPS coordinates will be collected at each barrier if possible and the location of the barrier will be noted on a 1:24,000 scale map.

Barrier will be classified as to the range of flow that they are expected to impede passage. For barrier that are expected to remain passage obstructions at higher flow, a second site visit is planned to evaluate these barrier at a higher flow. The evaluation of potential barrier at high flow will be conducted in conjunction with Study 11, the instream flow study where controlled flow releases will provide the opportunity to observe the barrier under higher flows.

Product of the Study

A map of passage barriers and impediments to migration will be presented in the Exhibit E of the FERC license application. This section of the report will describe the class and severity of barriers observed and provide a list of the most sever barriers observed and describe their likely effects on fish passage and at what flow ranges these effects would be evident.

Study Schedule

This study will be continued in conjunction with the Instream Flow Study (Study 11) in May and completed in conjunction with the Aquatic Habitat Survey (Study 9) in June.

References

Powers, P.D. and J.F. Orsborn. 1985. Final Project Report, part 4 of 4, Analysis of Barriers to Upstream Fish Migration: An Investigation of the Physical and Biological Conditions Affecting Fish Passage Success at Culverts and Waterfalls. Albrook Hydraulics Laboratory, Washington State University, Pullman, Washington. Prepared for BPA Fisheries Project. Project # 82-14. August 1985.

Study 11

Instream Flow Study
KILARC-COW CREEK PROJECT
FERC 606

Study Plan Title: Instream Flow Study

Objectives of Study: To determine the impacts of the Project diversions on the fisheries habitat in the bypass reaches. The results of this study will assist in the identification of factors potentially limiting fish populations in the project reaches and in the determination of appropriate minimum instream flows. The objectives of the instream flow study are to:

1. Describe the quantity and quality of habitat available for resident rainbow and brown trout and anadromous steelhead, fall Chinook salmon, and possibly spring Chinook salmon. These determinations will be based on habitat simulation models and the relative types and proportions of mesohabitats available within the bypass reaches as determined by the habitat inventory studies,

2. Describe how this habitat changes with flow,

3. Contribute to the assessment of the potential impacts of the Project on fish habitat and populations in the Project Area, and

4. Assist in determination of appropriate minimum instream flow recommendations for the Project Area.

The study will examine flow versus habitat relationships for two reaches on Old Cow Creek and two reaches on South Cow Creek.

Study Methods: The habitat versus flow relationships for several life stages of each target species using the Physical HABitat SIMulation (PHABSIM) programs of the Instream Flow Incremental Methodology (IFIM) shall be assessed. This approach entails developing hydraulic models that predict velocity and depth across transects placed in the various habitats present in the river (Bovee 1982). PHABSIM was selected because it provides a widely accepted method to evaluate the effects of incremental changes in flow on aquatic resource values. The PHABSIM is commonly used in setting appropriate instream flow regimes throughout the United States and is commonly used in FERC

relicensing (Reiser *et al.* 1989). PHABSIM allows the user to simulate the quantity and quality of physical habitat available to fish or other aquatic resources over a range of flows. This information can then be used in evaluating how to balance instream and out-of-stream uses.

In order to adequately represent habitat conditions in the Project Area, ENTRIX will take the following steps: (1) conduct a habitat inventory to determine the relative proportion of habitat types available in Project streams (e.g., pools, riffles, runs, etc.); (2) install study transects in each of the major habitat types present; (3) collect field measurements at a range of flows sufficient to develop models that can simulate a wide range of habitat conditions; (4) develop hydraulic models to represent physical habitat conditions in the Project Area; and (5) develop flow versus habitat relationships using the relative proportion of observed habitat types, the hydraulic models, and Habitat Suitability Criteria (HSC) that describe the preferences of the target species at various life stages.

Transect Selection. Transects will be selected to represent important habitat types in the PHABSIM models. Habitat types that are not extensively utilized by the target species such as cascades and bedrock sheets will not be represented in the PHABSIM models. Preliminary review of topography and geomorphic conditions on the project streams indicates that there are two reaches in each stream. South Cow Creek is approximately 3.5 miles long and is divided into the upper and lower canyon reaches. A moderate to steep gradient confined within a V shaped valley characterizes the upper canyon. Substrates are dominated by cobble and gravel, although larger substrates are common. The only tributary to this reach is Mill Creek, which enters about 150 yards downstream of the Cow Creek Diversion. The lower canyon is much steeper and more incised. Dominant substrates are boulder and cobble. Gravels are less common than in the upper canyon reach. This reach includes a 1,200-foot section where the creek emerges from the canyon. This section has similar characteristics to the upper canyon reach and will be represented by the models for the upper canyon.

Old Cow Creek is divided into two sections with the lower section extending approximately 1.7 miles upstream of the Kilarc Powerhouse. A deeply incised channel

with large substrate characterizes the upper section. While the average gradient is approximately the same in the upper and lower sections, the gradient in the upper section is comprised of rapid drops interspersed with areas of more moderate gradient. The substrate in this section is mainly cobble and gravel with numerous boulders. The lower sections has generally somewhat smaller substrates although still mainly cobble, with fewer boulders, and more fine sediment. The gradient through this reach is more constant than in the upper section. The Kilarc-Cow project is "run-of-the-river" and does not store water. Therefore natural runoff must be used to provide calibration flows for the instream flow study. In order to comply with FERC mandated timelines this information must be collected in Spring 2003 to be included in the draft license application. Habitat inventory studies could not be completed prior to the onset of high winter flows. Therefore, transect selection for the PHABSIM study will be based on a field review of stream conditions and placement of transects through the important habitat types observed.

A transect selection team consisting of agency representatives and PG&E's representatives will walk portions of the study streams to obtain a feel for the types of habitats present. A maximum of three potential study sites within the reach will be visited to select a study site that is representative of the habitat types observed during the stream walk. Within the site selected, transects will be placed by the team in representative habitat units. The number of transects to be placed in each unit will be based on the judgement of the transect selection team, based on the features present within that unit. Two to three transects will be placed in pool habitat units (depending on its size and configuration), two transects in riffles and pocket water habitat units, and one transect in run habitat units. Transects will not be placed in areas that cannot be hydraulically modeled, such as areas with numerous water surface elevations, multiple braids, etc. Transects will be clustered together to facilitate identification of potential calibration errors in the subsequent hydraulic models and the collection of data in the field.

A qualified biologist, experienced in the application of the IFIM will review the potential study sites within the reach and place preliminary transects in each site. Transects will be

reviewed and approved by the appropriate regulatory agencies prior to final installation and initiation of data collection. Transect selection is anticipated to occur in late May 2003. One study site will be selected in each of the four reaches with seven to nine transects to be placed in each study site.

Data Collection. Basic input data for the PHABSIM hydraulic models include depth, mean-column velocity, substrate composition, and cover at numerous points (verticals) across each transect. For each transect, discharge, velocity and depth, water surface elevation, energy slope, and stage of zero flow will be measured. Substrate and cover conditions will be visually assessed for each vertical. Water surface elevations are required for three or more calibration discharges in order to develop stage-discharge relationships, which are a central component of the hydraulic model. It is anticipated that measurements for the calibration data for Old Cow Creek will be collected at flows ranging between 3 to 7 cfs for the low flow, 15 to 20 cfs for the middle flow, and 30 to 50 cfs for the high flow. Calibration measurements for South Cow Creek are expected to range between 3 to 7 cfs for the low flow, 25 to 35 cfs for the middle flow, and 70 to 90 cfs for the high flow. Velocities will be measured at each transect at the low and high flows. These measurements will be used to develop individual single flow PHABSIM models that overlap in the middle range of flows. Substrate and cover data will be collected during low flow, when these elements are most visible. Field data collection procedures and data reduction techniques used in this study followed those described by Trihey and Wegner (1981) and Trihey (1980). It is anticipated that high and middle flow data collection will occur immediately following transect selection efforts. Low flow measurements will likely be collected during summer baseflows sometime during the month of July 2003.

