PACIFIC GAS AND ELECTRIC COMPANY

DeSabla-Centerville Hydroelectric Project FERC Project No. 803




Updated Study Results and License Application Sections

Exhibit E, Section 6.0, Affected Environment:
Updated Section 6.2.2.4 - Measure and Evaluate Water Quality in Project Reservoirs and Project-Affected Stream Reaches (Study 6.3.2-5)
Updated Section 6.3.2.2 - Characterization of Fish Populations in Project Reservoirs and Project-Affected Stream Reaches (Study 6.3.3-4)

Exhibit E, Section 7.0, Environmental Analysis:
Updated Sections 7.2.4 through 7.2.7 and 7.3.6

December 2007

6.2 Water Resources

6.2.2.4 *Updated* - Measure and Evaluate Water Quality in Project Reservoirs and Project-Affected Stream Reaches (Study 6.3.2-5)

6.2.2.4.1 Study Objectives

The objective of the study was to measure and evaluate key indicators of water quality in waters in the Project area. Though Project O&M does not typically generate direct discharges of contaminants or constituents described under the Basin Plan, hydrological and geomorphological changes to the system resulting from ongoing activities of water storage, diversion, and discharge, as well as recreation on Project reservoirs have the potential to affect water quality in the Project Area. The study was designed to evaluate the following potential water quality issues: 1) impoundment of water within Project reservoirs that increases sediment trapping and limits air-water and sediment-water exchanges, may affect dissolved oxygen (DO), and indirectly affect dissolved nutrients and other constituents (e.g., dissolved metals) at downstream sites; 2) Project operations may result in increased turbidity and elevated concentrations of herbicide residues within Project-affected reaches; 3) recreational use of Project reservoirs and associated camping/day-use facilities (i.e., motorized boats, public bathrooms and feeding of geese or ducks) may result in local contamination of reservoir surface waters with hydrocarbons and/or fecal coliform bacteria during periods of heavy use. In order to evaluate the above issues, reservoir and river water quality parameters (i.e., nutrients, minerals, metals, hydrocarbons, bacteria, Chlorophyll-a, herbicides, conductivity, pH, dissolved oxygen, and turbidity) were examined throughout the Project area, and compared with applicable criteria.

6.2.2.4.2 Study Area

In the Butte Creek watershed, the study area included: 1) Butte Creek between the Butte Creek Head Dam and Centerville Powerhouse; and 2) Butte Canal. The following are tributaries to Butte Creek that were studied indirectly because they are diverted into the Upper Butte Creek Canal: Inskip Creek, Kelsey Creek, and Clear Creek. In the WBFR watershed, the study area included: 1) WBFR between Round Valley Reservoir and Hendricks Diversion Dam; 2) WBFR between Hendricks Diversion Dam and the Miocene Diversion, a non-Project structure; 3) Philbrook Creek between Philbrook Reservoir and WBFR; and 4) Cunningham Ravine, Little West Fork, and Long Ravine, which are tributaries to the WBFR that are diverted into Hendricks Canal. The study area also included the two Project storage reservoirs (Round Valley and Philbrook reservoirs) and DeSabla Forebay.

6.2.2.4.3 Methods

Water quality in the study area was examined via collection of *in situ* data and water samples for laboratory analysis of constituents identified in the FERC-approved study plan (PG&E 2005). Data were collected seasonally at river and reservoir sites, with target surveys for analytical parameters of concern during periods of heavy recreational usage of Project reservoirs. Following quality control review of data, spatial and temporal trends were examined for each parameter, and measured values were compared with Basin Plan water quality objectives for protection of beneficial uses.

Sampling Locations

Water quality sampling was performed at fifteen locations: Philbrook and Round Valley reservoirs, DeSabla Forebay, five locations along the WBFR, and seven locations along Butte Creek. Table E6.2.2.4-1 lists the locations and station numbers, and Figure E6.2.2.4-1 through Figure E6.2.2.4-3 (maps of study area) show the locations.

Table E6.2.2.4-1. Water quality study station locations.

Station No.	Reach Name	Description	Station Location Deg° min' sec" N Latitude			Deg° min' sec" W Longitude		
WEST BRANCH FEATHER RIVER								
RVR1	Round Valley	Round Valley Reservoir	40°	4'	23"	121°	27'	17"
WBFR1	Coon Hollow	WBFR above Philbrook Creek	40°	2'	2"	121°	30'	37"
PBR1	Philbrook Creek	Philbrook Reservoir	40°	1'	44"	121°	28'	29"
PBR1-R[1]	Philbrook Creek	Philbrook Reservoir Boat Ramp	40°	1'	48"	121°	28'	19"
PBR1-C[1]	Philbrook Creek	Philbrook Lake Campground	40°	1'	40"	121°	28'	15"
PBR1-I[1]	Philbrook Creek	Inlet at Philbrook Reservoir	40°	1'	34"	121°	27'	40"
PBR1-D[1]	Philbrook Creek	Philbrook Reservoir Dam	40°	1'	45"	121°	28'	36"
PBC1	Philbrook Creek	Philbrook Creek above WBFR	40°	2'	2"	121°	30'	37"
WBFR2	Inskip	WBFR above Hendricks Diversion	39°	56'	18"	121°	31'	53"
WBFR3	Hendricks	WBFR above Big Kimshew Creek	39°	52'	48"	121°	30'	26"
WBFR4	Hendricks	WBFR above Miocene Diversion	39°	48'	51"	121°	34'	16"
BUTTE CREEK								
BC1	Upper Butte	Butte Creek at Head Dam	39°	58'	49"	121°	35'	14"
BXC1	Upper Butte	Butte Canal above Hendricks Canal	39°	53'	9"	121°	36'	45"
HC1	Upper Butte	Hendricks Canal above Butte Canal	39°	53'	9"	121°	36'	45"
DS1	Upper Butte	DeSabla Forebay	39°	52'	23"	121°	36'	45.3"
DS1-A[1]	Upper Butte	DeSabla Forebay near PSEA Campground Dock	39°	52'	27"	121°	36'	45.2"
DS1-B[1]	Upper Butte	DeSabla Forebay near Spillway	39°	52'	21"	121°	36'	47"
DS1-C[1]	Upper Butte	DeSabla Forebay near PSEA Campground Inlet	39°	52'	30"	121°	36'	45"
DS1-D[1]	Upper Butte	DeSabla Forebay Eastern Shore near Inlet	39°	52'	28"	121°	36'	40"
DS1-E[1]	Upper Butte	DeSabla Forebay Eastern Shore near Dam	39°	52'	23"	121°	36'	40"
BC2	Upper Butte	Butte Creek above DeSabla Powerhouse	39°	52'	11"	121°	37'	57"
BC3	DeSabla	Butte Creek at Centerville Diversion	39°	52'	2"	121°	37'	59"
BC4	Centerville	Butte Creek above Centerville Powerhouse	39°	47'	22"	121°	39'	28"

Table E6.2.2.4-1 (continued)

Station No.	Reach Name	Description	Station Location Deg ° min' sec" N Latitude			Station Location Deg ° min' sec" W Longitude		
BC5	Centerville	Butte Creek below Centerville Powerhouse	39°	47'	3"	121°	39'	36"

Notes:
[1] Non-routine station sampled only for hydrocarbons or coliform bacteria.

Synoptic Surveys

In situ and chemical water quality data were collected during Reservoir Synoptic Surveys, River Synoptic Surveys, and Reservoir Target Surveys, and analyzed as described below. Twelve river stations and three reservoir stations were sampled (Table E6.2.2.4-1). Since sampling activities differed among sites and sampling events, Table E6.2.2.4-2 shows which sampling activities were conducted during each event.

Table E6.2.2.4-2. Seasonal synoptic sampling matrix by site for 2006 and 2007.

Station Number	2006 Spring	2006 Independence Day Weekend	2006 Summer	2006 Labor Day Weekend	2006 Fall	2007 Summer
WEST BRANCH FEATHER RIVER						
RVR1	ISP, WQ	-	ISP, WQ	-	ISP, WQ	-
WBFR1	IS, WQ	-	IS, WQ	-	IS, WQ	IS, WQ
PBR1	ISP, WQ, Col, Hg, MeHg	Col, HC	ISP, WQ, Col, Hg, MeHg	Col, HC	ISP, WQ, Col, Hg, MeHg	ISP, WQ, Col, Hg, MeHg
PBC1	IS, WQ	-	IS, WQ	-	IS, WQ	IS, WQ
WBFR2	IS, WQ, CAM17, Hg	-	IS, WQ, CAM17, Hg	-	IS, WQ, CAM17, Hg	IS, WQ, CAM17, Hg
WBFR3	IS, WQ	-	IS, WQ	-	IS, WQ	WQ
WBFR4	IS, WQ	-	IS, WQ	-	IS, WQ	IS, WQ
BUTTE CREEK						
BC1	IS, WQ	-	IS, WQ	-	IS, WQ	IS, WQ
BXC1	IS, WQ	-	IS, WQ	-	IS, WQ	IS, WQ
HC1	IS, WQ	-	IS, WQ	-	IS, WQ	IS, WQ
DS1	ISP, WQ, Col	Col, HC	ISP, WQ, Col	Col, HC	ISP, WQ, Col	ISP, WQ, Col
BC2	IS, WQ	-	IS, WQ	-	IS, WQ	IS, WQ
BC3	IS, WQ	-	IS, WQ	-	IS, WQ	IS, WQ
BC4	IS, WQ	-	IS, WQ	-	IS, WQ	IS, WQ
BC5	IS, WQ, CAM17, Hg	-	IS, WQ, CAM17, Hg	-	IS, WQ, CAM17, Hg	IS, WQ, CAM17, Hg

Notes:

Please refer to Table E6.2.2.4-6 and Figure E6.2.2.4-1 for station locations and descriptions

IS = *in situ* parameters measured (water temperature, DO, specific conductivity, pH, turbidity)

ISP = *in situ* water quality profile

WQ = routine water quality samples collected for nutrients, minerals, total and dissolved metals (Cu, Ni, Ag, total Mn and Fe), and Chlorophyll-a. No metals samples were collected at site WBFR3 (upstream of Big Kimshew Cr.) per access agreement with property owner, Sierra Pacific Industries.

CAM17 = water quality samples collected for analysis of total CAM17 metals (see Table E6.2.2.4-3).

Hg= total mercury samples collected

MeHg = methyl mercury samples collected

Col = total and fecal coliform bacteria samples collected from surface water

HC = hydrocarbon samples collected during July 4th and Labor Day weekend sampling events

Reservoir Synoptic Surveys

PG&E collected samples during the 2006 spring runoff period (May), the 2006 and 2007 summer low-flow periods (August), and the 2006 fall period following overturn of summer thermal stratification (October, prior to first major rain event) in Project reservoirs. This resulted in a total of three reservoir synoptic surveys during 2006 and one survey in 2007. The reservoir synoptic surveys included *in situ* profiles of the basic water quality parameters listed in Table E6.2.2.4-3, as well as grab samples for water chemistry, nutrients, and biological parameters described in Tables E6.2.2.4-2 and 3. In order to represent reservoir water quality and water column structure, *in situ* measurements were taken throughout the water column. Grab samples for laboratory analysis were taken in both the epilimnion (near surface) and hypolimnion (0.5 m from bottom) of the reservoir. Sampling locations were identified with a handheld GPS unit (Table E6.2.2.4-1).

Table E6.2.2.4-3. Water Quality Study analytical methods, minimum detection limits, and sample hold times.

Parameter	Symbol	Method	Detection limits[1] and units	Hold time
IN SITU WATER QUALITY				
Water temperature	°C or °F	EPA 170.1	0.1°C	Field probe
Dissolved oxygen	DO	SM 4500-O	0.4 mg/L	Field probe
Specific conductance	SpC	SM 2510A	1.0 uS/cm	Field probe
pH	pH	SM 4500-H	0.1 s.u.	Field probe
Turbidity	-	SM 2130 B	0.1 NTU	Field probe
Secchi Depth	-	USGS	0.1 m	Field
MINERALS & GENERAL				
Total Alkalinity	Alk	EPA 310.1	5.0 mg/L	14 d
Calcium	Ca	EPA 200.7	0.2–0.8 mg/L	180 d
Magnesium	Mg	EPA 200.7	0.02–0.09 mg/L	180 d
Potassium	K	EPA 200.7	0.4–1.5 mg/L	180 d
Sodium	Na	EPA 200.7	0.06–.0.25 mg/L	180 d
Chloride	Cl	EPA 300.0[2]	0.10–0.73 mg/L	28 d
Sulfate	SO_4	EPA 300.0[2]	0.15 mg/L	28 d
Hardness as $CaCO_3$	-	EPA 200.7[2]	0.6–2.4 mg/L	180 d < pH 2
Total Suspended Solids	TSS	EPA 160.2	1.0 mg/L	7 d
Total Dissolved Solids	TDS	EPA 160.1	1.0 mg/L	7 d
NUTRIENTS				
Nitrate-Nitrite	NO_3+NO_2-N	EPA 300.0[2]	0.01–0.15 mg/L	28 d < pH 2
Ammonia	NH_4-N	EPA 350.3[2]	0.02–0.08 mg/L	28 d < pH 2
Total Kjeldahl Nitrogen	TKN-N	EPA 351.3[2]	0.1–0.43 mg/L	28 d < pH 2
Total phosphorous	TP	EPA 365.3[2]	0.004–0.02 mg/L	28 d < pH 2
Orthophosphate	PO_4-P	EPA 365.3[2]	0.005–0.032 ug/L	48 h < 4 °C
BIOLOGICAL				
Chlorophyll-*a*	Chl-a	SM 10200H	0.00050–0.05 mg/L	24 h < 4 °C
Total colifom	-	SM 9223B[2]	2.0 MPN/100mL	6 h
Fecal coliform	-	SM 9222D[2]	2.0 MPN/100mL	6 h
METALS[3]				
Antimony[4]	Sb	EPA 200.8[2]	0.1 ug/L	48 h; 180 d < pH 2
Arsenic[4]	As	EPA 200.8[2]	0.1–0.7 ug/L	48 h; 180 d < pH 2
Barium[4]	Ba	EPA 200.8[2]	0.01–0.18 ug/L	48 h; 180 d < pH 2
Beryllium[4]	Be	EPA 200.8[2]	0.1–0.13 ug/L	48 h; 180 d < pH 2
Cadmium[4]	Cd	EPA 200.8[2]	0.05–0.07 ug/L	48 h; 180 d < pH 2
Chromium[4]	Cr	EPA 200.8[2]	0.1 ug/L	48 h; 180 d < pH 2
Cobalt[4]	Co	EPA 200.8[2]	0.1 ug/L	48 h; 180 d < pH 2
Copper (total and dissolved)[4]	Cu	EPA 200.8[2]	0.1–0.13 ug/L	48 h; 180 d < pH 2
Iron	Fe	EPA 200.7	4–450 ug/L	48 h; 180 d < pH 2
Lead[4]	Pb	EPA 200.8[2]	0.05–0.1 ug/L	48 h; 180 d < pH 2
Manganese	Mn	EPA 200.8	0.1–0.27 ug/L	48 h; 180 d < pH 2

Table E6.2.2.4-3. Water Quality Study analytical methods, minimum detection limits, and sample hold times.

Mercury[4]	Hg	EPA 1631	0.01–0.13 ng/L	28 d
Methyl Mercury	Me-Hg	EPA 1630	0.004 ng/L	24 h < 4 ^{o}C
Molybdenum[4]	Mo	EPA 200.8[2]	0.08–0.1 ug/L	48 h; 180 d < pH 2
Nickel (total and dissolved)[4]	Ni	EPA 200.8[2]	0.180–0.2 ug/L	48 h; 180 d < pH 2
Selenium[4]	Se	EPA 200.8[2]	0.0284–0.5 ug/L	48 h; 180 d < pH 2
Silver (total and dissolved)[4]	Ag	EPA 200.8[2]	0.12–0.1 ug/L	48 h; 180 d < pH 2
Thallium[4]	Tl	EPA 200.8[2]	0.018–0.2 ug/L	48 h; 180 d < pH 2
Vanadium[4]	V	EPA 200.8[2]	0.1–0.3 ug/L	48 h; 180 d < pH 2
Zinc[4]	Zn	EPA 200.8[2]	0.4–0.5 ug/L	48 h; 180 d < pH 2
HYDROCARBONS				
Total Petroleum Hydrocarbons—gasoline	-	EPA 8015/8260B	3.5 ug/L	7 d
Total Petroleum Hydrocarbons—diesel/motor oil	-	EPA 8015	19–21 ug/L	14 d
Methyl tertiary-butyl ether	MTBE	EPA 8015/8260B	0.04 ug/L	7 d
Benzene, toluene, ethylbenzene, and xylene	BTEX	EPA 8015/8260B	0.02-0.04 ug/L	7 d
Oil and grease	-	EPA 1664	1.4 mg/L	28 d
Parameter	**Symbol**	**Method**	**Detection limits1 and units**	**Hold time**
HERBICIDES				
Glyphosate	-	EPA 547M	3.00 ug/L	14 d < 4 ^{o}C
Aminomethylphosphonic acid	AMPA	EPA 547M	5.00 ug/L	14 d < 4 ^{o}C
Imazapyr	-	EPA 3535M [5] CDFG-WPCL-LCMS [6]	0.100 ug/L	14 d < 4 ^{o}C
Chlorsulfuron	-	EPA 3535M [5] CDFG-WPCL-LCMS [6]	0.100 ug/L	14 d < 4 ^{o}C
Triclopyr	-	EPA 3535M [5] CDFG-WPCL-LCMS [6]	0.100 ug/L	14 d < 4 oC
Bromacil	-	EPA 3535M [5] CDFG-WPCL-LCMS [6]	0.100 ug/L	14 d < 4 oC
Sulfometuron methyl	-	EPA 3535M [5] CDFG-WPCL-LCMS [6]	0.100 ug/L	14 d < 4 oC

- No symbol used

1 Detection limits are given as established minimum values for EPA or standard methods of *in situ* water quality measurement and as laboratory reported quality assurance results ("minimum detection limit," or "MDL"). Ranges are given where laboratory MDL's differed among sampling events.

2 Indicates deviation from method specified in FERC-approved study plan, for some or all samples for a given analyte. In general, substituted methods provided lower MDL's as compared to methods set forth in the Study Plan. However, the analytical laboratory was not able to achieve lower reporting limits for all analytes and consequently a number of analytes were reported as J flag values (estimated value less than the reporting limit but above the MDL and subject to high degree of variability, not quantitative).

3 Metals analyses refer to total metals unless otherwise noted.

4 Indicates CAM 17 metal.

5 Extraction method.

6 California Department of Fish and Game (CDFG), - Water Pollution Control Laboratory (WPCL) - Liquid Chromatography Mass Spectrometry (LCMS). Laboratory SOPs that describe the methods in more detail are on file at Stillwater Sciences.

River Synoptic Surveys

Concurrent with reservoir surveys, PG&E sampled riverine water quality during the 2006 spring runoff period (May), the 2006 and 2007 summer low-flow periods (August), in fall 2006 following reservoir overturn (October, prior to first major rain event). This resulted in a total of four synoptic surveys for each sampled Project reach during the study period. The synoptic surveys within the Project reaches included the *in situ* water quality parameters listed in Table E6.2.2.4-3 (excluding secchi depth), as well as grab samples for water chemistry, nutrients, and biological parameters described in Tables E6.2.2.4-2 and 3. Sampling locations were determined with a handheld GPS unit (Table E6.2.2.4-1).

Reservoir Target Surveys

In order to assess impacts of recreational use on reservoir water quality, PG&E collected samples once each on the 2006 Independence Day and Labor Day holiday weekends (July 3 and September 5, 2006), and once on August 7, 2007. In 2006, surface grab samples were taken near the dam in Philbrook Reservoir for hydrocarbons, and near sites with greater potential for localized fecal coliform contamination in Philbrook Reservoir and DeSabla Forebay (Tables E6.2.2.4-2 and 3). In 2007, Philbrook Reservoir and DeSabla Forebay were sampled for fecal coliform only. The sample sites were selected because of known recreational use, including sites near swimming, camping, and picnic areas with restroom facilities near the shore.

Field Methods for Water Sample Collection

Surface water grab samples were collected at 0.1 m depth in flowing water at river stations, and from an inflatable boat powered by electric motor at reservoir stations. All water samples were placed in laboratory-prepared sample bottles (material and preservation appropriate to the sampled analyte), kept on ice while in the field, and stored at 4°C until analysis (Table E6.2.2.4-3). The sample bottles for total metals analyses collected in the Spring were received with acid preservative in the bottle from the laboratory. Since the dissolved metals samples were filtered at the laboratory, the laboratory-supplied bottles did not contain acid preservative. Nitrile static-dissipative gloves were worn for all water quality sampling with the exception of "clean hands" mercury sampling as described below.

All samples for total and methyl mercury analysis (reservoir and riverine) were collected using EPA Method 1669. Long length, anti-static, Class M1.5 compatible clean vinyl gloves, as well as trace-clean glass bottles, were provided double-bagged by the laboratory and used by the "clean hands" designee for collection of all mercury samples. Hypolimnetic samples were collected using an acid-washed, 1.2-liter all-Teflon® coated Kemmerer bottle (Wildco Supply Company, Buffalo, New York) that could be remotely closed using a messenger line and weight from the reservoir surface. Immediately prior to sampling, the Kemmerer bottle was acid-washed using trace-metal clean grade acid and tested for trace residues using laboratory-supplied trace-clean water (i.e., equipment blank).

During the Spring and Summer 2006 events, trace metals and field-preserved analytes were collected with an acid-washed 1 L all-Teflon® bottle and decanted. The all-Teflon® bottle was acid-washed prior to each field effort, and immediately prior to collection of samples for CAM 17 metals. Equipment blanks were collected at the end of each field effort to identify any cross-site contamination of sampling vessels. A 12 ft aluminum extension pole with plastic swing sampler attachment and all-Teflon® sample bottle was employed where necessary to reach flowing water at river stations. The pole was positioned roughly perpendicular to river flows and downstream of the bottle attachment at all times. To better prevent potential cross-site contamination, the preceding method was modified for the Fall 2006 event to allow direct collection of all samples into laboratory-supplied bottles.

Finally, grab samples for hydrocarbon and bacterial analyses were collected as described above for surface water samples. Care was taken to eliminate gaseous headspaces in filled hydrocarbon sample bottles. Sterile seals on coliform sample bottle lids were maintained until exact time of sampling. Personnel collecting the samples wore a new pair of nitrile gloves at each station, and notes were made regarding the presence of waterfowl or other potential sources of bacterial contamination.

Field Methods for Collection of In Situ Parameters

Water temperature, conductivity, DO, and pH were measured in reservoir profiles and at all river stations with a YSI 600XL multi-parameter Sonde (Yellow Springs Instruments, Yellow Springs, Ohio). Turbidity was measured in reservoir profiles and at all river stations with a pre-calibrated YSI 6920 multi-parameter Sonde, and in surface (river and reservoir) and bottom water (reservoir) samples with a Hach 2100P portable turbidimeter (Hach Company, Loveland, Colorado). YSI and Hach specifications are described in Table E6.2.2.4-4. Conductivity and pH probes on multi-parameter Sondes were checked for accuracy in standard solutions before and after each field day, and re-calibrated if accuracy specifications were not met. Dissolved oxygen probes were recalibrated at each station and checked for accuracy against concentrations measured in Winkler titrations (Grasshoff 1983) at the beginning and end of each day using a Dissolved Oxygen Test Kit (Model OX-DT, Hach Company, Loveland, Colorado).

Table E6.2.2.4-4. YSI 600XL and 6920 specifications for range, resolution, and accuracy.

Parameter	Range	Resolution	Accuracy
Water temperature	-5 to +70°C	0.01°C	±0.15°C
Conductivity	0 to 100mS/cm	0.001 to 0.1 mS/cm	±0.5% of reading +0.001 mS/cm
DO (% Saturation)	0 to 500%	0.1%	0 to 200%: ±2% air sat; 200 to 500%: ±6% air sat
DO (mg/L)	0 to 50 mg/L	0.01 mg/L	0 to 20 mg/L: ±0.2 mg/L; 20 to 50 mg/L: ±0.6 mg/L
pH	0 to 14 units	0.01 unit	±0.2 unit
Turbidity (NTU, YSI 6920)	0 to 1000 NTU	0.1 NTU	± 2% of reading or 0.3 NTU
Turbidity (NTU, Hach Turbidimeter)	0 to 1000 NTU	0.01 NTU	± 2% of reading
DO (mg/L; Winkler titration)	1 to 10 mg/L	0.02 mg/L	--

Laboratory Analysis

Analytical methods for field and laboratory measured water quality parameters are identified in Table E6.2.2.4-3. Test America (Sacramento, CA), Basic Laboratory (Redding, CA) and Studio Geochimica (Seattle, WA) performed laboratory water chemistry analyses. TestAmerica and Basic Laboratory are certified by the California Department of Health Services (CDHS) under the Environmental Laboratory Accreditation Program (ELAP), which mandates quality assurance for standard analysis methods, metrics and procedures. Studio Geochimica performed all low-level mercury analyses using ultra-trace clean sample handling procedures (Table E6.2.2.4-3).

Quality Control Review Procedures

Prior to data analysis, quality control (QC) reviews of data were performed, including detailed review of laboratory method detection limits (MDL’s) and method reporting limits (MRL's), method blanks, field notes and graphical representations of data points. In general, laboratory MDL's specified in Table E6.2.2.4-3 are concentrations at which the lab can report with 99 percent confidence that the analytical result is not actually zero. This is usually three times the standard deviation based upon analysis of replicated spike additions to pure water at the expected MDL (Oblinger Childress et al. 1999). In all cases, the MDL's in Table E6.2.2.4-3 are lower than the criteria listed in Table E6.2.2.4-5. The MRL is more subjective and is set by each lab differently due to matrix interferences and changes in routine laboratory QC results, but typically the MRL is set at five times the standard deviation, as determined above, added to the MDL. All results falling below laboratory MRL's but above the MDL's were noted by the laboratory as “J-flagged” to represent estimated concentrations with lower confidence levels. J-flagged data should be considered semi-quantitative data in that they are not “zero” but replicate samples and analysis would likely show a high degree of variability.

In addition to laboratory QC procedures, field duplicates and blanks were collected at a rate of approximately one in 10 samples but not less than one sample per trip. Duplicates showing variation greater than 10 percent were flagged for further review. Upon review, duplicate samples that showed variation greater than ten percent, but were not already J-flagged (i.e. marked by the laboratory as estimated values carrying a high degree of uncertainty) were flagged as “JD” (uncertainty based on duplicate review). Field and equipment blank results above the MRL were compared with sample results from the relevant sampling event. Where field and/or equipment blank results were greater than the MRL and also greater than sample results, affected sample results from that field trip were not reported (NR). Where field and/or equipment blank results were above the MRL but less than the sample results, the blank result was subtracted from sample results before reporting. These results were flagged as having been blank adjusted (BA) in all tables.

All flagged data were reviewed with the laboratory to determine their suitability and noted as flagged for any subsequent analyses. The SWRCB (2004a) *Water Quality Control Policy for Developing California’s Clean Water Act Section 303(d) List* (Listing Policy) Section 6.1.5.5 specifically states that, "When the sample value is less than the quantitation limit (method reporting limit) and the quantitation limit is greater than the water quality standard, objective, criterion or evaluation guideline, the results shall not be used in the analysis" (SWRCB 2004a). Therefore, although laboratory methods were selected with MDLs below the applicable water quality criteria, any instances that estimated J-flag values are above applicable criteria do not meet the SWRCB Listing Policy guidelines.

Data Analysis

Analyses of validated water chemistry and *in situ* parameter data included: 1) comparisons to relevant water quality criteria or objectives, and 2) evaluation of any spatial or temporal patterns (e.g., metals, nutrients, inorganics, *in situ* parameters) indicating whether Basin Plan Standards are or are not supported. All data were also compared with study criteria, including applicable Basin Plan Water Quality Objectives and other recommended numerical limits (Tables E6.2.2.4-5 and 6).

Water quality effects were of concern if there was non-compliance with applicable narrative Water Quality objectives from the California Regional Water Quality Control Board’s Water Quality Control Plan (Basin Plan) for the Central Valley Region (CVRWQCB 2006), as well as numerical objectives contained in the California Toxics Rule (CTR; USEPA 2000a), and other applicable sources (e.g. USEPA 20001, 2003, 2004, SWRCB 2004b, Tables E6.2.2.4-5 and 6). In addition to determining whether Project-affected surface waters are consistent with Basin Plan standards, data from this study were used to determine whether water quality is protective of beneficial uses designated by the Basin Plan, including municipal and domestic supply, agricultural irrigation and stock watering, electrical power production, contact recreation, warm and cold water freshwater habitat, cold water fish migration, and wildlife habitat.

Table E6.2.2.4-5. Narrative water quality criteria to support Designated Beneficial Uses.

Water Quality Objective	Description
Bacteria	In terms of fecal coliform. Less than a geometric average of 200 per 100 mL water on five samples collected in any 30-day period and less than 400 per 100 mL on ten percent of all samples taken in a 30-day period.
Biostimulatory Substances	Water shall not contain biostimulatory substances that promote aquatic growth in concentrations that cause nuisance or adversely affect beneficial uses.
Chemical Constituents	Waters shall not contain chemical constituents in concentrations that adversely affect beneficial uses. Although certain trace element levels have been applied to particular water bodies, no portion of the Project affected area is cited within the Basin Plan (CVRWQB 2006). Other limits for organic, inorganic and trace metals are provided for surface waters that are designated for domestic or municipal water supply. In addition, waters designated for municipal or domestic use must comply with portions of Title 22 of the California Code of Regulation.
Color[1]	Water shall be free of discoloration that causes a nuisance or adversely affects beneficial uses.
Dissolved oxygen	Monthly median of the average daily dissolved oxygen concentration shall not fall below 85 percent of saturation in the main water mass, and the 95 percent concentration shall not fall below 75 percent of saturation. Minimum level of 7 mg/L. When natural conditions lower dissolved oxygen below this level, the concentrations shall be maintained at or above 95 percent of saturation.
Floating Material[1]	Water shall not contain floating material in amounts that cause a nuisance or adversely affect beneficial uses.
Oil and Grease	Water shall not contain oils, greases, waxes or other material in concentrations that cause a nuisance, result in visible film or coating on the surface of the water or on objects in the water, or otherwise adversely affect beneficial uses.
pH	The pH of surface waters will remain between 6.5 to 8.5, and cause changes of less than 0.5 in receiving water bodies.
Pesticides[1]	Waters shall not contain pesticides or a combination of pesticides in concentrations that adversely affect beneficial uses. Other limits established as well.
Radioactivity[1]	Radionuclides shall not be present in concentrations that are harmful to human, plant, animal or aquatic life nor that result in the accumulation of radionuclides in the food web to an extent that presents a hazard to human, plant, animal or aquatic life.
Sediment[1]	The suspended sediment load and suspended-sediment discharge rate of surface waters shall not be altered in such a manner as to cause a nuisance or adversely affect beneficial uses.
Settleable Material[1]	Waters shall not contain substances in concentrations that result in the deposition of material that causes a nuisance or adversely affects beneficial uses.
Suspended Material	Waters shall not contain suspended material in concentrations that cause a nuisance or adversely affect beneficial uses.
Tastes and Odor	Water shall not contain taste- or odor-producing substances in concentrations that impart undesirable tastes and odors to domestic or municipal water supplies or to fish flesh or other edible products of aquatic origin, or that cause nuisance, or otherwise adversely affect beneficial uses.
Water temperature[2]	The natural receiving water temperature of interstate waters shall not be altered unless it can be demonstrated to the satisfaction of the Regional Water Quality Control Board that such alteration in water temperature does not adversely affect beneficial uses. Increases in water temperatures must be less than 2.8°C above natural receiving-water temperature.
Toxicity	All waters shall be maintained free of toxic substances in concentrations that produce detrimental physiological responses in human, plant, animal, or aquatic life. Compliance with this objective will be determined by analysis indicator organisms, species diversity, population density, growth anomalies, and biotoxicity tests as specified by the Regional Water Quality Control Board.
Turbidity	In terms of changes in turbidity (NTU) in the receiving water body: where natural turbidity is 0 to 5 NTUs, increases shall not exceed 1 NTU; where 5 to 50 NTUs, increases shall not exceed 20 percent; where 50 to 100 NTUs, increases shall not exceed 10 NTUs; and where natural turbidity is greater than 100 NTUs, increase shall not exceed 10 percent.

Notes:

1 Criteria not directly sampled as part of this study, and PG&E is unaware of any reports of water quality issues regarding this criteria or potential linkages with Project operations.

2 Water temperature is addressed separately in the water temperature Study (Section E6.2.2.3). Although water temperature was measured as an in situ parameter during Water Quality sampling events, all discussion of water temperature in the context of Basin Plan criteria is contained in the water temperature section.

Table E6.2.2.4-6. Numeric water quality criteria to support Designated Beneficial Uses.

Basin Plan Water Quality Objective (Potentially Affected Beneficial Uses)	Symbol or Abbreviation	Numeric Criteria to Support Beneficial Use	Reference	Notes
BACTERIA				
Fecal coliform	-	< 200 MPN per 100 mL; (geometric mean)	CVRWQCB 2006	Water contact recreation, using minimum of not less than five samples for 30 day average. See Table E6.2.2.4-5 for details.
BIOSTIMULATORY SUBSTANCES				
Nitrite-Nitrate	NO_2 +NO_3 - N	None	--	--
Total Kjeldahl Nitrogen	TKN	None	--	--
Total Phosphorous	TP	None	--	--
Orthophosphate	PO_4 - P	None	--	--
Chlorophyll-a	Chl-a	None	--	--
CHEMICAL CONSTITUENTS				
Alkalinity	-	None	--	--
Antimony	Sb	6 ug/L	CDHS 2006	Title 22 Primary MCL
Arsenic	As	0.05 mg/L	CDHS 2006	Title 22 Primary MCL
Barium	Ba	1 mg/L	CDHS 2006	Title 22 Primary MCL
Benzene	CH_6	1 ug/L	CDHS 2006	Title 22 Primary MCL
Beryllium	Be	4 ug/L	CDHS 2006	Title 22 Primary MCL
Cadmium	Cd	0.005 mg/L	CDHS 2006	Title 22 Primary MCL
Calcium	Ca	None	--	--
Cobalt	Co	None	--	--
Chromium	Cr	50 ug/L	CDHS 2006	Title 22 Primary MCL
Conductivity	SpC	150 uS/cm	CVRWQCB 2006	Aquatic Life Protection
Ethylbenzene	-	300 ug/L	CDHS 2006	Title 22 Primary MCL
Lead	Pb	0.015 mg/L	CDHS 2006	Title 22 Primary MCL
Magnesium	Mg	None	--	--
Mercury	Hg	50 ng/L	USEPA 2000a	CTR for sources of drinking water
Mercury	Hg	0.002 mg/L	CDHS 2006	Title 22 Primary MCL
Methyl Mercury	Me-Hg	70 ng/L	USEPA 2001	USEPA IRIS Reference Dose for Human Toxicity
Nickel	Ni	0.1 mg/L	CDHS 2006	Title 22 Primary MCL
Nitrate-Nitrite	NO_3+NO_2 - N	10 mg/L	CDHS 2006	Title 22 Primary MCL (“Blue baby Syndrome”)
Potassium	K	None	--	--
Selenium	Se	0.05 mg/L	CDHS 2006	Title 22 Primary MCL
Thallium	Tl	2 ug/L	CDHS 2006	Title 22 Primary MCL
Toluene	-	150 ug/L	CDHS 2006	Title 22 Primary MCL
Vanadium	V	None	--	--
Xylene	-	1.75 mg/L	CDHS 2006	Title 22 Primary MCL

Table E6.2.2.4-6 (continued)

Basin Plan Water Quality Objective (Potentially Affected Beneficial Uses)	Symbol or Abbreviation	Numeric Criteria to Support Beneficial Use	Reference	Notes
DISSOLVED OXYGEN				
Dissolved Oxygen	DO	> 7 mg/L (minimum)	CVRWQCB 2006	Aquatic life protection
		> 75% sat in 95% of samples	CVRWQCB 2006	Aquatic life protection
		> 85% sat in 50% of samples	CVRWQCB 2006	Aquatic life protection
SUSPENDED MATERIAL				
Total Dissolved Solids	TDS	450 mg/L	CDHS 2006	Title 22 Secondary MCL
Total Suspended Solids	TSS	None	--	--
OIL AND GREASE				
Oil & Grease	-	Narrative (See Table E6.2.2.4-1)	CVRWQCB 2006	Absent by visual observation. In general, should not be present in quantities which result in film or coating
pH				
pH	pH	6.5-8.5	CVRWQCB 2006	Aquatic life protection
TASTES & ODOR				
Chloride	Cl	250 mg/L	CDHS 2006	Title 22 Secondary MCL
Conductivity	SpC	900 umhos	CDHS 2006	Title 22 Secondary MCL
Copper	Cu	1 mg/L	CDHS 2006	Title 22 Secondary MCL
Iron	Fe	0.3 mg/L	CDHS 2006	Title 22 Secondary MCL
Manganese	Mn	0.05 mg/L	CDHS 2006	Title 22 Secondary MCL
Methyl tert-butyl ether	MTBE	5 ug/L	CDHS 2006	Title 22 Secondary MCL
Silver	Ag	0.1 mg/L	CDHS 2006	Title 22 Secondary MCL
Sodium	Na	30-60 mg/L	USEPA 2004	Sodium Restricted Diet
Sulfate	SO_4	250 mg/L	CDHS 2006	Title 22 Secondary MCL
Total Petroleum Hydrocarbons—gasoline	TPH-g	5 ug/L	SWRCB 2004b	Taste and odor threshold determined by SWRCB
Total Petroleum Hydrocarbons—diesel (and as estimated criterion for motor oil)	TPH-d	100 ug/L	SWRCB 2004b	Taste and odor threshold determined by SWRCB based on USEPA health advisory
Zinc	Zn	5 mg/L	CDHS 2006	Title 22 Secondary MCL
TOXICITY [1]				
Ammonia as N	NH_3-N	24.1 mg/L (CMC); 4.1-5.9 mg/L (CCC)	USEPA 2000a	CTR criteria over 0-20^{o}C assuming pH 7.0
		5.6 mg/L (CMC); 1.7-2.4 mg/L (CCC)	USEPA 2000a	CTR criteria over 0-20^{o}C assuming pH 8.0
		0.9 mg/L (CMC); 0.3-0.5 mg/L (CCC)	USEPA 2000a	CTR criteria over 0-20^{o}C assuming pH 9.0
Arsenic	As	0.34 mg/L (CMC); 0.15 mg/L (CCC)	USEPA 2000a	CTR criteria for sources of drinking water
Copper	Cu	1.5 ug/L (CMC); 1.3 ug/L (CCC)	USEPA 2000a	CTR for filtered [0.45 um] sample assuming hardness of 10 mg/L as $CaCO_3$
		2.9 ug/L (CMC); 2.3 ug/L (CCC)	USEPA 2000a	CTR for filtered [0.45 um] sample assuming hardness of 20 mg/L as $CaCO_3$

Table E6.2.2.4-6 (continued)

Basin Plan Water Quality Objective (Potentially Affected Beneficial Uses)	Symbol or Abbreviation	Numeric Criteria to Support Beneficial Use	Reference	Notes
		5.0 ug/L (CMC); 3.7 ug/L (CCC)	USEPA 2000a	CTR for filtered [0.45 um] sample assuming hardness of 35 mg/L as $CaCO_3$
		7.0 ug/L (CMC); 5.0 ug/L (CCC)	USEPA 2000a	CTR for filtered [0.45 um] sample assuming hardness of 50 mg/L as $CaCO_3$
Nickel	Ni	66.8 ug/L (CMC); 7.4 ug/L (CCC)	USEPA 2000a	CTR for filtered [0.45 um] sample assuming hardness of 10 mg/L as $CaCO_3$
		120.0 ug/L (CMC); 13.3 ug/L (CCC)	USEPA 2000a	CTR for filtered [0.45 um] sample assuming hardness of 20 mg/L as $CaCO_3$
		192.6 ug/L (CMC); 21.4 ug/L (CCC)	USEPA 2000a	CTR for filtered [0.45 um] sample assuming hardness of 35 mg/L as $CaCO_3$
		260.5 ug/L (CMC); 28.9 ug/L (CCC)	USEPA 2000a	CTR for filtered [0.45 um] sample assuming hardness of 50 mg/L as $CaCO_3$
Silver	Ag	0.07 ug/L (CMC)	USEPA 2000a	CTR for filtered [0.45 um] sample assuming hardness of 10 mg/L as $CaCO_3$
		0.22 ug/L (CMC)	USEPA 2000a	CTR for filtered [0.45 um] sample assuming hardness of 20 mg/L as $CaCO_3$
		0.57 ug/L (CMC)	USEPA 2000a	CTR for filtered [0.45 um] sample assuming hardness of 35 mg/L as $CaCO_3$
		1.1 ug/L (CMC)	USEPA 2000a	CTR for filtered [0.45 um] sample assuming hardness of 50 mg/L as $CaCO_3$
TURBIDITY				
Turbidity	-	increase < 1 NTU for 1-5 NTU background; increase < 20% for 5-50 NTU background	CVRWQCB 2006	Aesthetics, disinfection, egg incubation
Secchi Depth	-	None	--	--

Notes:

- \- No symbol used
- [1] Criteria calculated from the CTR (USEPA 2000a) based on sample hardness (mg/L as $CaCO_3$) and dissolved concentrations of copper, nickel, and silver.

CMC = Criteria Maximum Concentration
CCC = Criteria Chronic Concentration

The numeric criteria in Table E6.2.2.4-6 have been drawn from a variety of sources to address the narrative water quality objectives given in Table E6.2.2.4-5. For aquatic toxicity, Table E6.2.2.4-6 shows the Criterion Maximum Concentrations (CMC) and Criterion Continuous Concentrations (CCC) defined under the CTR (USEPA 2000a). The CMC is defined as the highest concentration to which aquatic life can be exposed for a short period of time without deleterious effects. The CCC is defined as the highest concentration to which aquatic life can be exposed for an extended period of time without deleterious effects. Because ammonia toxicity is both pH- and water temperature-dependent, Table E6.2.2.4-6 provides a range of limits with site-specific criteria calculated (USEPA 2000a) for individual samples.