Model Calibration and Development. The PHABSIM program is designed to simulate environmental conditions (i.e., stream velocity, stream depth, streambed substrate, and cover) and assess habitat versus flow relationships for aquatic organisms at various life stages. This is accomplished by using field measurements to develop a stage-discharge relationship that can be used to predict depth along a transect for a range of stream flows. Stage-discharge predictions will be developed using the IFG-4a regression model of the

PHABSIM program. The IFG-4a is the preferred model for use in this study, because the empirically derived relationship generally works well within a reasonable range of extrapolation for most habitat types and it is relatively easy to calibrate. This model regresses the logarithm of discharge against the logarithm of water surface elevation minus the stage at zero flow. If the mean error of the IFG-4a model exceeds acceptable limits or produces unrealistic stage changes, the MANSQ model or the Step Backwater method may be used. The stage-discharge relationship, in conjunction with the velocity calibration measurements, can be used to predict velocity and depth for each vertical for unmeasured flows. Model calibration will be consistent with the recommendations of the USGS Instream Flow Group. Data reduction and modeling for Project Area streams will occur between August and November of 2003.

Flow versus Habitat Relationships. Flow versus habitat relationships will be developed using the hydraulic simulations and habitat suitability criteria that describe the depth, velocity, substrate, and cover preferences of the target species for various life stages. As mentioned previously, the target species include resident rainbow and brown trout, and anadromous steelhead, fall Chinook salmon, and possibly spring Chinook salmon depending on the results of Study 9 (*Aquatic Habitat Surveys*). Life stages will include spawning and fry and juvenile rearing for all species and adult rearing for resident trout. Existing HSC will be used to represent habitat utilization for the PHABSIM study. Criteria for many of the target species have been developed in the local area. For instance, fall run Chinook and rainbow trout criteria have been developed for Battle Creek and rainbow and brown trout have been developed for Bucks Creek (Payne and Associates 1991). The HSC used will be selected in consultation with participating resource agencies.

Products of Study: The results of this study will be presented in the License Application Exhibit E and will include calibrated PHABSIM models, a description of model calibration statistics and reliability, habitat versus flow functions by water year type, and a discussion of the relative effects of instream flows on the fish populations in the affected streams.

Study Schedule: This study will be conducted in 2003 with data collection in May/June and September of 2003.

References:

Bovee, K. D. 1982. A guide to stream habitat analysis using the Instream Flow Incremental Methodology. Instream Flow Information Paper No. 12, FWS/OBS-82/26.

Milhous, R. T., D. L. Wegner, and T. Waddle. 1984. User's Guide to the Physical Habitat Simulation System (PHABSIM). Information Paper 11. U.S. Fish and Wildlife Service, Fort Collins, Colorado.

Payne T.R. and Associates 1991. Site-specific Habitat Suitability Curves for Chinook Salmon and Rainbow Trout in Battle Creek, Shasta and Tehama Counties. Prepared for California Department of Fish and Game, Redding, CA. 18 pp + appendices.

Payne T.R. and Associates 1991). Instream Flow Study for Milk Ranch, Bucks, and Grizzly Creeks, Bucks Creek Project (FERC 619). Document prepared for Pacific Gas and Electric Company by Thomas R. Payne & Associates, Arcata, California. 61 pp + apps.

Reiser, D.W., T.A. Wesche and C. Estes, 1989. Status of instream flow practices in North America, Fisheries, 14(2); 22-29.

Trihey, E. W. 1980. Field Data Reduction and Coding Procedures for Use of the IFG-2 and IFG-4 Hydraulic Simulation Models; (Draft Report). U.S. Fish and Wildlife Service, Cooperative Instream Flow Service Group, Fort Collins, Colorado.

Trihey, E. W., and Wegner. 1981. Field Data Collection Procedures for Use with the Physical Habitat Simulation System of the Instream Flow Group. U.S. Fish and Wildlife Service, Cooperative Instream Flow Service Group, Fort Collins, Colorado.

Study 12

Fish Population Studies
KILARC-COW CREEK PROJECT
FERC 606

Study Plan Title: Fish Population Studies

Study Objective: To characterize the distribution and abundance of fish species within the Project Area with emphasis on anadromous and resident salmonids, the target species.

Study Methods: ENTRIX will conduct fish population surveys to describe the distribution and relative abundance of fish species within areas that might be affected by the project, including the bypass reaches and the Kilarc Forebay. Fish population surveys will be conducted using snorkel surveys because electrofishing cannot be conducted in many areas due to the possible presence of listed salmonids. Snorkel surveys will be conducted in all stream-sampling locations to facilitate comparison of populations in different areas of the stream. In sample locations upstream of where anadromous salmonids may exist, qualitative electrofishing surveys will be conducted in addition to snorkel surveys to assist in age determination. In Kilarc Forebay, boat electrofishing and gillnet surveys will be conducted. Sampling will be conducted in May or June (in conjunction with the first entrainment sampling) and September.

Sampling Locations. ENTRIX will conduct fish sampling in the bypass reaches, Mill Creek, Hooten Gulch, and the Kilarc Forebay (Figure 2). Sampling will also be conducted above the two diversions and below the project tailraces for comparison purposes. Sampling sites will be selected to reflect the general proportion of habitat types present in the project streams and to represent different stream reaches as reflected by differences in channel morphology. Because an impassable passage barrier to anadromous salmonids exists in Old Cow Creek in the bypass reach, fish population sites will also be located above and below these barriers. Anadromous fish cannot reach the Old Cow Creek Diversion due to an absolute barrier identified by CDFG approximately 2.3 miles upstream from the Kilarc Powerhouse.

Snorkeling. Methods will generally be similar to those presented in Flosi *et al*. (1998). Surveys will be performed between 0900 to 1600 hours to maximize the likelihood that light intensity will be suitable for observing fish (Hankin and Reeves 1988). Direct observation surveys will not be conducted on overcast days (Platts *et al*. 1983). Divers will enter the water slightly below the downstream end of the sample unit (Hankin and Reeves 1988). They will move directly across and slightly below the lowermost boundary of the sample unit into their designated swimming lane. When in position, the divers will move upstream to the lowermost boundary of the sample unit. From a fixed position and prior to moving upstream, the divers will look upstream to locate fish on the fringe of vision (Platts *et al*. 1983). Divers will identify and count fish species in their lane while moving slowly upstream at a uniform, even, pace with no abrupt movements. Fish will be counted as they pass below or to the side of an observer. Cover for fish will be inspected closely for concealed fish (Fausch and White 1981; Hicks and Watson 1985).

Fish lengths will be estimated by comparison with a fish length calibration cord. The calibration cord is a piece of small diameter rope with size length categories marked on it. In addition to the fish length calibration cord, all divers will be trained in estimating fish lengths, so estimates of fish length will be accurate.

Snorkel sampling will be conducted at five sites on Old Cow Creek, five sites on South Cow Creek, two sites on Mill Creek, and one site on Hooten Gulch. In each area to be sampled in each stream, snorkel surveys will be conducted in three run and three pool units. Bankside observations will be conducted for riffle units which are too shallow to effectively snorkel. Fish will be enumerated by species, and length category by experienced fisheries biologists. Fish will be enumerated by species, and length category (25-mm intervals). For each site sampled, the following parameters will be recorded: stream, reach, unit number, habitat type, unit length, average width, average depth, dominant substrate, cover conditions, air temperature, water temperature, and underwater visibility.

Electrofishing. Electrofishing will be conducted on Old Cow Creek, South Cow Canal, and Kilarc Forebay. Qualitative electrofishing will be used in areas in Old Cow Creek where listed salmonids are not present to obtain information for age and growth studies on trout that cannot be obtained without physically handling the fish and collecting scales. This information will be used to assist in determining size at age relationships for these species and to determine growth patterns. South Cow main canal will be sampled by electrofishing to determine if fish are present in the canal. Sampling will be conducted near the head of the canal to minimize the opportunity to capture fish that have moved up from the Forebay.

Qualitative electrofishing will be utilized upstream of passage barriers for anadromous fish (specifically the barrier identified by CDFG 2.3 miles upstream of the Kilarc Powerhouse) to facilitate age and growth studies for resident trout. In Old Cow Creek and the South Cow Canal, electrofishing will be conducted using a backpack electrofishing unit (depending on the width of the stream sampled). Settings on the unit will be adjusted to provide adequate strength for polarization and anesthesia of fish based on site-specific conditions. The electrofishing team will consist of one backpack electrofisher, and one net person as the streams are narrow. Electrofishing will generally be conducted as described by Reynolds (1996). The fish captured during each sampling event pass will be identified to species, measured for length and weighed. Scale samples will be collected from salmonids to facilitate age and growth analyses.

Kilarc Forebay will be sampled using a barge or boat mounted electrofishing unit and gill nets to identify the species and size of fish present. Electrofishing will consist of a single sampling event in May or June. During this event, electrofishing will be conducted along two-shoreline areas approximately 100 meters long that are shallow enough to be effectively electrofished (maximum depth of about 1.5 meters). Gill netting will be conducted using three variable, ¼-inch mesh, gill nets set perpendicular to the shoreline. Each gill net set will be set just before dusk and pulled four hours later. All fish captured by either electrofishing or gill netting will be processed as described above. CDFG will be consulted prior to sampling to avoid the period immediately after fish stocking takes place.

South Cow Forebay will be sampled by gill net to determine if fish are present within the Forebay. With the installation of screen on the South Cow Diversion in 1985, fish should be excluded from the canal and the Forebay. Qualitative electrofishing will be conducted in the South Cow canal to determine the presence/absence of fish in this canal.

Products of Study: ENTRIX will provide a description of the distribution and relative abundance of fish in the project affected reaches and an evaluation of project effects on the fish community. This description will include:

- The phenology of fish species observed in project streams
- A list of sites sampled and summary of physical characteristics
- The species and number of fish observed in each site and a description of the community composition within each site and reach
- Fish population per kilometer/mile and fish population per hectare/acre
- Number of fish observed by species and size category
- A discussion of community structure and relative health including a comparison of fish population size and structure within the project affected areas with those above and below the project affected area, as well as with studies available from other nearby streams (i.e. Battle Creek, Olsen Relicensing project, Moreli Ranch Project).

Study Schedule: During May 2003 PG&E and ENTRIX will consult with resource agencies regarding the proposed study plan and select the sampling sites for the stream surveys. After the resource agencies have approved the study plan ENTRIX will mobilize to conduct the surveys during May or June 2003, depending on the timeline of the approval process. A second sampling event will occur in September. The fish population surveys will also be coordinated with the spring sampling for Study 13, *Fish Entrainment.*

References:

Fausch, K. D., and R. J. White. 1981. Competition between brook trout (*Salvelinus fontinalis*) and brown trout (*Salmo trutta*) for positions in a Michigan stream. Canadian Journal of Fisheries and Aquatic Sciences 38:1220-1227.

Flosi, G, S. Downie, J Hopelain, M. Bird, R. Coey and B. Collins. 1998. California Salmonid Stream Habitat Restoration Manual ,State of California Resources Agency, Department of Fish and Game, Third Edition, January 1998

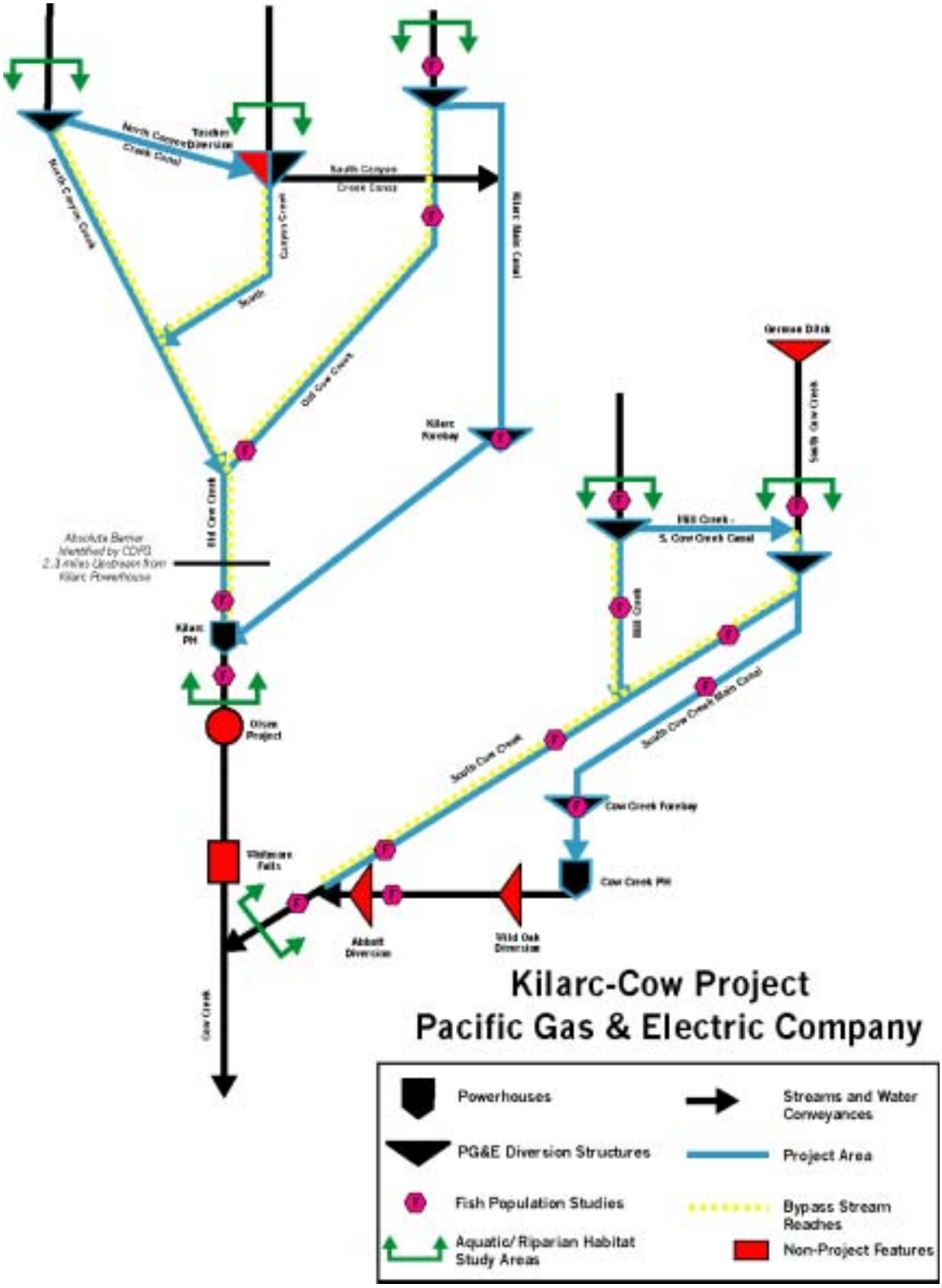
Hankin, D. G., and G. H. Reeves. 1988. Estimating total fish abundance and total habitat area in small streams based on visual estimation methods. Canadian Journal of Fisheries and Aquatic Sciences 45:834-844.

Hicks, B. J., and N. R. N. Watson. 1985. Seasonal changes in abundance of brown trout (*Salmo trutta*) and rainbow trout (*S. gairdnerii*) assessed by drift diving in the Rangitikei River, New Zealand. New Zealand Journal of Marine and Freshwater Research 19:1-10.

Platts, W. S., W. F. Megahan, and G. W. Minshall. 1983. Methods for evaluating stream, riparian, and biotic conditions. USDA For. Serv. Gen. Tech. Rep. INT-138.

Reynolds, J. B., Chapter 8, Electrofishing. B. R. Murphy and D. W. Willis (editors). 1996. Fishery Techniques, 2nd edition. American Fisheries Society. Bethesda, Md.

Figure 2 - 2003 Fish Population Study Locations



Study 13

Potential Effects of Entrainment on Fish
KILARC-COW CREEK PROJECT
FERC 606

Study Plan Title: Potential Effects of Entrainment on Fish

Objective of Study: To characterize the opportunity for fish entrainment at the Old Cow Creek Diversion.

Study Methods: ENTRIX will conduct fish entrainment surveys at the head of Kilarc Forebay to assess potential entrainment at the Old Creek Diversion. This study will evaluate potential entrainment by sampling fish transported by the Kilarc Canal and assessing conditions at the entrance to the diversion (including the location of the diversion intake and approach velocities).

ENTRIX will utilize fyke nets in the Kilarc Main Canal upstream of the Kilarc Forebay. . The primary species anticipated to be captured are rainbow and brown trout. Anadromous salmonids cannot reach the Kilarc Diversion due to an impassable barrier located about 2.3 miles upstream of the powerhouse. For these species, fish migrations are most likely to occur during the spring and early summer when fry are emerging from the gravel. Two sampling events will be conducted. The first sampling event will occur in May or June 2003 to assess the potential for entrainment during the adult migration and fry dispersal period, when fish are most likely to be entrained. A second entrainment sampling will occur in September 2003 to evaluate potential entrainment during periods when fish are less mobile. Sampling will be conducted for three days and three nights during each sampling period. During each period sampling will consist of an approximate 72 hour (3 days/3 nights) fyke net set where the net will be checked every 12 hours, during the morning and evening.