For several metals (e.g., cadmium, copper, lead, nickel, silver, and zinc) CTR aquatic toxicity criteria are applicable to the dissolved metal concentration only and are determined by calculation from the dissolved metal fraction (i.e., 0.45 um filtered) and water hardness (mg/L as $CaCO_3$) in the sample. Criteria listed in Table E6.2.2.4-6 are for hardness of 10, 20, 35, and 50 mg/L as $CaCO_3$, however site-specific criteria were calculated from the CTR (USEPA 2000a) based on observed hardness in collected samples. For samples in which only total metals (i.e., unfiltered) are measured the CTR criteria do not apply and toxicity criteria are evaluated by comparison of the total metal concentration with the Title 22 primary MCLs provided under Chemical Constituents in the table above.

For human toxicity related to drinking water uses, the Table E6.2.2.4-6 criteria are generally based on a one-in-a-million incremental lifetime cancer risk estimate for carcinogens, as well as threshold toxicity levels for non-carcinogens. In general, CDHS (2006) maximum contaminant levels (MCLs) for drinking water are used, which are generally set as close to the levels at which no known or anticipated adverse effect on human health would occur, but may be adjusted upwards depending upon available technologies and the cost of treatment.

For water quality objectives under Biostimulatory Substances, the Basin Plan provides no guidance as to numerical water quality criteria to be applied within the Project area.

Water temperatures measured during the 2006 Water Quality study are not discussed in the context of Basin Plan criteria; that discussion is provided in section E6.2.2.3 (Develop Water Temperature Model and Monitor Water Temperature).

6.2.2.4.4 Results

Some 1,852 results, not including blank or duplicate samples, were determined by laboratory analysis from June 30, 2006 to August 28, 2007. *In situ* water quality parameters were measured at 12 sites during each of three events, and at one site during an unscheduled canal outage. Ten reservoir profiles of *in situ* parameters in Project reservoirs were conducted during this period as well. A detailed discussion is provided below by parameter.

Quality Control Review

Quality control (QC) review focused on the accuracy and precision of reported results. Although control of accuracy is addressed by instrument calibrations at standard conditions (e.g., dissolved oxygen in saturated air) and the use of standard solutions (e.g., pH standards, laboratory spike recovery tests, etc.), all laboratory data were reviewed upon receipt from the laboratory and flagged where apparent results were unexpectedly higher or lower than other samples collected in the same vicinity or in prior sampling events. In addition, field blank results were reviewed to assess potential contamination by sampling equipment (Teflon® grab sample bottle and Teflon® Kemmerer bottle). All field and equipment blank results above the laboratory reporting limit (MRL) are reported in Table E6.2.2.4-7. Data failing this or other QC review criteria (e.g.

dissolved > total), and data flagged upon receipt were reviewed with the laboratory to determine their suitability for use in subsequent analyses.

Based upon quality control reviews, approximately 4 percent of the laboratory results were excluded from subsequent analyses (69 results). Excluded results were not reported ("NR") in tables presented in this report. J-flagged data were not subjected to precision-based QC review due to the inherent uncertainty in these values and these values do not meet the SWRCB Listing Policy Section 6.1.5.5 guidelines as mentioned previously (SWRCB 2004a). A detailed account of the QC review for each sampling event and resultant excluded data is given in Table E6.2.2.4-7.

Table E6.2.2.4-7. Quality control review from sampling efforts through Summer 2007.

Parameter[a]	Affected Stations	QC Issue[b]	Action Taken	Rationale
SPRING 2006				
PO_4 - P	WBRF3	1	Laboratory has been contacted. Response pending. Flagged as "not available" (NA).	Sample was collected and submitted to laboratory. Analysis was requested on original chain of custody sheet.
PO_4 - P	WBFR4, DS1(E) and (H), BC2, BC3, BC4, BC5, BXC1	2	Data retained, but expected results are below MDL for substituted method (2 mg/L) and thus uninformative.	There are currently no numeric Basin Plan criteria for TP or PO_4-P, so these results are not as material to the quantitative discussion of Basin Plan objectives.
TP	All stations sampled (except WBFR3)	3, 4	Results are not reported (NR).	Multiple cases of total (TP) < dissolved (PO_4- P) decrease confidence in data. Blank results are higher than most sample results, also making data suspect.
Chl-a	All stations except WBRF3	5, 6	Results are not reported (NR) for affected samples.	Combination of hold-time exceedances and improper filtration may bias chlorophyll a results low in sample, making "ND" results suspect.
Total and Fecal Coliform	PBR1 stations, DS1	6	Data retained, but qualified in discussion of Basin Plan criteria.	Blank results are negative and sample results follow spatial pattern observed during July 4th sampling event. No high results suspected due to hold-time exceedance.

Table E6.2.2.4-7 (continued)

Parameter[a]	Affected Stations	QC Issue[b]	Action Taken	Rationale
Cl	All stations except WBFR3	4	Results are not reported (NR).	None of the sample results are outside the expected range and none approach Basin Plan criteria. However, blank results are higher than most sample results, making data suspect.
TDS	All stations except WBFR3	4,7, 8 (PBR1(E))	Sample results are reported as measured value minus trip blank (BA); one resulting negative value reported as ND; one high result not reported (NR) pending consultation with laboratory.	Order-of-magnitude differences in sample results within a reach are unlikely. Background contamination identified in trip blank or residue in sampling equipment may affect all samples.
Me-Hg, Hg	PBR1(H)	4	Data retained.	Inadequate reagent water supplied by analytical laboratory for collection of equipment blank. Standard deionized water believed to have been contaminated with low levels of Hg, thus affecting equipment blank but not samples.
Fe	WBFR2	8	One high result not reported (NR) pending consultation with laboratory.	Order-of-magnitude differences in sample results within a single reach are unlikely.
Ni	PBC1, HC1	3 (HC1), 8 (PBC1, Dissolved)	Data from HC1 retained. Data from PBC1 not reported (NR) pending additional consultation with laboratory.	Uncertainty may be high where results are only slightly above MRL (HC1). PBC1 result is suspect.
Zn	WBFR2, BC5	4,7	Sample results for WBFR2 are reported as measured value minus average blank value (BA). Sample results for BC5 are not reported (NR).	Background contamination identified in trip blank or residue in sampling equipment may affect all samples. BC5 results suspect because blank values higher than sample value.
DO	All stations sampled	9	A second multiparameter sonde (recently calibrated) was used to QC the primary instrument	DO measurements taken with both instruments were within expected range, and QC instrument had passed recent calibration checks.

Table E6.2.2.4-7 (continued)

Parameter[a]	Affected Stations	QC Issue[b]	Action Taken	Rationale
INDEPENDENCE DAY WEEKEND 2006				
No QC issues identified.				
SUMMER 2006				
TP, PO_4 - P	WBFR3, WBFR4, BC1, BC2, BC4, DS1(E) and (H)	3	Data retained.	Uncertainty may be high due to results only slightly above MRL. PO_4-P is likely the dominant fraction of TP.
Cu	BC4, DS1(H), WBFR4, PBR1(E), RVR1(E) and (H)	3	Data retained, J-flagged where applicable.	Similarity between total and dissolved values likely due to uncertainty in results near laboratory MRL and large dissolved fraction of Cu.
TKN	All stations sampled	4,7, 8 (WBFR3)	Affected sample results are reported as measured value minus blank value (BA). One high result not reported (NR) pending consultation with laboratory.	Background contamination identified in trip blank or residue in sampling equipment would affect all samples. Order-of-magnitude differences in sample results within a single reach are unlikely.
TSS	BC5	4	Sample result is reported as measured value minus equipment blank value (BA). Resulting value below MRL is J-flagged.	TSS detected only at BC5 which may be due to residual sediment in water column caused by a party of inner tubers passing by at time of sampling. TSS residue on equipment may also have affected BC5 result.
TDS	All stations except WBFR3	4,7	Sample results are reported as measured value minus trip blank value (BA); resulting negative values reported as ND; resulting values below MRL are J-flagged.	Blank results may be due to background contamination or due to residue on sampling equipment, which would affect some samples.
Hg (total)	All stations sampled	4,7	Results for sample collected with Kemmerer are reported as measured value minus equipment blank value (BA). Trip blank data excluded.	Blank results may be due to residue on sampling equipment, which would affect samples collected with that equipment. Trip blank likely contaminated; whole batch contamination unlikely (per communication with laboratory director).

Table E6.2.2.4-7 (continued)

Parameter[a]	Affected Stations	QC Issue[b]	Action Taken	Rationale
LABOR DAY WEEKEND 2006				
Motor Oil	PBR1	7	Data adjusted by subtracting trip blank result from all sample results (BA). Resulting values below MRL are J-flagged.	Trip blank was not opened during sampling; analytical batch blank was negative. Determined to be due to background contamination of trip blank bottle, which may have affected samples.
FALL 2006				
Total and Fecal Coliform	Trip Blank	6	Data not used in QC review of sample results.	No trip blank from any other sampling event had a high result. Sample results do not approach Basin Plan objectives.
TP, PO_4 - P	WBFR1	3	Data retained.	Uncertainty may be high due to results only slightly above MRL. PO_4-P is likely the dominant fraction of TP.
Cr	WBFR2, BC5	7	Data adjusted by subtracting trip blank result from all sample results (BA).	Trip blank was not opened during sampling; analytical batch blank was negative. Determined to be due to background contamination of sample bottle, which may have affected other samples.
TKN	All stations except WBFR3	7	Sample results are reported as measured value minus blank value (BA). Resulting values below MDL are reported as ND.	Background contamination identified in trip blank could affect all samples.
TDS	PBR1(H), DS1(H)	4	Data adjusted by subtracting equipment blank result from results (BA) at all stations where equipment was used.	Sampling equipment (Kemmerer) likely contacted bottom of reservoir and acquired sediment on release valve. Samples may have been affected.
Cu	PBR1(H), HC1, BC4	3	Data retained.	Similarity between total and dissolved values likely due to uncertainty in results near laboratory MRL and large dissolved fraction of Cu.

Table E6.2.2.4-7 (continued)

Parameter[a]	Affected Stations	QC Issue[b]	Action Taken	Rationale
Hg	PBR1(H)	4	Affected sample is not reported (NR).	Equipment blank result exceeded sample result. Contamination is possible and data suspect.
HERBICIDE SAMPLING 2007				
No QC issues identified.				
SUMMER 2007				
NO_2, NO_3	All stations	7	Sample results are reported as measured value minus blank value (BA). Resulting values below MDL are reported as ND. Resulting values above the MDL but below the MRL are J-flagged.	Background contamination identified in trip blank could affect all samples.
NH_3	All stations	7	Sample results are reported as measured value minus blank value (BA). Resulting values below MDL are reported as ND. Resulting values above the MDL but below the MRL are J-flagged.	Background contamination identified in trip blank could affect all samples.
Cl	BXC1, HC1	4	Sample results are reported as measured value minus blank value (BA). Resulting values below MDL are reported as ND. Resulting values above the MDL but below the MRL are J-flagged.	Blank results may be due to residue on sampling equipment, which would affect some samples.
TP, PO4 - P	WBFR1	3	Data retained.	Uncertainty may be high due to results only slightly above MRL. PO4-P is likely the dominant fraction of TP.
Total Ag, Dissolved Ag	BC3	3	Data retained.	Similarity between total and dissolved values likely due to uncertainty in results near laboratory MRL and large dissolved fraction of Ag.
Total Ni, Dissolved Ni	WBFR1, WBFR2, PBR1 (E), DS1 (E), DS1 (H), BC3, BC5	3	Data retained.	Similarity between total and dissolved values likely due to uncertainty in results near laboratory MRL and large dissolved fraction of Ni.

Table E6.2.2.4-7 (continued)

Parameter[a]	Affected Stations	QC Issue[b]	Action Taken	Rationale
Total Cu	All stations	7	Data not reported.	Background contamination identified in trip blank could affect all samples. Since reported contamination was larger than most of the sample results, correction of results is unrealistic.
Dissolved Cu	PBR1 (H), DS1 (H)	4	Data adjusted by subtracting equipment blank result from results (BA) at all stations where equipment was used.	Blank results may be due to residue on sampling equipment, which would affect some samples.
Fecal coliforms	DS1-D, DS1-E	5	Data retained.	Analysis was performed outside of standard laboratory holding time: samples were refrigerated, so results were not likely to be affected. If results were affected, bacteria counts would be higher than the actual values, so using the reported results is a conservative approach.

Notes: [a] Abbreviations for analytical parameters are given in Table E6.2.2.4-3.
[b] QC Issues:
1. Laboratory did not provide results for the specified analyte.
2. Incorrect method used for analysis due to laboratory error.
3. Result for dissolved or other subspecies fraction greater than result for total (e.g. Dissolved Cu > Total Cu; PO_4-P > Total P).
4. Equipment blank result >/= MRL.
5. Improper filtration due to laboratory error
6. Samples analyzed outside of recommended hold-time.
7. Trip blank result >/= MRL.
8. Suspected laboratory reporting error due to order-of-magnitude difference in sample results from all other samples.
9. DO concentration measured with Winkler titrations not near expected value.

Due to laboratory errors and several positive trip blank results observed during Spring 2006, a different analytical laboratory was contracted for analysis of certain water quality parameters during subsequent sampling events. Data of questionable quality from all sampling events were scrutinized and treated as described in Table E6.2.2.4-7. For all results, the use of J-flagged and adjusted data has been noted in subsequent analyses since the resulting uncertainty at these levels is greater. Laboratory MDL values were used in cases when results were below the MDL. Finally, in addition to the quality control review above, estimated uncertainty in analytical results was calculated based on duplicate measurements (Table E6.2.2.4-8). For field instruments used to measure *in situ* parameters, the manufacturer resolution is provided as a measure of uncertainty. The uncertainty measure reported in Table E6.2.2.4-8 is an aggregate estimator of variability in all 2006 and 2007 field duplicates collected for each analyte. In addition, to ensure precision in the data reported for each sampling event, the absolute value of the difference in field duplicates divided by the mean value (spread/mean for each duplicate pair) was calculated for each analyte during each sampling event. For cases in which the derived value was greater than 0.1, all data were flagged as having uncertainty based on the duplicate analysis (JD). Results J-flagged by the analytical laboratory were not used in this portion of the uncertainty analysis.

Following the QC review and uncertainty analyses described above, all results indicating potential exceedances of Basin Plan criteria were examined for quality and accuracy. The uncertainty estimates were intended to indicate the potential for “false positives” in circumstances where results exceeded the water quality objectives (Table E6.2.2.4-6) by less than the calculated uncertainty (Table E6.2.2.4-8).

Table E6.2.2.4-8. Estimated uncertainty in reported values calculated from analysis of duplicate measurements collected during each sampling event in 2006 and 2007.

Parameter	Units	Standard deviation of field duplicates[1]
***IN SITU* WATER QUALITY[2]**		
Water temperature	°C	0.01°C
Dissolved oxygen	mg/L	0.01 mg/L
Conductivity	uS/cm	0.001 to 0.1 uS/cm
pH	s.u.	0.01 unit
Turbidity	NTU	0.01-0.1 NTU
Secchi depth	m	0.03 m
MINERALS & GENERAL		
Total Alkalinity	mg/L	1.6
Calcium	mg/L	0.16
Magnesium	mg/L	0.06
Potassium	mg/L	0.00
Sodium	mg/L	0.04
Chloride	mg/L	0.17
Sulfate	mg/L	0.02
Hardness as $CaCO_3$	mg/L	0.87
Total Suspended solids	mg/L	0.71
Total Dissolved solids	mg/L	1.66
NUTRIENTS		
Nitrate-Nitrite	mg/L	0.04
Ammonia	mg/L	0.00
Total Kjeldahl nitrogen	mg/L	0.10
Total phosphorous	mg/L	0.01
Orthophosphate	ug/L	0.00
BIOLOGICAL		
Chlorophyll-*a*	mg/L	0.00
Total colifom	CFU/100mL	27.8
Fecal coliform	CFU/100mL	10.3
METALS		
Antimony	ug/L	0.00
Arsenic	ug/L	0.00
Barium	ug/L	0.03
Beryllium	ug/L	0.00
Cadmium	ug/L	0.00
Chromium	ug/L	2.17
Cobalt	ug/L	0.00
Copper (total and dissolved)	ug/L	0.65
Iron	ug/L	1.68
Lead	ug/L	0.19
Manganese	ug/L	0.10
Mercury	ng/L	0.08
Methyl mercury	ng/L	0.00
Molybdenum	ug/L	0.05
Nickel (total and dissolved)	ug/L	4.76
Selenium	ug/L	0.00

Table E6.2.2.4-8 (continued)

Parameter	Units	Standard deviation of field duplicates[1]
Silver (total and dissolved)	ug/L	0.13
Thallium	ug/L	0.00
HYDROCARBONS		
Vanadium	ug/L	0.15
Zinc	ug/L	104
Total petroleum hydrocarbons—gasoline	ug/L	2.30
Total petroleum hydrocarbons—diesel	ug/L	0.00
Total petroleum hydrocarbons—motor oil	ug/L	9.50
Methyl tertiary-butyl ether	ug/L	0.00
Benzene	ug/L	0.00
Toluene	ug/L	0.00
Ethylbenzene	ug/L	0.00
Xylene	ug/L	0.04
Oil and grease	mg/L	0.64

Notes:

1 Maximum likelihood estimator for standard deviation of all 2006 field duplicates for each analyte is reported here. Event-specific uncertainty estimates for quality control review were calculated as [(Sample – Duplicate)/Mean] for each set of duplicate samples. All results from a given event were flagged as "JD" if the event-specific uncertainty was > 0.1.

2 Manufacturer's resolution given for uncertainty of *in situ* parameters.

Spatial and Temporal Reach Gradients in Water Quality

In situ and analytical water quality parameters were collected as planned at twelve river stations during Spring, Summer and Fall 2006, and Summer 2007. Data were reviewed for quality and precision, and analyzed for spatial and temporal patterns relative to Project operations and local ecology. *In situ* data for river stations and analytical data for all stations are given in Tables E6.2.2.4-9 through 16, for all events through the Summer 2007 sampling.

Butte Creek

Seven river stations, including one station each in the Butte and Hendricks canals, were sampled in Spring, Summer, and Fall 2006, and an additional sampling event occurred in Summer 2007. Station HC1 is located on the Hendricks Canal immediately upstream of the confluence with Butte Canal (Figure E6.2.2.4-1). Though plotted adjacent to station BXC1 in longitudinal profiles, it should be noted that HC1 is not downstream of any Butte Creek station, and is not directly upstream of any Butte Creek station either, as the Hendricks and Butte Canals join above the next lower sampling location (BC3).

Measured values for *in situ* parameters in Butte Creek during 2006 and 2007 are given in Tables E6.2.2.4-9 and 10. Butte Creek water temperatures ranged from 5.8^{o}C (BC1, Spring) to 19.5^{o}C (BC5, Summer) during 2006, and 20.9 ^{o}C (BC4, Summer) in 2007. Water temperature generally increased from upstream to downstream Butte Creek stations during all sampling events (Figure E6.2.2.4-6). As shown in Figure E6.2.2.4-7, concentrations of DO in 2006 and 2007 ranged from 8.8 mg/L (BC2, Summer 2006) to 11.5 mg/L (BC3 and HC1, Spring 2006). Mean DO concentrations were slightly higher in Spring and Fall 2006 (11.0 and 10.8 mg/L, respectively) than in Summer 2006 (9.3 mg/L) or Summer 2007 (9.5 mg/L), perhaps because warmer summer water temperatures led to reduced oxygen solubility and/or to elevated biological oxygen demand. Longitudinal trends in Butte Creek for DO concentration during 2006 were minor, consisting of a slight depression in DO concentration at stations BXC1 (Spring) and BC2 (Summer and Fall) relative to upstream and downstream sites (Figure E6.2.2.4-7). Longitudinal trends in DO saturation were more pronounced, with increasing DO saturation downstream during Spring and Summer 2006, but not present in the Fall (Figure E6.2.2.4-8). The observed 2006 DO trend may be attributable to the positive downstream trend in water temperature (i.e. given similar DO concentrations, warmer water is more saturated than cold water), or to local effects of algal populations or Project infrastructure. DO saturation ranged from 99 percent (several stations, all sampling events) to 109 percent (several stations, Spring 2006). In contrast to 2006, the longitudinal profile of DO concentrations during Summer 2007 suggested a slightly different trend, with the highest measured DO concentration occurring in Butte Creek (BC2, 10.6 mg/L) just above DeSabla Powerhouse, and slightly lower concentrations (9.4 to 10.0 mg/L) at Butte Creek sites downstream of the powerhouse. As in 2006, longitudinal trends in DO saturation were more pronounced than for concentration, ranging from 94% at BC1 to 115% just above DeSabla Powerhouse (BC2) and 114% further downstream in Butte Creek (BC4). The 2007 trend may be due to warmer temperatures, particularly at site BC4 which also exhibited the highest water temperature in Butte Creek during Summer 2007 sampling (Figure E6.2.2.4-6).

Turbidity was low during all routine 2006 and 2007 sampling events, ranging from 0.3 NTU (BC1 and BC2, Fall 2006) to 3.9 NTU (BXC1, Spring 2006). Across all seasons in 2006, there was a general longitudinal increase in turbidity from upstream to downstream Butte Creek sites (Figure E6.2.2.4-9), while in Summer 2007 turbidity was highest in Butte Creek upstream of DeSabla Powerhouse (Site BC2) and decreased by approximately 1 NTU progressing downstream to site BC4. Specific conductance (SpC) measured at Butte Creek sites in 2006 ranged from 35 uS/cm (HC1, Spring) to 133 uS/cm at 25^{o}C (BC2, Fall). Values increased slightly from station to station BC2 (above DeSabla Powerhouse) during all 2006 sampling events, and were lower in Butte (BXC1) and Hendricks (HC1) canals as compared with Butte Creek sites. Specific conductance values for Summer 2007 in Butte Creek were consistently ~20 uS/cm lower than values measured during Summer 2006 sampling events but exhibited a similar longitudinal pattern. Seasonal patterns in SpC in 2006 were noticeable, doubling from Spring to Summer and increasing by ~10% from Summer to Fall (Figure E6.2.2.4-10). This is likely due to dilution from low-ionic strength snowmelt water in the Spring. Results for pH measured in Butte Creek in 2006 ranged from 6.78 (BC3, Spring) to 8.16 (HC1, Summer). No spatial or temporal trends were observed for pH in the Butte Creek study area during 2006 or 2007 (Figure E6.2.2.4-11).

Non-metal inorganic analytes (Calcium (Ca), Magnesium (Mg), Potassium (K), Sodium (Na), Chloride (Cl), Sulfate (SO_4), Alkalinity, and Hardness) in Butte Creek were low throughout 2006 and 2007. Results for each analyte are presented by station and sampling event in Tables E6.2.2.4-11 through 14. Several constituents (Alkalinity, Ca, Mg, Na, and Hardness) were noticeably lower in Spring 2006 than in Summer or Fall, perhaps due to dilution by snowmelt water. Chloride and SO_4 exhibited seasonal spatial trends in Fall 2006 and Summer 2007, decreasing slightly from upstream to downstream sites. In all sampling events, values for several analytes (i.e., hardness, alkalinity, Ca, Mg, Na, Cl, SO_4) tended to be slightly higher at station BC2 than at other Butte Creek sites. Hendricks Canal tended to exhibit lower concentrations of these analytes, and correspondingly Butte Creek sites downstream of DeSabla Powerhouse exhibited lower concentrations than those measured at BC2. None of the differences at BC2 indicate diminished water quality, however. Potassium was present at 1 mg/L at all sites in 2007 (MRL 1mg/L) whereas it was not detected at any site in 2006 (MRL 2 mg/L; the MRLs differ between the two years because different laboratories with differing MRLs were used in 2006 and 2007). Mg levels were slightly but consistently higher (0.1-1 mg/L) in 2007 as compared with the 2006 data. No TSS were detected above laboratory reporting limits at any Butte Creek stations except at BC4 in Spring 2006 (5 mg/L; Table E6.2.2.4-11). Results for TDS were above reporting limits at all Butte Creek stations during all sampling events. Concentrations increased from Spring 2006 (Butte Creek mean 22 mg/L) through the Fall 2006 (Butte Creek mean 83 mg/L). Longitudinal trends in TDS were not as strong or consistent, with a slight downstream increase from BC1 to BC4 in Spring 2006, a slight downstream decrease from BC1 to BC3 in Fall 2006, and a major depression at BC3 in Summer 2006 relative to both upstream and downstream sites (Figure E6.2.2.4-12). In 2007, TDS ranged from 82 mg/L at BC1 and BXC1 to 98 mg/L at BC2. These results overlapped with TDS values from Fall 2006, and were approximately 30 mg/L higher than observed TDS during Summer 2006.

Inorganic nitrogen (N) concentrations in Butte Creek were generally low during 2006 and 2007 sampling events. Concentrations of Total Kjeldahl Nitrogen (TKN) ranged from below laboratory detection limits (several stations in Spring and Fall 2006) to 3.3 mg/L (BXC1, Summer 2006). In Fall 2006, TKN declined from BC1 to BC2, then increased downstream to BC4 (Centerville Powerhouse; Figure E6.2.2.4-13). In Spring and Summer 2006, TKN concentrations were elevated at BXC1 relative to other sites (Figure E6.2.2.4-13). Elevated TKN levels also appeared downstream of BC1 in DeSabla Forebay and at station BC2 in Spring 2006. Ammonia was not detected at any station in Butte Creek during 2006 (Table E6.2.2.4-15). The presence of TKN without detectable levels of NH_4-N indicates a dominance of organic N. Since very low levels of planktonic algae were indicated (See Chlorophyll-a results, below) the observed nitrogen levels are likely due to attached algae or algal films. Analysis of total and dissolved organic N would be required to distinguish between the two. Nitrate + nitrite (NO_2+NO_3) concentrations exhibited no longitudinal trends and were either not detected or J-flagged results for all samples (Table E6.2.2.4-15). Concentrations of TKN, ammonia, and NO_2+NO_3 were below laboratory reporting limits throughout all stations during the 2007 sampling event (Figure E6.2.2.4-13). Total phosphorus concentrations in Butte Creek in 2006 ranged from below laboratory detection limits (several stations, all sampling events) to 0.063 mg/L (BC2, Summer), while in 2007 all stations were below laboratory detection limits (Figure E6.2.2.4-14). Though no spatial trends were observed in Spring or Fall 2006, Summer 2006 TP values increased at BC2 from upstream levels, and then decreased downstream to station BC4 (Figure E6.2.2.4-12). There were no strong spatial trends in orthophosphorus (PO_4-P) observed, however a marked increase in PO_4-P concentration at station BC2 in Summer 2006 relative to upstream and downstream values is of note (Table E6.2.2.4-16). An accompanying local change in pH or other *in situ* parameters did not occur. However, PO_4-P levels in Butte Creek were generally elevated in Summer 2006. That is, at pH's observed in the Study area (pH>6), PO_4-P solubility generally increases by a factor of 10-100 for each pH unit increase (Stumm and Morgan 1970). Similar trends were not seen in Summer 2007, when PO_4-P remained consistently at or below the MDL.

Chlorophyll-a was not detected in any reported measurements for Butte Creek sites in 2006 or 2007. This is to be expected, since flowing riverine environments are generally not conducive to the development of planktonic algal populations. Epilithic and epiphytic populations are more common, and less likely to be detected by tests for suspended chlorophyll.

Measured concentrations of total and dissolved metals in Butte Creek were generally low. Results for each analyte are presented by station and sampling event in Tables E6.2.2.4-17 through 20. Silver (Ag; total and dissolved) was below the MDL for all samples except for total Ag at BC2 in Spring 2006 (0.23 ug/L, J-flagged; Table E6.2.2.4-19) and Summer 2007 (0.72 ug/L) and dissolved Ag at BC3 in Summer 2007 (0.2 ug/L). Iron (Fe) concentrations increased progressively downstream of BC2 in Summer 2006 and Summer 2007. Iron concentrations were higher at the canal sites (BXC1, HC1) than at Butte Creek sites above the DeSabla Powerhouse (BC1, BC2) during all sampling events, suggesting that elevated levels of Fe downstream of the DeSabla Powerhouse may be partially due to inputs from the Butte and Hendricks canals. Results for Mn were elevated at BXC1 relative to upstream and downstream stations during all sampling events, and there was a slight downstream increase in Mn from BC1 to BC5 in Spring and Summer 2006 (Figure E6.2.2.4-15). Manganese levels in Summer 2007 varied only slightly (by 1.4 ug/L or less) between BC1 and BC4, but increased almost threefold at BC5 to a concentration of 6.8 ug/L.

<u>WBFR</u>

Six river stations, including one station in the Hendricks Canal, were sampled in Spring, Summer and Fall of 2006, and Summer of 2007. Though discussed above with Butte Creek stations, station HC1 was also considered in spatial analyses for the WBFR due to its location immediately downstream of the Hendricks Diversion Dam (station WBFR2). There are no WBFR stations downstream of HC1.

Measured values for *in situ* parameters in the WBFR during 2006 are given in Tables E6.2.2.4-9 and 10. WBFR water temperatures ranged from 5.4^{o}C (WBFR1, Fall) to 18.4^{o}C (WBFR4, Summer) during 2006. Water temperatures ranged from 6.1^{o}C to 19.3^{o}C during 2007. Water temperature increased from upstream to downstream WBFR stations, with a few exceptions (Figure E6.2.2.4-16). The higher water temperature observed at station WBFR3 during Spring 2006 sampling is due to the fact that sampling occurred much later in the season at this station. Similarly, the slightly lower water temperature observed at WBFR3 during Fall 2006 sampling may also be attributed to later sampling there relative to other stations. Elevated water temperatures at stations PBC1 and WBFR1 as compared to downstream station WBFR2 during Spring 2006 sampling are likely due to the fact that the former stations were sampled late in the afternoon (~16:00), whereas the latter was sampled in the morning (10:00). Concentrations of DO in 2006 ranged from 7.8 mg/L (WBFR3, Spring) to 11.5 mg/L (WBFR2, Spring). Measured DO was relatively constant throughout the WBFR study area, with perhaps a slight downward longitudinal trend in Summer 2006 and elevated concentrations at WBFR2 and HC1 as compared to upstream and downstream stations during Spring (Figure E6.2.2.4-17). Percent saturation results for DO were frequently over 100% in 2006 (Tables E6.2.2.4-9 and 10), with values ranging from 94% (WBFR3 in Spring and WBFR2 in Fall) to 105% (WBFR4, Spring). Longitudinal DO saturation patterns were reflective of trends in DO concentration in Spring and

Summer 2006 (Figure E6.2.2.4-18). Measured DO in 2007 varied slightly from measurements in 2006, with a slight upward longitudinal trend in DO saturation moving downstream, and DO concentration showing little variation along the reach. 2007 DO concentrations ranged from 8.2 to 9.4 mg/L on the WBFR sample sites.

Turbidity in the WBFR was low during all routine 2006 sampling events, ranging from 0.2 NTU (WBRF1 and WBFR4, Fall) to 2.1 NTU (WBFR4, Spring). Turbidity generally decreased from upstream to downstream stations in 2006 (Figure E6.2.2.4-19). Stations HC1 and WBFR4 are marked exceptions to this pattern, exhibiting increased turbidity as compared to upstream stations (WBFR2 and WBFR3, respectively) during all sampling events (Table E6.2.2.4-10). In 2007, turbidity was less than 1 NTU for all the WBFR stations and was within the range of turbidity observed in 2006. No longitudinal trend in 2007 turbidity data was observed (Figure E6.2.2.4-19). Measured SpC at WBFR sites in 2006 ranged from 32 uS/cm (WBFR4, Spring) to 108 uS/cm (WBFR1, Fall). There was generally no longitudinal trend in SpC in the WBFR (Figure Eg.2.2.2-20), but results were higher at WBFR1 than at PBC1 (a tributary) during all seasons. Measurements from 2007 indicate a downstream trend of increasing SpC, starting at 63 uS/cm (WBFR1) and rising to 80 uS/cm (WBFR4) at 25^{o}C (Figure E6.2.2.4-19). Seasonally, SpC doubled from Spring 2006 to Summer 2006 and increased by ~20% from Summer 2006 to Fall 2006 (Table E6.2.2.4-10). The seasonal trend is likely due to inputs of low-ionic strength snowmelt water in the Spring. SpC in Summer 2007 was lower than in Summer 2006 at all sites except WBFR3. WBFR3 was sampled three weeks after the other Summer 2007 stations and closer to the fall season, which may explain why SpC at this site reflected Fall 2006 results more closely than did other Summer 2007 sites. The range in pH observed in the WBFR in 2006 was small: 6.95 (PBC1, Spring 2006) to 8.05 (WBFR3, Fall 2006). A consistent pattern of increasing pH from station WBFR2 to downstream stations HC1 and WBFR3 was observed (Figure E6.2.2.4-19). This may be due to photosynthetic activity in wider, less-shaded portions of the reach, where uptake of carbon dioxide by epilithic algae during photosynthesis results in increased pH as calcium carbonate dissolves to replace depleted CO_2 and maintain the chemical equilibrium (Wetzel 2001). No consistent longitudinal trend was observed in pH during 2007, but pH values were consistently higher than 2006 values during all three seasons (with the exception of the WBFR3 site), ranging from 7.6 (WBFR2) to 8.1 (WBFR4), which may indicate a generally higher level of primary productivity in 2007 than in 2006. *In situ* parameters at WBFR3 were measured three weeks after the other sites, and showed a relatively low pH value.

Non-metal inorganic analytes (Ca, Mg, K, Na, Cl, SO_4, Alkalinity, and Hardness) in the WBFR were low throughout 2006, with some exceptions at site WBFR2 in the Spring. Results for each analyte are presented by station and sampling event in Tables E6.2.2.4-11 through 14. Na at site WBFR2 (above Hendricks Diversion) in Spring 2006 was 81 mg/L. No Na was detected in either the field or equipment blank for this sampling event, and no deviations from sampling protocols occurred. Accompanying this high Na result, concentrations of Ca, Mg, K, and Hardness were also elevated at site WBFR2 in the Spring (Tables E6.2.2.4-11 through 14). Aside from the WBFR2 results, however, concentrations of Ca, Mg, Hardness, and Alkalinity were lower in Spring 2006 than during other seasons.

Non-metal inorganic analytes were generally found in higher concentrations during Summer 2007 as compared with 2006 samples. Ca, Mg and K levels were slightly higher at almost all sites in 2007 (exceptions were Mg at WBFR3 and K at WBFR2), than Ca and Mg levels measured at the same sites in 2006. Sulfate was detected only in Fall 2006 and Summer 2007. In both sampling events, sulfate concentrations increased from upstream to downstream sites (Figure E6.2.2.4-22). Chloride was either undetected or results were very low for all WBFR sites during all 2006 sampling events (Table E6.2.2.4-14). Chloride concentrations were also slightly higher in Summer 2007 sampling events than in 2006, averaging 0.78 mg/L. Suspended solids were not measured above laboratory reporting limits at any WBFR station in 2006 (Table E6.2.2.4-11) and were not measured at all in 2007. Concentrations of TDS were detected above laboratory reporting limits at all WBFR stations during all 2006 and 2007 sampling events. Results were higher in the upper WBFR than in the Philbrook Creek tributary during all sampling efforts (Figure E6.2.2.4-23). In Spring and Summer 2006 there was a decreasing longitudinal trend in TDS from WBFR1 to WBFR4, interrupted by elevated TDS at WBFR3 (Figure E6.2.2.4-21). This break from the longitudinal trend may be attributed to different timing for sampling of WBFR3 during all events (i.e. several weeks later). In Fall 2006, TDS appeared to increase from the upper WBFR downstream to WBFR2, then to decrease and remain relatively constant downstream to WBFR4 (Figure E6.2.2.4-21). No noticeable longitudinal trend in TDS was detected during Summer 2007, and with the exception of site WBFR3, observed values were greater than those in Summer 2006.

As in Butte Creek, inorganic N concentrations in the WBFR were generally low during both 2006 and 2007. Concentrations of TKN in the WBFR ranged from below laboratory detection limits (one or more stations during all sampling events) to 1.9 mg/L (WBFR1, Summer 2006). Linear longitudinal trends in TKN were not present, however there was a pattern of generally higher concentrations at high-elevation sites (PBC1, WBFR1) as compared to the rest of the system in Summer and Fall 2006. This pattern was opposite of Spring 2006, where no TKN was detected upstream of site WBFR3 (near Big Kimshew Creek; Figure E6.2.2.4-24). All Summer 2007 TKN values fell below laboratory detection limits. No NO_2+NO_3-N was detected in Summer or Fall 2006, or in Summer 2007. NO_2+NO_3 levels up to 1.1 mg/L (PBC1) were measured in Spring 2006. No NO_2+NO_3 was detected in either the field or equipment blank for the Spring sampling event, and no deviations from sampling protocols occurred. TP results ranged from below laboratory detection limits (several stations, all sampling events) to 0.066 mg/L (WBFR1, Summer 2006). Ortho-phosphate results were also largely below laboratory detection limits, with some detected values generally between 0.01 and 0.02 mg/L. Temporal trends in TP and PO_4-P in the WBFR were the same as in Butte Creek, with generally elevated concentrations in Summer (Table E6.2.2.4-16). Spatially, there was a slight downstream *increase* in PO_4-P in the Summer 2006, excluding station HC1 (Figure E6.2.2.4-23). Ortho-phosphate in Summer 2007 in part resembles this pattern, rising to 0.03 mg/L PO_4-P at WBFR3, but values were otherwise below detectable levels. PO_4-P was detected only at station WBFR2 in Spring 2006 and only at station WBFR1 in Fall 2006. However, the elevated PO_4-P result (0.095 mg/L) observed at station WBFR1 relative to other stations (PO_4-P not detected) in Fall 2006 is suspect, as no TP was detected at this station (Table E6.2.2.4-6).

Chlorophyll-a was not detected at any site except WBFR3 in Spring 2006 (0.0013 mg/L; Table E6.2.2.4-16). This is to be expected since in general, flowing riverine environments are not conducive to the development of planktonic algal populations. Station WBFR3 is characterized by several large pools, however, which may permit localized suspended algal growth.

Although no metals samples were collected at WBFR3 due to site access agreements with the property owner, measured concentrations of total and dissolved metals at other locations in the WBFR were generally low. Results for each analyte are presented by station and sampling event in Tables E6.2.2.4-17 and 20. Silver was undetectable at most sites except WBFR2, where it rose to 0.63 mg/L in Summer 2007. Iron concentrations above minimum reporting values appeared in PBC1 but not in the mainstem. Concentrations of manganese (Mn) were generally higher in Philbrook Creek than in the WBFR, reaching a maximum of 64.3 ug/L in Summer 2007. These relatively high Mn concentrations may be due to reduction of solid MnO_2 allowing for dissolution of Mn and subsequent transport downstream. (Figure E6.2.2.4-26).

Sampling of CAM 17 Metals in Butte Creek and the WBFR

Samples for CAM 17 metals were collected as planned at WBFR2 and BC5 during Spring, Summer, and Fall 2006 sampling events. Analytical data are given in Tables E6.2.2.4-32 through 36.

Reservoir Water Quality

In situ and analytical water quality parameters were collected as planned at Project reservoirs during all 2006 sampling events. Analytical data for reservoir stations are given with river station analytical data (Tables E6.2.2.4-9 through 20). Data from *in situ* profiles are given in tables E6.2.2.4-21 through 25 below. Results from total and methyl mercury analyses are given in Table E6.2.2.4-26.

<u>Round Valley Reservoir</u>

Round Valley Reservoir was sampled for analytical and *in situ* parameters in Spring and Summer 2006. The reservoir is shallow (7 m in Spring when full) and well mixed with uniform water quality throughout the water column. The reservoir was dry by the time of the Fall 2006 sampling (October 10, 2006) and Summer 2007 sampling (August 7, 2007).

Water temperatures measured during *in situ* sampling of Round Valley Reservoir ranged from 10.3^{o}C (4 to 5 m depth, Spring) to 21.3 (all depths, Summer). Water temperatures declined by ~1^{o}C from surface to bottom in Spring (5 m profile) and remained constant from surface to bottom in Summer (3 m profile; Figures E6.2.2.4-27 and 28; Table E6.2.2.4-21). Concentrations of DO ranged from 7.0 mg/L (2 m depth, Summer) to 9.2 mg/L (3 m depth, Spring). The DO concentration remained relatively constant throughout the Spring profile, and decreased by ~0.5 mg/L from surface to bottom in Summer. Measured SpC ranged from 30 uS/cm (all depths, Spring) to 49 uS/cm (all depths, summer). The range in pH values was 6.9 (most depths, Spring) to 7.3 (all depths, Summer). Specific conductance and pH remained constant from surface to bottom in both Spring and Summer. Secchi depth exceeded the reservoir depth during both trips. Turbidity was low throughout, and highest in the middle of the Summer profile (1.1 NTU, 2 m depth).

Non-metal inorganic analyte concentrations were low, and similar among surface and bottom water samples where detected at all (Tables E6.2.2.4-11 through 14). The lone exception to this was TDS, which were detected at 12 mg/L at the surface in Spring, but not detected near the bottom. Results for each analyte are presented by station and sampling event in Tables E6.2.2.4-11 through 14.

Nutrients were detected during both Spring and Summer 2006 (Tables E6.2.2.4-15 and 16). Results for TKN ranged from below laboratory detection limits (bottom water, Spring) to 1.6 mg/L (surface water, Summer). Results for NO_3+NO_2-N ranged from below laboratory detection limits in Summer to 1.9 mg/L (surface water, Spring). No NH_4 was detected during either sampling event, suggesting that TKN is dominated by organic forms of N. This indicates a shift from inorganic (NO_2+NO_3) to organic N from Spring to Summer, likely due to microbial activity (i.e. inorganic nutrients early in the year fueled the growth of algal or microbial populations throughout the Summer, which led to organic N production and drawdown of the inorganic N pool). Orthophosphate was not detected in Round Valley during either sampling event, but TP ranged from below laboratory detection limits (surface water in Spring, bottom water in Summer) to 0.049 mg/L (surface water, Summer).

Chlorophyll-a was not detected in Summer, perhaps indicating P limitation of growth. Spring data were not reported due to a laboratory analytical error (Table E6.2.2.4-7).

Results for metallic analytes are presented by station and sampling event in Tables E6.2.2.4-17 through 20. Nickel and Ag were not detected above laboratory reporting limits during Spring or Summer 2006 (Tables E6.2.2.4-18 and 19). Copper and Mn were detected during both sampling events, in similar concentrations at surface to bottom. Iron was detected only in Summer, and surface concentrations (54 ug/L) were nearly double the bottom water result (29 ug/L; Table E6.2.2.4-20).

Philbrook Reservoir

Philbrook Reservoir was sampled for analytical and *in situ* parameters in Spring, Summer, and Fall 2006 and Summer of 2007.

Water temperatures measured during *in situ* sampling of Philbrook Reservoir ranged from 4.0^{o}C (16 m depth, Spring 2006) to 21.4^{o}C (0.5 to 2 m depth, Summer 2006). Observed water temperature profiles (Figures E6.2.2.4-29 through 32; Table E6.2.2.4-22 and 23) indicate that Philbrook Reservoir was stratified in Spring and Summer 2006 and in Summer 2007, with the surface mixed layer deepening by ~1 to 2 m between the 2006 sampling events (Figures E6.2.2.4-29 through 32; Table E6.2.2.4-22). By the time of the Fall 2006 sampling event, the mixed layer extended to the bottom of the reservoir (Figure E6.2.2.4-31). The thermocline in Summer 2007 was steeper and deeper (a 9.8^{o}C decline between 12 and 14 m depth in Summer 2007, as opposed to a 8.7 ^{o}C decline between 7 and 14 m depth in Summer 2006) (Fig E6.2.2.4-30 and 32; Table E6.2.2.4-23). Differences in drawdown rate or timing between 2006 and 2007 may account for the observed differences in the 2006 and 2007 summertime temperature profiles for Philbrook Reservoir.

Measured DO concentrations ranged from 0.7 mg/L (14 m depth, Summer 2007) to 12.0 mg/L (10 m depth, Summer 2006). Profiles of DO indicated metalimnetic maximums near 8 m depth in Spring and Summer 2006 and were constant with depth in Fall 2006. In Summer 2007, DO concentrations were highest in the epilimnion and decreased to <1 mg/L in the hypolimnion. Since nutrient and chlorophyll-a observations were consistently low in Philbrook Reservoir, the development of low oxygen conditions in the hypolimnion suggests that a highly stable thermal stratification may have persisted for several months in 2007, with a slow, steady depletion of DO in bottom waters during that period. DO saturation ranged from 8% (14 m depth, Summer 2007) to 148% within the Summer 2006 metalimnetic DO maximum (9 m depth). Measured SpC ranged from 44 uS/cm (1 to 9 m depth, Spring 2006) to 76 uS/cm (0.5 to 8 m depth, Fall 2006). The SpC increased slightly with depth in Spring 2006, decreased slightly with depth in Summer 2006, and was constant with depth in Fall 2006. SpC in Summer 2007 was reasonably constant with depth, with the exception of two sudden decreases of 5 to 10 uS/cm in the thermocline (13 m) and just below the thermocline (15 m). Measured pH values ranged from 6.4 (16 m depth, Spring 2006) to 7.8 (0.5 m depth, Summer 2006). The pH declined with depth in all profiles. Secchi depths were high in Spring and Summer (7.3 and 8.9 m, respectively). Secchi depth for Fall 2006 is not reported due to high winds and surface waves impeding both visibility and the ability to maintain a vertical cast. Secchi depth for Summer 2007 was not recorded. With the exception of reservoir bottom in Summer 2007, turbidity was low during all sampling events, ranging from 0 NTU (several depths) to 27.3 NTU (17 m, Summer, 2007). During 2006, turbidity increased with depth in Spring and remained relatively constant with depth in Fall. Turbidity in Summer 2006 reached a maximum just above the thermocline. In Summer 2007, layers of slightly elevated turbidity (1.7–2.4 NTU) over background levels (0.8–1.3 NTU) were observed at 3–5 m and 10–14 m depths. More elevated levels of turbidity (up to 27.3 NTU) were observed in the bottom two meters of the reservoir, but these elevated levels may have been due to sediment kicked up by the sampler contacting the reservoir bottom.

Non-metal inorganic analyte concentrations were low, and similar among surface and bottom water samples where detected at all (Tables E6.2.2.4-11 through 14). Results for each analyte are presented by station and sampling event in Tables E6.2.2.4-11 through 14.

Levels of TKN ranged from below laboratory detection limits (surface water, Spring and Fall 2006; bottom water, Summer 2007) to 2.2 mg/L (surface water, Summer 2006) (Table E6.2.2.4-15). In Fall 2006, TKN was not detected at the surface, but found at 2.0 mg/L in bottom waters, perhaps indicating that some seasonal mixing had occurred. NO_3+NO_2-N was detected only in bottom waters during the Spring 2006 sampling event at 1.1 mg/L and in surface waters at the level of the laboratory reporting limit (0.05 mg/L) in Summer 2007. Ammonia, TP, and PO_4-P were not detected above laboratory reporting limits during any sampling event (Tables E6.2.2.4-15 and 16).

Chlorophyll-a was not reported in Spring due to laboratory error, and was not detected during other sampling events.

Results for metallic analytes are presented by station and sampling event in Tables E6.2.2.4-17 and 20. Results from all events showed very low Hg and Me-Hg concentrations, either below laboratory detection limits or <1.0 ng/L in all samples (Table E6.2.2.4-26). Silver was not detected above laboratory MDLs during any sampling event (Table E6.2.2.4-19). Nickel was also not detected above laboratory MRLs during any sampling event (i.e., all estimated J-flag values not detectable above the MRL). Total and dissolved Cu results for Philbrook Reservoir were primarily not detectable above the MRL (i.e., estimated J-flag values not detectable above the MRL) with two exceptions: one bottom sample collected in the Spring which had a total concentration of 3.6 ug/L (the corresponding dissolved concentration was less than the MRL and was a J-flag estimated value of 0.44 ug/L), and a Summer 2007 surface water sample which had a dissolved concentration of 1.3 ug/L (total copper results were not reported for Summer 2007).

Elevated levels of Mn (up to 37.6 ug/L) were measured in the hypolimnion of Philbrook Reservoir in Fall 2006 and Summer 2007, as well as in the epilimnion in Fall 2006. In 2007, a further elevated Mn sample (64.3 ug/L) was detected downstream of the reservoir at site PBC1 (Table E6.2.2.4-20). The observed Mn levels in Philbrook Reservoir and downstream in Philbrook Creek suggest that Mn reduction is occurring in the reservoir, particularly at deeper points in the water column. Although not included in the study plan, 2007 redox profile measurements taken with the YSI 600XL multi-parameter Sonde indicate that Mn-reducing conditions (<225 mV) exist in both the epilimnion and the hypolimnion. As the oxidized form of Mn is a solid, chemical reduction of Mn would cause dissolution and a resultant increase in water column concentrations (Stumm, W. and J. J. Morgan 1996).

<u>DeSabla Forebay</u>

DeSabla Forebay was sampled for analytical and *in situ* parameters in Spring, Summer, and Fall 2006 and in Summer 2007.

Water temperatures measured during *in situ* sampling of DeSabla Forebay ranged from 8.6^{o}C (6 m depth, Fall 2006) to 15.91^{o}C (0.5 m depth, Summer 2007). Water temperature profiles were constant with depth, decreasing slightly in the top 1-2 m during Spring and Fall 2006 and Summer 2007 (Figures E6.2.2.4-33 through 36). Concentrations of DO ranged from 7.38 mg/L (1 m depth, Summer 2007) to 11.5 mg/L (5 m depth, Spring 2006). Profiles of DO were relatively constant with depth, but showed a slight increase from surface to near-bottom waters during all sampling events (Tables E6.2.2.4-24 and 25; Figures E6.2.2.4-33 through 36). Measured SpC ranged from 39 uS/cm (Spring 2006) to 115 uS/cm (Fall 2006). Depth profiles for SpC were constant during 2006 sampling events, and decreased slightly with depth during the Summer 2007 sampling event. Measured pH values ranged from 6.8 (3, 4, and 6 m depth, Spring 2006) to 7.89 (1 m depth, Summer 2007). Depth profiles for pH declined by ~0.3 units from surface to bottom during all 2006 sampling events (Tables E6.2.2.4-24 and 25). However, pH profiles measured in Summer 2007 increased ~0.1 unit from surface to bottom, and were elevated ~0.5 units from the Summer 2006 results. Turbidity was low during all 2006 sampling events, ranging from 0 NTU (4 and 5 m depth, Fall) to 2.6 NTU (3 to 4 m depth, Spring). However, turbidity was substantially higher in Summer 2007, ranging from 17.2 NTU at 0.5 m depth to 20.4 NTU at 6 m depth. As 2007 chlorophyll-a and nutrient results for DeSabla Reservoir were low (see text below), the increased turbidity observed in 2007 did not appear to be related to algal growth in the water column. Secchi depths ranged from 5.4 m (Summer 2007) to 6.9 m (Spring 2006). In 2006, Secchi depths in DeSabla Forebay were slightly lower than those measured in Philbrook Reservoir, however the presence of submerged aquatic vegetation in DeSabla Forebay may have reduced the accuracy of these readings.

Results for all non-metal inorganic analytes are presented by station and sampling event in Tables E6.2.2.4-11 through 14. Concentrations were generally low, and similar among surface and bottom water samples where detected at all (Tables E6.2.2.4-11 through 14). One exception to this was Cl, which was detected above laboratory reporting limits in bottom but not at all in surface samples in Summer 2006, and in surface but not bottom samples in Fall 2006 (Table E6.2.2.4-14). Also, TDS were found in surface waters at nearly twice the bottom water concentration in Summer 2006 (Table E6.2.2.4-11).

Levels of TKN in DeSabla Forebay ranged from below laboratory detection limits (surface water in Fall 2006, surface and bottom water in Summer 2006, and bottom water in Summer 2007) to 1.1 mg/L (surface water, Spring). Similarly to Philbrook Reservoir, TKN concentrations decreased in surface water and increased in bottom waters in Fall 2006 relative to levels detected in Spring 2006 or Summer 2006 (Table E6.2.2.4-15). This pattern may be the result of senescing microbial populations late in the season. Inorganic species of N (NO_2+NO_3-N and NH_4-N) were not detected in DeSabla Forebay during any sampling event in 2006. In Summer 2007, low levels of NH_4-N (0.02 mg/L, below the laboratory 0.05 mg/L MRL) were detected in surface waters, while bottom waters showed NO_2+NO_3-N levels of 0.07 mg/L (0.05 mg/L laboratory MRL). Total P concentrations ranged from below laboratory detection levels (surface water in Summer, surface and bottom water in Fall 2006 and Summer 2007) to 0.028 mg/L (surface water, Spring). Orthophosphate concentrations ranged from below laboratory detections levels (surface and bottom water, Spring 2006, Fall 2006, and surface water Summer 2006) to 0.024 mg/L (bottom water, Summer 2006). Neither TP nor PO_4 were detected in Fall 2006.

Chlorophyll-a was not detected during any sampling event, and Spring results were not reported due to a laboratory analytical error (Table E6.2.2.4-7).

Results for metallic analytes are presented by station and sampling event in Tables.E6.2.2.4-17 and 20. Ag was not detected above laboratory method detection limits during any sampling event (Table E6.2.2.4-19). Cu and Ni were not detected above laboratory MRLs during any 2006 sampling event (i.e., all estimated J-flag values not detectable above the MRL). However, Cu levels of 1.1 ug/L and 1.3 mg/L were detected in 2007 surface water and bottom water respectively. Fe was detected in Summer 2006, with bottom concentrations twice those in surface samples. This differs from the pattern observed in both Round Valley and Philbrook reservoirs, where surface concentrations exceeded bottom concentrations. Fe was also detected at lower levels in Summer 2007, with a higher concentration in the surface water, a pattern consistent with the patterns observed at the other reservoirs. Mn was detected in all samples, with no clear trend differentiating surface and bottom measurements (Table E6.2.2.4-20).

Table E6.2.2.4-9. Instantaneous *in situ* parameters collected at time of grab sample collection in Project reaches during 2006 and 2007. Part 1.

Parameter:	DO (mg/L)				DO (%)				Specific Conductivity (uS/cm at 25 °C)			
Site	Spr-06	Sum-06	Fall-06	Sum-07	Spr-06	Sum-06	Fall-06	Sum-07	Spr-06	Sum-06	Fall-06	Sum-07
WEST BRANCH FEATHER RIVER												
WBFR1	9.2	10.3	10.6	9.37	96	109	96	90	46	90	108	63
PBC1	9.4	9.5	9.4	7.45	98	101	101	92	39	61	86	61
WBFR2	11.5	9.5	9.7	8.15	104	102	94	88	33	88	103	68
WBFR3	7.8	8.9	10.5	8.51	94	100	95	98	70	86	99	104
WBFR4	11	8.7	10.2	8.95	105	98	105	104	32	85	97	80
BUTTE CREEK												
BC1	11.2	9.6	10.7	8.89	100	102	102	94	53	114	116	81
BXC1	10.1	9.2	10.6	8.92	99	100	102	95	47	106	115	81
BXC1(outage)	9.9	-	-	-	99	-	-	-	50	-	-	-
HC1	11.5	9	10.4	8.7	109	99	99	94	35	88	102	68
BC2	11	8.8	10.6	10.59	105	99	101	115	59	116	133	101
BC3	11.5	9.4	11.1	9.73	109	102	103	102	54	100	121	82
BC4	11.1	9.6	11	9.97	109	105	101	114	58	113	123	98
BC5	10.9	9.5	10.9	9.45	106	106	101	104	57	109	124	92

Note:

- Indicates no data collected. (Unscheduled outage occurred at station BXC1 during Spring sampling only.)

Table E6.2.2.4-10. Instantaneous *in situ* parameters collected at time of grab sample collection in Project reaches during 2006 and 2007. Part 2.

Parameter:	pH (s.u.)				Turbidity (NTU)				Water Temperature (ºC)			
Site	**Spr-06**	**Sum-06**	**Fall-06**	**Sum-07**	**Spr-06**	**Sum-06**	**Fall-06**	**Sum-07**	**Spr-06**	**Sum-06**	**Fall-06**	**Sum-07**
WEST BRANCH FEATHER RIVER												
WBFR1	7.37	7.37	7.33	7.78	0.67	0.55	0.2	0.80	9.99	10.15	5.41	6.06
PBC1	6.95	7.37	7.25	7.83	1.38	0.95	0.37	1.37	9.49	10.5	8.52	16.5
WBFR2	7.16	7.08	7.1	7.63	0.49	0.48	0.23	0.60	6	13.49	8.42	13.14
WBFR3	7.8	7.81	8.05	7.43	0.6	<0.5	<0.5	0.25	19.7	16.4	7.27	17.44
WBFR4	7.11	7.67	7.52	8.11	2.13	0.34	0.2	0.80	10.91	18.45	14.06	19.83
BUTTE CREEK												
BC1	7.5	7.43	7.48	7.78	1.22	0.44	0.33	1.13	5.84	13.5	8.54	12.79
BXC1	6.69	8.04	7.07	8	3.87	1.12	0.67	0.93	10.25	15.62	9.14	13.48
BXC1(outage)	7.08	-	-	-	42.6	-	-	-	10.76	-	-	-
HC1	7.23	8.16	7.52	8.03	3.7	1	1.17	1.67	8.72	16.3	9.77	14.14
BC2	6.87	8.03	7.52	8.31	1.23	0.54	0.33	2.20	11.1	19.04	11.46	17.22
BC3	6.78	8.1	7.41	8.23	1.52	0.89	0.9	1.83	10.91	17.25	9.83	15.71
BC4	7.04	7.8	7.46	8.56	1.88	0.84	0.8	0.97	13.53	18.86	10.91	20.88
BC5	7.24	7.86	7.22	8.5	2.26	1.28	0.63	1.13	13.34	19.46	10.87	19.3

Note:

\- Indicates no data collected. (Unscheduled outage occurred at station BXC1 during Spring sampling only.)

Table E6.2.2.4-11. Dissolved and suspended solids and hardness (mg/L) water quality data by station and season in the DeSabla-Centerville Project study area during 2006 and 2007.

Site	Total Suspended Solids (mg/L)				Total Dissolved Solids (mg/L)				Hardness as $CaCO_3$ (mg/L)			
	Spr-06	Sum-06	Fall-06	Sum-07	Spr-06	Sum-06	Fall-06	Sum-07	Spr-06	Sum-06	Fall-06	Sum-07
WEST BRANCH FEATHER RIVER												
RVR1(E)	2.0[J]	ND	-	-	12[BA]	ND[BA]	-	-	13	19	-	-
RVR1(H)	1.0[J]	ND	-	-	ND[BA]	ND[BA]	-	-	13	19	-	-
WBFR1	ND	ND	ND	-	28[BA]	55[BA]	75	78	20	38	45	42
PBR1(E)	4.0[J]	ND	ND	-	NR	4[BA,J]	50	51	22	28	35	34
PBR1(H)	1.0[J]	ND	ND	-	25[BA]	ND[BA]	36[BA]	44	23	26	35	34
PBC1	3.0[J]	ND	ND	-	14[BA]	28[BA]	54	48	21	30	45	35
WBFR2	2.0[J]	ND	ND	-	17[BA]	51[BA]	130	68	100	34	43	40
WBFR3	3.0[J]	ND	ND	-	71	110	92	75	36	41	44	45
WBFR4	1.0[J]	ND	ND	-	5[BA]	41[BA]	73	73	14	34	39	35
BUTTE CREEK												
BC1	3.0[J]	ND	ND	-	19[BA]	63[BA]	93	82	25	46	49	48
BXC1	ND	ND	ND	-	12[BA]	43[BA]	82	82	19	44	49	48
HC1	4.0[J]	ND	ND	-	8[BA]	37[BA]	77	66	18	37	41	40
DS1(E)	1.0[J]	ND	ND	-	21[BA]	102[BA]	81	82	17	40	44	43
DS1(H)	3.0[J]	ND	ND	-	31[BA]	55[BA]	69[BA]	78	18	40	45	41
BC2	1.0[J]	ND	ND	-	27[BA]	52[BA]	86	98	24	45	50	55
BC3	1.0[J]	ND	ND	-	23[BA]	7[BA]	80	86	22	43	48	42
BC4	5	ND	ND	-	29[BA]	49[BA]	80	93	23	47	46	46
BC5	1.0[J]	2.0[BA,J]	ND	-	20[BA]	65[BA]	79	87	25	44	46	44

Notes:

-	No data collected.
ND	Result below laboratory MDL
X[J]	Result below MRL, but above laboratory method detection limit (MDL) and reported here as a J-flag. Estimated J-flag values do not meet the SWRCB Listing Policy Section 6.1.5.5 as stated previously (SWRCB 2004a).
X[BA]	Result adjusted based on equipment or field blank result

Table E6.2.2.4-12. Mineral water quality parameters by station and season in the DeSabla-Centerville Project study area during 2006 and 2007.

Site	Total Alkalinity (mg/L)				Calcium (mg/L)				Magnesium (mg/L)			
	Spr-06	Sum-06	Fall-06	Sum-07	Spr-06	Sum-06	Fall-06	Sum-07	Spr-06	Sum-06	Fall-06	Sum-07
WEST BRANCH FEATHER RIVER												
RVR1(E)	19	28	-	-	3.1	4.1	-	-	1.3	2.1	-	-
RVR1(H)	20	28	-	-	3.1	4.1	-	-	1.3	2	-	-
WBFR1	28	58	61 JD	58	4.9	9.1	11	12	1.9	3.7	4.3	5
PBR1(E)	27	44	37 JD	40	6.3	7.9	10	12	1.5	1.9	2.3	3
PBR1(H)	29	31	40 JD	40	6.4	7.4	10	12	1.6	1.8	2.4	3
PBC1	25	57	41 JD	41	5.9	8.3	10	12	1.5	2.2	2.6	3
WBFR2	25	44	53 JD	51	28	8.4	11	12	8.6	3.2	3.9	4
WBFR3	37	48	53	55	9.2	10	11	12	3.1	3.8	4.2	4
WBFR4	28	42	47 JD	48	3.5	8.1	9.7	11	1.2	3.3	3.6	4
BUTTE CREEK SITES												
BC1	34	58	59 JD	62	5.8	11	11	13	2.4	4.6	4.9	5
BXC1	37	61	58 JD	61	4.4	10	12	13	2	4.5	4.8	5
HC1	24	50	77 JD	50	4.5	9.2	10	12	1.6	3.4	3.6	4
DS1(E)	25	51	57 JD	56	4.4	9.4	11	12	1.6	3.9	4.2	4
DS1(H)	25	51	59 JD	55	4.4	9.5	11	12	1.6	3.9	4.3	4
BC2	29	75	81 JD	67	5.5	10	12	14	2.4	4.7	5	6
BC3	37	62	60 JD	58	5.1	10	11	13	2.2	4.3	4.6	5
BC4	43	56	60 JD	60	5.4	11	11	14	2.2	4.6	4.4	5
BC5	35	59	60 JD	59	5.8	10	11	13	2.5	4.3	4.5	5

Notes:

- No data collected

X JD Duplicate results >MRL, but differed by >10%, suggesting uncertainty

Table E6.2.2.4-13. Mineral (mg/L) water quality data by station and season in the DeSabla-Centerville Project study area during 2006 and 2007.

Site	Potassium (mg/L)				Sodium (mg/L)			
	Spr-06	Sum-06	Fall-06	Sum-07	Spr-06	Sum-06	Fall-06	Sum-07
WEST BRANCH FEATHER RIVER								
RVR1(E)	ND	ND	-	-	1.2	1.9	-	-
RVR1(H)	ND	ND	-	-	1.2	1.9	-	-
WBFR1	ND	ND	ND	2.0	1.6	2.9	3.6	3
PBR1(E)	ND	ND	ND	0.5[J]	0.66	1.1	1.3	1
PBR1(H)	ND	ND	ND	0.5[J]	0.67	0.95	1.2	1
PBC1	ND	ND	ND	0.5[J]	0.73	1.1	1.3	1
WBFR2	6.1	ND	ND	1.0	81	2.5	3.2	2
WBFR3	ND	ND	ND	1.0	2.5	3.2	3.8	3
WBFR4	ND	ND	ND	1.0	1.4	3.5	3.6	4
BUTTE CREEK								
BC1	ND	ND	ND	1.0	1.9	3.7	4	4
BXC1	ND	ND	ND	1.0	2.3	3.6	3.9	4
HC1	ND	ND	ND	1.0	1.3	2.7	2.9	3
DS1(E)	ND	ND	ND	1.0	1.6	3.1	3.2	3
DS1(H)	ND	ND	ND	1.0	1.4	3.1	3.3	3
BC2	ND	ND	ND	1.0	2.2	3.9	4.2	5
BC3	ND	ND	ND	1.0	1.9	3.4	3.6	3
BC4	ND	ND	ND	1.0	2	3.7	3.5	4
BC5	ND	ND	ND	1.0	2.2	3.5	3.7	4

Notes:

- \- No data collected
- ND Result below laboratory MDL
- X[J] Result below MRL, but above laboratory method detection limit (MDL) and reported here as a J-flag. Estimated J-flag values do not meet the SWRCB Listing Policy Section 6.1.5.5 as stated previously (SWRCB 2004a).

Table E6.2.2.4-14. Mineral (mg/L) water quality data by station and season in the DeSabla-Centerville Project study area during 2006 and 2007.

Site	Chloride (mg/L)				Sulfate (mg/L)			
	Spr-06	Sum-06	Fall-06	Sum-07	Spr-06	Sum-06	Fall-06	Sum-07
WEST BRANCH FEATHER RIVER								
RVR1(E)	NR	ND	-	-	ND	ND	-	-
RVR1(H)	NR	ND	-	-	ND	ND	-	-
WBFR1	NR	ND	ND	0.21	ND	ND	ND	0.21[J]
PBR1(E)	NR	ND	ND	0.63	ND	ND	ND	0.6
PBR1(H)	NR	ND	ND	0.62	ND	ND	ND	0.6
PBC1	NR	ND	ND	0.62	ND	ND	ND	0.6
WBFR2	NR	ND	ND	0.68	ND	ND	0.59	0.7
WBFR3	1.4[J]	ND	0.63	1.3[JD]	ND	ND	1	1.3
WBFR4	NR	ND	1.2	2.42	ND	ND	2.1	2.4
BC1	NR	ND	0.58	0.5	ND	ND	0.59	0.5
BUTTE CREEK								
BXC1	NR	ND	0.62	0.27	ND	ND	2.9	0.5
HC1	NR	ND	ND	0.33[BA]	ND	ND	0.64	0.6
DS1(E)	NR	ND	0.51	0.58[BA]	ND	ND	0.65	0.6
DS1(H)	NR	4.4	ND	0.62	ND	ND	0.64	0.6
BC2	NR	2.8	1.1	2.18	ND	ND	1.8	2.2
BC3	NR	ND	0.72	0.91	ND	ND	0.93	0.9
BC4	NR	ND	0.81	1.29	ND	ND	1.2	1.3
BC5	NR	ND	0.84	1.07	ND	ND	1.2	1.1

Notes:

-	No data collected
NR	Data that were excluded during the QC review are indicated by "NR" (not reported). Exclusions are detailed in table E6.2.2.4-7.
ND	Result below laboratory MDL
X[J]	Result below MRL, but above laboratory method detection limit (MDL) and reported here as a J-flag. Estimated J-flag values do not meet the SWRCB Listing Policy Section 6.1.5.5 as stated previously (SWRCB 2004a).
X[BA]	Result adjusted based on equipment or field blank result
X[JD]	Duplicate results >MRL, but differed by >10%, suggesting uncertainty

Table E6.2.2.4-15. Nitrogen (mg/L) water quality data by station and season in the DeSabla-Centerville Project study area during 2006 and 2007.

Site	Nitrate + Nitrite (mg/L)				Ammonia Nitrogen (mg/L)				Total Kjeldahl Nitrogen (mg/L)			
	Spr-06	Sum-06	Fall-06	Sum-07	Spr-06	Sum-06	Fall-06	Sum-07	Spr-06	Sum-06	Fall-06	Sum-07
WEST BRANCH FEATHER RIVER												
RVR1(E)	1.9	ND	-	-	ND	ND	-	-	ND	1.6[BA,JD]	-	-
RVR1(H)	0.55[J]	ND	-	-	ND	ND	-	-	ND[JD]	0.84 [BA,JD]	-	-
WBFR1	ND	ND	ND	ND	ND	ND	ND	ND	ND[JD]	1.9 [BA,JD]	0.6[BA]	ND
PBR1(E)	ND	ND	ND	0.05[BA]	ND	ND	ND	ND	ND[JD]	2.2 [BA,JD]	ND [BA]	0.2
PBR1(H)	1.1	ND	ND	ND	ND	ND	ND	ND	0.56	0.28 [BA,JD]	0.9 [BA]	ND
PBC1	1.1	ND	ND	ND	ND	ND	ND	ND	ND	0.54 [BA,JD]	ND [BA]	ND
WBFR2	0.45[J]	ND	ND	ND	ND	ND	ND	ND	ND[JD]	ND [BA,JD]	ND [BA]	ND
WBFR3	ND	ND	ND	0.02[BA]	ND	ND	ND	ND	1.1[JD]	NR	0.6	ND
WBFR4	ND	ND	ND	ND	ND	ND	ND	ND	0.56[JD]	0.84 [BA,JD]	ND [BA]	ND
BUTTE CREEK												
BC1	0.66[J]	ND	ND	ND	ND	ND	ND	ND	ND[JD]	0.84 [BA,JD]	0.6 [BA]	ND
BXC1	ND	ND	ND	ND	ND	ND	ND	ND	1.1[JD]	3.34 [BA,JD]	ND [BA]	ND
HC1	0.57[J]	ND	ND	ND	ND	ND	ND	ND	ND[JD]	0.54 [BA,JD]	ND [BA]	ND
DS1(E)	ND	ND	ND	ND	ND	ND	ND	0.02[J]	1.1[JD]	0.28 [BA,JD]	ND [BA]	0.1[J]
DS1(H)	ND	ND	ND	0.07[BA]	ND	ND	ND	ND	0.56[JD]	ND [BA,JD]	ND [BA]	ND
BC2	ND	ND	ND	ND	ND	ND	ND	0.03[J]	0.84[JD]	0.84 [BA,JD]	ND [BA]	0.1[J]
BC3	ND	ND	ND	ND	ND	ND	ND	ND	ND[JD]	0.54 [BA,JD]	ND [BA]	ND
BC4	ND	ND	ND	ND	ND	ND	ND	ND	ND[JD]	0.84 [BA,JD]	0.9 [BA]	ND
BC5	ND	ND	ND	0.01[BA]	ND	ND	ND	0.02[J]	ND[JD]	0.84 [BA,JD]	ND [BA]	ND

Notes:

-	No data.
NR	Data that were excluded during the QC review are indicated by "NR" (not reported). Exclusions are detailed in table E6.2.2.4-7.
ND	Result below laboratory MDL
X[J]	Result below MRL, but above laboratory method detection limit (MDL) and reported here as a J-flag. Estimated J-flag values do not meet the SWRCB Listing Policy Section 6.1.5.5 as stated previously (SWRCB 2004a).
X[JD]	Duplicate results >MRL, but differed by >10%, suggesting uncertainty
X[BA]	Result adjusted based on equipment or field blank result

Table E6.2.2.4-16. Phosphorus and Chlorophyll-a (mg/L) water quality data by station and season in the DeSabla-Centerville Project study area during 2006 and 2007.

Site	Total Phosphorus (mg/L)				Orthophosphate (mg/L)				Chlorophyll-a (mg/L)			
	Spr-06	Sum-06	Fall-06	Sum-07	Spr-06	Sum-06	Fall-06	Sum-07	Spr-06	Sum-06	Fall-06	Sum-07
WEST BRANCH FEATHER RIVER												
RVR1(E)	NR	0.049	-	-	ND	ND	-	-	NR	ND	-	-
RVR1(H)	NR	ND	-	-	ND	ND	-	-	-	-	-	-
WBFR1	NR	0.066	ND	ND	ND	0.013	0.095	0.02[J]	NR	ND	ND	ND
PBR1(E)	NR	ND	ND	ND	ND	ND	ND	ND	NR	ND	ND	ND
PBR1(H)	NR	ND	ND	ND	ND	ND	ND	ND	-	-	-	ND
PBC1	NR	ND	ND	ND	ND	ND	ND	ND	NR	ND	ND	ND
WBFR2	NR	0.015	ND	ND	0.011	0.013	ND	0.01[J]	NR	ND	ND	ND
WBFR3	0.015[JD]	0.011	ND	0.03[J]	NA	0.02	ND	0.01[J]	0.0013	ND	ND	ND
WBFR4	NR	0.015	ND	ND	ND	0.018	ND	ND	NR	ND	ND	ND
BUTTE CREEK												
BC1	NR	0.015	ND	ND	0.013	0.018	ND	0.01[J]	NR	ND	ND	ND
BXC1	NR	0.02	ND	ND	ND	0.015	ND	0.01[J]	NR	ND	ND	ND
HC1	NR	0.018	ND	ND	ND	ND	ND	0.01[J]	NR	ND	ND	ND
DS1(E)	NR	ND	ND	ND	ND	0.018	ND	ND	NR	ND	ND	ND
DS1(H)	NR	0.011	ND	ND	ND	0.024	ND	0.01[J]	-	-	-	ND
BC2	NR	0.063	ND	ND	ND	0.095	ND	0.01[J]	NR	ND	ND	ND
BC3	NR	0.036	ND	ND	ND	0.011	ND	0.01[J]	NR	ND	ND	ND
BC4	NR	ND	ND	ND	ND	0.018	ND	ND	NR	ND	ND	ND
BC5	NR	0.022	ND	ND	ND	0.015	ND	ND	NR	ND	ND	ND

Notes:

-	No data collected
NA	Results not available at time of report writing
NR	Data that were excluded during the QC review are indicated by "NR" (not reported). Exclusions are detailed in table E6.2.2.4-7.
ND	Result below laboratory MDL
X[J]	Result below MRL, but above laboratory method detection limit (MDL) and reported here as a J-flag. Estimated J-flag values do not meet the SWRCB Listing Policy Section 6.1.5.5 as stated previously (SWRCB 2004a).
X[JD]	Duplicate results >MRL, but differed by >10%, suggesting uncertainty

Table E6.2.2.4-17. Total and dissolved copper by station and season in the DeSabla-Centerville Project study area during 2006 and 2007.

Site	Total Copper (ug/L)				Dissolved Copper (ug/L)			
	Spr-06	Sum-06	Fall-06	Sum-07	Spr-06	Sum-06	Fall-06	Sum-07
WEST BRANCH FEATHER RIVER								
RVR1(E)	0.21^{J}	0.6	-	-	0.38^{J}	0.8	-	-
RVR1(H)	0.26^{J}	0.6	-	-	0.34^{J}	0.7	-	-
WBFR1	0.32^{J}	ND	0.2^{J}	NR	0.34^{J}	0.3^{J}	0.2^{J}	1
PBR1(E)	0.36^{J}	0.3^{J}	0.7	NR	0.50^{J}	0.5	0.6	1.3
PBR1(H)	3.6	0.2^{J}	0.5^{J}	NR	0.44^{J}	0.4^{J}	0.6	0.5^{J}
PBC1	0.34^{J}	0.2^{J}	0.4^{J}	NR	0.49^{J}	0.4^{J}	0.5^{J}	1.2
WBFR2	1.2^{J}	0.2^{J}	0.3^{J}	NR	0.40^{J}	0.3^{J}	0.3^{J}	0.4^{J}
WBFR4	2.1	0.2^{J}	0.3^{J}	NR	1.4^{J}	0.7	0.4^{J}	0.4^{J}
BUTTE CREEK								
BC1	0.65^{JD}	ND	0.2^{J}	NR	0.34^{J}	0.3^{J}	0.3^{J}	1.7
BXC1	0.35^{J}	0.2^{J}	0.3^{J}	NR	0.66^{J}	0.3^{J}	0.3^{J}	0.3^{J}
HC1	0.60^{J}	0.1^{J}	0.2^{J}	NR	0.40^{J}	0.4^{J}	0.6	0.4^{J}
DS1(E)	0.42^{J}	0.2^{J}	0.3^{J}	NR	0.43^{J}	0.4^{J}	0.3^{J}	1.1
DS1(H)	0.63^{J}	0.2^{J}	0.3^{J}	NR	0.57^{J}	0.6	0.4^{J}	1.3
BC2	0.86^{J}	0.1^{J}	0.3^{J}	NR	0.50^{J}	0.4^{J}	0.3^{J}	1
BC3	0.27^{J}	0.1^{J}	0.3^{J}	NR	0.31^{J}	0.3^{J}	0.3^{J}	1.1
BC4	1.8^{J}	0.2^{J}	0.3^{J}	NR	0.45^{J}	0.5	0.6	1.2
BC5	0.44^{J}	0.2^{J}	0.3^{J}	NR	1.3^{J}	0.3^{J}	0.3^{J}	1.2

Notes:

-	No data collected
NR	Data that were excluded during the QC review are indicated by "NR" (not reported). Exclusions are detailed in table E6.2.2.4-7.
ND	Result below laboratory MDL
X^{J}	Result below MRL, but above laboratory method detection limit (MDL) and reported here as a J-flag. Estimated J-flag values do not meet the SWRCB Listing Policy Section 6.1.5.5 as stated previously (SWRCB 2004a).
X^{JD}	Duplicate results >MRL, but differed by >10%, suggesting uncertainty

Table E6.2.2.4-18. Total and dissolved nickel by station and season in the DeSabla-Centerville Project study area during 2006 and 2007.

Site	Total Nickel (ug/L)				Dissolved Nickel (ug/L)			
	Spr-06	Sum-06	Fall-06	Sum-07	Spr-06	Sum-06	Fall-06	Sum-07
WEST BRANCH FEATHER RIVER								
RVR1(E)	ND	ND	-	-	ND	0.2^{J}	-	-
RVR1(H)	ND	0.2^{J}	-	-	ND	0.2^{J}	-	-
WBFR1	0.19^{J}	0.2^{J}	0.2^{J}	ND	0.74^{J}	0.3^{J}	0.2^{J}	0.2^{J}
PBR1(E)	0.78^{J}	0.9^{J}	0.8^{J}	0.5^{J}	1.1^{J}	0.8^{J}	0.6^{J}	1.1^{J}
PBR1(H)	0.86^{J}	0.8^{J}	0.9^{J}	0.8^{J}	0.74^{J}	0.8^{J}	0.6^{J}	0.7^{J}
PBC1	0.83^{J}	0.5^{J}	0.4^{J}	0.6^{J}	NR	0.6^{J}	0.4^{J}	0.5^{J}
WBFR2	0.32^{J}	0.2^{J}	0.4^{J}	ND	0.65^{J}	0.3^{J}	0.2^{J}	0.2^{J}
WBFR4	1.1^{J}	0.3^{J}	0.4^{J}	0.3^{J}	0.33^{J}	0.4^{J}	0.3^{J}	0.3^{J}
BC1	0.21^{J}	0.2^{J}	0.3^{J}	ND	0.98^{J}	0.3^{J}	0.3^{J}	ND
BUTTE CREEK								
BXC1	0.61^{J}	0.3^{J}	0.3^{J}	ND	0.30^{J}	0.3^{J}	0.2^{J}	ND
HC1	0.37^{J}	0.2^{J}	0.3^{J}	0.4^{J}	2.6	0.3^{J}	0.3^{J}	0.2^{J}
DS1(E)	0.62^{J}	0.2^{J}	0.3^{J}	ND	0.29^{J}	0.4^{J}	0.3^{J}	0.2^{J}
DS1(H)	1.4^{J}	0.3^{J}	0.3^{J}	0.6^{J}	0.46^{J}	0.3^{J}	0.3^{J}	0.7^{J}
BC2	0.63^{J}	0.5^{J}	0.5^{J}	0.4^{J}	0.31^{J}	0.5^{J}	0.4^{J}	0.4^{J}
BC3	0.37^{J}	0.3^{J}	0.6^{J}	ND	0.93^{J}	0.3^{J}	0.3^{J}	0.2^{J}
BC4	0.37^{J}	0.5^{J}	0.4^{J}	0.3^{J}	0.42^{J}	0.6^{J}	0.5^{J}	0.3^{J}
BC5	0.41^{J}	0.4^{J}	0.5^{J}	0.7^{J}	0.38^{J}	0.4^{J}	0.5^{J}	0.4^{J}

Notes:

-	No data collected
ND	Result below laboratory MDL
X^{J}	Result below MRL, but above laboratory method detection limit (MDL) and reported here as a J-flag. Estimated J-flag values do not meet the SWRCB Listing Policy Section 6.1.5.5 as stated previously (SWRCB 2004a).
X^{JD}	Duplicate results >MRL, but differed by >10%, suggesting uncertainty

Table E6.2.2.4-19. Total and dissolved silver by station and season in the DeSabla-Centerville Project study area during 2006 and 2007.

Site	Total Silver (ug/L)				Dissolved Silver (ug/L)			
	Spr-06	Sum-06	Fall-06	Sum-07	Spr-06	Sum-06	Fall-06	Sum-07
WEST BRANCH FEATHER RIVER								
RVR1(E)	ND	ND	-	-	ND	ND	-	-
RVR1(H)	ND	ND	-	-	ND	ND	-	-
WBFR1	ND	ND	ND	ND	ND	0.1[J]	ND	ND
PBR1(E)	ND	ND	ND	ND	ND	ND	ND	ND
PBR1(H)	ND	ND	ND	ND	ND	ND	ND	ND
PBC1	ND	ND	ND	ND	ND	ND	ND	ND
WBFR2	ND	ND	ND	0.63	ND	ND	ND	ND
WBFR4	ND	ND	ND	ND	ND	ND	ND	ND
BUTTE CREEK								
BC1	ND	ND	ND	ND	ND	ND	ND	ND
BXC1	ND	ND	ND	ND	ND	ND	ND	ND
HC1	ND	ND	ND	ND	ND	ND	ND	ND
DS1(E)	ND	ND	ND	ND	ND	ND	ND	ND
DS1(H)	ND	ND	ND	ND	ND	ND	ND	ND
BC2	0.23[J]	ND	ND	0.720[JD]	ND	ND	ND	ND
BC3	ND	ND	ND	ND	ND	ND	ND	0.2[J]
BC4	ND	ND	ND	ND	ND	ND	ND	ND
BC5	ND	ND	ND	ND	ND	ND	ND	ND

Notes:

-	No data collected
ND	Result below laboratory MDL
X[J]	Result below MRL, but above laboratory method detection limit (MDL) and reported here as a J-flag. Estimated J-flag values do not meet the SWRCB Listing Policy Section 6.1.5.5 as stated previously (SWRCB 2004a).
X [JD]	Duplicate results >MRL, but differed by >10%, suggesting uncertainty

Table E6.2.2.4-20. Total iron and manganese by station and season in the DeSabla-Centerville Project study area during 2006 and 2007.