Each fish captured during the entrainment sampling will be identified to species, measured, and weighed to contribute to the age and growth evaluation. Scale samples will be collected from larger fish (>75 mm) to facilitate this study, as well.

Products of Study: The results and analysis of the entrainment sampling will be presented in a summary report. The following elements will be included:

- Description of conditions near the entrance to the diversion (orientation, position in the stream channel, approach velocities)
- List of species, number and size of fish captured
- Extrapolation of number to season
- Evaluation of potential effects on source population

Study Schedule: During May 2003 PG&E and ENTRIX will consult with resource agencies regarding the proposed study plan. After the resource agencies have approved the study plan ENTRIX will mobilize to conduct the first survey during May/June 2003. The second survey will be conducted during September 2003. The fish population surveys will be coordinated with the spring sampling for Study 12, *Fish Distribution and Abundance.* The data analysis and report preparation will occur from July through December 2003.

Study 14

Project Effects on Macroinvertebrates
KILARC-COW CREEK PROJECT
FERC 606

Study Plan Title: Project Effect on Macroinvertebrates

Objective of Study: To evaluate the project effects on macroinvertebrate habitat in the bypass reaches on Old Cow and South Cow Creeks.

Study Methods: Macroinvertebrate habitat will be evaluated using the Instream Flow Incremental Method as described by Gore *et al*. (in press) and Gore and Judy (1981). Gore *et al*. (in press) have developed habitat suitability criteria for Ephemeraptera, Plecoteria, and Tricheptera (EPT) fauna for use in high gradient or low gradient streams with 0.005 as the breakpoint between the two. The Instream flow studies described in Study 11 will be used to evaluate macroinvertebrate habitat as a function of flow. Habitat suitability criteria will be used to estimate the relationship between macroinvertebrate habitat and flow in the bypass reaches.

Products of Study: This study will provide habitat functions for EPT fauna that are important sources of food to other aquatic resources and indicators of water quality. The results of this evaluation will be presented in the Exhibit E of the FERC license application as an integrated discussion of fishery resources and water quality.

Study Schedule: This study will be conducted in conjunction with Study 11, *Instream Flow Study*. The data collection is scheduled for spring and summer of 2003.

References:

Gore, J., J. Layzer, and J. Mead (in press) Macroinvertebrate instream flow studies after 20 years: a role in stream management and restoration. Regulated Rivers.

Gore, J.A., and R.D. Judy, Jr. 1981. Predictive models of benthic macroinvertebrate density for use in instream flow studies and regulated flow management. *Can. J. Fish. Aquat. Sci.* 38: 1363-1370.

Study 15

Fish Protection Facility Studies
KILARC-COW CREEK PROJECT
FERC 606

Study Plan Title: Fish Protection Facility Studies

Objective of Study: To evaluate fish protection measures at the South Cow Creek Diversion.

Study Methods: The fish screen evaluation will focus on the performance of the fish screens located at the South Cow Creek Diversion for both South Cow and Mill Creeks. The screens were built to prevent entrainment into the main South Cow Canal and promote safe passage for young salmonids and adult steelhead for their downstream migrations. To evaluate screen effectiveness, velocity distribution across the face of the screens will be evaluated using an acoustic Doppler meter to measure three-dimensional velocities under high and low flow conditions. The acoustic Doppler meter will be positioned across the screen at points located at 2-foot by 2-foot vertical and horizontal intervals. For each measurement node, the average and peak velocities in the normal and transverse (sweeping) directions will be assessed. The measured velocities will be evaluated against CDFG and NMFS screening criteria for salmonid fry and juveniles. The screening design including screen opening, cleaning method, and sweeping velocities will be compared to the relevant screen criteria.

In addition to the fish screen design, the denil fish ladder located at the South Cow Diversion will also be evaluated against current CDFG criteria and NMFS guidelines. This evaluation will include the ladder slope, baffle spacing, resting stations, entrance conditions, and attraction flows.

Products of Study: The effectiveness of the current screen design will be described. The results of this evaluation will be presented in the Exhibit E of the FERC license application.

Study Schedule: These studies will be performed in the spring of 2003

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Study 16

Common Wildlife Species Surveys
KILARC-COW CREEK PROJECT
FERC 606

Study Plan Title: Common Wildlife Species Surveys

Objective of Study: To characterize general wildlife use within the Immediate Project Vicinity.

Study Methods: The common wildlife species study will consist of a literature review, identification of habitat for common wildlife species, and a reconnaissance-level field survey. Existing information pertinent to wildlife within 0.25 mile of the Immediate Project Vicinity will be compiled, reviewed and summarized. A literature review will be conducted, including a review of: 1) CDFG's California Natural Diversity Database (CNDDB, DFG 2000); 2) CDFG's Wildlife Habitat Relationship System (CDFG 2000b); and other relevant documents relating to the Project Area.

Wildlife habitat will be mapped in conjunction with vegetation community mapping and ground-truthing. Habitat for common wildlife species within these vegetation communities will be determined based on a review of *A Guide to Wildlife Habitats of California* (Mayer and Laudenslayer 1988).

Reconnaissance-level wildlife surveys will be conducted on foot and by vehicle, as appropriate. Wildlife observed or detected through sign (i.e., pellet, scat, track, feather, etc.) will be identified to species and recorded. Some species that are known to occur in the Project Vicinity, and for which appropriate habitat is present in the Project Area, will be recorded as "expected but not observed." Wildlife taxonomy will be based on *California's Wildlife, Volumes I, II and III* (Zeiner *et al*. 1988-1990).

These surveys will involve traversing habitats by walking and driving on roads in representative portions of the habitat types (vegetation communities). The area of coverage will include: (1) intake areas at the North Canyon Creek, South Canyon Creek, Kilarc, Mill Creek, and South Cow Creek diversion dams, (2) Kilarc Forebay, Kilarc Penstock, Kilarc Powerhouse, Cow Creek

Forebay, Cow Creek, Penstock, and Cow Creek Powerhouse, (3) North Canyon Creek Canal, South Canyon Creek Canal, Kilarc Main Canal, Mill Creek, and South Cow Creek Main Canal, and (4) diverted reaches of Old Cow Creek and South Fork Cow Creek.

Field verification (ground-truthing) will be conducted in areas owned by PG&E or for which PG&E has obtained permission for investigators to access private property and that can be safely accessed or viewed. Areas unsafe for access or viewing include steep cliffs and unstable slopes.

Visual surveys will be conducted to document the occurrence of wildlife species, including birds, mammals, reptiles, amphibians, and invertebrates. Additionally, loose boards, rocks, logs, and leaf litter will be checked for amphibians and reptiles. General observations of the suitability of cover types for various special-status species will also be recorded. All observations will be recorded in field notebooks and transcribed onto data sheets for input into a GIS database.

Products of Study: As part of the Exhibit E for the FERC license application, each wildlife species observed within the 0.25 mile Immediate Project Vicinity will be included and mapped. The report on wildlife resources will include a general description of habitat types in the Project Area, the results of the CNDDB and CDFG literature review, and a description of wildlife species observed and potentially occurring in the Project Area.

Study Schedule: Surveys will be conducted in April and June of 2003.

References:

California Department of Fish and Game (CDFG). 2000a. Rarefind 2, California Natural Diversity Database. Electronic database. Sacramento, California.

California Department of Fish and Game (CDFG). 2000b. Wildlife Habitat Relationship System. Electronic database. Sacramento, California.

Mayer, K.E. and W.F. Laudenslayer, Jr., editors. 1988. A Guide to Wildlife Habitats of California. California Department of Fish and Game, Sacramento, California.

Study 17

Special-Status Wildlife Surveys
KILARC-COW CREEK PROJECT
FERC 606

Study Plan Title: Special-Status Wildlife Survey

Objective of Study: To determine the presence or absence of special-status wildlife species and prepare mitigation and conservation plans, as necessary.