Site	Total Iron (ug/L)				Total Manganese (ug/L)			
	Spr-06	Sum-06	Fall-06	Sum-07	Spr-06	Sum-06	Fall-06	Sum-07
WEST BRANCH FEATHER RIVER								
RVR1(E)	ND	54	-	-	3	7.3	-	-
RVR1(H)	ND	29^{J}	-	-	2.8	7	-	-
WBFR1	ND	29^{J}	ND	ND	2.2	1.3	0.8	0.7
PBR1(E)	170^{J}	28^{J}	121	47^{J}	7.9	7.4	28	9.2
PBR1(H)	ND	ND	129	86^{J}	21.2	6	28	37.6
PBC1	ND	37^{J}	ND	107	8.2	5.5	2.1	64.3
WBFR2	NR	26^{J}	27^{J}	ND	1.3^{J}	0.9	1.5	2.2
WBFR4	ND	28^{J}	ND	11^{J}	0.97^{J}	1	0.7	2.4
BUTTE CREEK								
BC1	ND	39^{J}	32^{J}	ND	1.5^{J}	0.8	0.9	1.2
BXC1	ND	111	46^{J}	33	4	8	1.7	2.5
HC1	120^{J}	54^{J}	31^{J}	25	9.7	2.5	1.4	2.8
DS1(E)	ND	74^{J}	ND	71	3.5	3.4	3	7.6
DS1(H)	ND	162	ND	39	3.5	5.6	1.8	4.1
BC2	ND	30^{J}	ND	6^{J}	1.4^{J}	0.8	0.8	2.0^{JD}
BC3	ND	48^{J}	ND	25	1.9^{J}	2.6	1.4	3.3
BC4	ND	106	ND	47	1.7^{J}	2.2	1.4	2.6
BC5	ND	78^{J}	ND	105	3	2.9	1.5	6.8

Notes:

-	No data collected
ND	Result below laboratory MDL
X^{J}	Result below MRL, but above laboratory method detection limit (MDL) and reported here as a J-flag. Estimated J-flag values do not meet the SWRCB Listing Policy Section 6.1.5.5 as stated previously (SWRCB 2004a).
X^{JD}	Duplicate results >MRL, but differed by >10%, suggesting uncertainty

Table E6.2.2.4-21. Round Valley Reservoir *in situ* parameter data for Spring, Summer and Fall 2006 sampling events

	Spring 2006 Barometric Pressure: 623 mm Hg						Summer 2006 Barometric Pressure: 634 mm Hg						Fall 2006 Barometric Pressure not recorded					
Depth (m)	Temp (°C)	SpC (uS/cm)	DO (mg/L)	DO (%)	pH (s.u.)	Turb[1] NTU	Temp (°C)	SpC (uS/cm)	DO (mg/L)	DO (%)	pH (s.u)	Turb[1] NTU	Temp	SpC	DO	DO	pH	Turb[1]
0.5	11.6	30	9	102	7	0.4	21.3	49	7.4	100	7.3	0.9						
1	11.3	30	9.1	102	6.9	0.2	21.3	49	7.1	97	7.3	1.1						
2	11	30	9.1	101	6.9	0	21.3	49	7.0	96	7.3	0.8						
3	10.4	30	9.2	100	6.9	0	Bottom at 2.5 m						Reservoir dry. No sampling took place in Fall 2006.					

Table E6.2.2.4-21 (continued)

	Spring 2006 Barometric Pressure: 623 mm Hg						Summer 2006 Barometric Pressure: 634 mm Hg						Fall 2006 Barometric Pressure not recorded					
Depth	**Temp**	**SpC**	**DO**	**DO**	**pH**	**Turb[1]**	**Temp**	**SpC**	**DO**	**DO**	**pH**	**Turb[1]**	**Temp**	**SpC**	**DO**	**DO**	**pH**	**Turb[1]**
4	10.3	30	9.1	100	6.9	0												
5	10.3	30	9	99	6.9	0.5												
Bottom at 5.5 m																		

Notes:

1 Turbidity data collected with the YSI 6820 have been corrected based on parallel surface and bottom turbidity measurements made with the Hach turbidimeter. Negative values have been adjusted to 0 NTU.

Table E6.2.2.4-22. Philbrook Reservoir *in situ* parameter data for 2006 and 2007 sampling events. Part 1.

	Spring 2006 Barometric Pressure: 626 mm Hg						Summer 2006 Barometric Pressure: 628 mm Hg					
Depth (m)	**Temp (°C)**	**SpC (uS/cm)**	**DO (mg/L)**	**DO (%)**	**pH (s.u.)**	**Turb[1] NTU**	**Temp (°C)**	**SpC (uS/cm)**	**DO (mg/L)**	**DO (%)**	**pH (s.u.)**	**Turb[1] NTU**
0.5	7	45	10.3	99	7.2	0.4	21.4	67	7.3	100	7.8	0.5
1	7	44	10.9	104	7	0.3	21.4	67	7.3	102	7.7	0.8
2	6.8	44	10.2	96	6.9	0.5	21.4	67	7.5	103	7.7	0.9
3	6.7	44	10.2	95	6.9	0.4	21.3	67	7.4	102	7.6	0.9
4	6.7	44	10.2	95	6.9	0.4	21.3	67	7.4	102	7.5	0.9
5	6.6	44	10.2	95	6.8	0.5	21.4	67	7.4	102	7.5	0.8
6	5.4	44	10.3	96	6.8	0.5	21.3	67	7.4	101	7.6	0.9
7	5.2	45	10.3	96	6.7	0.6	21.3	67	7.4	101	7.5	0.8
8	4.6	44	10.8	101	6.7	0.6	20.5	67	9.1	123	7.4	0.6
9	4.4	44	10.3	96	6.6	0.6	17.0	61	11.7	148	7.4	0.3
10	4.2	45	10.2	95	6.6	0.7	14.9	59	12	145	7.3	0
11	4.1	45	10.1	97	6.5	0.7	-	-	-	-	-	-
12	4.1	45	10.1	96	6.5	0.8	13.1	58	11.8	137	7.3	0
13	4.1	45	10	94	6.5 2	0.9	-	-	-	-	-	-
14	4.1	46	10	93	6.5	1	11.8	58	11.6	130	7.1	0
15	4.1	46	10.7	100	6.5	1.2	-	-	-	-	-	-
16	4	48	9.7	90	6.4	1.2	10.0	57	10.7	115	7.00	0
17	Bottom at 16.5 m						Bottom at 16.5 m					

Notes:

1 Turbidity data collected with the YSI 6820 have been corrected based on parallel surface and bottom turbidity measurements made with the Hach turbidimeter. Negative values have been adjusted to 0 NTU.

2 Suspicious measurement (pH = 4.48) returned by YSI 600XL (primary instrument). Data corrected based on concurrent measurement made with YSI 6820.

\- No data collected

Table E6.2.2.4-23. Philbrook Reservoir in situ parameter data for 2006 and 2007 sampling events. Part 2.

	Fall 2006[1] Barometric Pressure: 618 mm Hg						Summer 2007 Barometric Pressure: 627.2 mm Hg					
Depth (m)	**Temp (°C)**	**SpC (uS/cm)**	**DO (mg/L)**	**DO (%)**	**pH (s.u)**	**Turb[2] NTU**	**Temp (°C)**	**SpC (uS/cm)**	**DO (mg/L)**	**DO (%)**	**pH (s.u)**	**Turb[2] NTU**
0.5	11.2	76	8.6	97	7.7	1.5	21.2	67	6.98	96	7.8	0.8
1	-	-	-	-	-	-	21.2	67	6.99	96	7.77	0.9
2	11.2	76	8.6	97	7.7	1.6	21.16	66	6.99	96	7.74	0.9
3	-	-	-	-	-	-	21.01	66	7.00	96	7.7	1.8
4	-	-	-	-	-	-	21.03	65	6.98	96	7.68	1.7
5	11.1	76	8.7	97	7.6	-	21	65	6.96	95	7.68	1.7
6	-	-	-	-	-	-	20.99	65	6.96	95	7.65	1.0
7	-	-	-	-	-	-	20.96	65	6.93	95	7.64	1.1
8	11.1	76	8.7	97	7.6	1.7	20.91	65	6.89	94	7.61	1.3
9	Bottom at 8.5 m						20.81	65	6.83	93	7.6	1.3
10							20.65	65	6.56	89	7.57	2.4
11							20.65	65	6.48	88	7.5	2.4
12							20.38	64	5.80	79	7.18	2.1
13							12.99	58	2.20	25	7.1	1.7
14							10.6	68	0.70	8	6.94	2.3
15							10.41	62	0.80	9	7.03	1.2
16							10.7	68	0.90	10	7.1	7.2
17							10.58	69	1.51	17	7.14	27.3
18							Bottom at 17 m					

Notes:

1 Depth intervals for *in situ* profile were extended during the Fall 2006 event to facilitate maintaining station and depth accuracy in spite of high winds and waves. Hypolimnetic depth intervals were also extended during the Summer 2006 event.

2 Turbidity data collected with the YSI 6820 have been corrected based on parallel surface and bottom turbidity measurements made with the Hach turbidimeter. Negative values have been adjusted to 0 NTU.

- No data collected

Table E6.2.2.4-24. DeSabla Forebay *in situ* parameter data for 2006 and 2007 sampling events. Part 1.

	Spring 2006 Event Barometric Pressure: 691 mm Hg						Summer 2006 Event Barometric Pressure: 692 mm Hg					
Depth (m)	**Temp (°C)**	**SpC (uS/cm)**	**DO (mg/L)**	**DO (%)**	**pH (s.u.)**	**Turb[1] NTU**	**Temp (°C)**	**SpC (uS/cm)**	**DO (mg/L)**	**DO (%)**	**pH (s.u.)**	**Turb[2] NTU[1]**
0.5	12.0	39	10.7	99.1	7.1	2.4	14.8	100	8.9	97	7.5	0.9
1	10.7	39	10.9	98.5	6.9	2.5	14.7	100	8.9	97	7.4	-
2	10.2	39	11	98	6.9	2.4	14.7	100	8.9	96	7.3	-
3	10	39	11	97.6	6.8	2.6	14.6	100	8.9	96	7.3	-
4	9.8	39	11.2	99	6.8	2.6	14.5	100	9.0	97	7.2	-
5	9.6	39	11.5	100.4	6.9	2.4	14.5	100	9.3	101	7.3	-
6	9.4	39	11.1	97.2	6.8	2.3	14.5	100	9.0	97	7.2	1
	Bottom at 6.5 m						Bottom at 6.5 m					

Notes:

1 Turbidity data collected with the YSI 6820 have been corrected based on parallel surface and bottom turbidity measurements made with the Hach turbidimeter. Negative values have been adjusted to 0 NTU.

2 YSI 6820 malfunctioning due to a damp electrical connection between Sonde and handset. Surface and bottom turbidity measurements made with Hach portable turbidimeter are reported.

\- No data collected

Table E6.2.2.4-25. DeSabla Forebay *in situ* parameter data for 2006 and 2007 sampling events. Part 2.

	Fall 2006 Event Barometric Pressure: 690 mm Hg						Summer 2007 Event Barometric Pressure: 687 mm Hg					
Depth (m)	**Temp (°C)**	**SpC (uS/cm)**	**DO (mg/L)**	**DO (%)**	**pH (s.u.)**	**Turb[1] NTU**	**Temp (°C)**	**SpC (uS/cm)**	**DO (mg/L)**	**DO (%)**	**pH (s.u.)**	**Turb[1] NTU**
0.5	10	115	10.7	104	7.6	0.5	15.91	80	7.56	85	7.76	17.2
1	9.2	115	10.9	105	7.5	0.8	15.56	78	7.38	82	7.89	17.4
2	9.2	115	10.9	105	7.4	0.5	14.52	77	7.53	82	7.88	17.9
3	9	115	11.1	106	7.4	0.5	14.27	75	7.55	82	7.86	18.5
4	8.9	115	10.7	102	7.3	0	14	75	7.66	83	7.85	19.1
5	8.6	115	11.1	105	7.3	0	14.01	74	7.63	82	7.85	20.4
6	6.6	115	11.2	101	7.3	0.6	Bottom at 5 m					
	Bottom at 6.5 m											

Note:

1 Turbidity data collected with the YSI 6820 have been corrected based on parallel surface and bottom turbidity measurements made with the Hach turbidimeter. Negative values have been adjusted to 0 NTU.

Table E6.2.2.4-26. Total and methyl mercury results by station and season in the DeSabla-Centerville Project study area during 2006 and 2007.

Site	Total Mercury (ng/L)				Methyl Mercury (ng/L))			
	Spr-06	Sum-06	Fall-06	Sum-07	Spr-06	Sum-06	Fall-06	Sum-07
WEST BRANCH FEATHER RIVER								
PBR1(H)	0.60[BA]	0.34[BA]	NR	.88[JD]	0.013[JD]	0.011 [JD]	0.031	0.056
WBFR2	0.53 [JD]	0.28	0.32	0.38	-	-	-	-
BUTTE CREEK								
BC5	0.49 [JD]	0.33	0.63	0.85	-	-	-	-

Notes:

-	No data collected
NR	Data that were excluded during the QC review are indicated by "NR" (not reported). Exclusions are detailed in table E6.2.2.4-7.
X[BA]	Result adjusted based on equipment or field blank result
X[JD]	Duplicate results >MRL, but differed by >10%, suggesting uncertainty.

Target Sampling of Coliform Bacteria in Philbrook Reservoir and DeSabla Forebay

Samples for total and fecal coliform were collected as planned in Philbrook Reservoir and DeSabla Forebay during all sampling events. Analytical data are given in Table E6.8.2.2-21. Fecal coliform values ranged from below laboratory detection limits (all Philbrook Reservoir stations, Spring 2006; PBR1-C and PBR1-I, Summer 2007) to >3,000 CFU/100 mL (DS1-A, Independence Day 2006). High fecal coliform levels were measured in DeSabla Forebay near the PSEA campground (DS1-A) during Spring (1600 CFU/100 mL), Independence Day Weekend (>2420 CFU/100 mL), Summer 2006 (668 CFU/100 mL), as well as during a follow-up sampling event conducted in response to the high 2006 Summer results (>1,600 CFU/100 mL). Geese and duck populations (up to 75 ducks and 15–20 geese) were noted in the sampling area on several of these occasions. High levels of fecal coliform were also measured in DeSabla Forebay at the eastern shore sites DS1-D (450 CFU/100 mL) and DS1-E (830 CFU/100 mL) in Summer 2007. Ducks and geese (approximately 45 total) were also observed in 2007, mostly along the eastern shore of the forebay.

Measured values for total coliform ranged from below laboratory detection limits (all Philbrook Reservoir stations, Spring 2006) to 5840 MPN/100 mL (PBR1-I, Fall 2006), with a number of stations also reporting a result of >2420 MPN/100 mL. Total coliform levels greater than 240 MPN/100mL were reported in all samples with the exception of the following: all samples, Spring 2006; PBR1-R and PBR1-C, Fall 2006; and PBR1-C and PBR1-I, Summer 2007. Approximately a dozen geese and mergansers were observed in Philbrook Reservoir during the Summer 2007 sampling.

Target Sampling of Hydrocarbons in Philbrook Reservoir

Samples for hydrocarbon parameters were collected as planned in Philbrook Reservoir and DeSabla Forebay during the Independence and Labor Day weekend sampling events. Results are presented for all analytes by station and sampling event in Tables E6.2.2.4-29 through 31. No BTEX constituents (Benzene, Toluene, Ethylbenze, Xylenes) were detected above laboratory reporting limits during either sampling event. Methyl-tert-butyl-ether (MTBE), gasoline, and diesel were either not detected or J-flagged results on both occasions. Results for gasoline from both the Independence Day and Labor Day sampling events (9.3 and 5.3 ug/L respectively) were J-flagged, indicating a high degree of uncertainty regarding precise values. Motor oil was detected during both sampling events (39 ug/L for Independence Day, J-flagged; 84 ug/L for Labor Day weekend). Oil and grease were not detected above laboratory reporting limits or observed by field staff during either sampling event.

Turbidity Monitoring During Scheduled and Unscheduled Canal Outages

Targeted turbidity monitoring was conducted on eight occasions during 2006, including four planned operational outages for scheduled Butte Canal debris cleanup or routine maintenance at Centerville Powerhouse, and four unscheduled operational outages when the powerhouse tripped off line (Table E6.2.2.4-27). The majority of sampling events in prior years also occurred for the Centerville Powerhouse and Butte Canal, with two events sampled at DeSabla Powerhouse in

2004 and one at Toadtown Powerhouse in 1996. During most turbidity sampling events in the data record, background samples were collected once per day from sites upstream of the powerhouse canals. Compliance samples were collected downstream of the canal confluence approximately every hour until conditions returned to near background or it was deemed unsafe to continue sampling (e.g., darkness). For the majority of events, turbidity was collected as grab samples in 1-liter containers and analyzed on-site using a calibrated portable turbidimeter (HF Model DRT-15CE, HF Scientific Inc., Ft. Myers, Florida). A single turbidity grab sample was recorded during an unscheduled outage on May 30, 2006, using a portable turbidimeter (Hach Model 2100P, Hach Scientific, Loveland, Colorado). Most recently, paired grab samples for turbidity and Total Suspended Solids (TSS) were collected on July 7, 2006 during an unscheduled outage. TSS was analyzed at Monarch Laboratory, Inc. in Chico, California.

Turbidity results for scheduled and unscheduled canal outages are summarized in Table E6.2.2.4-27, shown with event-specific background turbidity results when available, minimum and maximum compliance values, and the calculated Basin Plan criterion using the measured background value for each event plus the allowable increase in turbidity (generally <1 NTU; Table E6.2.2.4-5) for comparison. As shown in Table E6.2.2.4-27, scheduled outage events took place primarily during winter and spring months while unscheduled outages occurred during late summer, early fall (*Note: unscheduled outage data is available for Centerville Powerhouse only*).

During 2006, background turbidity ranged two orders of magnitude from 0.3 to 88.9 NTU. Prior years' background data also ranged two orders of magnitude (0.2 to 44.0 NTU), however the maximum historical turbidity reported was roughly half that measured in 2006. In general however, the historical turbidity record for scheduled and unscheduled canal outages is similar to the 2006 samples in that peak turbidity exceeded the current Basin Plan Water Quality Objective more often than not, but most events saw a return to background or compliance levels within 1-5 hours (Figure E6.2.2.4-4 a-d). More specific results are discussed below.

In 2006, of the four scheduled operational outages for Centerville Powerhouse, the May 11 and March 9 events exhibited peak turbidity levels 1.5 to 2.5 times greater than the Basin Plan criterion (Table E6.2.2.4-27). Sampling during both events was terminated before a complete return to either background levels or the Basin Plan criterion. During the August 2 and August 7 unscheduled events in Butte Canal (Table E6.2.2.4-27), turbidity was elevated 2.0 and 1.5 times over the Basin Plan criterion, however conditions on both dates returned to near background within two hours of peak measurements. Figure E6.2.2.4-4 shows representative turbidity time series data during scheduled and unscheduled canal outages. Dashed lines represent the applicable Basin Plan Water Quality criterion for turbidity (<1 NTU, Table E6.2.2.4-5), calculated using event-specific background concentrations. Note the different scale for the August 2, 2006 event (a). Sample intervals for the July 6 event (b) were hourly, showing a rapid increase of over an order of magnitude in measured turbidity 40 minutes after the canal release, followed by a decline to near background levels approximately four hours later.

An unscheduled outage occurred during Spring 2006 sampling of Butte Canal on May 30, 2006. Although water samples for laboratory analysis were not collected during this event, but *in situ* parameters were measured both during and after the event. *In situ* measurements did not differ between outage and post-outage sampling except for turbidity, which was higher by 39 NTU as measured by the Hach turbidimeter and by 147 NTU as measured by the multi-parameter datasonde. Results reported in Table E6.2.2.4-10 represent grab samples as the datasonde measurements were not reported due to unrepresentative sampling conditions along the bottom of the canal.

As found during 2006, prior years' maximum measured turbidity during scheduled canal outages for Centerville Powerhouse exceeded the applicable Basin Plan criterion by a factor of roughly 1.5 to 2. The exception to this was observed on January 24, 2005 (Figure E2.2.4-4c), when maximum turbidity in Butte Creek downstream of Centerville Powerhouse was approximately 18 times greater than the Basin Plan criterion. Recovery time to within 1 NTU above background levels ranged from 1–5.5 hours, where data are available. However, there were two instances of particularly long recovery time in the historical data record. For Centerville Powerhouse, the May 16, 2002 event saw a peak turbidity of 9.9 NTU (8.4 NTU increase over background concentrations) and a recovery time of greater than 24 hours. Of the two recorded canal outages for DeSabla Powerhouse, peak turbidity for the March 1, 2004 event was roughly three times greater and showed a recovery time of 18.5 hours. The Toadtown Powerhouse record includes only one date in August 1996, where peak turbidity was an order of magnitude above the current applicable Basin Plan level. However, no data is available to discern the recovery time to return to background turbidity levels.

As shown in Figure E6.2.2.4-5, the relationship between turbidity and TSS for the July 6, 2006 canal outage event shows a strong linear relationship (R^2=0.97, p<0.0001). Two measured turbidity values of 1.6 and 1.3 NTU produced TSS values greater than expected based on the linear model, falling outside the 95% confidence intervals for the slope mean (Figure E6.2.2.4-5). However, neither a natural-log (Packman et al. 1999) nor a $\log_{10}$ analysis (Christensen et al. 2001) improved the model fit, with overall R^2 values slightly lower (0.92 for both log models) and similar deviations of the residuals from normality due to the 1.6 and 1.3 NTU measurements. It is possible that the July 6, 2006 data more accurately reflect a shift from lower TSS conditions, where the sample was dominated by suspended clay and colloidal materials with a relatively steeper response in associated turbidity, to higher TSS conditions where the particle size distribution includes an increased frequency of larger soil particles that scatter light less efficiently and consequently produce a lower relative turbidity response. Further data collection would be required to confirm such a pattern, with turbidity and TSS measurements collected at 10-15 minute intervals throughout the event. Overall however, the observed linear relationship is not dissimilar from patterns observed in water bodies around the world, where regression parameters frequently vary depending upon natural variability in suspended solids size, shape, and composition as well as water color.

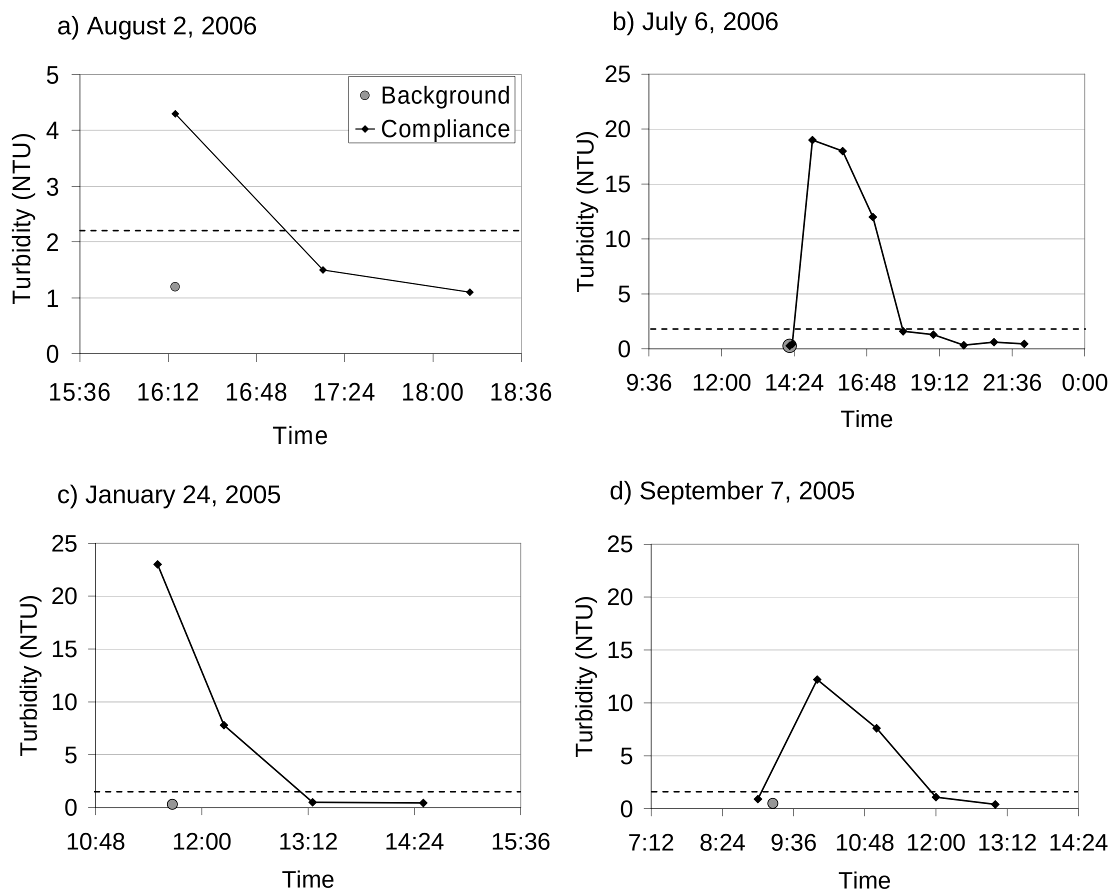

Figure E6.2.2.4-4. Example turbidity data for four dates during 2005-2006 in Butte Creek, following unscheduled (a), (b), (d) and scheduled (c) canal outages.

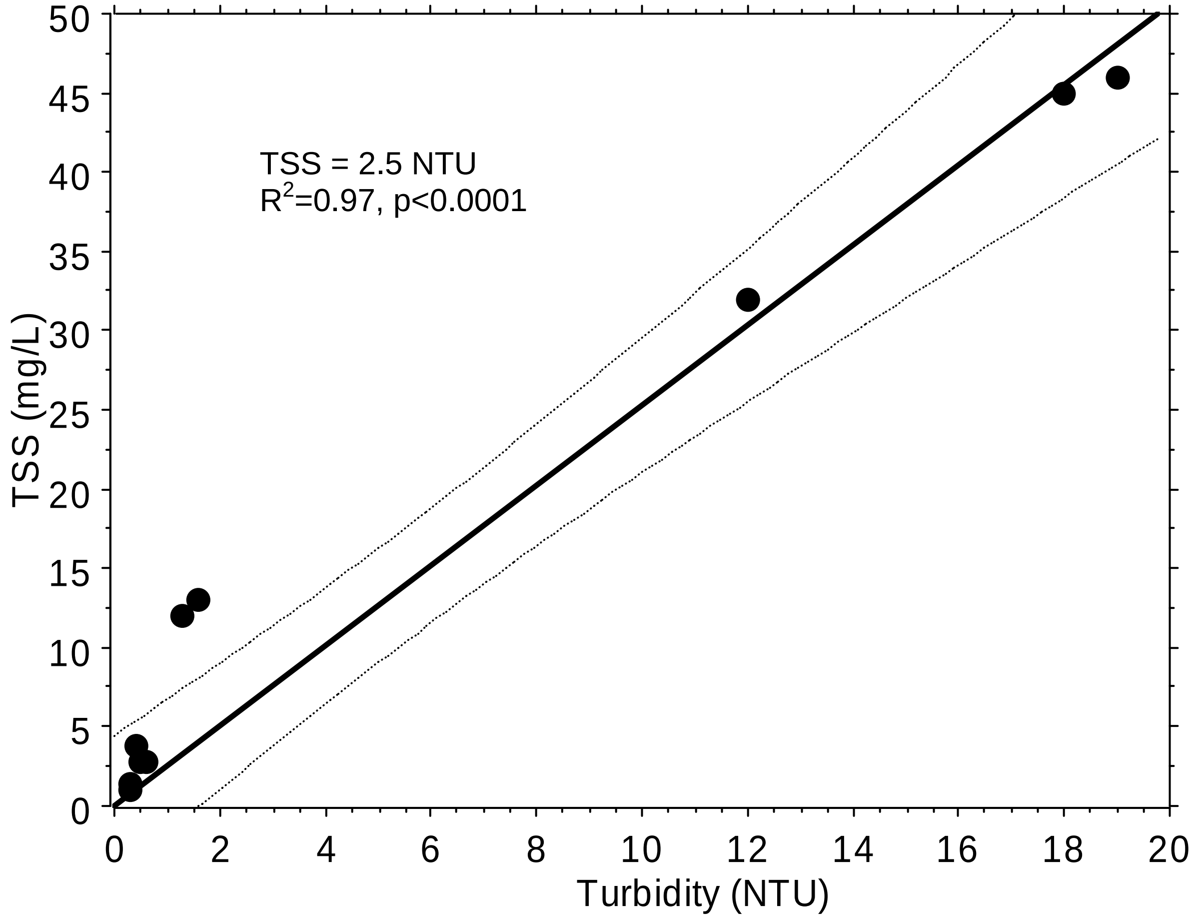

Figure E6.2.2.4-5. TSS and turbidity relationship for July 6, 2006 in Butte Creek following an unscheduled canal outage.

Table E6.2.2.4-27. Background and compliance turbidity measured during scheduled and unscheduled canal outages.

Date	Background Condition			Compliance Condition								Notes
	Site	Turbidity (NTU)		Site	Sample Interval (hour)	Number Samples	Min Turbidity (NTU)	Max Turbidity (NTU)	WQ Objective (NTU)[1]	Exceeded?	Recovery Time to WQ Obj (hrs)	
CENTERVILLE POWERHOUSE												
Scheduled operational outage[2]												
05/11/06	Butte Creek u/s of spill channel	1.6	± 0.1	Butte Creek at Steel Bridge	1	3	1.4	2.3	2.6	N	-	
03/20/06	Butte Creek at Steel Bridge	1.2	± 0.2	Butte Creek at Steel Bridge	1	2	5	5.4	2.2	Y	>1	
03/09/06	Butte Creek u/s of spill channel	3.6	± 0.4	Butte Creek at Steel Bridge	1	2	3.1	7.1	4.6	Y	>1	
02/28/06	Butte Creek u/s of spill channel	88.9	± 2	Butte Creek at Steel Bridge	3.5, 2	3	50.5	89.4	98.9	N	-	
03/17/05	Butte Creek u/s of spill channel	0.1	-	Butte Creek at Steel Bridge	1	3	0.2	1.5	1.1	Y	<2	
02/17/05	Butte Creek u/s of spill channel	0.5	-	Butte Creek at Steel Bridge	1	6	0.6	7.8	1.5	Y	>4	
01/24/05	Butte Creek u/s of spill channel	0.3	-	Butte Creek at Steel Bridge	1	4	0.4	23.0	1.3	Y	1.3	
01/12/05	Butte Creek u/s of spill channel	2.1	-	Butte Creek at Steel Bridge	1	3	1.7	4.2	3.1	Y	<2	
12/14/04	Butte Creek u/s of spill channel	1.1	-	Butte Creek at Steel Bridge	2	3	2.0	2.9	2.1	Y	5.5	
10/27/04	Butte Creek u/s of spill channel	1.8	-	Butte Creek at Steel Bridge	1	2	2.6	3.8	2.8	Y	>1	Switching over to high flow unit
09/16/04	-	-	-	Butte Creek at Steel Bridge	0.25	5	0.4	2.5	-	-	2.7	Switching over to low flow unit. Background site not given.

Table E6.2.2.4-27 (continued)

Date	Background Condition			Compliance Condition								Notes
	Site	Turbidity (NTU)		Site	Sample Interval (hour)	Number Samples	Min Turbidity (NTU)	Max Turbidity (NTU)	WQ Objective (NTU)[1]	Exceeded?	Recovery Time to WQ Obj (hrs)	
02/17/04	Butte Creek u/s of spill channel	17.5	-	Butte Creek at Steel Bridge	0.25	3	34.2	47.5	21	Y	>3	Exercised release gates at Lower Centerville Canal spill headworks
12/02/03	Butte Creek u/s of spill channel	2.0	-	Butte Creek at Steel Bridge	0.5	3	2.8	6.3	3.0	Y	>1	
09/25/03	Butte Creek u/s of spill channel	2.9/ 0.4	-	Butte Creek at Steel Bridge	1	4	1.2	5.2	3.9 / 1.4	Y	2.8	Two background samples taken
05/13/03	Butte Creek u/s of spill channel	1.6	-	Butte Creek at Steel Bridge	0.5	4	2.1	3.0	2.6	Y	1	
05/16/02	Butte Creek u/s of spill channel	0.5	-	Butte Creek at Steel Bridge	0.15-0.25	9	4.3	9.9	1.5	Y	>24	
07/17/96	Butte Creek u/s of spill channel	0.6	-	Butte Creek at Steel Bridge	0.5	2	0.9	2.7	1.6	Y	ND	
Unscheduled operational outage[3]												
08/07/06	Butte Creek near Helltown	1.2 [4]	± 0.2	Butte Creek at Steel Bridge	0.5, 1.25	3	1.4	3.4	2.2*	Y	<1.75	
08/02/06	Butte Creek near Helltown	1.2	± 0.2	Butte Creek at Steel Bridge	1	3	1.1	4.3	2.2	Y	<1	
07/06/06	Butte Creek u/s of spill channel	0.3	± 0.05	Butte Creek at Steel Bridge	1	9	0.3	19.0	1.3	Y	4	
09/07/05	Butte Creek u/s Helltown Bridge	0.5	-	Butte Creek at Steel Bridge	1	5	0.4	12.2	1.5	Y	2	
09/30/04	Butte Creek u/s of DeSabla PH	0.9	-	Butte Creek at Steel Bridge	-	1	-	1.4	1.9	N	-	Powerhouse tripped off line
Unknown reason for turbidity sample												
09/21/04	Butte Creek near Helltown	0.2	-	Butte Creek at Steel Bridge	1	3	1.4	4.9	1.2	Y	>2	

Table E6.2.2.4-27 (continued)

Date	Background Condition			Compliance Condition								Notes
	Site	Turbidity (NTU)		Site	Sample Interval (hour)	Number Samples	Min Turbidity (NTU)	Max Turbidity (NTU)	WQ Objective (NTU)[1]	Exceeded?	Recovery Time to WQ Obj (hrs)	
05/22/00	Butte Creek u/s of spill channel	2.0-3.4	-	Butte Creek at Steel Bridge	0.5	3	2.2	3.3	3-4.4	N	-	
DESABLA POWERHOUSE												
Scheduled operational outage[2]												
10/07/04	Butte Creek u/s of DeSabla PH	0.7	-	Butte Creek at LCDD	1	4	0.5	1.1	1.7	N	-	Testing bypass valve at DeSabla Powerhouse
04/01/04	Butte Creek u/s of DeSabla PH	1.0	-	Butte Creek at LCDD	1	5	1.4	5.3	2.0	Y	18.5	
TOADTOWN POWERHOUSE												
Scheduled operational outage[2]												
08/10/96	Butte Canal at BW15	0.5	-	Butte Canal above Forebay	daily	4	1.0	16.2	1.5	Y	ND	Hendricks Canal
GENERAL SYSTEM ACTIVITY												
12/08/04	Butte Creek at Steel Bridge	41.0/ 44.0	-	-	-	-	-	-	-	-	-	Natural conditions. Two data points available.
08/08/98	Butte Creek u/s of work area	0.5	-	Butte Creek d/s of work area	4	3	2.0	40	1.5	Y	ND	Flood damage repair

Notes:
1 Calculated using narrative criteria given in Table E6.2.2.4-5
2 Scheduled canal debris cleanup or routine powerhouse repair & maintenance
3 Powerhouse tripped off line
4 No background data collected on 08/07/2006. Assume background turbidity from 08/08/2006 applies.
- No data collected

Target Sampling of Fish Tissue Mercury in Philbrook Reservoir and DeSabla Forebay

Fish tissue total mercury, measured in both whole body and filet samples, was collected from Philbrook Reservoir and DeSabla Forebay during August 2006. Analytical data are given in Table E6.2.2.4-37. Fish were collected from multiple locations in each reservoir over two to three days, with twenty individuals of varying lengths included for analysis. Measured values for total mercury in filet samples ranged 24.1 to 27.0 ng/g for individual rainbow trout and 25.0 to 49.3 ng/g for composite samples of rainbow and brown trout. As expected, measured values in whole body samples were generally lower, ranging from 22.8 to 29.6 ng/g for individual rainbow trout and 25.8 to 35.4 ng/g for composite samples of rainbow and brown trout. All samples were well above the MDL (0.15 ng/g).

Target Sampling of Herbicides in Lower Centerville Canal

Water samples were collected from the Lower Centerville Canal near Pasa Way to establish a baseline for active herbicide ingredients prior to de-watering for herbicide applications in February 2007. Analytes were selected based on known constituents in herbicide applications from previous years and were consistent with actual herbicides used during 2007 (Glyphosate, Bromacil, Chlorsulfuron and Sulfometuron Methyl, Imazapyr, and Triclopyr; Table E6.2.2.4-38). The 2007 Centerville Canal application was discontinued after the first day due to heavy rains, and was completed on March 2, 2007. Post-application sampling occurred at the same location on March 27, 2007 following the first rain event. AMPA (aminomethylphosphonic acid), which is the primary degradation product of glyphosate and retains many of its physical properties, was also measured during post-application sampling because it is soluble, easily dissolved, and most likely more persistent than glyphosate (USGS 2003). Results for pre- and post-application herbicide sampling are provided in Table E6.2.2.4-38. All results were below the MDL.

Historical data comparison

There is considerable overlap between the area for which historical data are available and the monitoring area for 2006 and 2007 studies. For the purposes of the following summary, historical sampling sites specifically removed from the 2006 and 2007 monitoring area (e.g. Butte Creek near Chico) are not considered. A detailed review of historical water quality data is provided in the PAD (pages 5.2-16 to 5.2-22 and tables 5.2-24 to 5.2-27 *in* PG&E 2004). *In situ* parameter values were similar between 2006 and 2007 and historical data, except for pH, which had a somewhat larger range than recorded historically. pH measured in 2006 reached a low of 6.4 while the low end of the historical range was 7.1 and pH measured in 2007 was as high as 8.6, while the historical maximum was 8.4. Turbidity values were <15 NTU historically, which matches 2006 and 2007 measurements except for those observed in the Butte Canal during an unplanned outage, in which case measured 2006 values far exceeded the historical range. Historical nutrient data are limited. Concentrations of NO_3 (or NO_3+NO_2), NH_3 and TP measured in 2006 and 2007 were similar to historical values. 2006 concentrations of TKN and PO_4-P appear slightly higher than historical data and data from 2007. Chlorophyll-a levels were similar between 2006 and 2007 and historical results, however a more sensitive analytical technique (i.e. lower MDL) was used for historical measurements. Historical Total and Fecal Coliform measurements are limited in spatial scope and sampling frequency and therefore do not provide a strong basis for comparison with 2006 and 2007 results. However, 2006 and 2007 levels of Coliform bacteria, especially those measured in DeSabla Forebay, were higher than historically reported values. With the exception of a single high result observed for hardness in 2006, historical and 2006 and 2007 results for total hardness and general minerals (Ca, Na, K, Mg, Cl, SO_4) displayed similar ranges. Historical results indicate slightly more alkaline waters in the Project area than those of 2006 and 2007.

It should be noted that the historical sampling methods for trace metals did not follow USEPA Method 1669 and therefore may have been subject to contamination from field and laboratory sampling and handling techniques (USEPA 1996). Nevertheless, ranges of trace metals for which historical data were available were generally similar to ranges observed in 2006 and 2007. Specifically, historical and 2006 and 2007 ranges of Fe, Cu, Cd, Cr, Pb, Se were nearly the same, and levels of Hg and As were slightly lower in 2006 and 2007 than historical levels. Mn levels at most sites were lower than historical levels, however, several sites in or immediately below Philbrook Reservoir showed 2006 and 2007 Mn levels higher than those detected in historical data. In the case of Zn, 2006 and 2007 results were similar to historical values except for one sample from WBFR2 in Spring 2006 (which showed an anomalously high hardness of 100 mg/L as $CaC0_3$), which was higher than the historical maximum by a factor of two. This result was not reported as an exceedance in 2006 because the measurement was from a duplicate sample carrying a high degree of uncertainty due to variability in duplicate results. No historical data were available for Ni, Ag, Sb, Ba, Be, Co, Mo, Tl or V. Aluminum was reportedly measured during 2000-2002 monitoring efforts at levels exceeding applicable regulatory criteria (PG&E 2004). The Study Plan does not prescribe sampling for Al, so no there are no Al results from 2006 to compare with historical values.

Table E6.2.2.4-28. 2006 and 2007 Coliform Sampling Results in Philbrook Reservoir and DeSabla Forebay.

Site	Total Coliform (MPN/100 mL)						Fecal Coliform (CFU/100 mL)					
	Spr-06	July 4 -06	Sum-06	Labor Day -06	Fall-06	Sum-07	Spr-06	July 4 -06	Sum-06	Labor Day - 06	Fall-06	Sum-07
WEST BRANCH FEATHER RIVER												
PBR1-R	ND	>2,420	>2,420	683	109[JD]	1050	ND	27	<2	<1	1	4
PBR1-C	ND	2,420	>2,420	697	203[JD]	121.0	ND	40	2	<1	2	ND[GM]
PBR1-I	ND	>2,420	>2,420	3,080	5,840[JD]	222.0	ND	175	2	<1	<1	ND[GM]
BUTTE CREEK												
DS1-A	1600	>2,420	>2,420	2,480	836[JD]	2,420	1600	>3,000	668	78	144	124
DS1-B						2,420						84
DS1-C						>2,420						32
DS1-D						>2,420						450
DS1-E						>2,420						830

Notes:

ND Result below laboratory MDL

X[JD] Duplicate results >MRL, but differed by >10%, suggesting uncertainty

X[GM] Geometric mean of two samples. If one or both samples was a no detect, a no detect is reports

Table E6.2.2.4-29. Hydrocarbon sampling results for BTEX (Benzene, Toluene, Ethylbenzene and Xylenes) in Philbrook Reservoir area during 2006

Site	Benzene (ug/L)		Toluene (ug/L)		Ethylbenzene (ug/L)		Xylenes (ug/L)	
	July 4th	Labor Day	July 4th	Labor Day	July 4th	Labor Day	July 4th	Labor Day
PBR1	0.07[J]	ND	0.5	ND	0.1[J]	ND	0.7[J]	ND

Notes:

ND Result below laboratory MDL

X[J] Result below MRL, but above laboratory method detection limit (MDL) and reported here as a J-flag

Table E6.2.2.4-30. Hydrocarbon sampling results for MTBE (Methyl-tert-butyl-ether) and TPH (Gas, Diesel and Motor Oil) in Philbrook Reservoir area during 2006

Site	MTBE (ug/L)		Gasoline (ug/L)		Motor Oil (ug/L)		Diesel (ug/L)	
	July 4th	Labor Day	July 4th	Labor Day	July 4th	Labor Day	July 4th	Labor Day
PBR1	ND	ND	9.3[J]	5.3[J]	39[J]	32[BA,JD]	ND	ND

Notes:

ND Result below laboratory MDL

X[J] Result below MRL, but above laboratory method detection limit (MDL) and reported here as a J-flag

X[JD] Duplicate results >MRL, but differed by >10%, suggesting uncertainty

X[BA] Result adjusted based on equipment or trip blank result

Table E6.2.2.4-31. Hydrocarbon sampling results for Oil & Grease in Philbrook Reservoir area during 2006.