Study Methods: Vegetation communities will be mapped by aerial photography and ground-truthing. See Study 6 (*Vegetation Mapping Study Plan*) for further description of vegetation community mapping methodology. Habitat for common and special-status wildlife species within these vegetation communities will be determined based on a review of *A Guide to Wildlife Habitats of California* (Mayer and Laudenslayer, 1988).

Surveys will be conducted in representative habitat for special-status wildlife species and will be timed during the raptor-nesting season, in order to detect active raptor nests, especially those of bald eagle and American peregrine falcon. Special-status species with a high probability of occurrence will be specifically targeted. These species include: California red-legged frog (Study 18), foothill yellow-legged frog (Study 19), valley elderberry longhorn beetle (Study 20), northwestern pond turtle, bald eagle, California spotted owl, American peregrine falcon, willow flycatcher, California thrasher, ring-tailed cat, and several bat species. The survey timeline for special-status wildlife is presented in the following table.

Special-Status Wildlife Survey Timeline

SPECIES	STUDY	SURVEY TYPE	SURVEY TIMING
Invertebrates			
Valley Elderberry Longhorn Beetle *(Desmocerus californicus dimorphus)*	Study 20	Focused Surveys	May and July
Amphibians			
California Red-Legged Frog *(Rana aurora)*	Study 18	Protocol Level Survey	Site Assessment to be performed in June
Foothill Yellow-Legged Frog *(Rana boylii)*	Study 19	Protocol Level Survey Presence/Absence	June to August – tadpoles, juveniles, and adults
Reptiles			
Northwestern Pond Turtle (*Clemmys marmorata marmorata)*	Study 17	Habitat Based Approach	April and June

SPECIES	STUDY	SURVEY TYPE	SURVEY TIMING
Birds			
California Spotted Owl *(Strix occidentalis)*	Study 17	Habitat Based Approach	April and June
Bald Eagle *(Haliaeetus leucocephalus)*	Study 17	Habitat Based Approach	April and June
American Peregrine Falcon *(Falco peregrinus)*	Study 17	Habitat Based Approach	April and June
Willow Flycatcher *(Empidonax traillii)*	Study 17	Habitat Based Approach	April and June
California Thrasher *(Toxostoma redivivum)*	Study 17	Habitat Based Approach	April and June
Mammals			
Pacific Fisher *(Martes pennanti pacifica)*	Study 17	Habitat Based Approach	April and June
Pale Townsend's big-eared bat *(Plecotus townsendii pallescens)*, spotted bat *(Euderma maculatum)*, Small-footed, long-eared, fringed, long-legged, and Yuma myotis bats *(Myotis cillolabrum, evotis, thysanodes, volans, and yumanensis, respectively)*.	Study 17	Habitat Based Approach	April and June
Ring-Tailed Cat *(Bassariscus astutus)*	Study 17	Habitat Based Approach	April and June

Surveys will be conducted on foot (or by vehicle), in tandem, from dawn to dusk. Wildlife observed or detected through sign (i.e., pellet, scat, track, feather, etc.) will be identified to species and recorded. Special attention will be given to potential bald eagle and other raptor habitat by viewing snags, cliffs, and other habitats with binoculars and looking for evidence of roost or nest sites (e.g., whitewash). In addition, particular attention will be paid to the Kilarc Forebay as a suspected foraging location for bald eagles, American peregrine falcons and other raptors. Spot surveys will be performed at the Kilarc Forebay to identify whether the site is of marginal use to nomadic floaters or if the Forebay is a preferred foraging location. Surveys will start at dawn when raptors are actively foraging and last for 20 to 30 minutes. Qualified wildlife biologists will look for raptors during four site visits coinciding with the breeding season. Incidental sightings by other biologists on the project will also be recorded and ENTRIX will try to time the spot surveys with the stocking of the Forebay by CDFG. In addition to the spot surveys, PG&E will provide ENTRIX with a helicopter to do one aerial survey of the Project Area for bald eagles and other target species.

Other habitats in the Immediate Project Vicinity will be visited a minimum of two times during the 2003 raptor breeding season (generally March through August). Any nests or den sites observed during field studies will be reported to resource agencies, and plans to ensure their protection will be developed on a site-specific basis.

ENTRIX will identify and map habitats that could potentially support special-status (i.e., target) wildlife species based on vegetation and aquatic habitat surveys. Consultant shall use a habitat-based approach to determine the potential Project impact to special-status wildlife species. That is, if appropriate habitats for special-status wildlife species are identified in the Project Area, the species presence in that habitat would be assumed. Following completion of the habitat mapping, ENTRIX shall attend one meeting with the regulatory agencies (e.g., CDFG and USFWS) and PG&E to discuss observations and habitats identified onsite to support special-status wildlife and to discuss appropriate avoidance, protection, and mitigation measures.

Products from Study: The number of site visits, species observations, and detailed habitat descriptions will be reported. For species that are observed or are considered to potentially be present based on suitable habitat, detailed life history information will be provided, including: (1) specific habitat requirements, (2) seasonal movements/migration, (3) territories occupied, (4) reproduction cycles, and (5) project effects on distribution or abundance. Study information will be provided in the Exhibit E of the FERC license application.

Study Schedule: Surveys will be conducted in April and June of 2003. The first field survey will be performed in conjunction with Study 6, *Vegetation Mapping* and Study 16, *Common Wildlife Species Surveys.*

References:

Mayer, K.E. and W.F. Laudenslayer, Jr., editors. 1988. A Guide to Wildlife Habitats of California. California Department of Fish and Game, Sacramento, California

Study 18

California Red-Legged Frog Surveys
KILARC-COW CREEK PROJECT
FERC 606

Study Plan Title: California Red-legged Frog Surveys

Objective of Study: To determine the location of habitat and the presence or absence of California red-legged frog and develop mitigation, as necessary.

Study Methods: A site assessment and focused surveys for California red-legged frog (CRLF) will be conducted in accordance with USFWS approved protocol/guidelines. Under the current guidelines (i.e., USFWS Guidance on Site Assessment and Field Surveys for California Red-legged Frogs, February 1997), this would include the following: (1) determine the location of CRLF within 5 miles of the project site, (2) describe habitats on the project site and within 1 mile of the site, (3) prepare a site assessment report, and (4) complete focused surveys if determined necessary by USFWS. Each of these components is described below. During CRLF field surveys, all special-status amphibians and reptiles observed (including foothill yellow-legged frog and northwestern pond turtle) will be identified and mapped.

The locations of CRLF within the Project Area and within 8 km (5 miles) of the Project Area would be determined through consulting the California Natural Diversity Database, biological consultants, local residents, species experts, herpetologists, resource managers, and agency biologists. In addition, all habitats present within 1 mile of the Project Area would be identified. This would include review of recent aerial photographs and of National Wetlands Inventory (NWI) maps, followed by ground-truthing. In addition, PG&E will provide a helicopter for one aerial overflight of the Project Area to assess potential CRLF habitat. Photographs of potential breeding habitat and reconnaissance habitat data sheets will be completed. Upon completion of an appropriate literature review, aerial photograph review, and helicopter overflight of the Project Area, site assessment findings will be summarized and discussed with PG&E biologists to develop a strategy for selecting survey sites if necessary.

Following completion of the above tasks, a preliminary report would be prepared in accordance with the USFWS Guidelines that include the following: photographs of the Project Area, survey dates and times, names of surveyors, a description of methods, a map of the project site and vicinity indicating habitats present (e.g., aquatic and upland habitat). Following transmittal of this report to the USFWS, ENTRIX and PG&E will meet with the USFWS to discuss the need for additional surveys. If it is determined that focussed surveys are required, ENTRIX will complete these surveys in accordance with the USFWS protocol/guidelines.

Products of Study: A site assessment report and a report discussing the results of protocol visual encounter surveys (if required) will be prepared and provided in the Exhibit E of the FERC license application.

Study Schedule: Surveys will be conducted in June and August of 2003.

Study 19

Foothill Yellow-legged Frog Surveys
KILARC-COW CREEK PROJECT
FERC 606

Study Plan Title: Foothill Yellow-legged Frog Surveys

Objective of Study: To determine the location of habitat for and the presence or absence of foothill yellow-legged frog and develop mitigation, as necessary.

Study Methods: Surveys for foothill yellow-legged frog (FYLF) will be conducted according to methods presented by PG&E in their May 2002 document titled *A Standardized Approach for Habitat Assessments and Visual Encounter Surveys for the Foothill Yellow-Legged Frog (Rana boylii)*. The approach consists of preliminary field planning, visual encounter surveys (VES's) and site habitat assessments. In addition, PG&E will provide a helicopter for one aerial overflight of the Project Area to assess potential FYLF habitat to be included in the VES. This will be performed in conjunction with the CRLF habitat survey (Study 18).

During the preliminary field-planning phase, survey sites with potentially suitable FYLF habitat would be identified and the timing of surveys would be selected. The selection of survey sites will depend on identification of potentially suitable habitat in the Immediate Project Vicinity, the results of preliminary habitat assessments, and existing data on FYLF in the Project Area. Survey site selection would be based on information obtained from all available resources including, but not limited to: literature on habitat requirements and life history of FYLFs, historical records, knowledgeable biologists, topographic maps, aerial photographs, and habitat information obtained during preliminary ground surveys. Sites identified for surveys during the initial site selection process will be in representative sections of the Project Area that contain moderate-to high-value habitats for FYLFs, based on species-specific criteria.

Since the primary objective of the study is to determine presence of FYLF, two surveys would be conducted. These two surveys would include a tadpole survey in the late spring/early summer followed by a second survey for juveniles/subadults and adults in the late summer.

During the VES phase, the presence or absence of FYLF would be determined. This would include an overall site evaluation to determine habitats to be included in the VES, the selection of the appropriate survey method, and selection of preliminary site boundaries for the VES. At the beginning of the initial site visit, an overall site evaluation would be conducted from a distance so as not to disturb amphibians. Specific habitat data such as habitat type, distribution and extent would be recorded. The appropriate survey method is expected to consist of basic creek surveys conducted by a two-person team in tandem. Basic creek surveys are designed to evaluate selected reaches of a creek. Final survey boundaries would be established at the conclusion of the initial VES and would be used in the site habitat assessment and subsequent VESs.

During the site habitat assessment phase, which is conducted immediately following the initial VES, information collected would include riparian vegetation, aquatic and terrestrial cover, substrate, water quality, aquatic habitat, and upland habitat.

Visual encounter surveys would be conducted according to the approach provided in PG&E's above-referenced document. The VES would include aquatic habitats that can be adequately surveyed within approximately 2 hours. The VES would be conducted in tandem by a two-person team. Surveys would begin along the bank. Adjacent aquatic habitat would then be searched and finally suitable aquatic habitat would be searched. All observations would be recorded on VES data sheets.

Products of Study: The surveys will result in Creek Site Habitat Assessments specific to the FYLF and life stage data sheets, providing that FYLF are observed. This information will be summarized and presented in the Exhibit E of the FERC license application.

Study Schedule: The preliminary field planning surveys will be conducted in late May/early June, VES will be completed in June and August

Study 20

Valley Elderberry Longhorn Beetle Survey
KILARC-COW CREEK PROJECT
FERC 606

Study Plan Title: Valley Elderberry Longhorn Beetle Surveys

Objective of Study: The objective of this study is to provide a map showing potential habitat for valley elderberry longhorn beetle (VELB) in the Project Area by mapping the location of elderberry shrubs in the Project Area.

Study Methods: Elderberry surveys will be conducted in conjunction with the special status plant species surveys. The locations of elderberry shrubs found will be mapped. The number of stems greater than one inch in diameter will be recorded for each shrub. Observations of beetles or of stem holes will be noted. If stem holes are observed, but no beetles are present, the holes will be recorded as possible exit holes. If surveyors find elderberry shrubs with stem holes, the following stem count data will be recorded for those shrubs: less than 1 inch Diameter at Breast Height, 1 to 3 inches dbh, 3 to 5 inches, dbh, and greater than 5 inches dbh. The focused surveys will be performed in all accessible areas within 25 feet of diverted reaches and 100 feet of Project facilities.

Surveys will be conducted in conjunction with Studies 7 and 8, in areas that PG&E owns or for which PG&E has obtained permission to access streams from local property owners and that can be accessed safely. Areas unsafe for access include steep cliffs, unstable slopes, and areas bounded by impassable stream conditions

Products of Study: The results of the elderberry study, including maps of elderberry occurrences, will be presented in the Wildlife section and reported in the Exhibit E of the FERC license application.

Study Schedule: Surveys are scheduled for May and June 2003.

APPENDIX A
Simulated Hydrograph

PRELIMINARY DRAFT

ESTIMATION OF UNIMPAIRED FLOW FOR THE COW CREEK WATERSHED

Prepared for:

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May 5, 2003

Kilarc-Cow Creek Project FERC No. 606

ESTIMATION OF UNIMPAIRED FLOW IN COW CREEK, NEAR REDDING

Introduction

Cow Creek flows from the western flanks of the Cascade Range to the Sacramento Valley and enters the Sacramento River near Anderson, CA. Surface water flow of Cow Creek is derived from snow falling in the upper reaches of the watershed and rainfall falling in the lower and mid watershed. Groundwater accretions help maintain the stream flow during the dry summer months. Water is diverted from several locations in the watershed for irrigation and power generation. A portion of the irrigation diversions return to the river depending on the water demands (including evapotranspiration) and climatic conditions such as rainfall and evaporation.

To better understand the potential effects of the Pacific Gas & Electric (PG&E) hydropower diversions on the natural stream flow, the historic unimpaired flow was estimated. Unimpaired flow is defined for this analysis as the stream flow that would be present in the absence of diversions and other man-induced modifications to stream flow. Unimpaired flow estimates are needed at two locations in the watershed, upstream of PG&E's South Cow Creek Diversion and Kilarc Diversion.

Data Sources

Stream flow data are available from several gages in the Cow Creek watershed (Table 1). The Cow Creek at Millville gage is the primary streamflow monitoring gage in the watershed and is located near the Sacramento River. The Cow Creek at Millville daily flow records are available for 1949 to present. The flow at this point reflects the inflow of all of the Cow Creek tributaries and the diversions. Because of the influence of all of the different inflows, diversions, and return flows, the flow at this gage does not reflect the unimpaired flow of the watershed.

Estimating the unimpaired flow upstream of the two PG&E diversions requires stream flow data that cover the largest possible record. For this analysis, the Cow Creek at Millville and South Cow Creek near Millville gage records were used. The period from 1957 through 1972 provides a continuous record for both gages. These records were supported with short-term records at Little Cow Creek, Clover Creek, and Oak Run Creek. In addition, PG&E has monitored flow in the Kilarc and South Cow Diversion canals.

Methodology

The approach to computing unimpaired flow was patterned after the flow per unit area approach advocated by the State Water Resources Control Board. Flow per unit area (the unit flow) involves relating the measured flow at a gage to the total area tributary to that gage. For this watershed, the method uses the unit flow of Cow Creek at Millville as the dependant variable to estimate the unit flow elsewhere in the watershed. With the Millville gage as the dependant variable the unit flow at other locations can be estimated for the 1949 to present period of record. In this way, the limited flow records at other locations in the watershed are extended to the entire period.

There are several steps involved in determining the unimpaired flow in the Cow Creek watershed. In general, the steps involve determining a time series of the unit flow, adjust the flows for the effects of the diversions, develop a regression of Cow Creek flow with South Cow Creek flow, and apply the regression to other points in the watershed for the entire record.

Table 1. USGS Gaging Stations in the Cow Creek Watershed.