Site	Oil & Grease (mg/L)	
	July 4th	Labor Day
PBR1	3.2[J]	ND

Note
ND Result below laboratory MDL

Table E6.2.2.4-32. CAM 17 metals (ug/L) by station and season in the DeSabla-Centerville Project study area during 2006 and 2007

Site	Antimony (ug/L)				Arsenic (ug/L)				Barium (ug/L)			
	Spr-06	Sum-06	Fall-06	Sum-07	Spr-06	Sum-06	Fall-06	Sum-07	Spr-06	Sum-06	Fall-06	Sum-07
WEST BRANCH FEATHER RIVER												
WBFR2	ND	ND	ND	ND	ND	0.2[J]	ND	ND	3.22	3.1	3.70	4.20
BUTTE CREEK												
BC5	ND	ND	ND	ND	ND	0.4[J]	ND	ND	4.03	4.3	4.5	6.10

Notes:
ND Result below laboratory MDL
X[J] Result below MRL, but above laboratory method detection limit (MDL) and reported here as a J-flag

Table E6.2.2.4-33. CAM 17 metals (ug/L) by station and season in the DeSabla-Centerville Project study area during 2006 and 2007

Site	Beryllium (ug/L)				Cadmium (ug/L)				Chromium (ug/L)			
	Spr-06	Sum-06	Fall-06	Sum-07	Spr-06	Sum-06	Fall-06	Sum-07	Spr-06	Sum-06	Fall-06	Sum-07
WEST BRANCH FEATHER RIVER												
WBFR2	ND	ND	ND	ND	ND	ND	ND	ND	3.30[JD]	0.400[JD]	0.1[BA,J]	1.4
BUTTE CREEK												
BC5	ND	ND	ND	ND	ND	ND	ND	ND	0.7[J, JD]	1.5[JD]	0.2[BA,J]	1.7

Notes:
ND Result below laboratory MDL
X[J] Result below MRL, but above laboratory method detection limit (MDL) and reported here as a J-flag
X[JD] Duplicate results >MRL, but differed by >10%, suggesting uncertainty
X[BA] Result adjusted based on equipment or field blank result

Table E6.2.2.4-34. CAM 17 metals (ug/L) by station and season in the DeSabla-Centerville Project study area during 2006 and 2007

Site	Cobalt (ug/L)				Lead (ug/L)				Molybdenum (ug/L)			
	Spr-06	Sum-06	Fall-06	Sum-07	Spr-06	Sum-06	Fall-06	Sum-07	Spr-06	Sum-06	Fall-06	Sum-07
WEST BRANCH FEATHER RIVER												
WBFR2	ND	ND	ND	ND	0.200[J]	ND	ND	ND	0.260[J]	ND	0.1[J]	0.2[J]
BUTTE CREEK												
BC5	ND	ND	ND	0.2[J]	ND	ND	ND	ND	ND	ND	0.1[J]	0.1[J]

Notes:
ND Result below laboratory MDL
X[J] Result below MRL, but above laboratory method detection limit (MDL) and reported here as a J-flag

Table E6.2.2.4-35. CAM 17 metals (ug/L) by station and season in the DeSabla-Centerville Project study area during 2006 and 2007

Site	Selenium (ug/L)				Thallium (ug/L)			
	Spr-06	Sum-06	Fall-06	Sum-07	Spr-06	Sum-06	Fall-06	Sum-07
WEST BRANCH FEATHER RIVER								
WBFR2	ND	ND	ND	ND	ND	ND	ND	ND
BUTTE CREEK								
BC5	ND	ND	ND	ND	ND	ND	ND	ND

Notes:
ND Result below laboratory MDL

Table E6.2.2.4-36. CAM 17 metals (ug/L) by station and season in the DeSabla-Centerville Project study area during 2006

Site	Vanadium (ug/L)				Zinc (ug/L)			
	Spr-06	Sum-06	Fall-06	Sum-07	Spr-06	Sum-06	Fall-06	Sum-07
WEST BRANCH FEATHER RIVER								
WBFR2	0.810[J]	2.2	1.5[JD]	ND	106.0[BA,JD]	ND	2.3[J]	2.3[J]
BUTTE CREEK								
BC5	1.780[J]	3	0.7[JD]	1.4	NR	ND	2.2[J]	2.0[J]

Notes:
ND Result below laboratory MDL
X[J] Result below MRL, but above laboratory method detection limit (MDL) and reported here as a J-flag
X[BA] Result adjusted based on equipment or trip blank result
X[JD] Duplicate results >MRL, but differed by >10%, suggesting uncertainty

Table E6.2.2.4-37. Total mercury results from fish tissue sampling in the DeSabla-Centerville Project study area during 2006

Site	Dates sampled	Reservoir location[1]	Species and sample size (n)	Fork length (mm)[2]	Total Hg (ng/g)			
					Measured		Normalized to 200 mm	
					Whole body	Filet	Whole body	Filet
WEST BRANCH FEATHER RIVER								
Philbrook Reservoir	August 28-29, 2006	A	Composite of rainbow and brown trout (n=4 to 14)	--	34.9	49.3	--	--
		B	Rainbow trout (n=1)	226	29.6	25.1	26.2	22.2
		C	Composite of rainbow and brown trout (n=2 to 7)	--	25.8	25.0	--	--
BUTTE CREEK								
DeSabla Forebay	August 30-31, 2006	A	Rainbow trout (n=1)	213	24.9	24.4	23.4	22.9
			Composite of rainbow and brown trout (n=2 to 7)	--	35.4	43.6	--	--
		B	Rainbow trout (n=1)	298	22.8	27.0	15.3	18.1
			Composite of rainbow and brown trout (n=4 to 14)	--	34.0	33.9	--	--

Notes:
[1]Transect locations to be defined.
[2]Fork length data are not available for composite samples.

Table E6.2.2.4-38. Herbicide sampling results for pre-application (February 11) and post-application (March 27) conditions for the Centerville Canal during 2007

Site	Glyphosate		AMPA		Chlorsulfuron		Bromacil		Sulfometuron Methyl		Imazapyr		Triclopyr	
	Feb 11	Mar 27	Feb 11	Mar 27	Feb 11	Mar 27	Feb 11	Mar 27	Feb 11	Mar 27	Feb 11	Mar 27	Feb 11	Mar 27
LCC-1	ND	ND	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Notes:
ND Result below laboratory MDL

Comparisons with Basin Plan Water Quality Objectives and Standards

Based on *in situ* and analytical water quality parameters measured in this study, seven exceedances of Basin Plan objectives were identified. Site- and date-specific details of exceedances are provided in Table E6.2.2.4-39, and a discussion of exceedances in the context of Basin Plan objectives for the protection of beneficial uses is provided below. As of April 2007, data are considered "final," however all associated analyses, qualifiers, and designations of Basin Plan exceedances will remain "preliminary" until the final DeSabla-Centerville relicensing report is issued.

Bacteria

The Basin Plan includes a water quality objective for fecal coliform bacteria in waters designated for contact recreation (REC-1). The Basin Plan objective for fecal coliform is a geometric mean of < 200 MPN per 100 mL of water from five samples within a 30 day period and < 400 MPN per 100 mL in ten percent of all samples taken within a 30-day period (Table E6.2.2.4-6). Because no five samples were collected within the same 30-day period in 2006, the five sample geometric mean objective cannot be strictly evaluated during that year. Despite this, it appears that fecal coliform levels at site DS1-A were high enough to pose concern for several reasons. First, individual samples from site DS1-A exhibited fecal coliform concentrations above 200 MPN (or CFU)/100 mL on a one-time basis during spring, Independence Day and summer sampling events. Second, individual samples at this site were also greater than 200 MPN/100 mL during follow-up sampling conducted in response to the high results from the spring and summer events. DS1-A samples were also above 400 CFU per 100 mL in 100% of samples taken between spring and summer events. Finally, the geometric mean of the four samples collected at this site during the 42 day period between July 3 and August 14, 2006 was 1,127 CFU/100 mL, or greater than 200 MPN per 100 mL. Geese and duck populations (4 to 75 birds, often near the sampling site) were noted in DeSabla Forebay during the Independence Day, Summer 2006, Summer follow-up and Labor Day sampling events. Thus while fecal coliform levels in DeSabla Forebay were high enough to pose concern during much of the summer, sampling dates were not within the same 30-day period and therefore were not conducive to the construction of the 5-sample geometric mean listed in the Basin Plan. During 2007, coliform samples were taken at five locations in DeSabla Forebay (sites DS1-A through DS1-E, Table E6.2.2.4-1) on a single date (August 7, 2007). The spatially averaged geometric mean of these samples was 166 CFU/100mL. Because the two sites on the eastern shore (DS1-D and DS1-E) exceeded 200 CFU/100mL, it implies that a 30-day geometric mean at these stations may exceed the Basin Plan criteria. Therefore, the Summer 2007 fecal coliform results indicate that fecal coliform levels may be of concern periodically at certain locations in the DeSabla Forebay. During both 2006 and 2007, the presence and distribution of waterfowl seems highly correlated with these elevated fecal coliform observations.

Biostimulatory Substances

The Basin Plan does not contain specific numerical water quality objectives for nutrients, but specifies that water shall not contain biostimulatory substances which promote aquatic growths in concentrations that cause nuisance or adversely affect beneficial uses. Although submerged aquatic vegetation was found in portions of DeSabla Forebay during the Summer and Fall 2007 sampling events, measured nutrient concentrations during 2006 and 2007 were low. It is likely that the shallow impoundment provides conditions conducive to the growth of aquatic plants, even in low to moderate nutrient concentrations and that the observed aquatic vegetation is not due to levels of biostimulatory substances.

Chemical Constituents

The Basin Plan requires that water designated for use as domestic or municipal supply shall not contain concentrations of chemical constituents in excess of the MCLs specified in the provisions of Title 22 of the California Code of Regulations. Low levels of other inorganic and trace metal constituents in samples collected throughout the study area demonstrate generally high water quality typical of many snow-melt fed river systems of the Sierra Nevada.

Color

The Basin Plan includes a narrative Water Quality Objective regarding color. Resource agencies did not request that PG&E measure color during relicensing studies. PG&E is unaware of any instances where the color of the water in the vicinity of the Projects has been reported as a potential problem.

Dissolved Oxygen

The Basin Plan requires that the monthly median of the mean daily DO concentrations shall not fall below 85 percent of saturation in the main water mass, and the 95 percent concentration shall not fall below 75 percent of saturation. Minimum dissolved oxygen levels are required to remain above 7.0 mg/L at all times. In Summer 2006, DO concentrations measured in Round Valley Reservoir approached the 7.0 mg/L criterion (Table E6.2.2.4-21).

In Summer 2007, Round Valley Reservoir was found dry. In Philbrook Reservoir, the entire water column exhibited DO concentrations lower than 7.0 mg/L (Table E6.2.2.4-6). However, these levels were still above Basin Plan criteria for percent DO saturation in the upper water column above 12 meters depth. Between 12 and 17 meters depth, in the hypolimnion, DO levels ranged from 0.7 to 5.8 mg/L and 8% to 79% saturation. Although the low DO levels in the Philbrook hypolimnion show an apparent exceedance of Basin Plan criterion, the majority of the water column and the nearest downstream site (WBFR 2) exhibited DO levels above the minimum saturation criteria. Therefore, the Licensee does not consider the exceedances observed during this sampling event in the Philbrook Reservoir hypolominon to be significant.

Floating Material

The Basin Plan includes a narrative Water Quality Objective regarding floating material that states water shall be free of floating material in amounts that cause nuisance or adversely affect beneficial uses. Resource agencies did not request that PG&E measure floating material during relicensing studies. PG&E is unaware of any instances where floating material in the vicinity of the Projects has been reported as a potential problem, and is required to keep all reservoirs free of floating debris under the current FERC license articles.

Hydrocarbons

The Basin Plan requires that the water not contain hydrocarbons, oils, greases, waxes or other material in concentrations that cause nuisance, result in visible film or coating on the surface of the water or on objects in the water, or otherwise adversely affect beneficial uses. Hydrocarbons were sampled during Independence Day and Labor Day target sampling events (Tables E6.2.2.4-29 to 31). No exceedances of Basin Plan criteria were identified.

pH

The Basin Plan requires that the pH shall not be depressed below 6.5 nor raised above 8.5. Measured pH values approached the lower end of the Basin Plan target range (6.5–8.5; Table E6.2.2.4-6) in bottom waters in Spring. The instrument used to measure pH was checked against a reference standard and recalibrated less than twelve hours prior to sampling, but since the manufacturer specified accuracy is ±0.2 pH units (Table E6.2.2.4-4), the difference between the measured value (6.4) and the Basin Plan objective low (6.5) is too small to be reported as an exceedance of Basin Plan objectives. Similarly, including the instrument accuracy in the pH levels of 8.6 and 8.5 measured in Summer 2007 at the BC4 and BC5 sites suggests that these sites did not exceed the Basin Plan maximum pH criterion of 8.5.

Pesticides

The Basin Plan includes extensive discussions related to water quality objectives for pesticides. However, resource agencies did not request PG&E collect or analyze water quality samples for pesticides as part of the relicensing studies. No pesticide use was reported by PG&E within the upper watershed of the study area, or in association with Project O&M.

Sediment and Settleable Solids

The Basin Plan requires that suspended sediment load and suspended sediment discharge of surface waters shall not be altered in such a manner as to cause a nuisance or adversely affect beneficial uses. Resource agencies did not request that PG&E collect or analyze water quality samples for sediment and settleable solids as part of the relicensing studies.

Tastes and Odor

The Basin Plan requires that waters shall not contain taste- or odor-producing substances in concentrations that impart undesirable tastes or odors to domestic or municipal water supplies or to fish flesh or other edible products of aquatic origin, or that cause nuisance, or otherwise adversely affect beneficial uses. One sodium concentration (81 mg/L) was found in excess of the applicable criterion (30-60 mg/L; Table E6.2.2.4-6) at station WBFR2 during the Spring sampling event.

Water Temperature

A full treatment of water temperatures measured in the Project area in the context of Basin Plan water temperature standards is provided separately in the Water Temperature Study (section 6.2.2.3).

Toxicity

The Basin Plan requires that waters shall be maintained free of toxic substances in concentrations that produce detrimental physiological responses in human, plant, animal, or aquatic life. During the 2006 study, no water samples exceeded any of the applicable dissolved or total criteria for dissolved and total metal concentrations, respectively.

Analytical results for total mercury in filets of collected fish samples from Philbrook Reservoir and DeSabla Forebay were well below the National Recommended Water Quality Criteria for Human Health Consumption for Organism Only at 0.3 mg/kg (300 ng/g) (USEPA 2001, 2002). This fish tissue guideline is based on wet weight, edible portions of fish tissue (filet). Presuming that all or most of the mercury present in the samples is as methyl Hg, this guideline can be measured as total Hg. This is a conservative assumption which is discussed in USEPA (2000a) to decrease analysis costs, as total Hg is considerably less expensive to measure than methyl Hg and it is generally accepted that the majority of mercury present in fish tissue is as methyl Hg (Tollefson 1989 as cited in USEPA 2000a).

Turbidity

The Basin Plan requires that waters be free of changes in turbidity that cause nuisance or adversely affect beneficial uses. Turbidity was low throughout 2006 and 2007 at all stations (<4 NTU), except for two occasions on which unscheduled outages occurred in Butte Canal (site BXC1, [43 NTU]; Steel Bridge July 6 [19 NTU]). The relatively high turbidity levels measured following these two unscheduled outages were reduced to near background levels within 24 hours for site BXC1 and 4 hours for Steel Bridge. However the elevated turbidity observed during both of these unscheduled outages exceeds the Basin Plan criteria of <1 NTU increase (Table E6.2.2.4-6). Four other scheduled or unscheduled canal outages produced downstream turbidity increases >1 NTU during 2006, however peak turbidity was relatively lower, ranging from 3.4 to 7.1 NTU with recovery times below 4–5 hours.

Although the two highest turbidity levels observed in 2006 occurred during unscheduled outage events, the historical data record indicates that turbidity increases occurred during both scheduled and unscheduled canal outages (Table E6.2.2.4-27). Generally, the unscheduled outage events occurred during summer and fall months when background turbidity is naturally low, which resulted in exceedances of the Basin Plan objective of <1 NTU increase in all but one event (10/07/2004). Scheduled operational outages took place mainly during winter and spring months when seasonal storm events are likely to transport higher sediment loads through Project streams. Despite the potential for higher allowable increase in turbidity at higher background levels (e.g., 10 NTU allowable increase for background measurement from 50–100 NTU; Table E6.2.2.4-5), there was only one scheduled canal outage during naturally high turbidity conditions

(02/28/2006; Table E6.2.2.4-27) and most events exceeded Basin Plan water quality objectives in one or more samples.

Table E6.2.2.4-39. Summary of exceedances of Basin Plan water quality objectives identified in 2006 and 2007.

Station	Sampling Event	Parameter	Result	Units	Criteria	Criteria Units	Data Qualifier?[1]
BACTERIA							
DS1-A	Spring 2006	Fecal Coliform	1600	CFU/100mL	< 200; 30 day, 5 sample geometric mean	MPN/100mL	N
DS1-A	July 4th 2006	Fecal Coliform	>3000	CFU/100mL	< 200; 30 day, 5 sample geometric mean	MPN/100mL	N
DS1-A	Summer 2006	Fecal Coliform	668	CFU/100mL	< 200; 30 day, 5 sample geometric mean	MPN/100mL	N
TASTE & ODOR							
WBFR2	Spring 2006	Na	81	mg/L	30-60	mg/L	N
TURBIDITY							
BC1–BXC1, BC1–BC5	Spring 2006	Turbidity	1.1, 2.6	NTU	<1 unit increase	NTU	N
WBFR2–HC1	Spring 2006	Turbidity	1.6	NTU	<1 unit increase	NTU	N
Steel Bridge [2]	03/09/2006	Turbidity [3]	7.1	NTU	<1 unit increase	NTU	N
Steel Bridge [2]	03/20/2006	Turbidity [3]	5.4	NTU	<1 unit increase	NTU	N
Steel Bridge [2]	07/06/2006	Turbidity [3]	19.0	NTU	<1 unit increase	NTU	N
Steel Bridge [2]	08/02/2006	Turbidity [3]	4.3	NTU	<1 unit increase	NTU	N
Steel Bridge [2]	08/07/2006	Turbidity [3]	3.4	NTU	<1 unit increase	NTU	N

Notes:

1 Data marked as having qualifier(s) are pending further review with respect to suitability for use in evaluating water quality based on Basin Plan objectives. The term “qualifier” includes J-flags, QC analyses, etc. Exceedances will not be reported for data without the highest degree of confidence.

2 Approximately 600 meters downstream of Butte Canal confluence with Butte Creek (downstream of Centerville Powerhouse).

3 Maximum turbidity from a distribution of results measured over regular time intervals following a scheduled or unscheduled canal outage (Table E6.2.2.4-27).

6.2.2.4.5 Summary

Analytical and *in situ* water quality data were collected during Spring, Summer, Fall, Independence Day and Labor Day Weekend sampling events in 2006, while herbicide sampling was conducted in Spring 2007. In total, 1,852 analyte concentrations (not including blank or duplicate samples) were determined by laboratory analysis from June, 2006 through March, 2007. *In situ* water quality parameters were measured at 12 sites during each of three events, and at one site during an unscheduled canal outage. Ten reservoir profiles of *in situ* parameters in Project reservoirs were conducted during this period as well. Following QC review, 4 percent of analytical results and no *in situ* results were excluded from further analyses. Following data analysis, water quality in the Project area was determined to be generally in accordance with Basin Plan objectives, exceedances of Basin Plan objectives for bacteria and turbidity were identified. Water fowl populations appear to contribute to high fecal coliform levels in DeSabla Forebay during the summer, and the Butte and Hendricks canals may contribute to locally elevated turbidity in excess of Basin Plan objectives.

6.2.2.4.6 List of Appendices

- Appendix E6.2.2.4-A Water Quality - A: DeSabla-Centerville Project (FERC No. 803) – 2006 Analytical Laboratory Reports and Chain of Custody Sheets

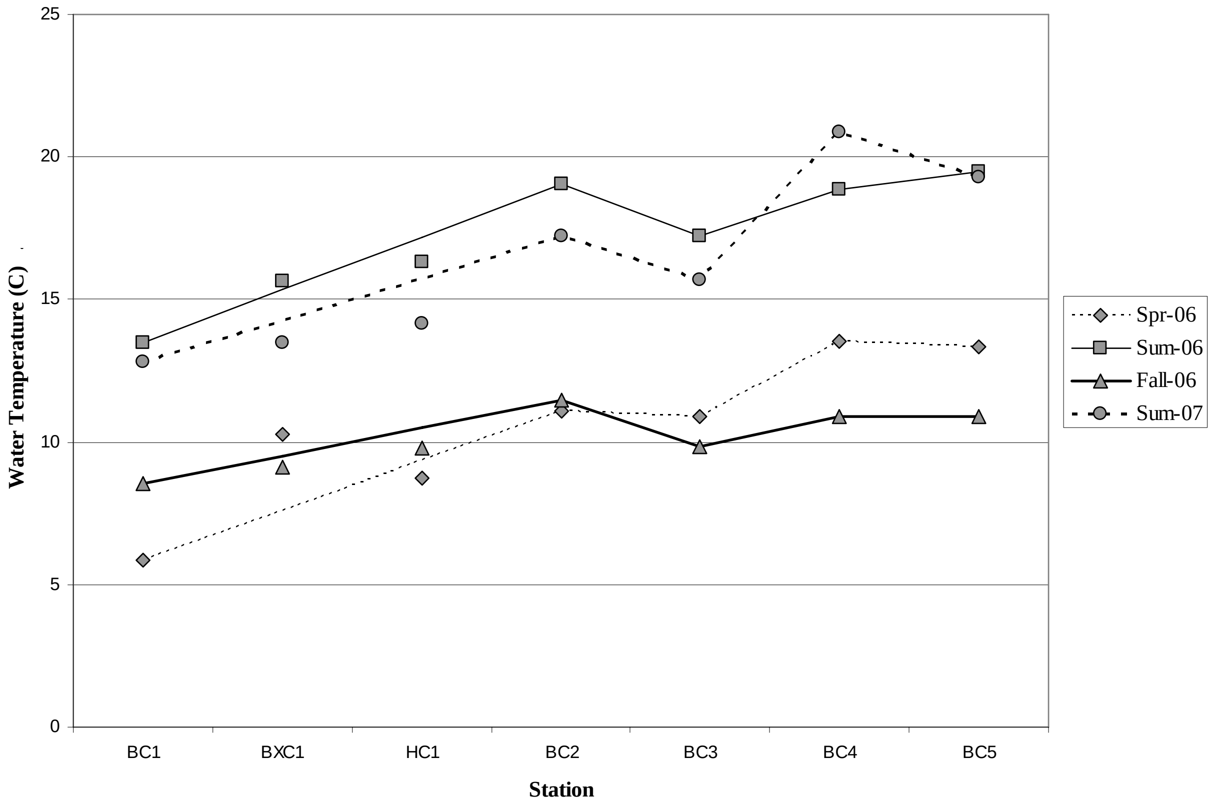

Figure E6.2.2.4-6. Longitudinal profiles of water temperature in Butte Creek during 2006 and 2007.

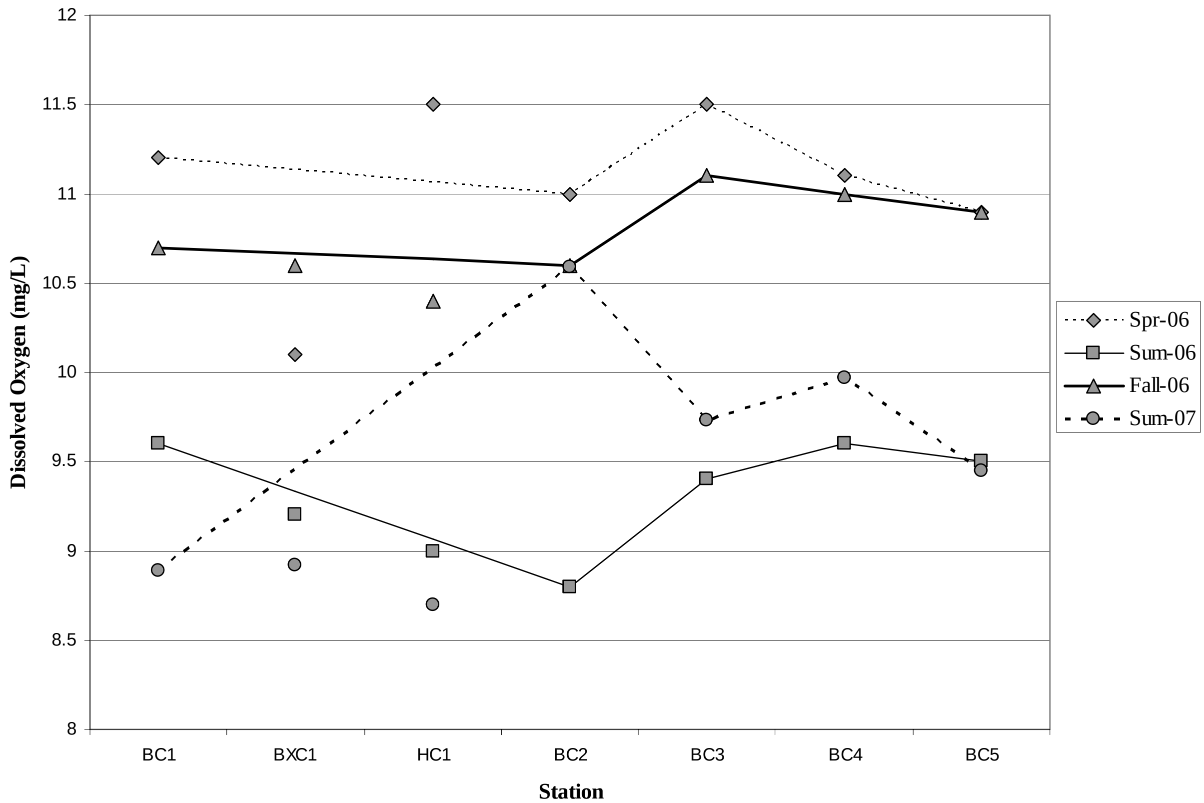

Figure E6.2.2.4-7. Longitudinal profiles of DO concentration in Butte Creek during 2006 and 2007.

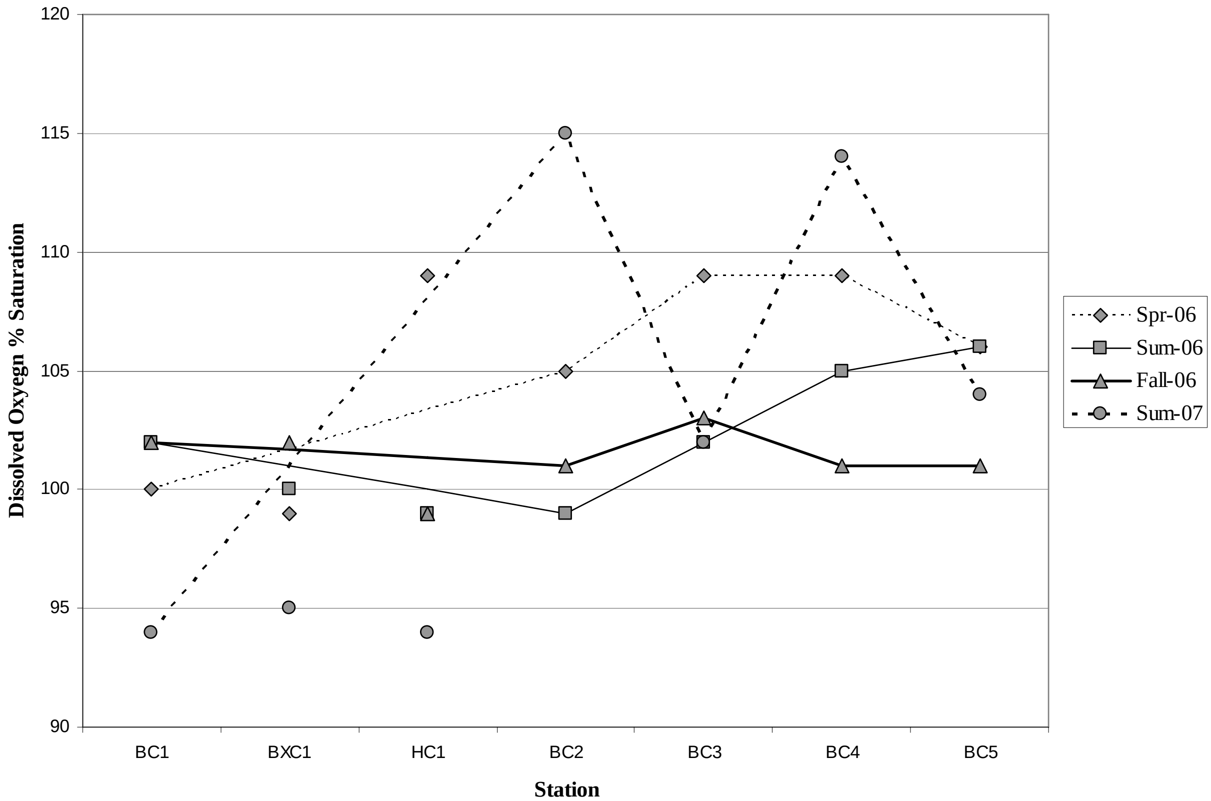

Figure E6.2.2.4-8. Longitudinal profiles of DO percent saturation in Butte Creek during 2006 and 2007.

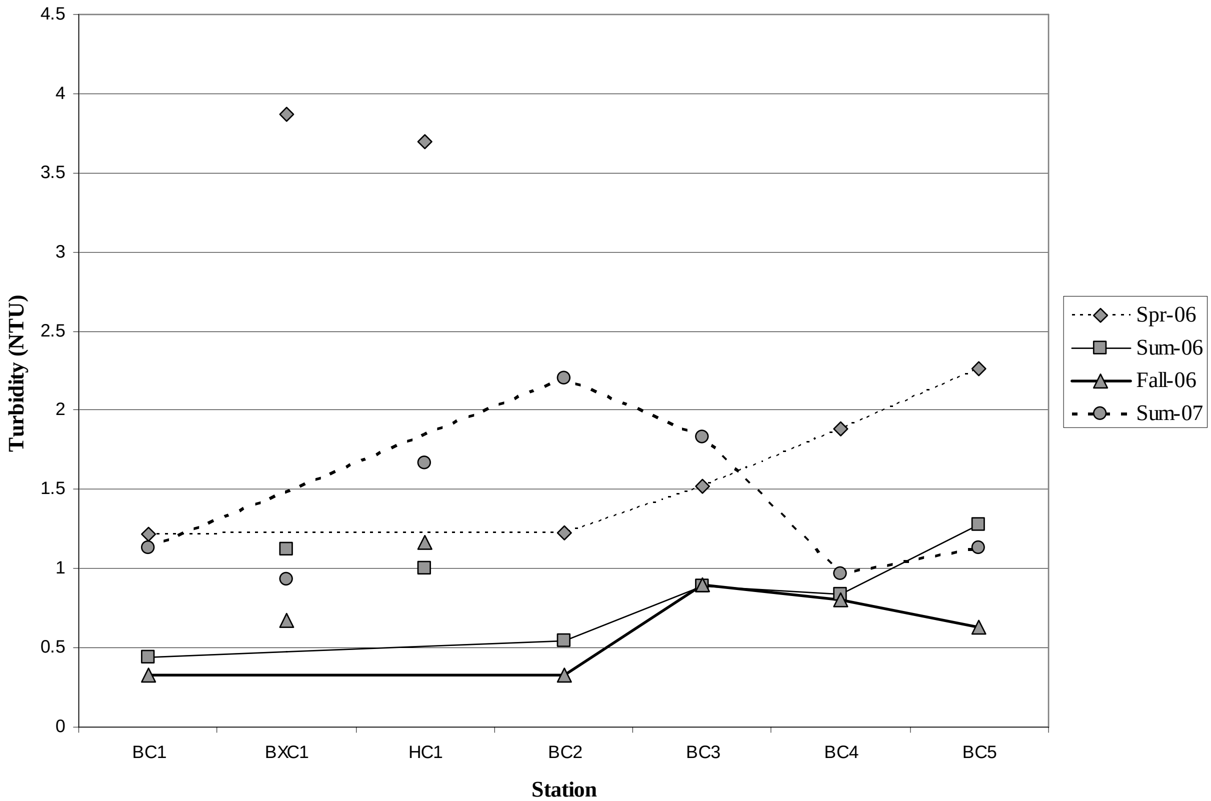

Figure E6.2.2.4-9. Longitudinal profiles of turbidity in Butte Creek during 2006 and 2007

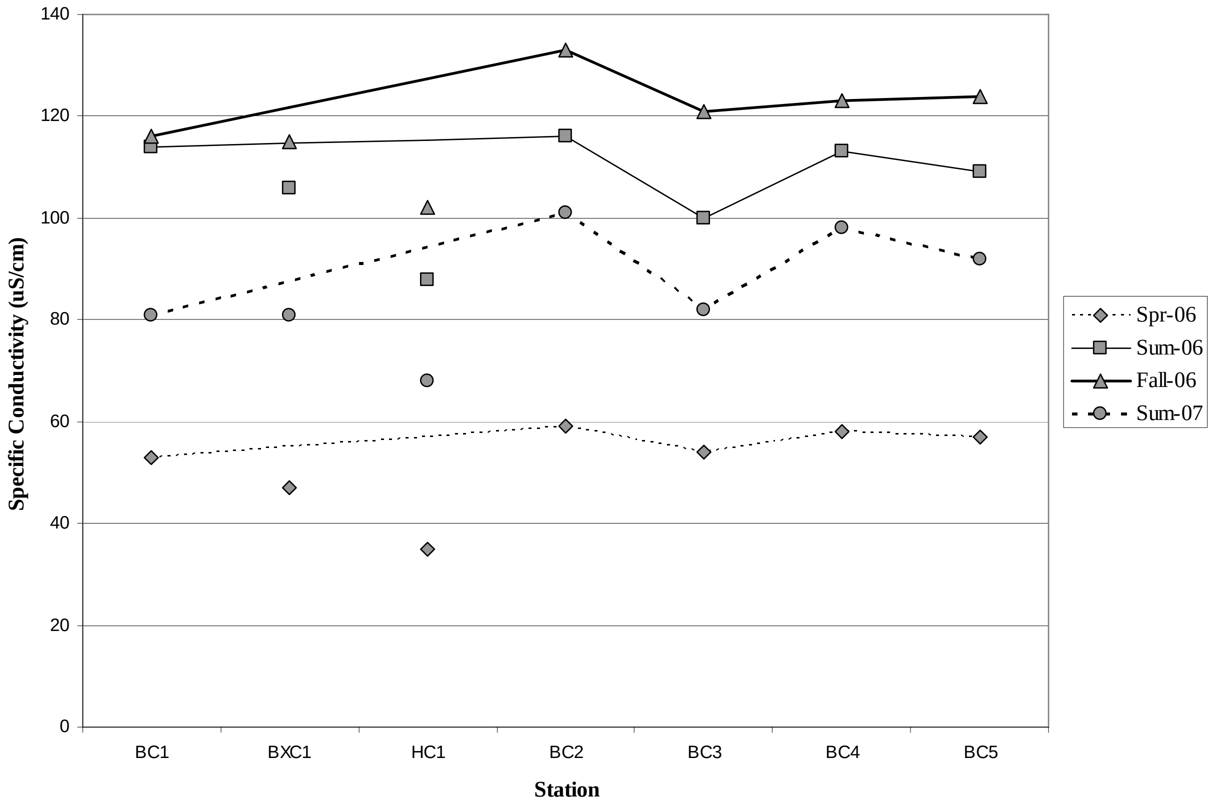

Figure E6.2.2.4-10. Longitudinal profiles of specific conductivity in Butte Creek during 2006 and 2007.

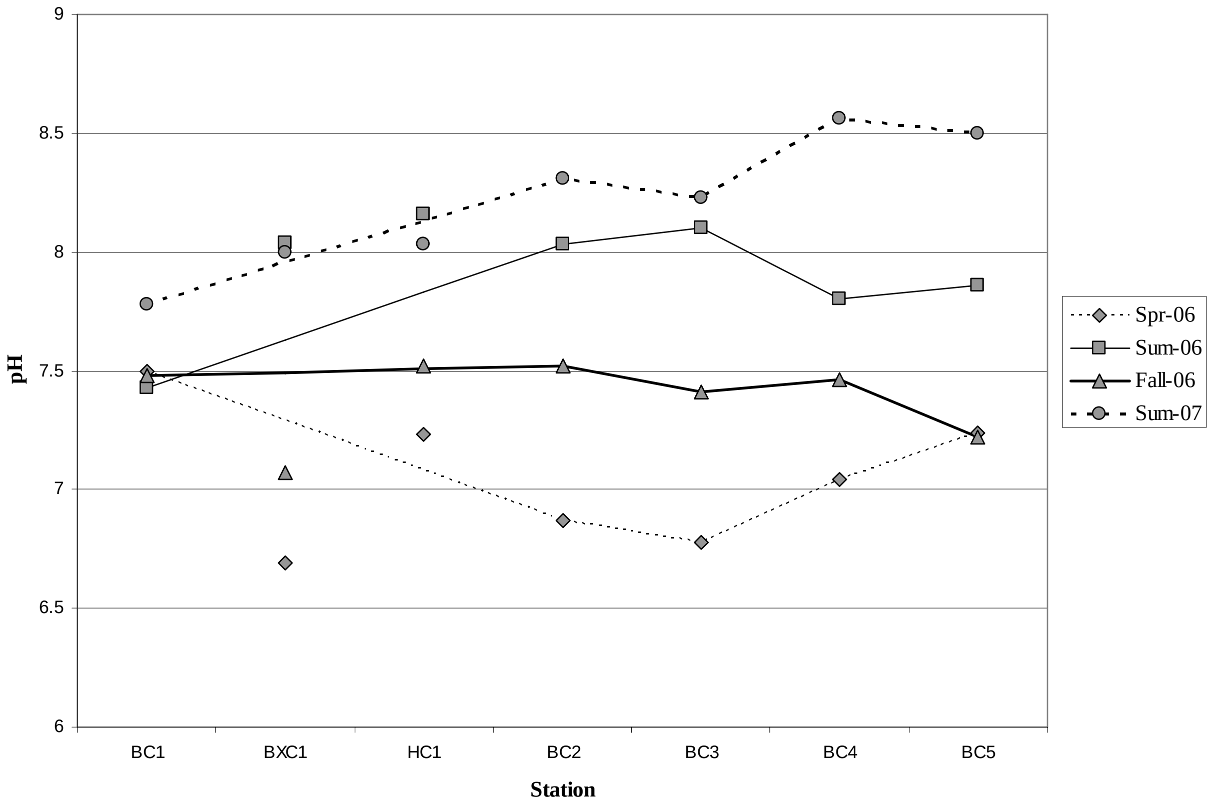

Figure E6.2.2.4-11. Longitudinal profiles of pH in Butte Creek during 2006 and 2007

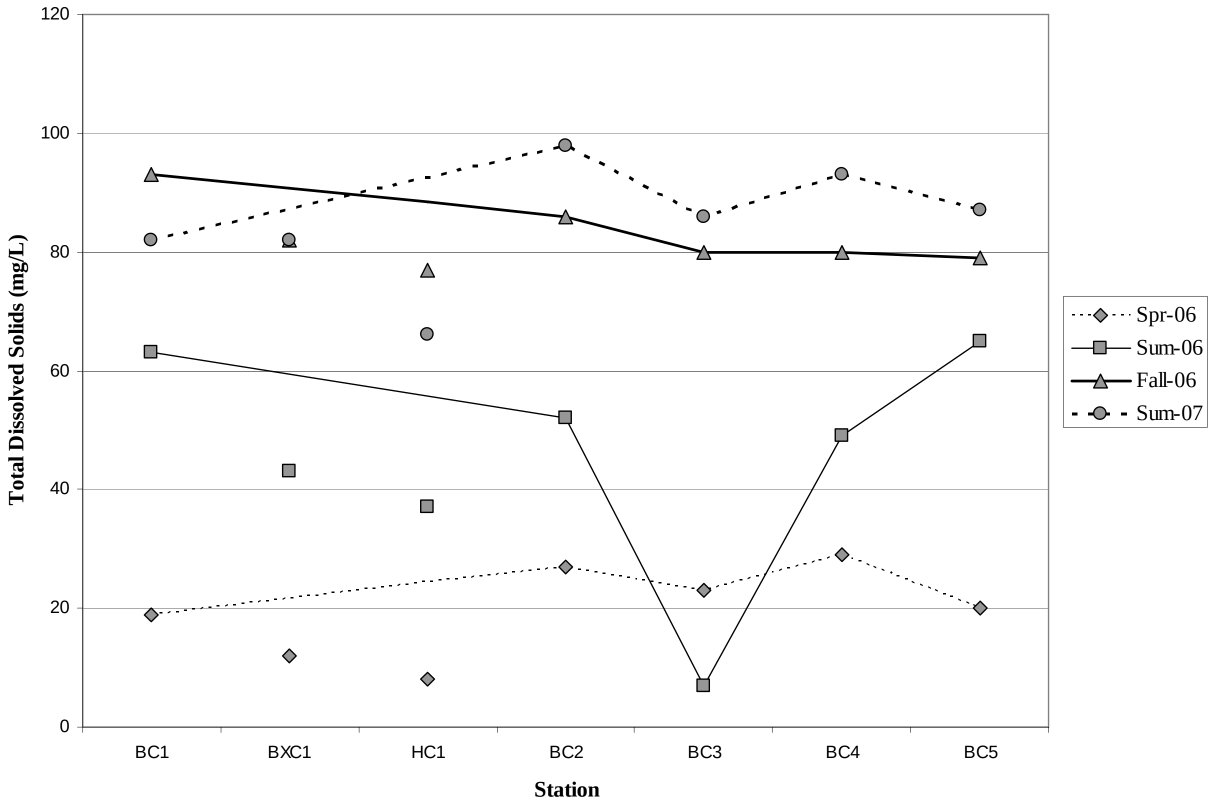

Figure E6.2.2.4-12. Longitudinal profiles of TDS in Butte Creek during 2006 and 2007.

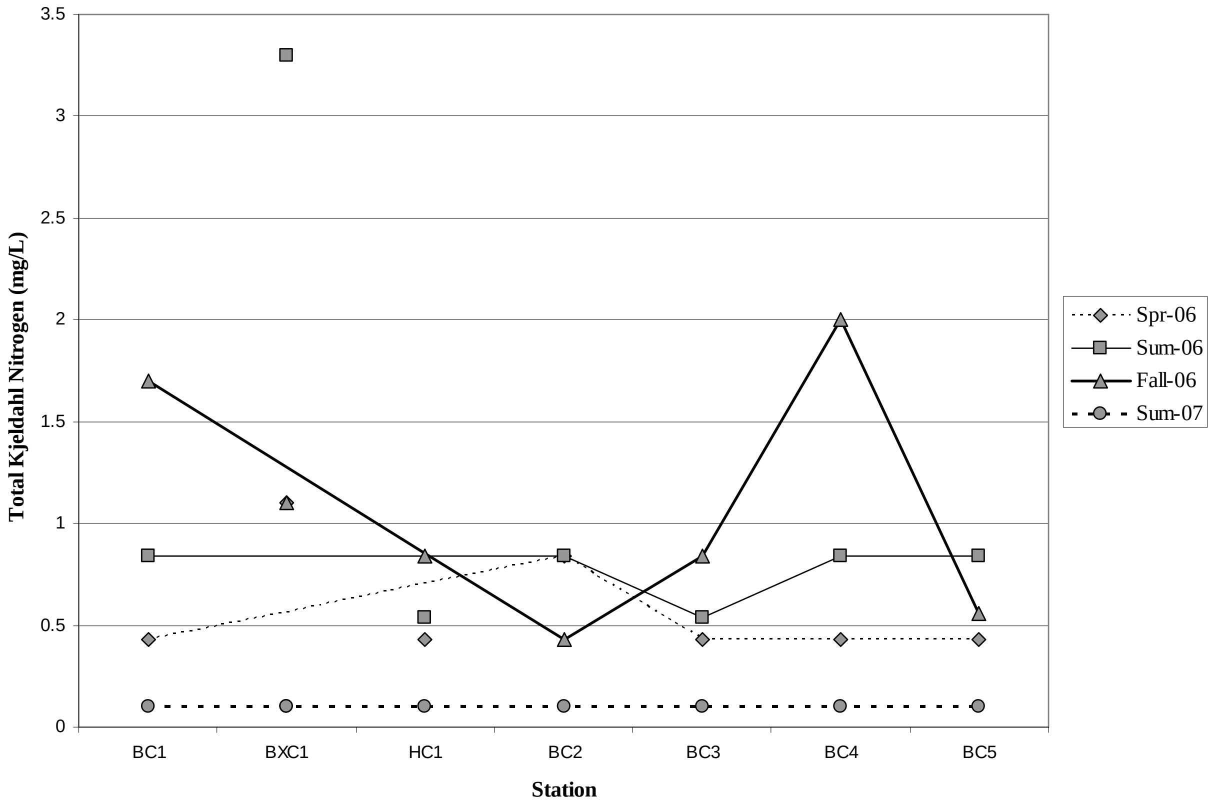

Figure E6.2.2.4-13. Longitudinal profiles of TKN concentration in Butte Creek during 2006 and 2007.

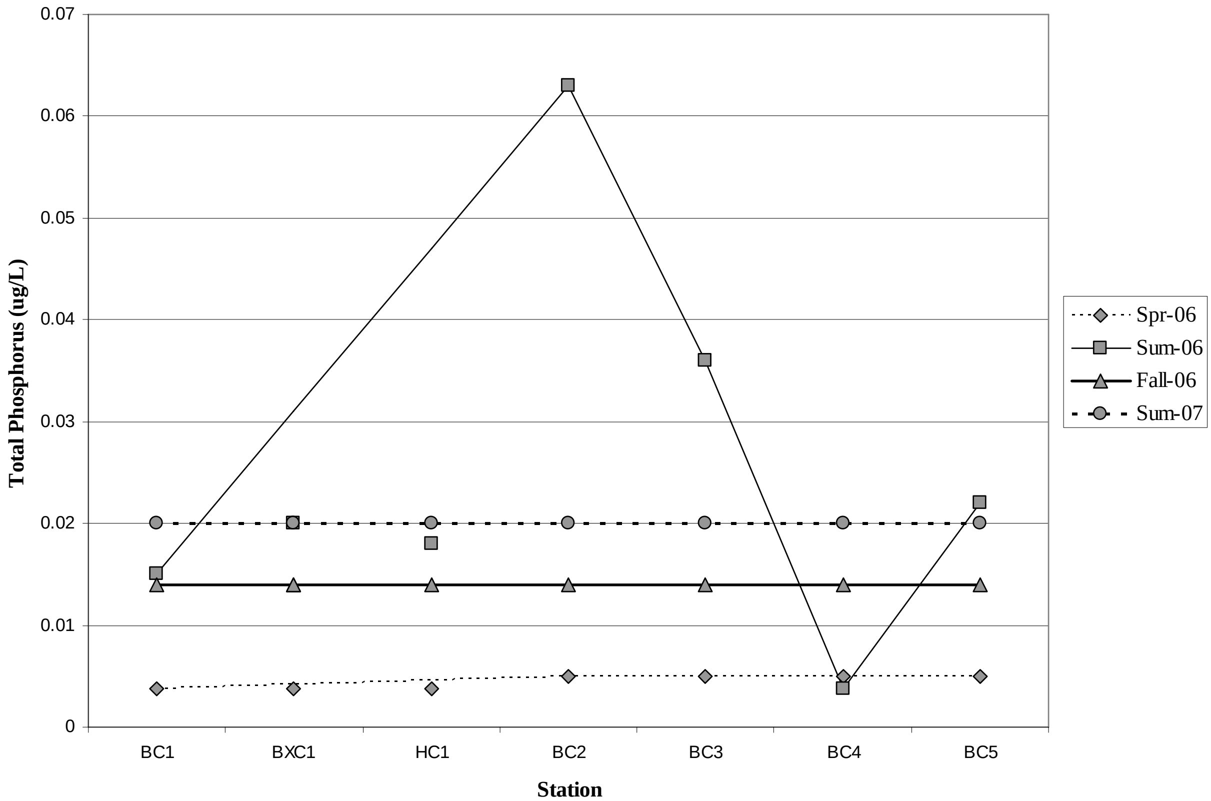

Figure E6.2.2.4-14. Longitudinal profiles of TP concentration in Butte Creek during 2006 and 2007. Spring 2006 results <0.005 mg/L are estimated J-flagged values.

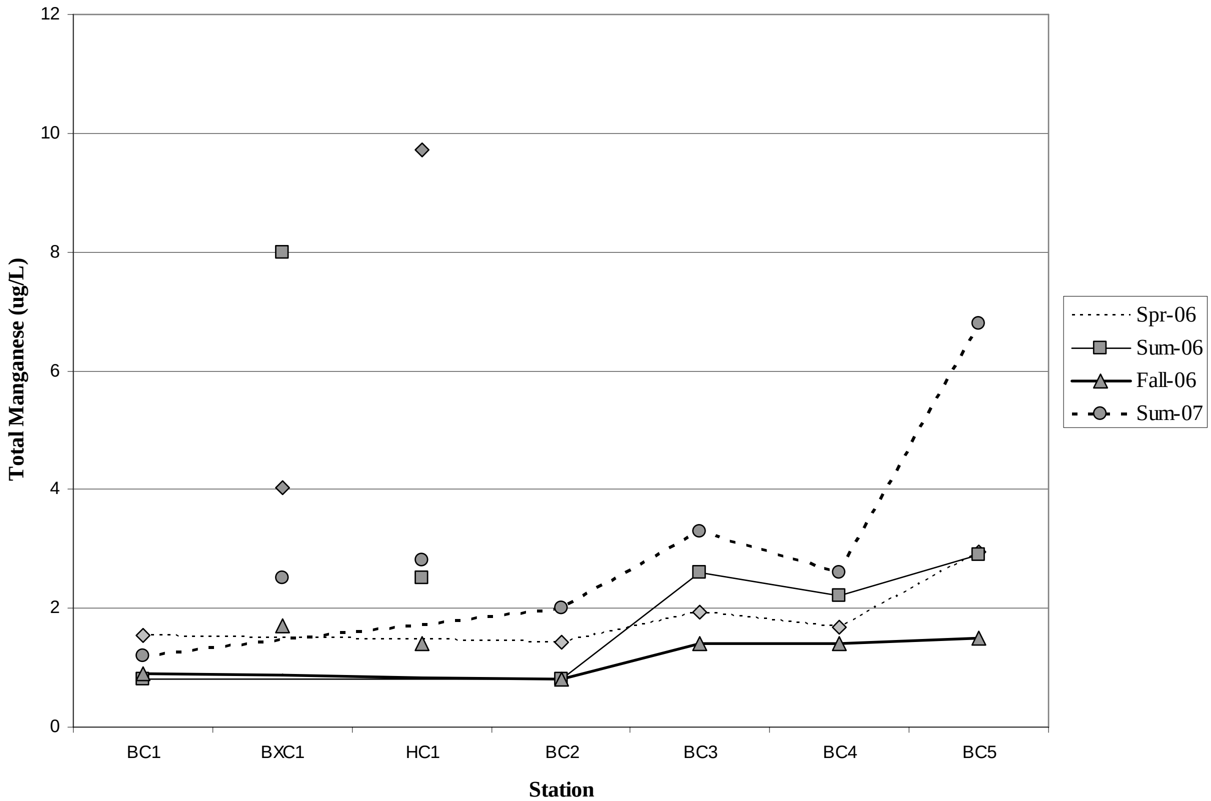

Figure E6.2.2.4-15. Longitudinal profiles of Mn concentration in Butte Creek during 2006 and 2007. Results <0.2 ug/L from Spring 2006 are estimated J-flagged values

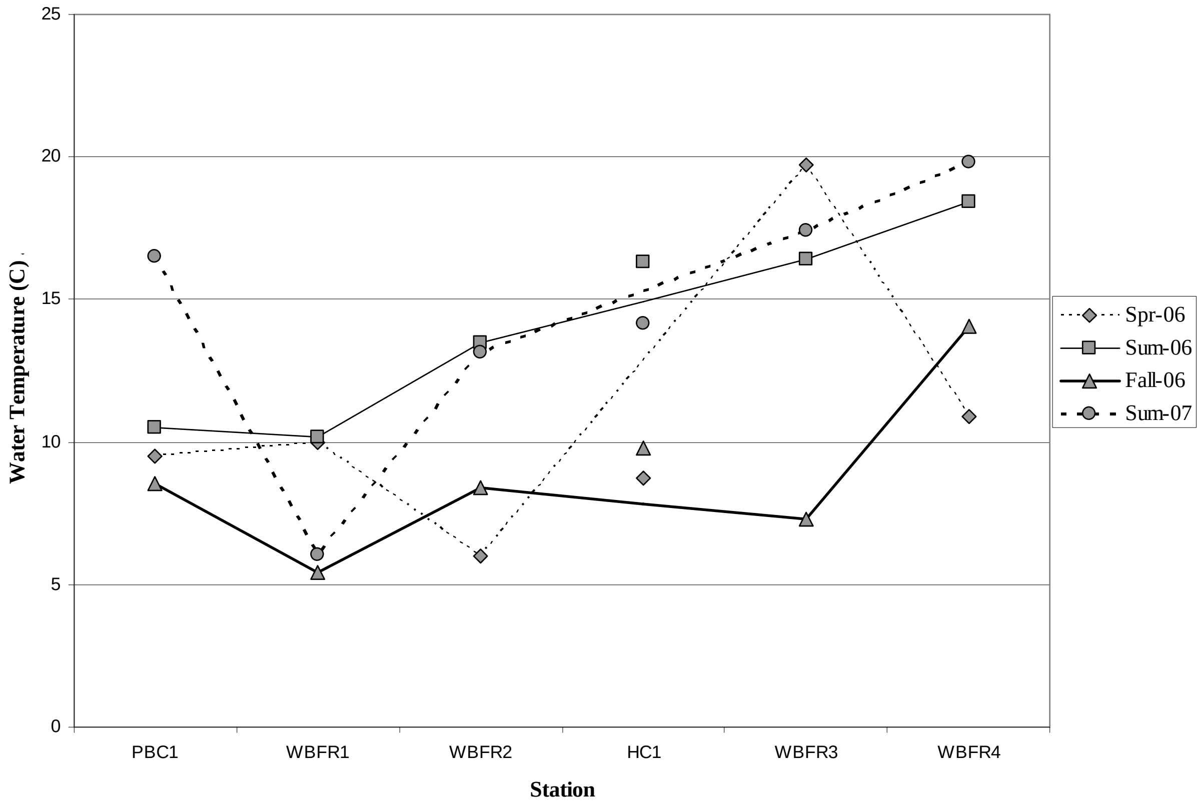

Figure E6.2.2.4-16. Longitudinal profiles of water temperature in WBFR during 2006 and 2007.

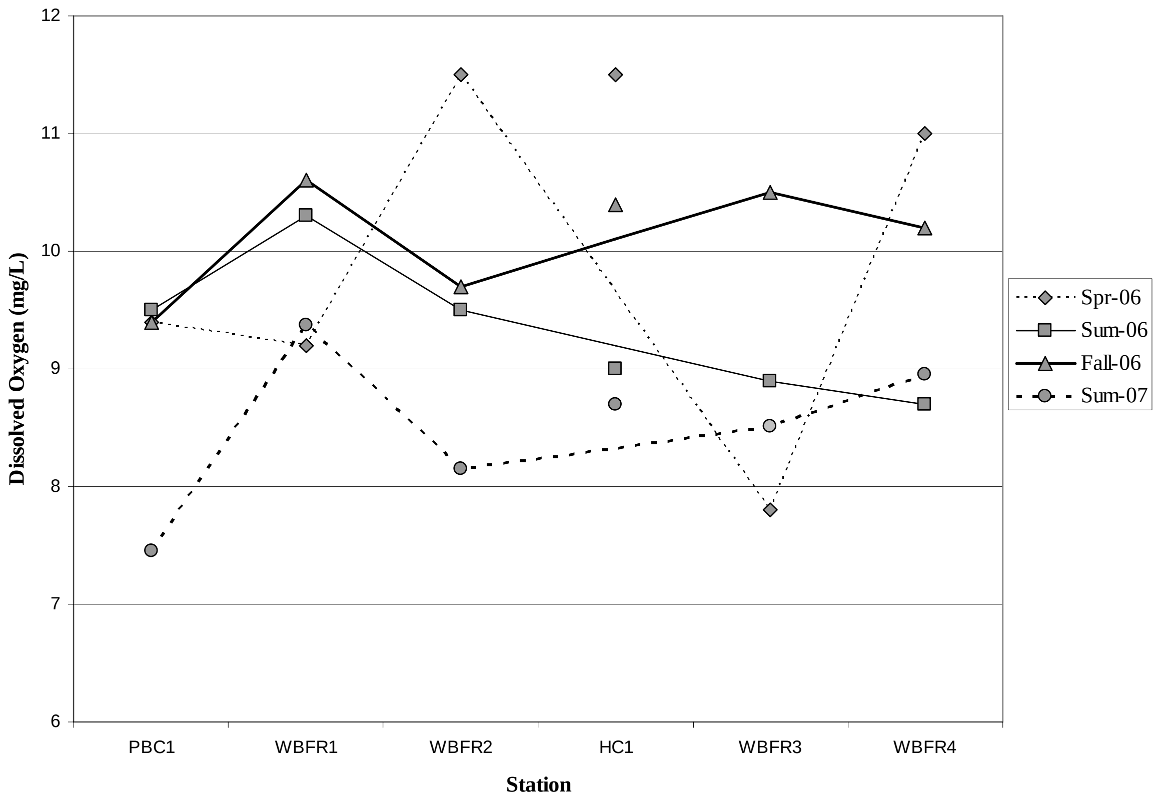

Figure E6.2.2.4-17. Longitudinal profiles of DO concentration in WBFR during 2006 and 2007

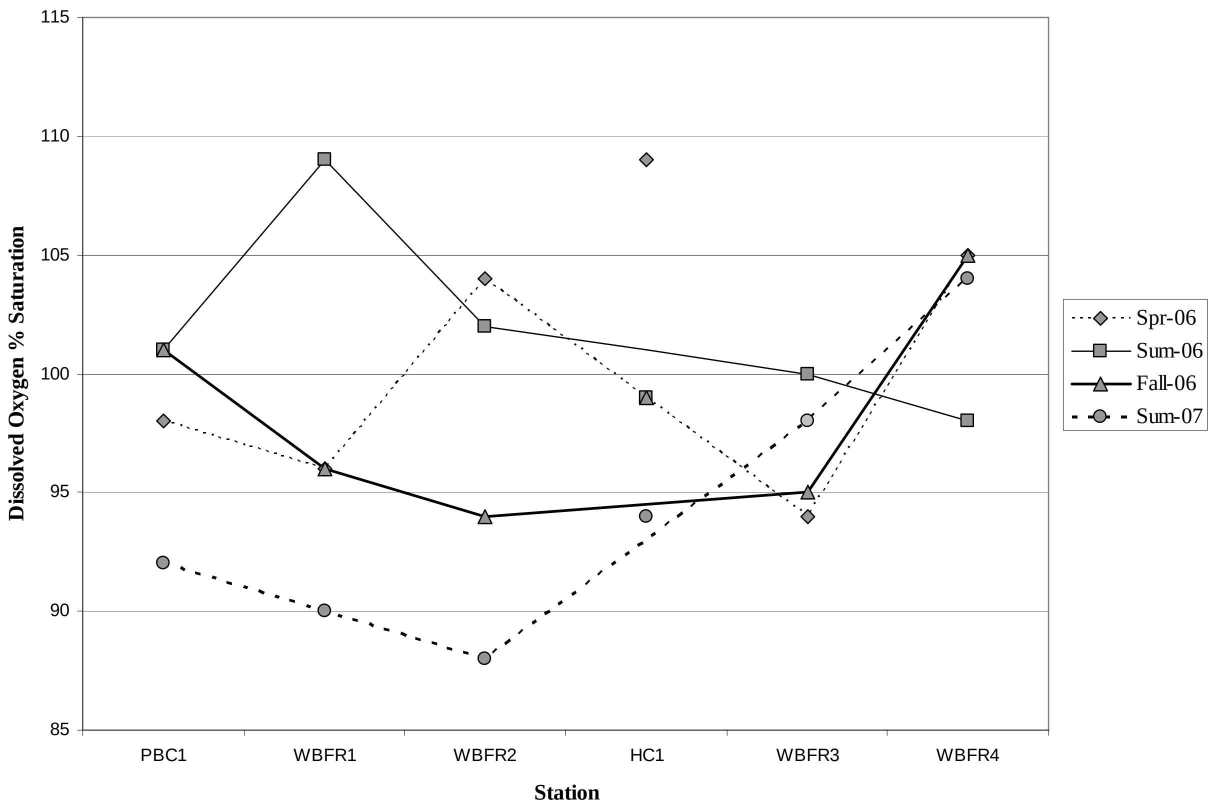

Figure E6.2.2.4-18. Longitudinal profiles of DO percent saturation in WBFR during 2006 and 2007.

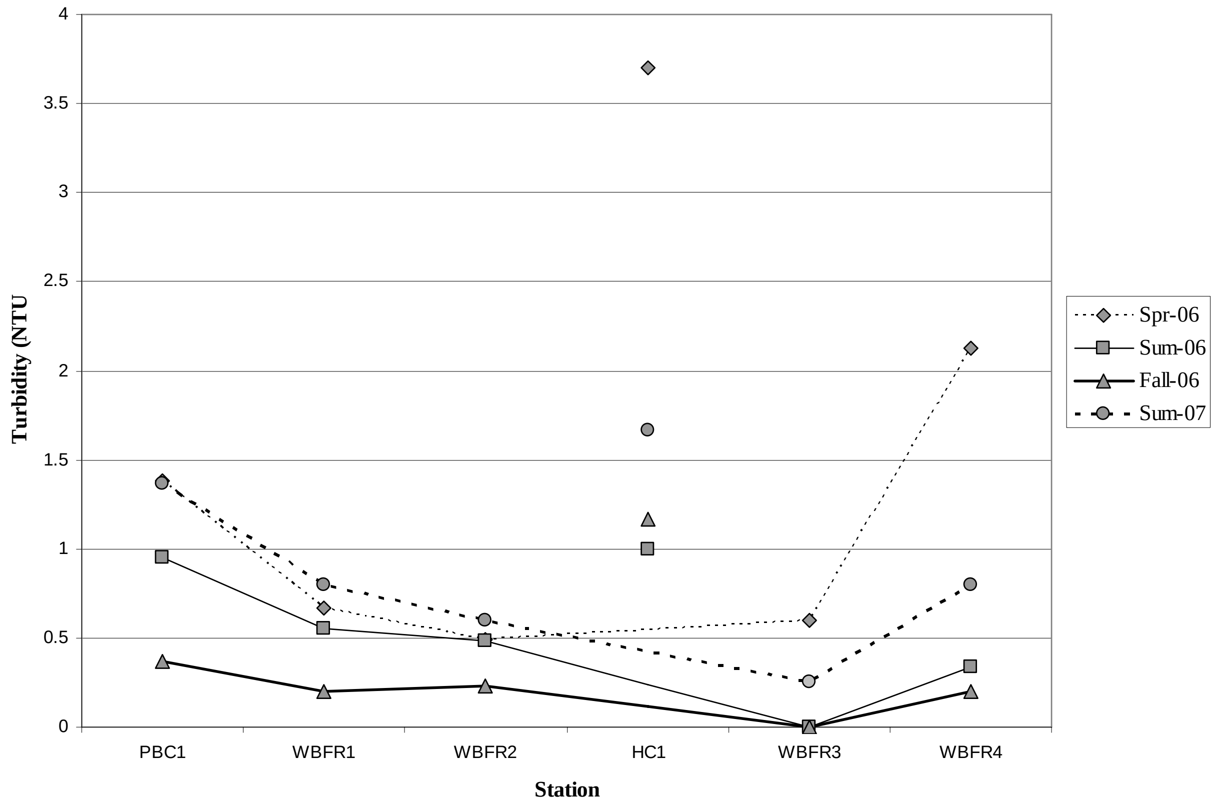

Figure E6.2.2.4-19. Longitudinal profiles of turbidity in WBFR during 2006 and 2007

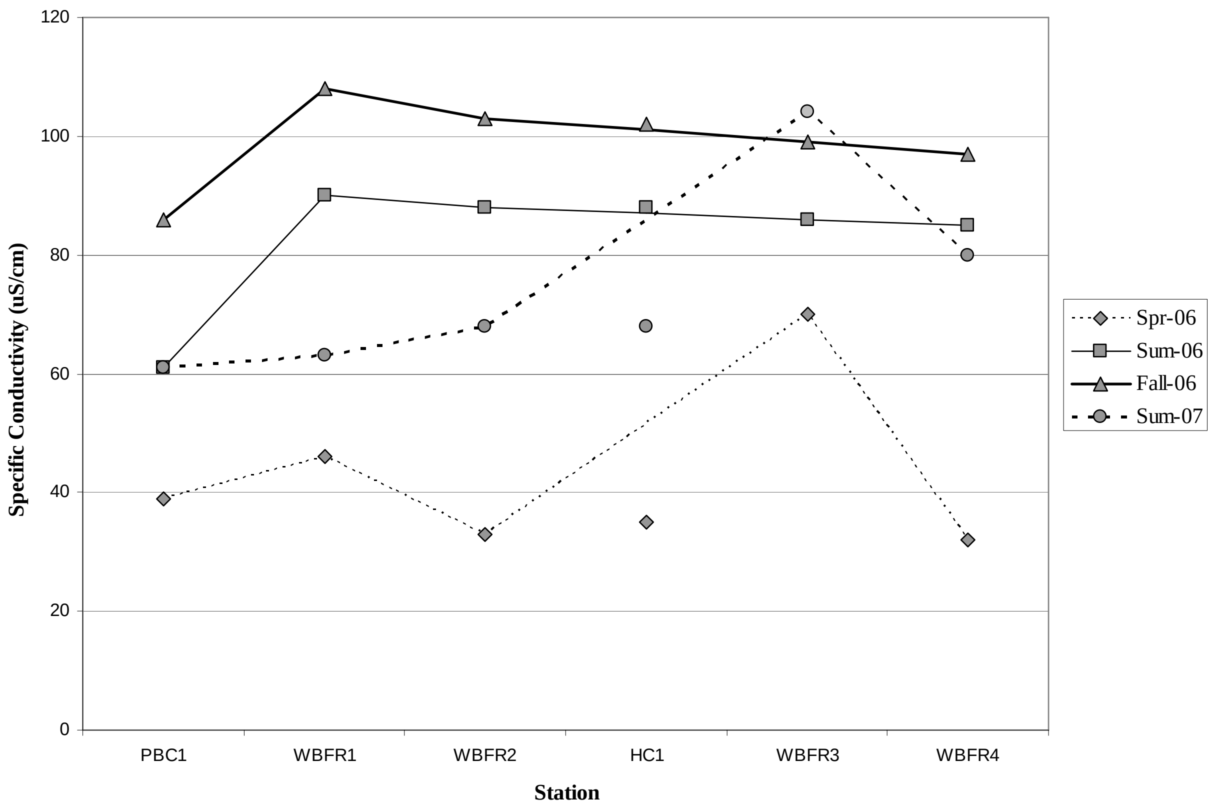

Figure E6.2.2.4-20. Longitudinal profiles of specific conductivity in WBFR during 2006 and 2007.

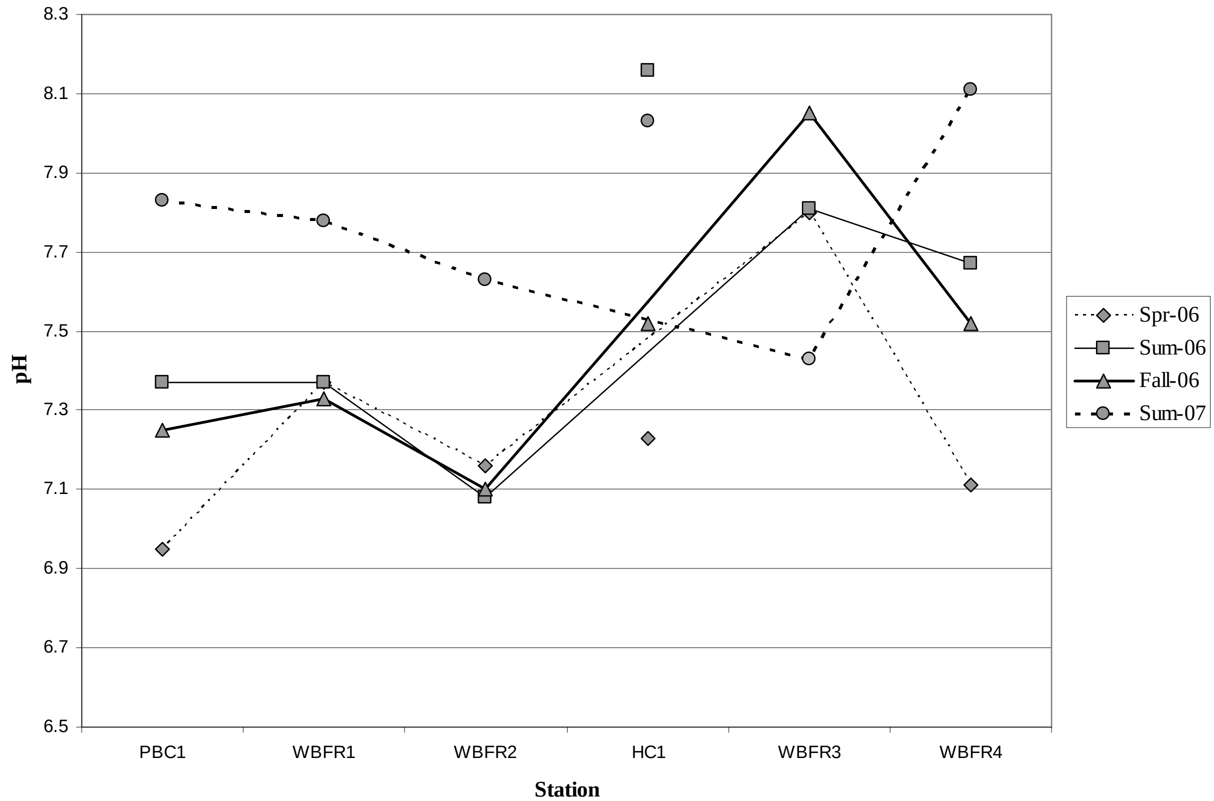

Figure E6.2.2.4-21. Longitudinal profiles of pH in WBFR during 2006 and 2007

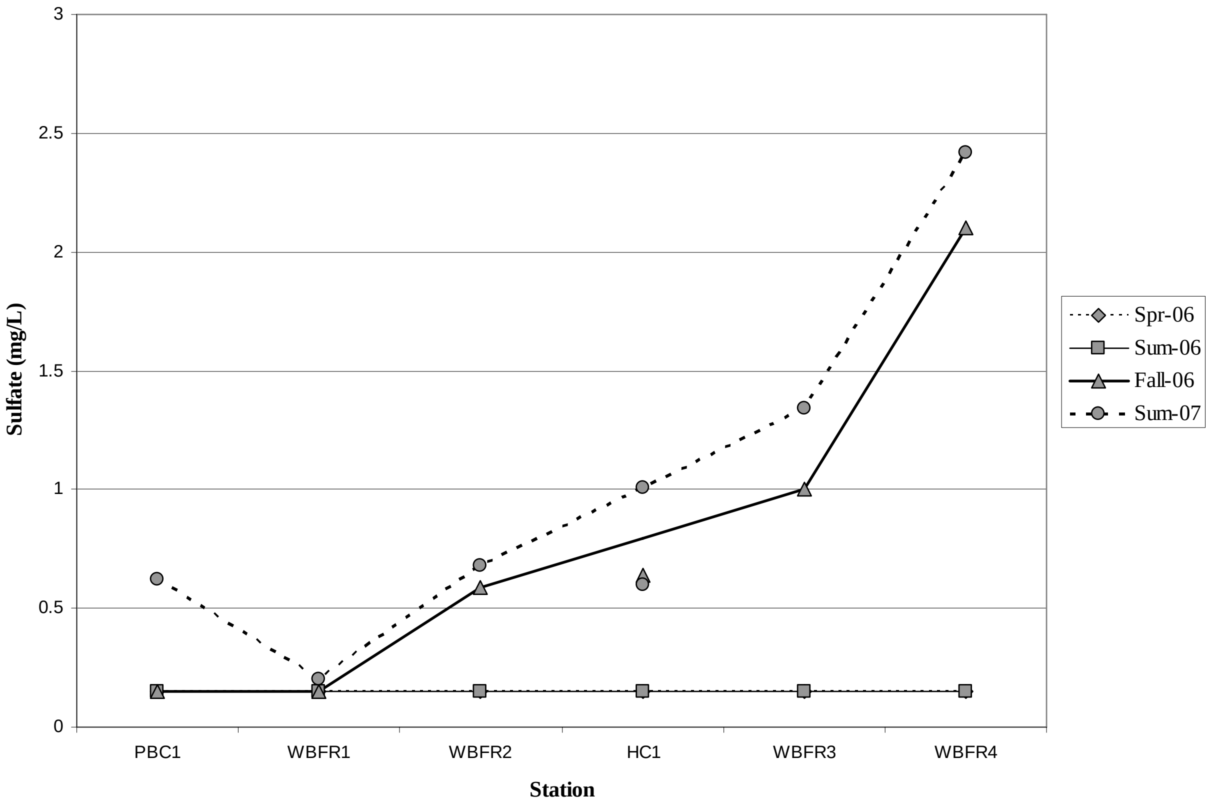

Figure E6.2.2.4-22. Longitudinal profile of SO_4 concentration in WBFR during Fall 2006. SO_4 was not detected in Spring or Summer 2006.

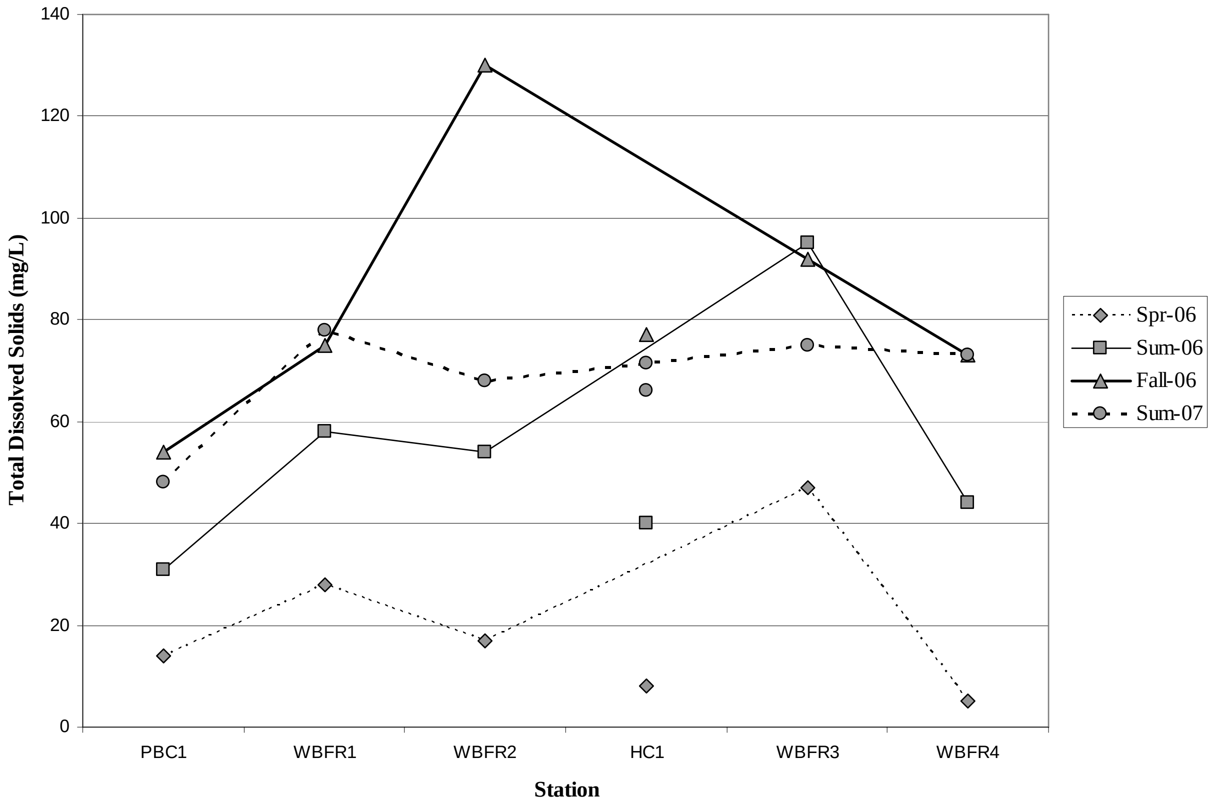

Figure E6.2.2.4-23. Longitudinal profiles of TDS concentration in WBFR during 2006 and 2007.

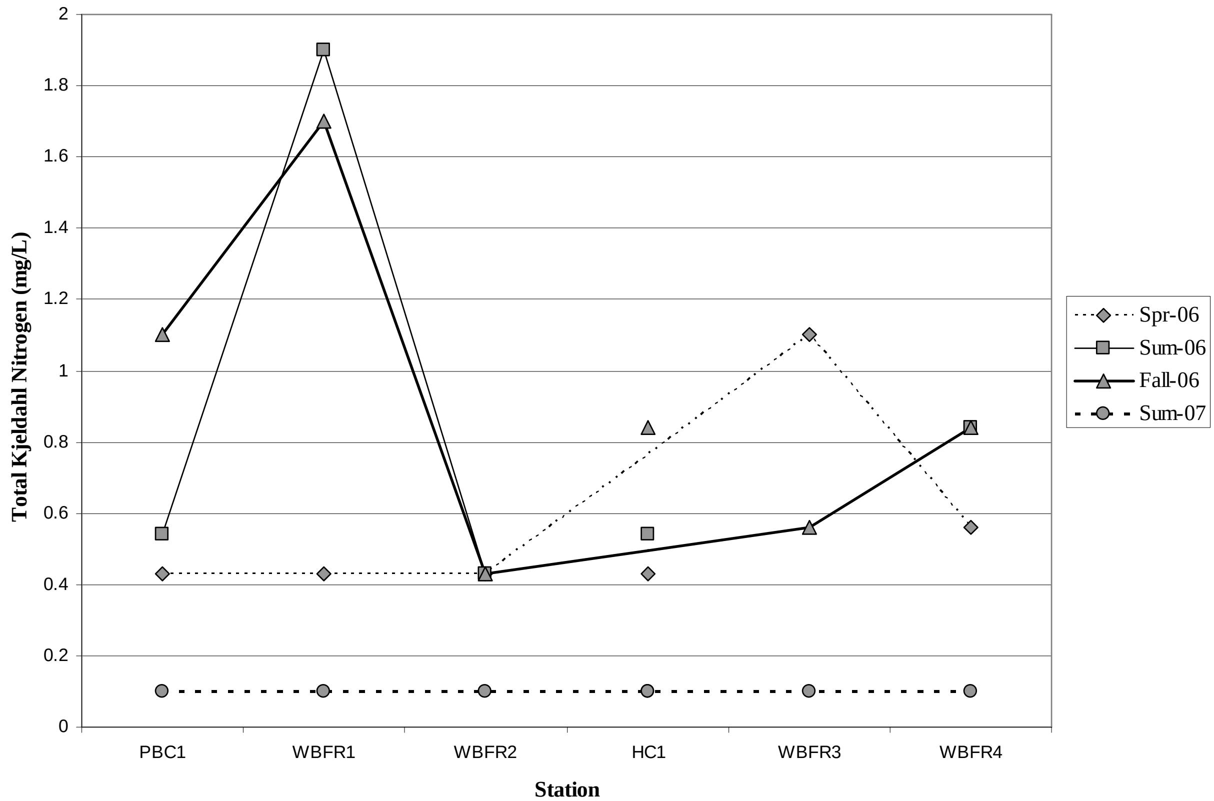

Figure E6.2.2.4-24. Longitudinal profiles of TKN concentration in WBFR during 2006 and 2007.

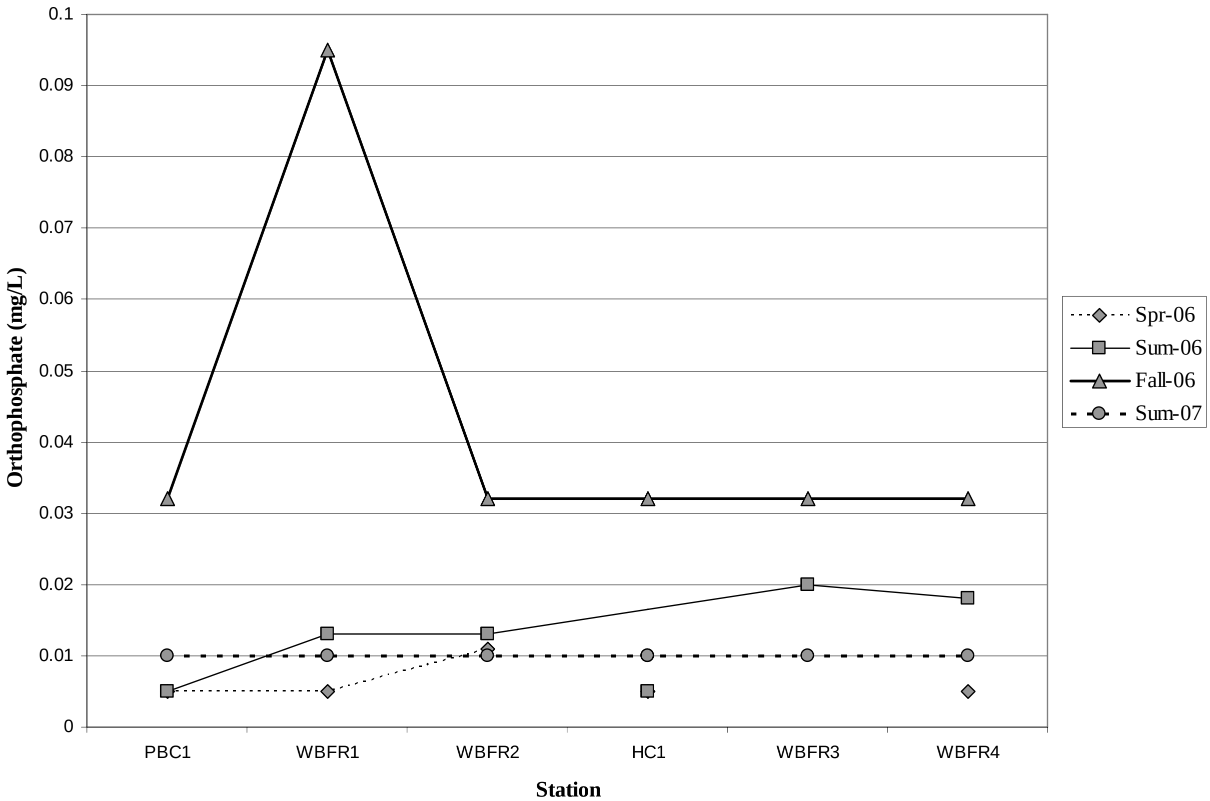

Figure E6.2.2.4-25. Longitudinal profiles of PO_4-P concentration in WBFR during Summer 2006 and 2007.