Station Number	Station Name	Latitude	Longitude	Area (mi^2)	Starting Date	Ending Date
2.1.1.1.2 USGS-reported Stations						
11374000	Cow Creek near Millville, CA	40°30'20"	122°13'55"	425	1949	Present
11373200	Oak Run Creek near Oak Run, CA	40°41'25"	122°02'35"	11	1957	1966
11372200	South Cow Creek near Millville, CA	40°32'55"	122°05'30"	77.3	1956	1972
11373300	Little Cow Creek near Ingot, CA	40°44'45"	122°03'40"	60.8	1957	1965
11372700	Clover Creek near Oak Run, CA			19	1957	1959
11272080 (CB133)	South Cow Creek Canal Diversion to South Cow Creek, near Whitmore	40°35'35"	121°58'53"	NA	1984	Present
11372325 (CB132)	Kilarc Canal Diversion to Old Cow Creek, near Whitmore, CA	40°41'13"	121°48'27"	NA	1983	Present
11372350	Old Cow Creek below Diversion to Olson Powerplant, near Whitmore	40°40'10"	121°53'27"	32.6	1990[1]	Present
11372330	Olson Powerplant near Whitmore, CA	40°38'20"	121°55'27"	NA	1990[1]	Present
11372500	Cow creek at Millville	40°32'40"	122°10'30"	166	1912[4]	1914
11373000	Clover Creek at Millville	40°30'10"	122°11'00"	52.5	1912[4]	1914
11373500	Little Cow Creek at Palo Cedro	40°33'50"	122°13'40"	145	1912[4]	1914
2.1.1.1.3 Non-USGS-reported Stations						
CB87	Kilarc Powerhouse[2]	*	*	NA	1975	Present
CB88	Cow Creek Powerhouse[2]	*	*	NA	1974	Present
CB2	Kilarc Diversion[2]	*	*	NA	1981	2001
CB4	South Cow Creek Diversion[2]	*	*	NA	1981	1997
NA	Glendenning Creek, below confluence with Bear Gulch[3]	*	*	*	5/64	10/64
NA	S. Cow Creek above German Ditch[3]	*	*	*	6/64	10/64
NA	Atkins Creek at Bateman Rd[3]	*	*	*	5/64	10/64
NA	Mill Creek at Mill Creek Road[3]	*	*	*	5/64	10/64
NA	Cow Creek below Confluence of Old Cow and S. Cow Creeks[3]	*	*	*	5/64	10/64
NA	Kilarc Powerhouse Ditch above Siphon[3]				5/64	9/64
NA	S. Cow Creek Powerhouse Ditch[3]				5/64	9/64
NA	Bassett Ditch above all laterals[3]				5/64	10/64
NA	German Ditch above all laterals[3]				5/64	10/64

1 – Incomplete data with missing years
2 – Data collected by PG&E but not verified or published by USGS
3 – Data collected in 1964 as part of the Cow creek adjudication
4 – Data collected as a single peak flow
* - Data are not known.
Note: Station number in parentheses for non-USGS-reported stations is PG&E's station number.

Determine Flow per Unit Area

The daily flow records for Cow Creek at Millville and South Cow Creek near Millville were summed for each month of the record to compute average monthly flow. Monthly flows were used instead of daily flows because of the travel time in the watershed has only a minor influence on monthly flows.

The monthly flow data were divided by the watershed area to yield the unit flow. The watershed areas are 425 square miles and 77.3 square miles for Cow Creek at Millville and South Cow Creek near Millville, respectively.

Estimate Diversions

There are extensive diversions in the watershed that occur seasonally and annually. The diversions are identified in the water rights adjudication for the Cow Creek Watershed. The adjudication identifies the diversions, locations of the diversions, and flow rate of the diversions.

While these diversions are identified in the adjudication, they are not monitored for period of operation or diversion rates. Therefore, it is unknown what effect these diversions have on stream flow or how the flow records must be adjusted to remove the effect of the diversions. It is known that the diverted water is used for irrigation and the portion of the diversion is consumptively used, with the unused amount returning to the river.

A monthly consumptive use estimate was developed and applied to the cumulative irrigation rates identified in the adjudication. This estimate reflects the percentage of the water diverted from the river that subsequently (within the same month) returns to the river. Each monthly estimate is applied to the total allowable diversion a specified in the adjudication. The allowable diversion is aggregated to a point upstream of the Cow Creek and South Cow Creek flow monitoring gages.

Adjust Measured flow for Diversions

The measured flows were adjusted for the diversions by applying the monthly consumptive use estimate to the total irrigation and adding this amount to the measured flow. The net result is to add the consumptive use assumed to occur upstream of the flow gages back into the measured flow. This provides an estimate of the unimpaired flow at each gage.

Separate Monthly Estimates of Unit Flow

Analysis of the unit flow showed that it changes with season. This is to be expected because of the variability of hydrologic inputs. For example, streamflow that responds to a rainfall event is different than streamflow responding to snow melt or base flow. Therefore, the unit flows must be separated by season.

The time series of unit flow for the Cow Creek and South Cow Creek gages was segregated by month to develop monthly regression equations. Through analysis of the unit flow data it was determined that some months stand alone while other months can be combined for the regressions. The months used in the regressions are shown in Table 2.

Table. Months Used or Combined in the Regression.

Month	Month
October	May through June
November through March	July through August
April	September

Linear regression equations relating unit flow of Cow Creek and South Cow Creek were developed for each of the months or combination of months.

Compute Estimated Flow at Different Points in the Watershed

The regression equations were applied to the unit flows for the Cow Creek gage to estimate the unit flow at the South Cow Creek gage. This was conducted for the full Cow Creek record from 1949-2000.

Next, the unit flows were multiplied by watershed areas at the Kilarc and South Cow Creek diversions (23.1 and 47.0 square miles, respectively) to estimate the unit flow at each PG&E diversion.

Upon examination of the results it was determine that this method underestimated the low-flow periods. The limited data set of daily flows collected for the Little Cow (8 years), Clover (2 years), and Oak Run (9 years) creeks was evaluated using the same unit flow procedure and it was determined that the regression equations developed for unit flow of South Cow Creek near Millville should be adjusted to reflect the unit flows further upstream in the watershed. Therefore, an adjustment factor was developed from the flows in the tributaries and applied to the results of the estimates of the unimpaired flow at Kilarc and South Cow creeks.

Results

The results of the analysis are presented in Tables 3 and 4, and Figure 1. These flows were compared with historic diversions recorded by PG&E for the period 1980-2000 to assess the reasonableness of the estimated flows. From this comparison it is apparent that the estimated unimpaired flows are reasonable and are consistent with the historic PG&E diversions.

Table 3. Estimated Unimpaired Flow for Old Cow Creek above Kilarc Diversion Canal.

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1950	24	19	20	94	133	87	79	82	55	47	44	26
1951	35	59	144	131	131	77	66	81	48	47	45	26
1952	28	53	191	188	171	111	92	129	74	58	49	30
1953	27	23	146	205	44	57	89	128	103	58	51	29
1954	28	37	35	112	97	115	114	73	55	48	48	30
1955	27	56	83	57	36	31	75	81	47	45	43	25
1956	24	52	224	298	94	58	70	152	70	54	49	29
1957	33	23	21	33	70	118	71	106	57	49	46	33
1958	47	54	82	150	311	153	145	108	85	62	52	31
1959	28	22	24	91	125	46	61	59	45	43	43	28
1960	24	17	19	49	131	80	57	67	45	43	42	24
1961	24	42	98	51	145	87	74	76	57	45	44	26
1962	25	32	94	43	145	93	68	65	48	44	43	25
1963	98	32	100	59	100	65	221	124	59	53	47	28
1964	29	62	25	66	28	28	51	56	49	44	42	25
1965	24	55	175	175	50	39	180	80	53	48	49	27
1966	25	46	42	128	86	70	87	63	45	44	42	24
1967	23	63	87	186	62	93	154	221	108	57	48	28
1968	28	21	40	101	176	84	62	60	47	44	50	26
1969	29	33	141	286	232	89	110	127	71	55	49	28
1970	30	24	191	379	89	88	57	56	50	48	45	27
1971	28	109	170	140	44	138	89	104	76	58	49	30
1972	29	26	49	58	74	91	78	64	50	46	45	27
1973	32	64	104	201	159	117	76	86	54	49	46	30
1974	32	173	183	293	101	211	132	98	68	62	53	30
1975	29	24	37	41	164	166	99	108	70	55	51	29
1976	38	29	34	22	70	55	68	54	43	43	49	27
1977	24	18	18	19	18	22	42	50	40	42	42	28
1978	24	24	97	210	153	179	163	95	56	49	46	30
1979	29	21	20	62	161	77	74	105	48	45	44	26
1980	36	53	117	191	185	103	69	71	55	49	46	29
1981	27	20	40	73	85	126	70	58	44	43	43	26
1982	32	180	227	131	176	144	156	99	64	60	51	32
1983	32	58	131	157	304	361	125	153	102	72	58	37
1984	32	81	270	63	75	60	69	79	58	50	48	28
1985	34	101	53	27	42	46	64	53	45	45	44	34
1986	29	35	57	96	315	194	68	80	52	49	46	34
1987	29	21	21	60	86	137	58	49	42	44	43	25
1988	23	20	85	116	27	31	56	71	54	45	44	24
1989	23	60	37	63	37	230	105	69	49	47	45	32
1990	41	22	20	88	41	62	51	93	70	46	44	25
1991	23	18	17	17	22	93	53	54	42	43	42	23

Table 3. Estimated Unimpaired Flow for Old Cow Creek above Kilarc Diversion Canal.