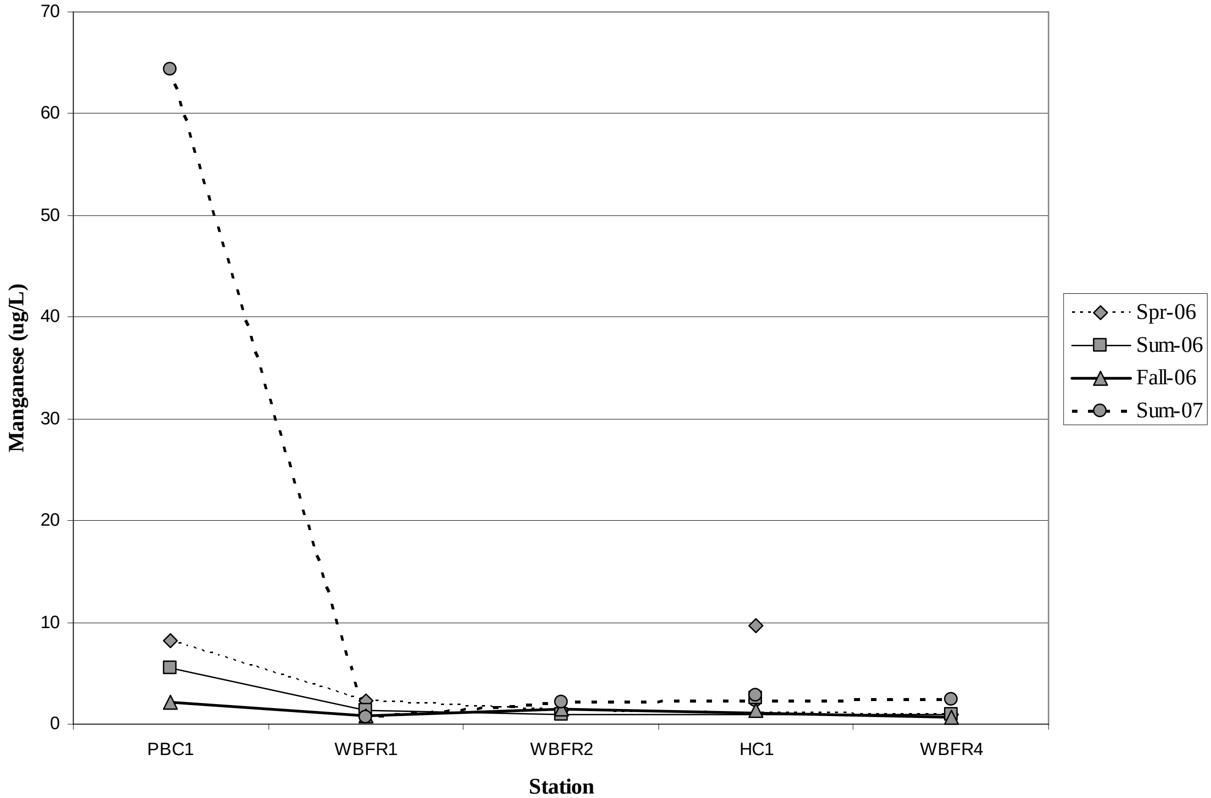

Figure E6.2.2.4-26. Longitudinal profiles of Mn concentration in WBFR during 2006 and 2007. Results <2 ug/L from Spring are estimated J-flagged values. No Mn samples were collected at WBFR3.

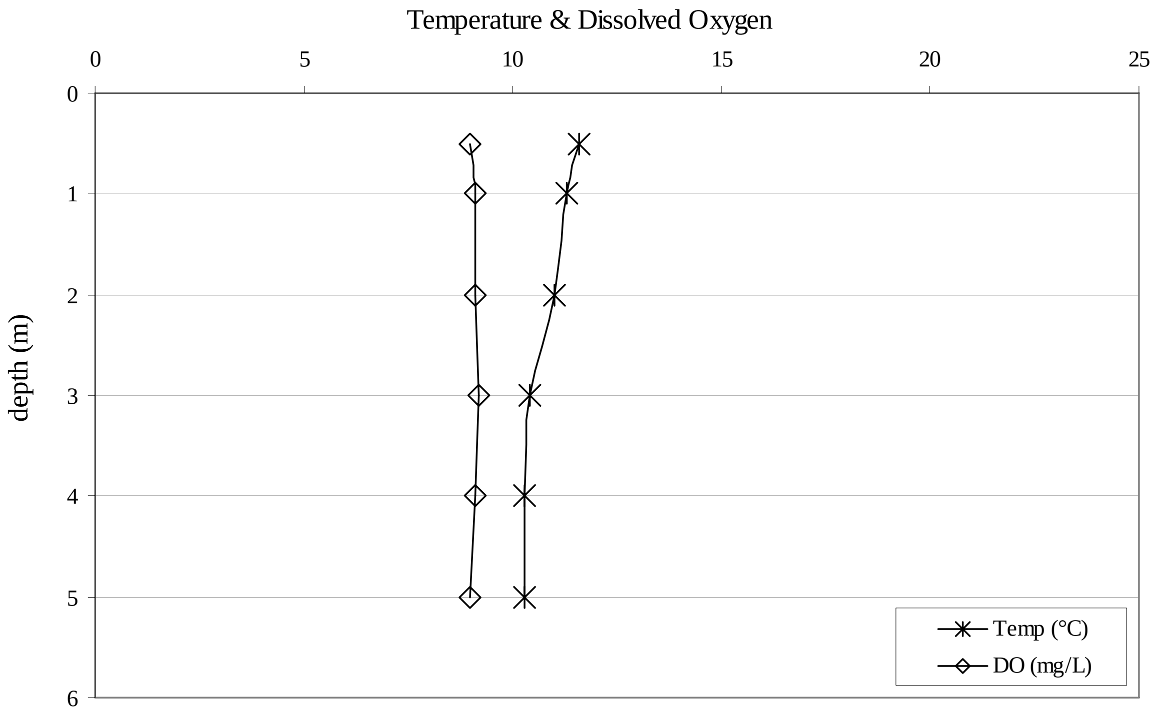

Figure E6.2.2.4-27. Water temperature and DO profiles for Round Valley Reservoir in Spring 2006.

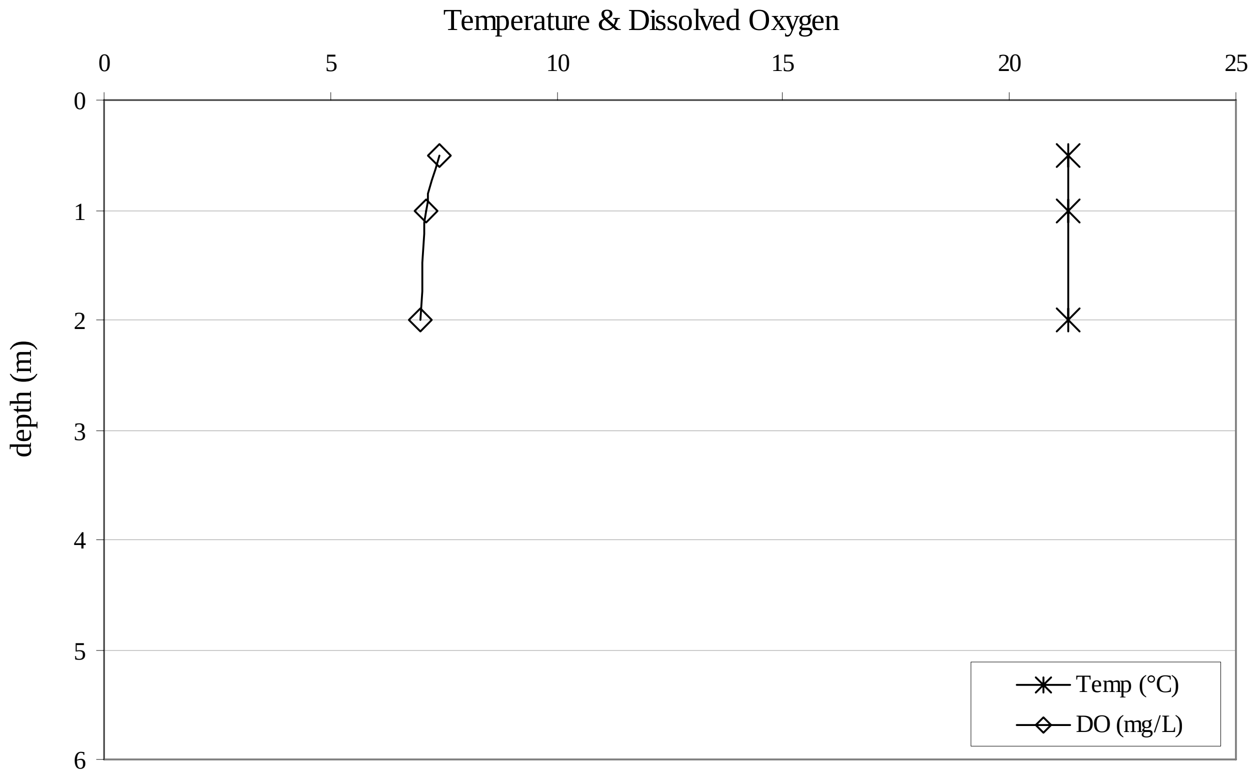

Figure E6.2.2.4-28. Water temperature and DO profiles for Round Valley Reservoir in Summer 2006.

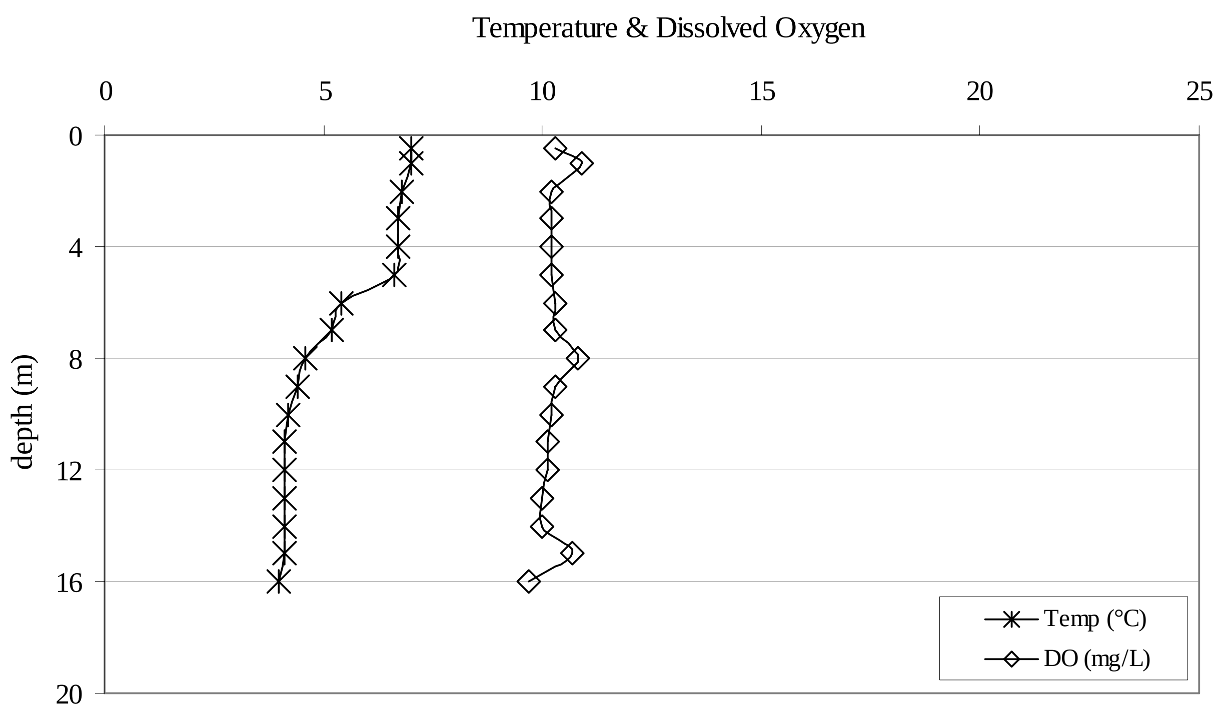

Figure E6.2.2.4-29. Water temperature and DO profiles for Philbrook Reservoir in Spring 2006.

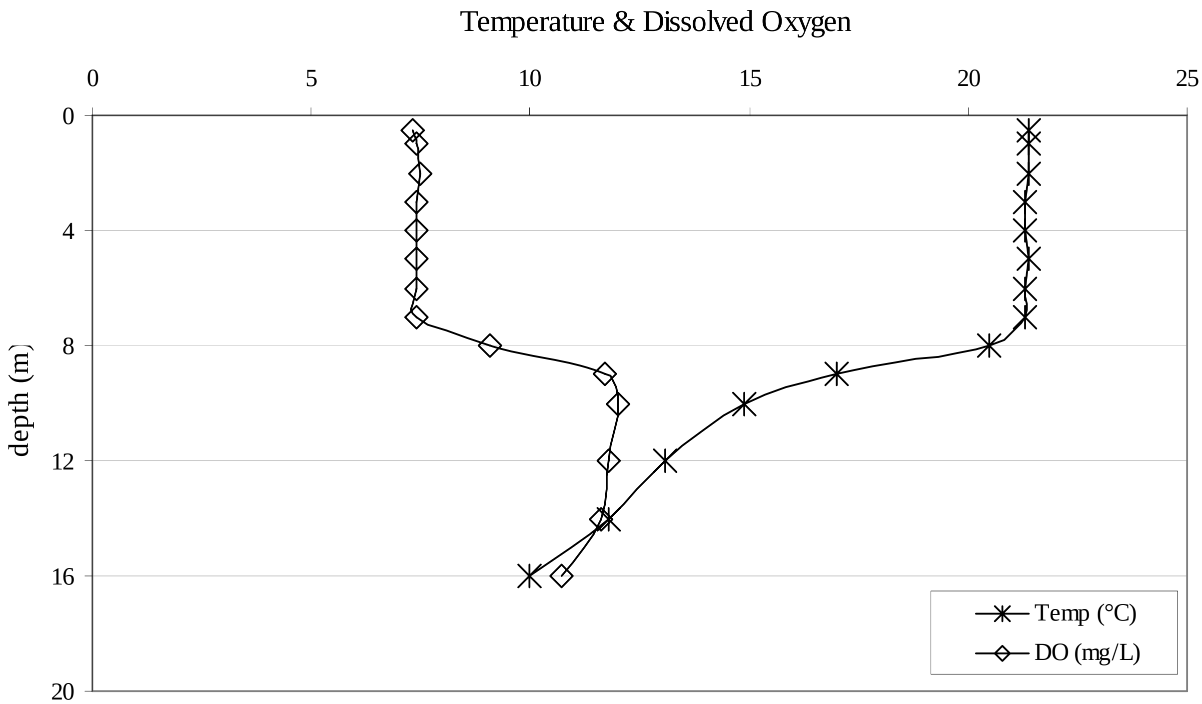

Figure E6.2.2.4-30. Water temperature and DO profiles for Philbrook Reservoir in Summer 2006.

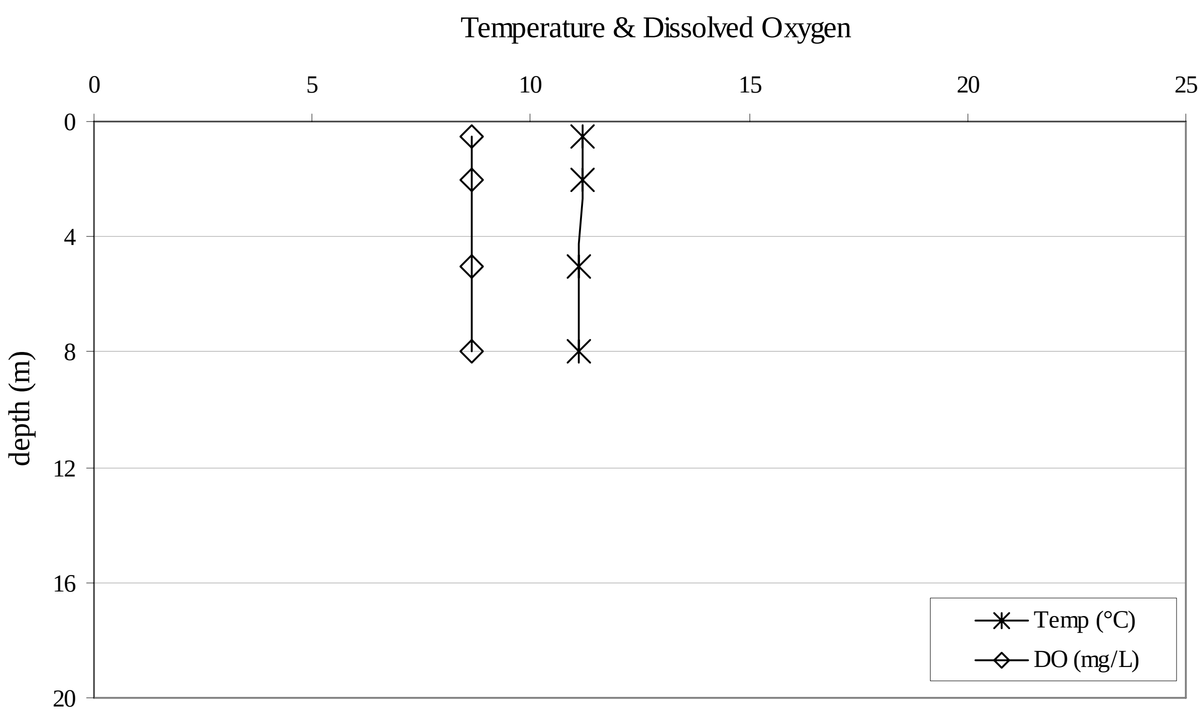

Figure E6.2.2.4-31. Water temperature and DO profiles for Philbrook Reservoir in Fall 2006.

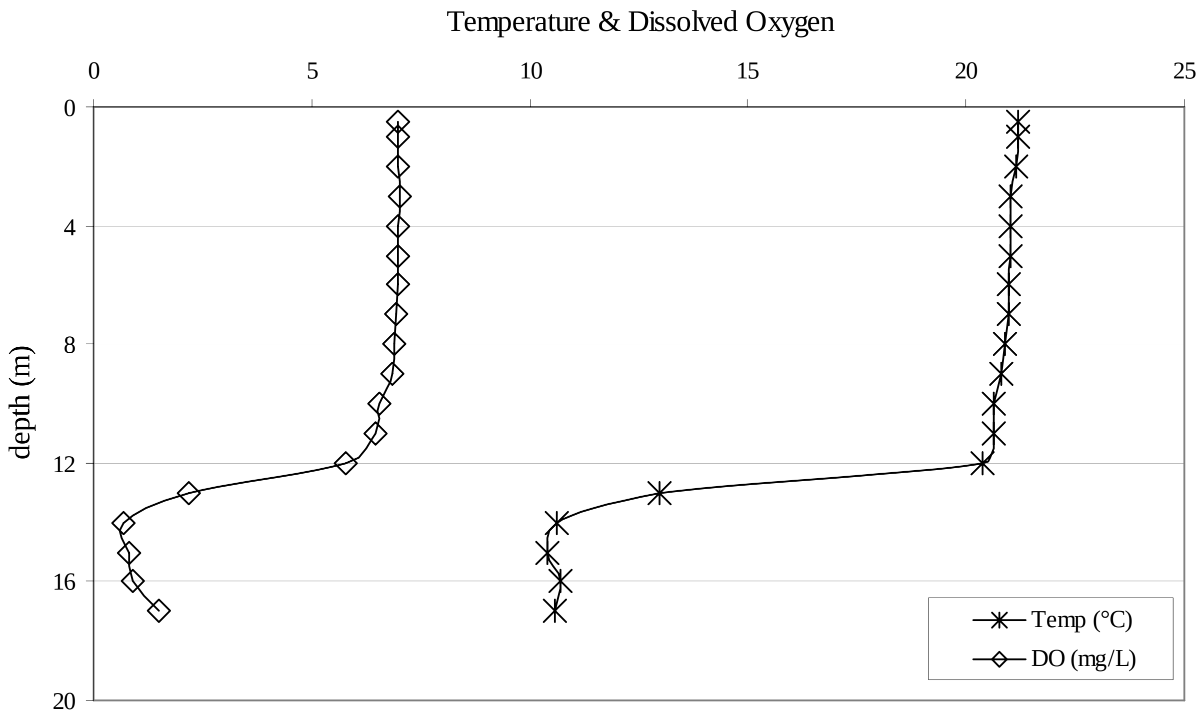

Figure E6.2.2.4-32. Water temperature and DO profiles for Philbrook Reservoir in Summer 2007.

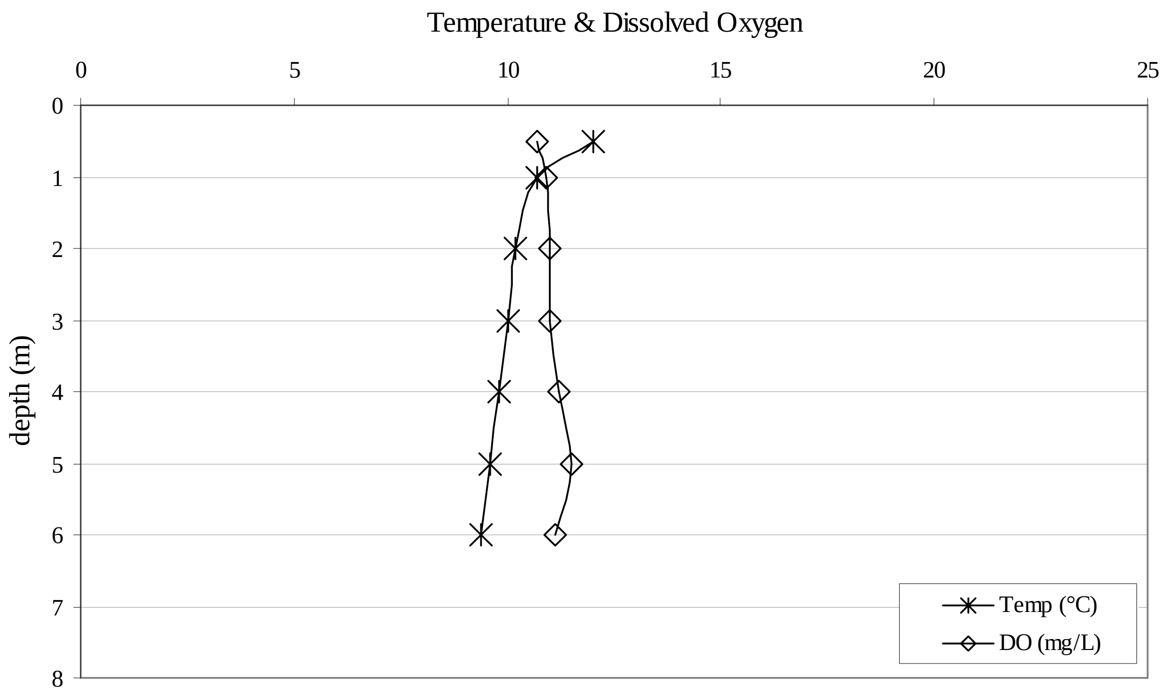

Figure E6.2.2.4-33. Water temperature and DO profiles for DeSabla Forebay in Spring 2006.

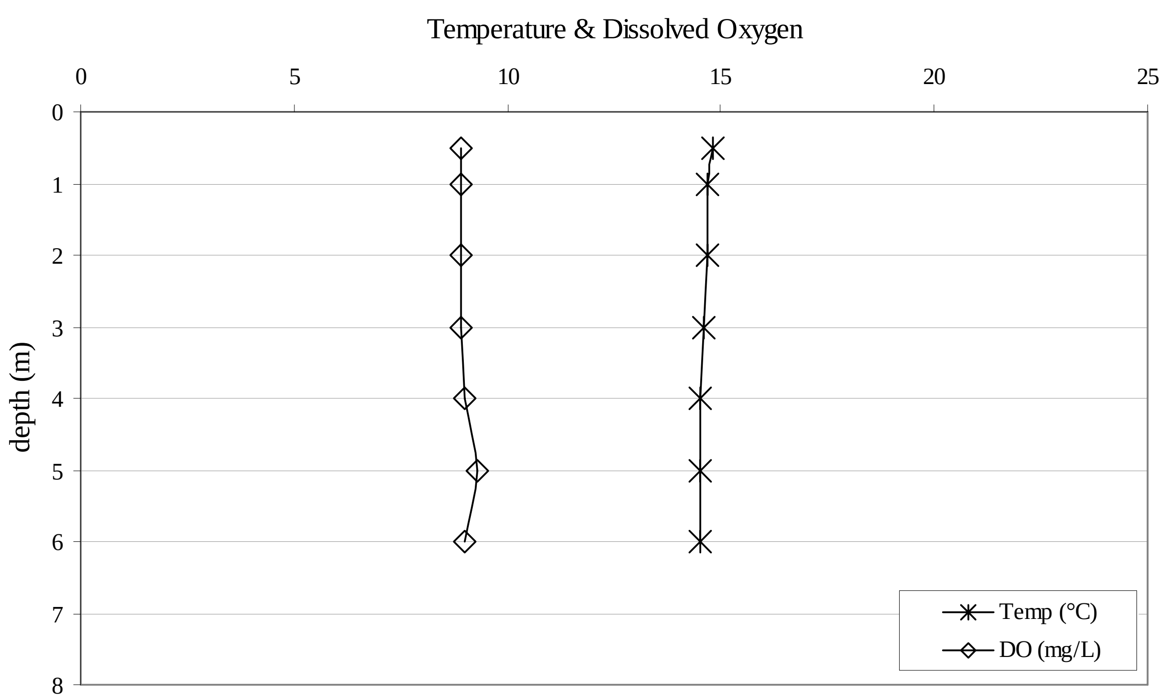

Figure E6.2.2.4-34. Water temperature and DO profiles for DeSabla Forebay in Summer 2006.

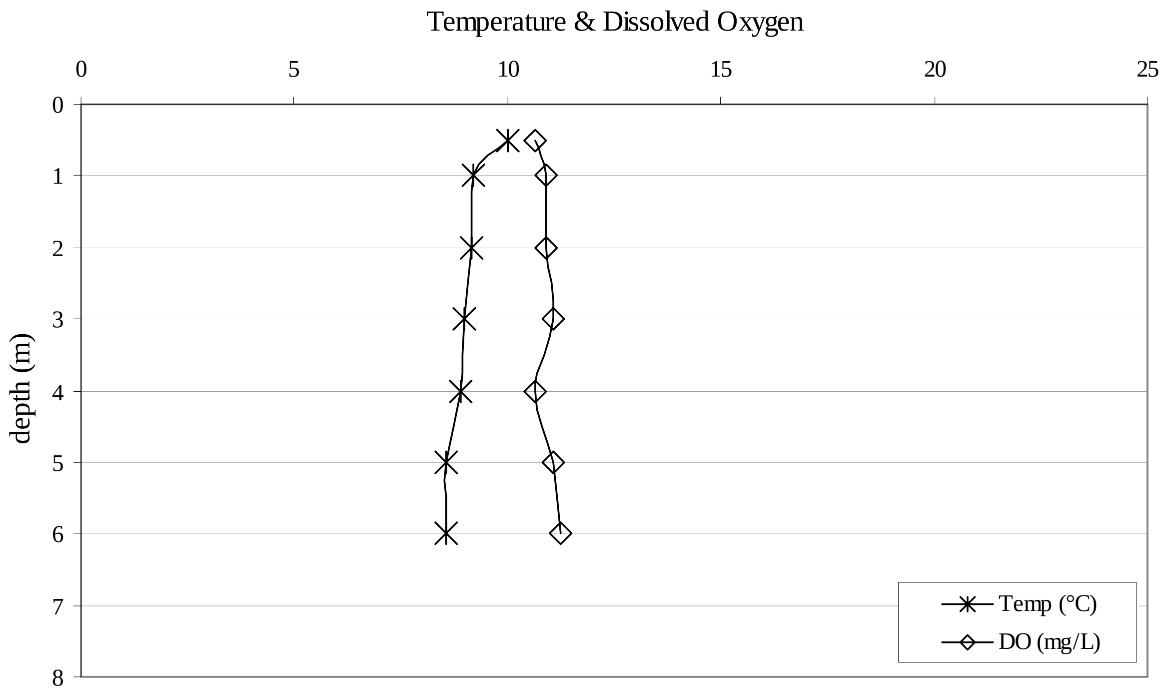

Figure E6.2.2.4-35. Water temperature and DO profiles for DeSabla Forebay in Fall 2006

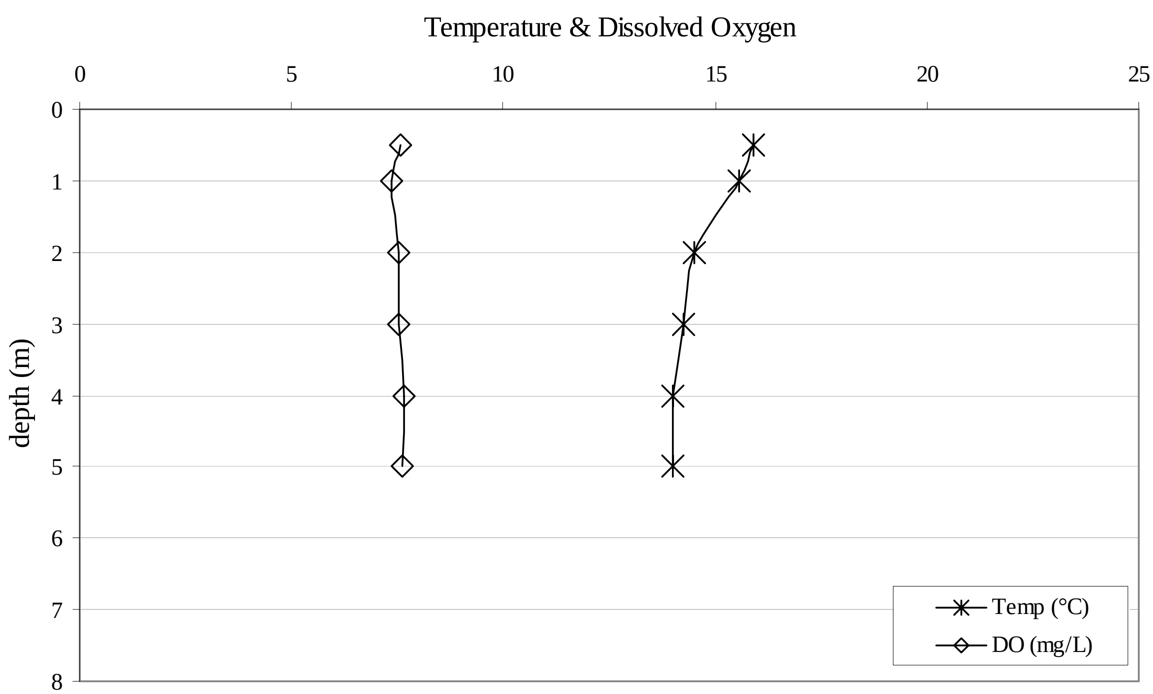

Figure E6.2.2.4-36. Water temperature and DO profiles for DeSabla Forebay in Summer 2007

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6.3 Fish and Aquatic Resources

6.3.2.2 *Updated* - Characterization of Fish Populations in Project Reservoirs and Project-Affected Stream Reaches (Study 6.3.3-4)

PG&E collected fish population data in 2006 and included this information in the application. As recommended by FERC in its July 5, 2007 Study Plan Determination for this study, PG&E also sampled fish at six additional stream locations in September–October 2007. This report includes the results of both 2006 and 2007 fish population monitoring efforts.

6.3.2.2.1 Study Objectives

The objective of the study is to characterize the relative abundance, distribution, and structure of the fish communities in Project-affected[1] waters, and to analyze indirect and cumulative effects of the Project on fisheries resources.

6.3.2.2.2 Study Area

The Study Area included all Project reservoirs and Project-affected stream reaches. To differentiate sections of the Study Area, individual streams were divided into reaches for analysis purposes. Reaches were defined as the section of stream between readily identifiable endpoints, such as a structure or confluence. Streams above Project facilities were described similarly (e.g., Butte Creek upstream of Butte Diversion Dam). Reaches on tributary streams that contained diversions into Project canals were described as being upstream or downstream of the diversion (e.g., Inskip Creek upstream of diversion).

Specifically, the Study Area in the Butte Creek watershed included: 1) DeSabla Forebay; 2) Butte Creek between Butte Creek Diversion Dam and Lower Centerville Diversion Dam; 3) Butte Creek between Lower Centerville Diversion Dam and Centerville Powerhouse; 4) Butte Creek between Centerville Powerhouse and the Honey Run Covered Bridge; and 5) Inskip Creek, Kelsey Creek, and Clear Creek, which are tributaries to Butte Creek that are diverted into the Butte Canal. No sampling was conducted on Little Butte Creek since the feeder diversion is rarely operated, and then only during high runoff periods (PG&E 2004).

In the West Branch Feather River (WBFR) watershed, the Study Area included: 1) Philbrook Reservoir; 2) WBFR between Round Valley Reservoir and Hendricks Head Dam; 3) WBFR between Hendricks Head Dam and Miocene Diversion, a non-Project structure; 4) Philbrook Creek upstream of Philbrook Reservoir, 5) Philbrook Creek between Philbrook Reservoir and the WBFR; and 6) Little West Fork, Cunningham Ravine, and Long Ravine, which are tributaries to the WBFR that are diverted into Hendricks Canal. No sampling was conducted in Round Valley Reservoir; during PG&E stream channel surveys in summer of 2004, it was determined that Round Valley Reservoir and the WBFR watershed upstream of the reservoir go dry during the summer.

[1] Project-affected is defined as directly affected by Project presence, operation or maintenance (PG&E 2004).

6.3.2.2.3 Methods

Study Sites

In 2006, study sites for each Project–affected stream included 1–4 sites located within each Project-affected reach, and one reference site upstream of the applicable water diversion, where appropriate. Where possible, fish sampling sites were located at historic fish sampling sites or sites with similar geomorphic and aquatic habitat characteristics for comparative purposes. Stream monitoring sites were selected to provide coverage of the Project Area at stratified and safely accessible locations. Fish stream monitoring sites are shown in Figure E6.3.2.2.-1 at the end of this report. Fish monitoring sites on Project reservoirs are shown in Figures E6.3.2.2-2 and E6.3.2.2.-3 at the end of this report. Monitoring sites are labeled on GIS maps based on the stream that they are in and the river mile where the site occurs. Sites in the WBFR include the acronym "WBFR" and the river mile (e.g., WBFR 16.0). Similarly, sites in Butte Creek begin with "Butte" and include the river mile (e.g., Butte 50.5). WBFR river mile 0.0 represents the confluence with the North Fork Feather River that is flooded by Lake Oroville, and Butte Creek river mile 0.0 represents the confluence with the Sacramento River. Monitoring sites on tributaries to Butte Creek or the WBFR include the stream name as well as the designation "F" for fish and the site number from upstream to downstream (e.g., Philbrook Creek upstream of Philbrook Reservoir is labeled Philbrook –F1). A list of all stream monitoring sites, sample methods used, and dates sampled in 2006 are included in Table E6.3.2.2-1.

Following the 2006 surveys, FERC recommended that "PG&E [in 2007]: (1) re-sample the site upstream (RM 72.2) and downstream (RM 71.8) of the Butte Creek Diversion Dam on Butte Creek utilizing electrofishing, as required by the study plan; (2) sample the site upstream of the DeSabla Powerhouse using backpack electrofishing or direct observation (as conditions dictate), as required by the study plan, and as proposed by PG&E; (3) sample an additional site downstream of the Lower Centerville Diversion Dam using direct observation so comparisons of fish populations upstream and downstream of the diversion can be made, as proposed by PG&E; (4) re-sample the site immediately upstream (RM 30.2) of the Hendricks Head Dam using electrofishing, if possible, as proposed by PG&E; and (5) re-sample the site immediately downstream (RM 28.5) of the Hendricks Head Dam, making every effort possible to use the same methodology as upstream of the diversion, as proposed by PG&E." A list of all six stream monitoring sites, sample methods used, and dates sampled in 2007 are included in Table E6.3.2.2-2. Fish sites were located within one mile of their respective diversion to account for any influence of the diversion.

Monitoring of fish populations in Project reservoirs occurred in Philbrook Reservoir and DeSabla Forebay in 2006. Six to seven monitoring sites were located within each reservoir in shallow margin habitat around the reservoir shoreline, as well as near-shore and deep-water locations. Monitoring site labels on GIS maps are sequentially numbered for each reservoir based on sample method and number (e.g., S-4 is the fourth site sampled by beach seine; G-3 is the third site sampled by gillnet). Reservoir monitoring sites, sample methods used, and dates sampled are included in Table E6.3.2.2-1.

Table E6.3.2.2-1. Fish population monitoring site locations, survey methods, and survey dates for the DeSabla-Centerville Project Study Area, 2006.

Site Name	Site Description	Location (UTM NAD 83) Easting	Location (UTM NAD 83) Northing	Survey Method	Survey Dates
BUTTE CREEK					
Upstream of Butte Creek Diversion Dam					
Butte 72.2	Butte Creek upstream of Butte Creek Diversion Dam	10S 0620526	4427024	Snorkel	10/14/06
Downstream of Butte Creek Diversion Dam					
Butte 71.8	Butte Creek downstream of Butte Creek Diversion Dam	10S 0620426	4426422	Snorkel	10/14/06
Butte 65.3	Butte Creek at Doe Mill Bridge	10S 0618282	4418693	Backpack electrofishing	09/17/06
Downstream of DeSabla Powerhouse and Forks of Butte Powerhouse					
Butte 61.9[a]	Butte Creek upstream of Lower Centerville Diversion Dam	10S 0616957	4414015	Snorkel	09/18/06
Downstream of Lower Centerville Diversion Dam					
Butte 61.7	Butte Creek downstream of Lower Centerville Diversion Dam	10S 0616777	4413723	Snorkel	09/18/06
Butte 60.8	Butte Creek at Quartz Bowl	10S 0616866	4412556	Snorkel	09/19/06
Butte 59.0	Butte Creek at Whiskey Flat	10S 0615864	4410186	Snorkel	09/11/06
Butte 56.5	Butte Creek at Helltown	10S 0614946	4406662	Snorkel	09/09/06
Downstream of Centerville Powerhouse					
Butte 54.6	Butte Creek at Humbug Bridge	10S 0614510	4404239	Snorkel	09/07/06
Butte 53.4	Butte Creek at Quail Run Bridge	10S 0613602	4402565	Snorkel	09/08/06
Butte 50.5	Butte Creek at Honey Run Covered Bridge	10S 0611485	4399651	Snorkel	09/06/06
BUTTE CREEK TRIBUTARIES					
Inskip-F1	Inskip Creek upstream of diversion	10S 0620612	4426393	Backpack electrofishing	10/18/06
Inskip-F2	Inskip Creek downstream of diversion	10S 0620728	4426238	Backpack electrofishing	10/18/06
Kelsey-F1	Kelsey Creek upstream of diversion	10S 0620886	4424192	Backpack electrofishing	10/16/06
Kelsey-F2	Kelsey Creek downstream of diversion	10S 0620860	4424194	Backpack electrofishing	10/16/06
Clear-F1	Clear Creek upstream of diversion	10S 0622238	4422887	Backpack electrofishing	10/18/06
Clear-F2	Clear Creek downstream of diversion	10S 0620675	4422728	Backpack electrofishing	10/18/06

Table E6.3.2.2-1 (continued)

Site Name	Site Description	Location (UTM NAD 83) Easting	Location (UTM NAD 83) Northing	Survey Method	Survey Dates
WEST BRANCH FEATHER RIVER					
Downstream of Round Valley Reservoir					
WBFR 43.6	West Branch Feather River downstream of Round Valley Reservoir	10T 0631568	4436570	Backpack electrofishing	09/18/06
Downstream of Coon Hollow Creek					
WBFR 41.1	West Branch Feather River downstream of Coon Hollow Creek	10T 0628813	4434980	Backpack electrofishing	09/15/06
Downstream of Philbrook Creek					
WBFR 35.0	West Branch Feather River at Road 25N06	10T 0625655	4428676	Backpack electrofishing	10/19/06
WBFR 30.2	West Branch Feather River upstream of Hendricks Diversion	10S 0625455	4423010	Snorkel	10/13/06
Downstream of Hendricks Diversion					
WBFR 28.5	West Branch Feather River at Hendricks Canal Road "A"	10S 0626205	4420061	Backpack electrofishing	10/17/06
WBFR 23.3	West Branch Feather River downstream of Big Kimshew Creek	10S 0627437	4414591	Snorkel	10/12/06
WBFR 16.0	West Branch Feather River at Jordon Hill Bridge	10S 0622580	4409561	Snorkel	09/10/06
WEST BRANCH FEATHER RIVER TRIBUTARIES					
Coon-F1	Coon Hollow Creek - upstream of WBFR	10T 0630792	4435395	Backpack electrofishing	09/14/06
Philbrook-F1	Philbrook Creek - upstream of Philbrook Reservoir	10T 0631860	4431551	Backpack electrofishing	09/16/06
Philbrook-F2	Philbrook Creek - downstream of Philbrook Reservoir	10T 0627393	4432380	Backpack electrofishing	09/16/06
Long-F1	Long Ravine - upstream of diversion	10S 0624989	4419259	Backpack electrofishing	10/20/06
Long-F2	Long Ravine - downstream of diversion	10S 0624303	4417348	Backpack electrofishing	10/20/06
Cunningham-F1	Cunningham Ravine- upstream of diversion	10S 0622662	4418398	Backpack electrofishing	10/11/06
Cunningham-F2	Cunningham Ravine- downstream of diversion	10S 0622246	4417906	Backpack electrofishing	10/15/06
Little West Fork-F1	Little West Fork - upstream of diversion	10S 0621630	4418382	Backpack electrofishing	10/11/06
Little West Fork-F2	Little West Fork - downstream of diversion	10S 0622179	4417893	Backpack electrofishing	10/15/06

Table E6.3.2.2-1 (continued)

Site Name	Site Description	Location (UTM NAD 83)		Survey Method	Survey Dates
		Easting	Northing		
RESERVOIRS					
Philbrook Reservoir					
Philbrook-G1	Western edge, near southwest shoreline of Philbrook Reservoir	10T 0630064	4431877	Gillnet	08/28/06–08/30/06
Philbrook-G2	Western edge, near northwest shoreline of Philbrook Reservoir	10T 0630032	4432015	Gillnet	08/28/06–08/30/06
Philbrook-G3	Northwest edge of Philbrook Reservoir	10T 0630092	4432123	Gillnet	08/28/06–08/30/06
Philbrook-S1	Eastern end of Philbrook Reservoir at small island	10T 0630775	4431504	Beach seine	08/29/06
Philbrook-S2	Eastern end of Philbrook Reservoir near stream channel	10T 0630064	4431877	Beach seine	08/29/06
Philbrook-S3	West bank of Philbrook Reservoir	10T 0630205	4432256	Beach seine	08/29/06
Philbrook -S4	West end near spillway	10T 0630097	4432196	Beach seine	08/29/06
DeSabla Forebay					
DeSabla-G1	Near western shore of DeSabla Forebay	10S 0618633	4414535	Gillnet	08/30/06–09/01/06
DeSabla-G2	Shallow south west shoreline of DeSabla Forebay	10S 0618675	4414504	Gillnet	08/30/06–09/01/06
DeSabla-E1	Southeast shore of DeSabla Forebay	10S 0618651	4414613	Boat electrofishing	08/31/06
DeSabla-E2	Northwest corner of dam of DeSabla Forebay	10S 0618676	4414681	Boat electrofishing	08/31/06
DeSabla-E3	Northern edge near shoreline of DeSabla Forebay	10S 0618769	4414730	Boat electrofishing	08/31/06
DeSabla-E4	Southwest shoreline near DeSabla Forebay Dam	10S 0618616	4414504	Boat electrofishing	08/31/06

[a] The monitoring site located at Butte 61.9 was intended to be sampled at approximately river mile 62.3, upstream of both Lower Centerville Diversion Dam and DeSabla Powerhouse. The study plan was misinterpreted and the site was inadvertently located upstream of Lower Centerville Diversion Dam but downstream of DeSabla Powerhouse instead of upstream of DeSabla Powerhouse. In 2007, the site upstream of the DeSabla Powerhouse was surveyed (Butte 62.0; see table E6.3.2.2.2-2.)