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1992	22	17	23	28	110	57	57	41	39	43	42	23
1993	28	20	92	214	152	144	132	136	136	60	53	29
1994	37	22	46	32	96	45	55	64	44	43	42	24
1995	23	23	59	305	101	310	137	185	92	63	52	30
1996	26	20	70	128	173	92	103	142	63	54	48	29
1997	27	25	147	257	59	47	65	56	49	48	47	30
1998	30	54	65	315	381	151	139	281	181	87	62	36
1999	32	91	80	70	205	108	88	90	67	55	51	29
2000	28	34	30	122	204	128	79	69	51	50	46	30

Table 4. Estimated Unimpaired Flow for South Cow Creek above South Cow Diversion Canal.

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1950	48	39	40	190	271	178	161	167	113	95	90	52
1951	72	120	293	266	266	156	134	165	98	96	91	53
1952	58	108	388	383	347	225	186	262	151	118	100	61
1953	55	47	296	416	90	116	182	260	209	119	103	59
1954	56	75	71	228	197	233	233	148	111	97	98	60
1955	55	114	169	116	74	64	153	164	96	91	87	51
1956	49	105	456	607	192	117	143	309	142	110	99	59
1957	67	46	44	67	142	240	144	216	116	99	94	67
1958	97	109	167	306	632	311	295	219	174	127	106	63
1959	57	46	50	185	254	94	124	121	91	88	87	58
1960	49	34	39	99	267	163	117	137	91	87	85	49
1961	48	86	200	104	295	177	150	154	116	92	89	52
1962	51	66	190	88	295	188	138	133	97	89	88	50
1963	199	65	204	121	203	133	450	253	121	107	96	56
1964	58	126	51	134	56	56	104	113	100	90	86	50
1965	48	112	357	356	102	80	366	162	108	98	100	55
1966	51	94	85	261	176	142	177	129	92	89	86	50
1967	47	128	177	379	126	190	314	450	219	115	97	56
1968	57	43	81	206	358	170	126	122	96	89	102	53
1969	59	66	288	582	472	181	225	259	144	113	99	58
1970	62	50	390	770	181	178	116	114	102	97	92	54
1971	58	222	346	286	89	282	180	211	155	118	101	61
1972	59	53	99	118	150	185	158	131	101	94	91	54
1973	65	131	212	409	324	237	155	174	110	100	94	61
1974	66	352	373	596	205	429	268	200	138	126	108	61
1975	58	49	75	84	333	339	201	220	142	112	104	59
1976	77	58	69	44	142	112	139	110	88	88	99	55
1977	50	37	36	39	36	45	85	101	81	85	85	56
1978	49	49	198	428	311	365	331	193	114	101	93	61
1979	59	43	40	126	327	156	150	215	98	92	90	53
1980	74	109	239	388	376	210	140	144	111	100	94	58
1981	55	40	81	148	173	257	142	118	89	88	87	52
1982	66	365	461	266	358	292	317	201	130	123	103	65
1983	65	118	267	319	618	734	254	312	207	147	117	76
1984	64	165	550	129	153	121	141	160	119	102	98	57
1985	68	205	108	55	85	93	129	108	91	92	90	68
1986	60	71	117	196	641	395	138	164	106	100	94	68

Table 4. Estimated Unimpaired Flow for South Cow Creek above South Cow Diversion Canal.

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1987	59	42	43	123	176	278	117	99	85	90	88	51
1988	48	40	172	236	56	63	114	145	109	91	89	50
1989	47	122	75	128	75	468	213	141	99	95	91	66
1990	83	45	40	179	83	127	104	189	143	94	89	51
1991	47	37	35	35	44	188	108	110	86	87	85	47
1992	46	34	47	58	224	115	115	84	80	87	85	47
1993	56	41	186	436	308	294	269	276	277	122	109	59
1994	76	45	94	65	194	91	111	131	90	88	86	49
1995	47	46	120	620	206	630	278	377	186	128	105	61
1996	53	41	142	261	352	187	209	290	128	110	97	60
1997	55	51	299	523	121	96	132	115	101	99	95	60
1998	61	109	131	641	775	307	284	573	369	177	126	74
1999	65	185	163	142	417	220	180	182	136	111	103	60
2000	56	69	61	249	416	261	160	141	103	102	93	62

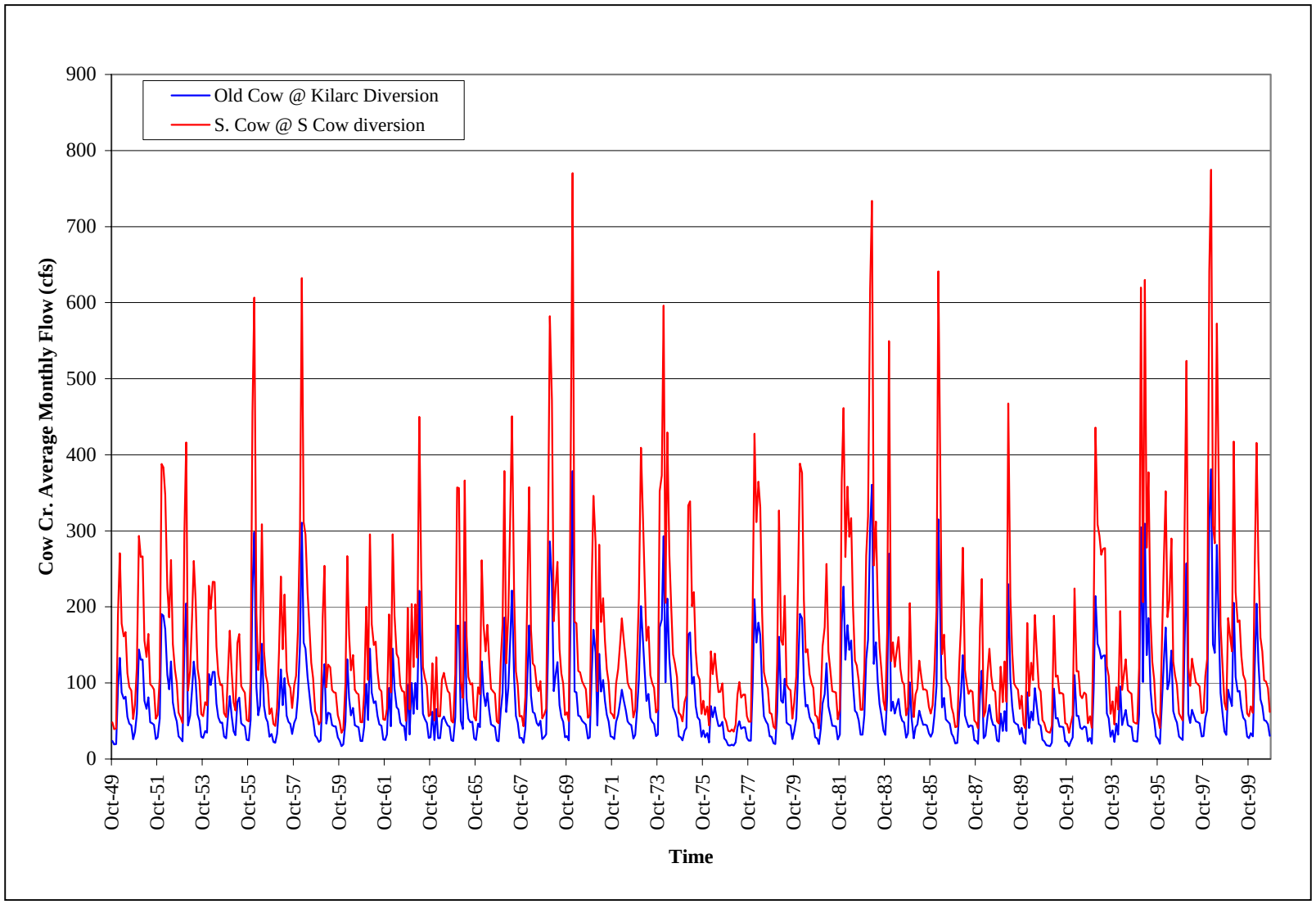

Figure 1. Unimpaired Flow for Old Cow Creek and South Cow Creek.