Table E6.3.2.2-2. Fish population monitoring site locations, survey methods, and survey dates for the DeSabla-Centerville Project Study Area, 2007.

Site Name	Site Description	Location (UTM NAD 83) Easting	Location (UTM NAD 83) Northing	Primary Survey Method (Comparison Method)	Primary Survey Date
BUTTE CREEK					
Butte 72.1	Upstream of Butte Creek Diversion	10S 0620525	4427026	Night Snorkel	10/24/07
Butte 71.9	Downstream of Butte Creek Diversion	10S 0670493	4426509	Night Snorkel (Backpack electrofishing)	10/23/07
Butte 62.0	Upstream of Lower Centerville Diversion and DeSabla Powerhouse	10S 0616925	4414278	Night Snorkel (Backpack electrofishing)	10/01/07
Butte 61.7	Downstream of Lower Centerville Diversion	10S 0616786	4413760	Night Snorkel	10/01/07
WEST BRANCH FEATHER RIVER					
WBFR 29.3	Upstream of Hendricks Head Dam	10S 0625360	4422093	Backpack electrofishing (Day Snorkel)	09/25/07
WBFR 28.5	Downstream of Hendricks Head Dam	10S 0626107	4420242	Backpack electrofishing	09/26/07

Stream Sampling

In 2006, stream sampling was conducted using backpack electrofishing or direct observation (snorkel) methods. In 2007, stream sampling was also conducted using backpack electrofishing or direct observation (snorkel) methods. In 2007, however, PG&E focused on using similar methods upstream and downstream of each diversion and used electrofishing whenever feasible. When backpack electrofishing was not possible at both sites (upstream and downstream of a diversion), snorkel methods were used in its place with a methods comparison between backpack electrofishing and snorkeling at one site at each diversion.

Electrofishing

Electrofishing was conducted at stream locations that allowed adequate and safe capture of fish (typically less than 4 feet maximum depth and velocities that allowed for safe wading). Sampling was conducted in a section of stream approximately 300 feet in length where feasible. Electrofishing sites in Butte Creek and the WBFR were partitioned into two segments composed of different habitat types which were representative of habitat observed in that section of the reach. This method was employed to increase sampling efficiency and capture probabilities.

Electrofishing was conducted at 20 sites in 2006, and at 4 sites in 2007. Once the sample site was located, the crew prepared the site for sampling by installing block nets at the upper and lower boundary of the sample unit. Block nets made of 3/16-inch mesh were used to prevent movement of fish in and out of the survey area to facilitate an accurate assessment of the sample population.

Sampling was conducted following procedures identified by Reynolds (1996) using 1–2 sampling teams with Smith-Root backpack electrofishers (Model LR-24). Each sampling team included a field technician carrying a backpack electrofisher and 1–2 persons netting the stunned fish, depending on the size of wetted stream channel, habitat complexity, and fish densities. Prior to sampling, the settings on the backpack electrofishing unit were adjusted to provide adequate strength for polarization and anesthesia of fish based on site-specific conditions.

Proceeding upstream, the teams simultaneously electrofished each sampling segment. In order to thoroughly sample each segment and maximize capture efficiency, the electrofishing teams maintained their stationing in a straight line perpendicular to the thalweg. A multiple pass sampling effort was used, whereby stunned fish were captured and temporarily removed from the sample site during each pass. Three to four passes of equal effort were made to capture as large of a percentage of the population as possible. The number of passes that were made was dependant on the capture ratio of fish on successive passes.

Captured fish were placed in buckets and held until the completion of the pass for processing. Fish captured in each segment during each pass were counted and measured separately.

Captured fish were identified to species and counted. Each fish was measured to the nearest millimeter (mm) for fork length (FL) and weighed to the nearest 0.1 gram (g). Captured fish in 2007 were also measured for total length (TL). Processed fish were kept in live wells until the electrofishing had been completed. Fish were then released back into the segment where they were captured. Any mortalities, lesions, or abnormalities were noted. Crayfish, a foothill yellow-legged frog predator, were collected and noted during the electrofishing survey.

Habitat descriptors and physical habitat measurements were recorded at each site. Each segment was characterized by habitat type (e.g., pool, run, or riffle). The length of each sampling segment was measured along the thalweg to the nearest foot, and the mean width of each sampling segment was calculated by measuring the width of the wetted channel to the nearest 0.1 foot at six or more evenly spaced transects. The area of each sampling segment was calculated by multiplying length by mean width. The approximate maximum and average depths and the approximate discharge of the segment were recorded. Substrates and fish cover were visually estimated at each site. Measurements of water temperature, dissolved oxygen (DO), electrical conductivity, and specific conductance were collected using an YSI 85 multi-parameter meter. pH was measured using an Oakton pH Testr 2. GPS coordinates were recorded at the top and bottom of each sample unit using NAD 83 as the datum. Photographs were taken to document the specific location and conditions of the site.

Direct Observation

Direct observation methods (snorkeling) were used to assess fish populations at sites that could not be adequately or safely electrofished, or at sites that contained species listed under the Endangered Species Act or as Federally Sensitive (Butte Creek downstream of Lower Centerville Diversion Dam, and WBFR from Hendricks Head Dam to the Miocene Diversion Dam). Snorkel surveys were conducted at a variety of habitat types within each study site. In general, five to seven habitat units were selected at each site based on their relative proportion of occurrence within the reach as previously determined from the habitat mapping results [Reported in the Instream Flow Studies for Lower Butte Creek (Section 6.3.2.1), Upper Butte Creek (Section 6.3.2.7), Lower WBFR (Section 6.3.2.8), and Upper WBFR (Section 6.3.2.9) of this report]. The habitat units sampled were generally contiguous.

In 2006, snorkeling was conducted at 13 sites in Butte Creek and the WBFR: 10 sites in Butte Creek and three sites in the WBFR. Snorkel methods were used to make a qualitative assessment of fish populations in streams and to characterize fish communities with special emphasis on juvenile salmon and steelhead in lower Butte Creek to supplement CDFG adult spring-run Chinook survey data (Reported in Section 6.6.2.1 of the FLA - Survey Spring-Run Chinook Salmon Pre-Spawning Mortality and Spawning Escapement).

In 2007, snorkeling was conducted at five sites, including three sites that were also electrofished. Ultimately, four of the five snorkel surveys were conducted after sunset based on the results of a daytime / nighttime comparison to electrofishing results (discussed below under *Stream Sampling Methods Comparison*).

Snorkeling was conducted using the following procedures identified by Dolloff *et al*. (1996). Specifically, divers entered the stream either upstream or downstream from the area to be sampled. Divers briefly rested to acclimate and to allow any fish in the area to resume normal behavior. Snorkeling was typically conducted in an upstream direction; however, in deep water habitats with stream velocities that prevented upstream movement, divers floated downstream.

Snorkel crews consisted of three to four divers, depending on stream width and water visibility. Divers were aligned across the channel, typically at the downstream end of the survey area where the river was stratified into snorkel lanes to avoid duplicating fish counts. Divers proceeded upstream through the habitat in designated lanes at a slow, even and uniform pace. Divers recorded counts of individual fish by species where possible and estimated total length into 25-50 mm size classes (e.g., 25-50 mm, 50-75 mm, or 300-350 mm) as the fish passed below or to the side of each observer. Observers calibrated underwater length estimates using objects with calibrations of known total length.

In 2006, surveys were conducted between 0930 hours and 1630 hours to ensure that optimum light conditions were available during the survey, as outlined in the study plan. In 2007, a daytime / nighttime comparison was conducted before continuing with the remainder of the surveys, and it was determined that night surveys produced results that were more closely comparable to the electrofishing. Night diving was conducted in a similar manner as described above with divers carrying underwater dive lights to provide sufficient light for the survey. In 2007, a multiple pass technique was also employed where each segment was snorkeled from downstream to upstream using three consecutive passes to allow for estimates of variability as well as a more refined population abundance estimate using bounded counts (discussed below under *Analysis*).

Start and end times were noted, and all data recorded on the dive slates were transcribed to a data sheet upon completion of the snorkel survey. General site information was collected in the same manner as described for the electrofishing methods. In addition to parameters collected at electrofishing sites, underwater visibility was estimated by horizontal measurements using a Secchi disk. During daytime surveys, Secchi measurements were averaged between measurements taken into and away from the sun; during night surveys, one measurement was taken using a dive light.

Stream Sampling Methods Comparison

During the 2007 surveys, it was PG &E's intent to conduct backpack electrofishing upstream and downstream of Both Butte Creek Diversion Dam and Hendricks Head Dam; however, a site that could be electrofished safely and effectively could not be located within one mile of Butte Creek Diversion Dam. Consequently, this site was surveyed using direct observation methods. Direct observation and electrofishing methods were then employed at the second site as well as at the site upstream of Lower Centerville Diversion to allow for comparisons between the two methods and sites.

Table E6.3.2.2-3. Fish sites included in the methods comparison analysis in 2007.

Stream	Diversion	Location	Site	Survey Date	Method	Included in Method Comparison	Segment
Butte Creek	Butte Creek Diversion Dam	Upstream	Butte 72.1	10/24/2007	Night Snorkel		1
							2
		Downstream	Butte 71.9	9/28/2007	Day E-fish[1]	X	2
						X	3
				10/23/2007	Night Snorkel		1
						X	2
						X	3
	Lower Centerville Diversion Dam	Upstream	Butte 62.0	10/1/2007	Night Snorkel	X	1
							2
				9/29/2007	Day E-fish[1]	X	1
		Downstream	Butte 61.7	10/1/2007	Night Snorkel		1
							2
West Branch Feather River	Hendricks Head Dam	Upstream	WBFR 29.3	9/25/2007	Day E-fish	X	Lower
						X	Upper
				9/30/2007	Day Snorkel[1]	X	Lower
						X	Upper
		Downstream	WBFR 28.5	9/26/2007	Day E-fish		Lower
							Upper

[1] Method used for comparison purposes only.

The comparison of methods between direct observation and electrofishing was made at one site at each of three diversions where direct observation was used in 2007 (Table E6.3.2.2-3). The surveys for the comparison were conducted within the same habitat units (segments) to allow for direct comparison.

One electrofishing site was snorkeled during the daytime (WBFR 29.3) and a second electrofishing site was snorkeled after sunset (Butte 62.0). It was determined that the nighttime snorkeling results were more closely comparable to the backpack electrofishing results and the surveys continued at the remaining three sites using night snorkeling.

Reservoir Sampling

Reservoir fish sampling was conducted in 2006 using beach seines, boat electrofishing, and variable-mesh gillnets. The three methods were combined to sample different habitat types within the study reservoirs, including areas that may contain smaller fish that would not be captured by the gillnets. The three methods are described below.

A subsample of trout collected during sampling in Philbrook Reservoir and DeSabla Forebay was kept for mercury tissue analysis (Reported in Section 6.2.2.4 of the FLA, Measure and Evaluate Water Quality in Project Reservoirs and Project-Affected Stream Reaches).

Gillnetting

Gillnetting took place during late summer when the reservoirs were drawn down. Variable mesh gillnets were deployed at three locations covering near-shore and deepwater habitats in Philbrook Reservoir (Figure E6.3.2.2-2 located at the end of this report). In DeSabla Forebay, two variable-mesh gillnets were deployed in deep water in the vicinity of the intake structure (Figure E6.3.2.2-3 located at the end of this report).

Gillnets were 125 feet long, each with five panels 25 feet wide by 6 feet deep. Each panel consisted of a different mesh size (1 inch, 1.5 inches, 2 inches, 3 inches, or 4 inches) so that a gradient of sizes was represented across the net. The nets were oriented perpendicular to the shoreline with the finest mesh panel closest to the shore. The times of deployment and locations of each gillnet site were recorded with photos taken of each gillnet after deployment to document both location and placement relative to the shoreline. Gillnets were set for two consecutive day and night periods (approximately 48 hours total per gillnet).

Captured fish were placed in a bucket or live well for processing. Captured fish were identified to species and counted. Each fish was measured (to the nearest mm FL) and weighed (to the nearest 0.1 g). Fish were then released back into the reservoir near where they were captured. Any mortalities, lesions, or abnormalities were noted. Crayfish, a foothill yellow-legged frog predator, were collected and noted during the survey.

Habitat descriptors and physical habitat measurements were recorded at each site including the minimum, maximum, and average depth. Water temperature, dissolved oxygen (DO), electrical conductivity, and specific conductance were measured at the approximate average depth of each site using a YSI 85 multi-parameter meter. GPS coordinates (NAD 83 datum) were recorded at each site.

Beach Seine

In addition to gillnetting, beach seining was conducted in Philbrook Reservoir to further define the size, species, and relative abundance of fish in shallow water. Beach seines were used to sample for fish in areas with shallow depths, gradual slopes, and small substrates. Beach seines were used at four sites on Philbrook Reservoir. Areas lacking large debris and areas with emergent vegetation were emphasized whenever possible.

Beach seines used for sampling were 50 feet long and 6 feet tall. The seines were made of 0.25 inch mesh and included a 6-square foot bag in the center of the net. Two people deployed the beach seine. One end of the beach seine was deployed from the shoreline until either the depth exceeded 4 feet or the net was fully deployed. The net was then brought back toward the shoreline in a broad sweep.

Fish processing methods were conducted in the same manner as described for the gillnetting methods. Habitat descriptors and physical habitat measurements were collected in the same manner as described for the gillnetting methods. In addition to parameters collected during gillnetting, substrates and fish cover were visually estimated at each beach seine site.

Boat Electrofishing

In addition to gillnetting, boat electrofishing was conducted at four sites in DeSabla Forebay to further define the size, species, and relative abundance of fish along the shoreline. Boat electrofishing was used to sample for fish in areas that were close to the shoreline, but could not be sampled by beach seine due to depths greater than 4 feet, or large substrate material.

Boat electrofishing was conducted using a Smith-Root SR-18 electrofishing boat. Prior to sampling, the settings of the electrofishing unit were adjusted to provide adequate strength for polarization and anesthesia of fish based on site-specific conditions. The driver of the boat operated the electrofishing unit while two crew members netted fish off the bow. The boat fished in a zigzag pattern along the shoreline nosing into smaller (or shallower) habitat areas. The total area sampled and the time fished were recorded.

Captured fish were placed into a live well located on the boat with reservoir water continuously circulated through it. Fish processing methods were conducted in the same manner as described for the gillnetting methods. Habitat descriptors and physical habitat measurements were collected in the same manner as described for the gillnetting and beach seine methods.

Analysis

Data collected during fish population studies were entered into a Microsoft Access® database for data reduction, tabulation, and summary. Fish population data collected during the 2006 and 2007 studies were compared to historical data from the Project Area.

Species Composition

The relative abundance of fish at each site was calculated to identify fish species composition and distribution patterns throughout the Study Area.

Age Class Distribution

Length frequency histograms were developed for all fish species observed in the Study Area. Breaks or modalities within the histogram were evaluated for analysis of approximate age class structure.

Density, Biomass, and Catchable Trout Estimates

For stream sites monitored by electrofishing, trout density (number per 100 meters of stream) and biomass estimates (kilograms per acre of surface area) with 95 percent confidence intervals were computed for each site and each individual site segment. Where sufficient capture numbers and pass depletions occurred, calculations were made using the Zippin (1958) method described by Platts et al. (1983). Where there was insufficient depletion of the population, the maximum-likelihood population estimation method was used in place of Zippin, using MicroFish Demonstration Version 3.0 Software© developed by J. S. Van Deventer (Van Deventer, J.S. and W.S. Platts. 1989). Using the two methods allows for more accurate estimates and increased confidence of population estimates, individual species estimates, and species lifestage estimates. The number of catchable size trout per stream mile was also calculated for each site and individual segment. Catchable trout (defined as > 6 in) were defined for analysis purposes as >152 mm FL when observed during electrofishing surveys, and > 150 mm TL when observed during snorkel surveys. Because the number of catchable sized trout in each segment was typically too small to allow for an independent regression analysis, the estimated number of catchable trout within the sample area was calculated by multiplying the proportion of trout that were catchable size by the population estimate of trout over 100 mm TL (e.g., if 10 of 50 trout over 100 mm TL were catchable size [20 percent], and the population estimate of trout over 100 mm TL was 60 fish, the estimate for number of catchable trout was 20 percent x 60 = 12). This calculation is based on the assumption that catchable size trout have a similar probability of capture to that of all trout over 100 mm TL.

For sites monitored by direct observation in 2006, trout density (number per 100 meters of stream) and the number of catchable sized trout per stream mile was also calculated based on the total number of fish observed within the sample area.

For snorkel sites, or electrofishing sites where the Zippin method could not be used to combine the segment data (e.g., one segment required a three-pass effort and another segment required a four-pass effort), the average trout density, biomass, and catchable trout estimates for each site (all segments combined) were calculated using a weighted average based on the area (for biomass), or length (for the density and the number of catchable trout per mile) of each individual segment relative to the site as a whole. The weighted average was calculated by adding the estimated biomass, density, or catchable trout for the segments (S), each multiplied by that segment's area or length (A), and then dividing by the total area or length sampled, as shown below.

$$\text{Weighted average for site with two segments} = \frac{(S1 \times A1) + (S2 \times A2)}{(A1+A2)}$$

Where:
S1 = Biomass or density for segment 1
A1 = Area or length for segment 1
S2 = Biomass or density for segment 2
A2 = Area or length for segment 2

Density, biomass, and catchable trout estimates were made for all trout species combined as well as individual species separated by lifestage. Fish identified as "rainbow hybrid/color morph" were combined with rainbow trout for these analyses given that the assumed hybridization is with a subspecies of rainbow trout.

For stream sites surveyed by direct observation in 2007, trout density ($\tilde{y}_B$; number per 100 meters of stream) was calculated using the bounded counts estimator (Robson and Whitlock 1964, Regier and Robson 1966, Overton 1971, Routledge 1982, all as cited in Mohr and Hankin in press). Estimates were first calculated for individual segments:

$$\tilde{y}_B = d_{[m]} + (d_{[m]} - d_{[m-1]}),$$

where $d_{[m]}$ is the maximum number of fish counted during any of the passes, $d_{[m-1]}$ is the 2nd highest count, and counts are arranged in ascending order as: $d_{[1]} \le d_{[2]} \le d_{[3]} \le \cdots \le d_{[m-1]} \le d_{[m]}$. The 95% confidence intervals were calculated based on Robson and Whitlock (1964) and Routledge (1982). The lower bound (N_L) was calculated as: $N_L = d_{[m]}$ (Robson and Whitlock 1964). The upper bound (N_U) was calculated as: $N_U = d_{[m]} + [(1-\alpha)/\alpha] \cdot [d_{[m]} - d_{[m-1]}]$ where α is the level of significance (i.e., α=0.05 for calculation of a 95% confidence interval [CI]) (Robson and Whitlock 1964), unless $d_{[m]} = d_{[m-1]}$, in which case the upper bounds for the CI is equivalent to the abundance estimate, and the coverage probability for the CI tends to be poor. Routledge (1982) proposed an adjustment that provides improved coverage probabilities to the confidence intervals for this circumstance, with the upper bound instead being estimated as: $N_U = d_{[m]} + (1-\alpha)/(\alpha f)$, where f is the number of times that the largest dive count is repeated.

Assumptions underlying the use of the bounded counts estimator include:

a) no fish are double-counted on any given pass
b) all fish present can be observed
c) diver observation probability is constant over all *m* dives

Assumption (a) is more likely to be violated when there are large numbers of fish (i.e., greater than 20) (Mohr and Hankin in press); implications are for an overestimate. If assumption (b) is not met, then there is a tendency to underestimate abundance. Assumption (c) is captured in the variability of observations and this could lead to greater uncertainty in the estimates of abundance than what is calculated.

Total estimates of fish abundance by location (defined as the conglomeration of the two or three sampled segments) were calculated as the summed abundance estimates per segment and divided by the cumulative lengths of the appropriate segments. The values of the lower bounds of the 95% CI from individual segments were summed to calculate the lower bound of the 95% CI for each location. This value was simply the sum of the maximum counts from each segment. The upper bound of the CI for each location was calculated using variance based on the upper bounds of the CI for the individual segments.

Trout biomass estimates for 2007 snorkel sites were estimated using a length/weight regression generated from the 2007 Butte Creek electrofishing data: $W = 0.00002*(L^{2.8643})$, where W= weight and L= Total Length. Individual weights were first calculated based on the lengths of fish observed during the pass with the highest number of observations. Trout biomass was estimated based on the population estimate for the site.

Catch Per Unit Effort

For reservoir sampling, gillnetting, seining, and boat electrofishing, results are reported both as total catch and in terms of catch per unit effort (CPUE). CPUE for fishes captured by beach seine was calculated by dividing the number of fish of each species by the total surface area of water sampled (e.g., fish/ft^2). CPUE for fishes captured by boat electrofishing was calculated by dividing the number of fish of each species captured by the total area of water sampled multiplied by the length of time fished [e.g., fish/(ft^2 x sec.)]. CPUE for fishes captured by gillnet was calculated by dividing the number of fish of each species by the dimensions of the gillnets multiplied by the length of time fished [e.g., fish/(ft^2 x hr)]. CPUE was summarized by reservoir location and species.

6.3.2.2.4 Results

Habitat Measurements and Survey Conditions

Site habitat conditions varied within the Study Area. In Butte Creek, the steepest channel gradients were between Helltown (RM 56) and just above Lower Centerville Diversion Dam (RM 62), and just below Butte Creek Diversion Dam (RM 71.8). Sites within these sections typically had deeper pools and swifter water in both run and riffle habitats than did the lower sections of Butte Creek (below Helltown) and the section above Butte Creek Diversion Dam. Despite these differences, the habitat type distributions and substrate compositions were similar between most of the sites. The site inadvertently sampled in 2006 between DeSabla Powerhouse and Lower Centerville Diversion Dam was located in a steep, confined reach with high flow; habitat in this short section was not similar to the habitat upstream of DeSabla Powerhouse. The habitat upstream of DeSabla Powerhouse was surveyed in 2007. Habitat conditions observed during the 2006 and 2007 monitoring are summarized in Appendix E6.3.2.2-C.

Feeder tributaries in the Butte Creek watershed were in steeply sloped canyons. As a result, feeder tributary habitat was generally composed of short pool and riffle habitats. The substrate was composed primarily of bedrock and boulders that often formed cascades and falls.

In the lower reaches of the WBFR, stream habitat contained larger run and pool habitats compared to the upper reaches. Unlike Butte Creek, however, the upper reaches of the WBFR were not confined by steep canyons and the stream habitat contained fewer boulders. The upper WBFR varies considerably between Round Valley Reservoir and Hendricks Head Dam. The channel downstream of Round Valley Reservoir is narrow with a higher percentage of canopy cover. In addition, flow between Round Valley Reservoir and Coon Hollow Creek is intermittent with no surface flow by summertime. Channel conditions between Coon Hollow Creek and just below Philbrook Creek are similar; however, the flow source in the WBFR below Philbrook Creek alternates between releases from Round Valley Reservoir in the spring and early summer, to releases from Philbrook Reservoir through the summer and fall months.

The channel gradient in WBFR tributaries was not as steep as in Butte Creek tributaries. As a result, the stream habitat within the WBFR feeder tributaries generally contained more riffle habitat with smaller particle-size substrates (including gravels and cobble). The stream habitat in Coon Hollow Creek was similar to the stream conditions in the WBFR downstream of Coon Hollow Creek. The stream habitat in Philbrook Creek varied considerably between sites above the reservoir and below the reservoir. Philbrook Creek is intermittent above the reservoir with broad meandering channels composed of gravel and cobble, whereas the channel downstream of Philbrook Reservoir is more confined with larger substrates (boulder and bedrock).

Stream Survey Methods Comparison

Because the intent of the 2007 surveys was to collect comparable data upstream and downstream of Project diversions, the methods used to survey upstream and downstream were the same. The general intent was also to collect this data via backpack electrofishing at Butte Creek and Hendricks diversions ; however, site conditions did not allow this at all sites.

The comparison of results between the one daytime snorkel location and the first nighttime snorkel location indicated that night snorkeling results more closely matched the backpack electrofishing results (Table E6.3.2.2-4 and Figure E6.3.2.2-4).

Comparison of trout abundance estimates from night snorkel observations and backpack electrofishing showed that the backpack electrofishing surveys yielded higher population estimates than direct observation (Figure E6.3.2.2-4).

The fewer fish observed via direct observation, as compared to backpack electrofishing, implies that one assumption of the bounded count estimator was not met for direct observation surveys: that all fish present can be observed. The wide confidence intervals may be explained by habitat variability within each segment; larger confidence intervals imply that diver observation probability was not constant over all three dives.

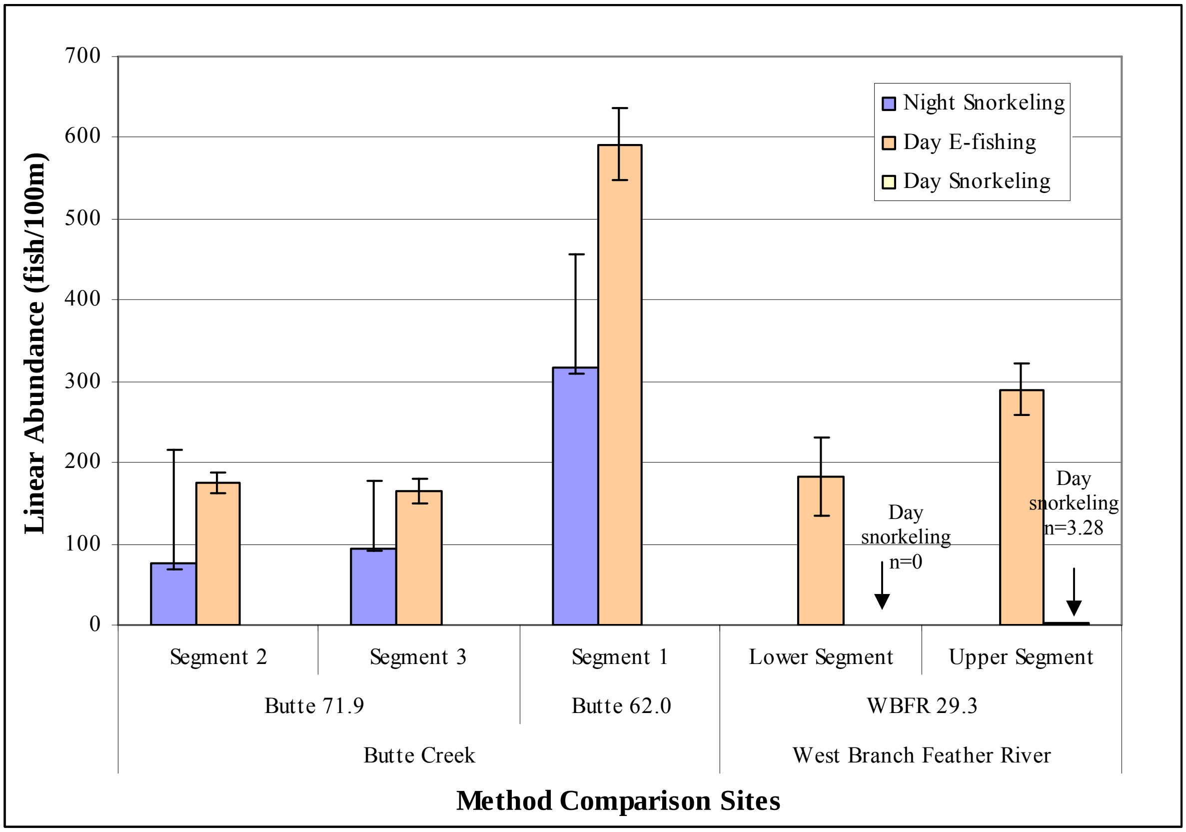


Figure E6.3.2.2-4. Site method comparison results for Butte Creek and West Branch Feather River sample sites surveyed by both backpack electrofishing and direct observation, 2007.

Table E6.3.2.2-4. Site method comparison results summary for Butte Creek and West Branch Feather River sample sites surveyed by both backpack electrofishing and direct observation, 2007.

Stream	Site	Location	Method	Segment	Dominant Habitat Types	All Age Classes			Young of Year			Juv/Adult			Catchable Trout
						Abundance (fish/100m)	Lower 95% C.I.	Upper 95% C.I.	Abundance (fish/100m)	Lower 95% C.I.	Upper 95% C.I.	Abundance (fish/100m)	Lower 95% C.I.	Upper 95% C.I.	Abundance (fish/100m)
Butte Creek	Butte 71.9	Downstream of Butte Creek Diversion	E-fish	2	riffle, run	175.3	163	187.6	88.9	77.6	100.1	86.8	80.1	93.5	27.6
				3	pool, riffle	165	148.8	181.1	96.8	77.6	116	70.1	64.1	76.2	23.4
			Night Snorkel	2	riffle, run	77.2	69.5	216.1	54	38.6	331.9	38.6	38.6	75.3	15.4
				3	pool, riffle	95	90.5	176.5	43	40.7	83.7	83.7	67.9	368.8	22.6
	Butte 62.0	Upstream of Lower Centerville Diversion and DeSabla PH	E-fish	1	riffle, run, pool	591.6	547.5	635.7	375.1	332.6	417.6	218.7	199	238.5	80.3
			Night Snorkel	1	riffle, run, pool	317.8	310	457.3	219.6	175.7	1010.1	229.9	178.3	1159.9	67.2
West Branch Feather River	WBFR 29.3	Upstream of Hendricks Head Dam	E-fish	Lower	pool, riffle, run	183	134.5	231.5	87	57.3	116.8	96.6	56.6	136.5	43.9
				Upper	riffle, run	290.3	259.2	321.5	168	149.5	186.5	124.2	94.5	153.9	56.4
			Day Snorkel	Lower	pool, riffle, run	0	**	**	0	0	0	0	**	**	0
				Upper	riffle, run	3.28	**	**	0	0	0	3.28	**	**	3.28

** Confidence intervals were not calculated for this site due to low observation numbers.

Species Composition

During the 2006 and 2007 surveys, species observed in the Study Area were similar to species identified historically (Table E6.3.2.2-5). However, three fish species had not been documented in the Study Area before; they are one species of trout (brook trout), one minnow (golden shiner), and a rainbow trout hybrid/color morph that was observed in both the Butte Creek and WBFR drainages. These trout hybrids are assumed to be hybrids of rainbow trout with rainbow trout subspecies that were introduced into the Study Area during fish stocking in streams and reservoirs. CDFG stocking records (Section E6.3.1 of the FLA) include trout of unknown origin released into the Study Area between 2000 and 2003. The numbers of fish observed throughout the Study Area in 2006, categorized by species, are listed in Table E6.3.2.2-6. Butte Creek supports many more species than the other streams or reservoirs within the Study Area. The species composition observed at the sites surveyed in 2007 was similar to what was observed in 2006 (Figure E6.3.2.2-9). Populations near each of the three Project diversions on Butte Creek and the West Branch Feather River included only trout species, composed predominantly of rainbow trout with fewer brown trout.

Pacific lamprey had been previously documented in the Study Area, but was not observed during the 2006 surveys. However, the timing of the fish surveys may have not aligned with the migration period of the lamprey adults, and lamprey juveniles are difficult to observe during snorkel surveys because they burrow into soft substrates. Riffle sculpin had also been previously documented in the Study Area; PG&E did observe sculpin species during the 2006 snorkel surveys, but was unable to identify the fish to species without capture.

In Butte Creek, fish species composition was exclusively trout in the upper watershed, changing to transitional zone species (e.g., hardhead and Sacramento pikeminnow), and anadromous species (Chinook salmon and steelhead *[O. mykiss]*) below Lower Centerville Diversion Dam (Figure E6.3.2.2-5). The anadromous fish range within the Project Area was identified in PG&E (2004) as Butte Creek downstream of Lower Centerville Diversion Dam. For the purpose of this study, *O. mykiss* observations downstream of the Lower Centerville Diversion Dam were reported as steelhead/rainbow trout because differentiating between steelhead and rainbow trout was not possible during snorkel surveys; however, adult steelhead were not observed upstream of Quartz Bowl (near RM 60) during the 2006 surveys. In the three Butte Creek tributaries surveyed, fish species composition was exclusively trout (Figure E6.3.2.2-6).

In the upper watershed of the WBFR, fish species composition was exclusively trout but changed to transitional zone species (e.g., hardhead and Sacramento pikeminnow) at the lowermost survey site. The species composition at all WBFR survey locations is graphically represented in Figure E6.3.2.2-7. In the five WBFR tributaries surveyed, fish species composition was exclusively trout (Figure E6.3.2.2-8). Brook, brown, rainbow, and rainbow hybrid /color morph fish were the species observed.

Species compositions of Philbrook Reservoir and DeSabla Forebay are primarily made up of trout (Figures E6.3.2.2-10 and E6.3.2.2-11). CDFG maintains the trout population in Philbrook Reservoir through annual stocking and in DeSabla Forebay through bi-weekly stocking. A small population of golden shiner was also observed along the shoreline within DeSabla Forebay.

Table E6.3.2.2-5. Fish species documented in the DeSabla-Centerville Project Study Area.[1]

Stream Reaches and river miles	Butte Creek				Butte Creek Tributaries			WBFR	West Branch Feather River Tributaries					Reservoirs			References
	Upstream of Butte Div. Dam (72.2) [2]	Butte Creek Div. Dam to Lower Centerville Div. Dam (71.8, 65.3, 61.9)	Lower Centerville Div. Dam to Centerville Powerhouse (61.7, 60.8, 59.0, 56.5)	Centerville PH to Parrott-Phelan Div. Dam (54.6, 53.4, 50.5)	Inskip Creek [2, 4]	Kelsey Creek [2, 4]	Clear Creek, [4]	West Branch Feather River (43.6, 41.1, 35.0, 30.2, 28.5, 23.3, 16.0)	Coon Hollow Creek [2]	Philbrook Creek [5]	Long Ravine [2, 4]	Cunningham Ravine [2, 4]	Little West Fork, [4]	DeSabla Forebay	Round Valley Reservoir [3]	Philbrook Reservoir	
Petromyzontidae (Lamprey family)																	
Pacific lamprey			●	●													PG&E, 2004
Salmonidae (Salmon and trout family)																	
Chinook salmon (spring run)			● ○	● ○													PG&E, 2004
Chinook salmon (fall run)				●													PG&E, 2004
Steelhead / rainbow			● ○	● ○													PG&E, 2004
Rainbow trout	○	● ○	●	●	○	○	● ○	● ○	○	● ○	○	○	● ○	● ○	●	● ○	PG&E, 2004
Rainbow hybrid / color morph		○						○	○	○							
Brown trout	○	● ○	●	●			● ○	● ○	○	● ○	○	○	● ○	● ○	●	● ○	PG&E, 2004
Brook trout								○	○								
Cyprinidae (Minnow family)																	
California roach			● ○	● ○													PG&E, 2004
Golden shiner														○			
Hardhead			● ○	● ○													PG&E, 2004
Sacramento pikeminnow			● ○	● ○													PG&E, 2004
Pikeminnow/ hardhead			○	○													
Cyprinid species			○	○				○									
Catostomidae (Sucker family)																	
Sacramento sucker			● ○	● ○				○									PG&E, 2004
Cottidae (Sculpin family)																	
Riffle sculpin		●	●	●													PG&E, 2004
Cottus species			○	○													
Embiotocidae (Surfperch family)																	
Tule perch			●	● ○													PG&E, 2004

1 ○ denotes species documented during 2006-2007 surveys; ● denotes species documented historically (before 2004)
2 No historic data available;
3 Not sampled in 2006;
4 Includes stream area upstream and downstream of feeder diversion,
5 Includes upstream and downstream of Philbrook Reservoir

Table E6.3.2.2-6. Number of fish observed during September-October 2006 stream surveys in the DeSabla-Centerville Project Study Area.

Site Name	Site Description	Survey Method	Number Observed															
			Brook trout	Brown trout	Chinook salmon	Rainbow trout	Rainbow hybrid / color morph	Steelhead / rainbow	Sacramento sucker	Cottus species	Cyprinid species	Hardhead	Sacramento pikeminnow	Pikeminnow / hardhead	California roach	Tule perch	Golden shiner	Total Number Observed
BUTTE CREEK																		
Butte 72.2	Upstream of Butte Creek Diversion	Snorkel		2		11												13
Butte 71.8	Downstream of Butte Creek Diversion	Snorkel				1												1
Butte 65.3		E-fish		1		94	1											96
Butte 61.9	Downstream of DeSabla Powerhouse	Snorkel				57												57
Butte 61.7	Downstream of Lower Centerville Diversion	Snorkel						238										238
Butte 60.8		Snorkel						263		1								264
Butte 59.0		Snorkel						142	242	9	435		22		1			851
Butte 56.5		Snorkel			90			74	2,735	8		29	166	3,586	199			6,887
Butte 54.6	Downstream of Centerville Powerhouse	Snorkel			107			68	102	7	32	21	17	16	31			401
Butte 53.4		Snorkel			72			58	164	1		20	59	227	23			624
Butte 50.5		Snorkel			4			33	911	1	280	22	789		800	2		2,842
BUTTE CREEK TRIBUTARIES																		
Inskip-F1	Inskip Creek - upstream of diversion	E-fish				14												14
Inskip-F2	Inskip Creek - downstream of diversion	E-fish				42												42
Kelsey-F1	Kelsey Creek - upstream of diversion	E-fish				22												22
Kelsey-F2	Kelsey Creek - downstream of diversion	E-fish				20												20
Clear-F1	Clear Creek - upstream of diversion	E-fish		13		30												43
Clear-F2	Clear Creek - downstream of diversion	E-fish				11												11
WEST BRANCH FEATHER RIVER																		
WBFR 43.6	Downstream of Round Valley Reservoir	E-fish	2			5												7
WBFR 41.1	Downstream of Coon Hollow Creek	E-fish		25		45	2											72
WBFR 35.0	Downstream of Philbrook Creek	E-fish		5		65												70
WBFR 30.2		Snorkel		1		3												4
WBFR 28.5	Downstream of Hendricks Diversion	E-fish		3		105												108
WBFR 23.3		Snorkel		1		34												35
WBFR 16.0		Snorkel		4		76			32		1,212							1,324

Table E6.3.2.2-6 (continued)

Site Name	Site Description	Survey Method	Number Observed: Brook trout	Brown trout	Chinook salmon	Rainbow trout	Rainbow hybrid / color morph	Steelhead / rainbow	Sacramento sucker	Cottus species	Cyprinid species	Hardhead	Sacramento pikeminnow	Pikeminnow / hardhead	California roach	Tule perch	Golden shiner	Total Number Observed
WEST BRANCH FEATHER RIVER TRIBUTARIES																		
Coon-F1	Coon Hollow Creek upstream of WBFR	E-fish	17	4		160	29											210
Philbrook-F1	Philbrook Creek - upstream of reservoir	E-fish		599														599
Philbrook-F2	Philbrook Creek - downstream of reservoir	E-fish		5		41	3											49
Long-F1	Long Ravine - upstream of diversion	E-fish		2		29												31
Long-F2	Long Ravine - downstream of diversion	E-fish		28		42												70
Cunningham-F1	Cunningham Ravine - upstream of div.	E-fish				45												45
Cunningham-F2	Cunningham Ravine - downstream of div.	E-fish		37														37
Little West Fork-F1	Little West Fork - upstream of Diversion	E-fish				23												23
Little West Fork-F2	Little West Fork - downstream of Div.	E-fish		28		1												29
PHILBROOK RESERVOIR																		
G1	Western edge, near southwest shoreline	Gillnet		3		48												51
G2	Western edge, near northwest shoreline	Gillnet				8												8
G3	Northwest edge of reservoir	Gillnet		3		13												16
S1	Southern edge of reservoir at small island	Seine																0
S2	Eastern edge of reservoir near stream channel	Seine																0
S3	West bank of reservoir	Seine				3												3
S4	West end of reservoir near spillway	Seine																0

Table E6.3.2.2-6 (continued)

Site Name	Site Description	Survey Method	Number Observed															
			Brook trout	Brown trout	Chinook salmon	Rainbow trout	Rainbow hybrid / color morph	Steelhead / rainbow	Sacramento sucker	Cottus species	Cyprinid species	Hardhead	Sacramento pikeminnow	Pikeminnow / hardhead	California roach	Tule perch	Golden shiner	Total Number Observed
DESABLA FOREBAY																		
G1	Near western shore	Gillnet		5		5												10
G2	Shallow southwest shore	Gillnet		6		3												9
E1	Western shore	E-fish				1												1
E2	Northwest shore	E-fish															16	16
E3	Northern edge near shoreline	E-fish															0	
E4	Southwest shoreline near dam	E-fish		1		2												3

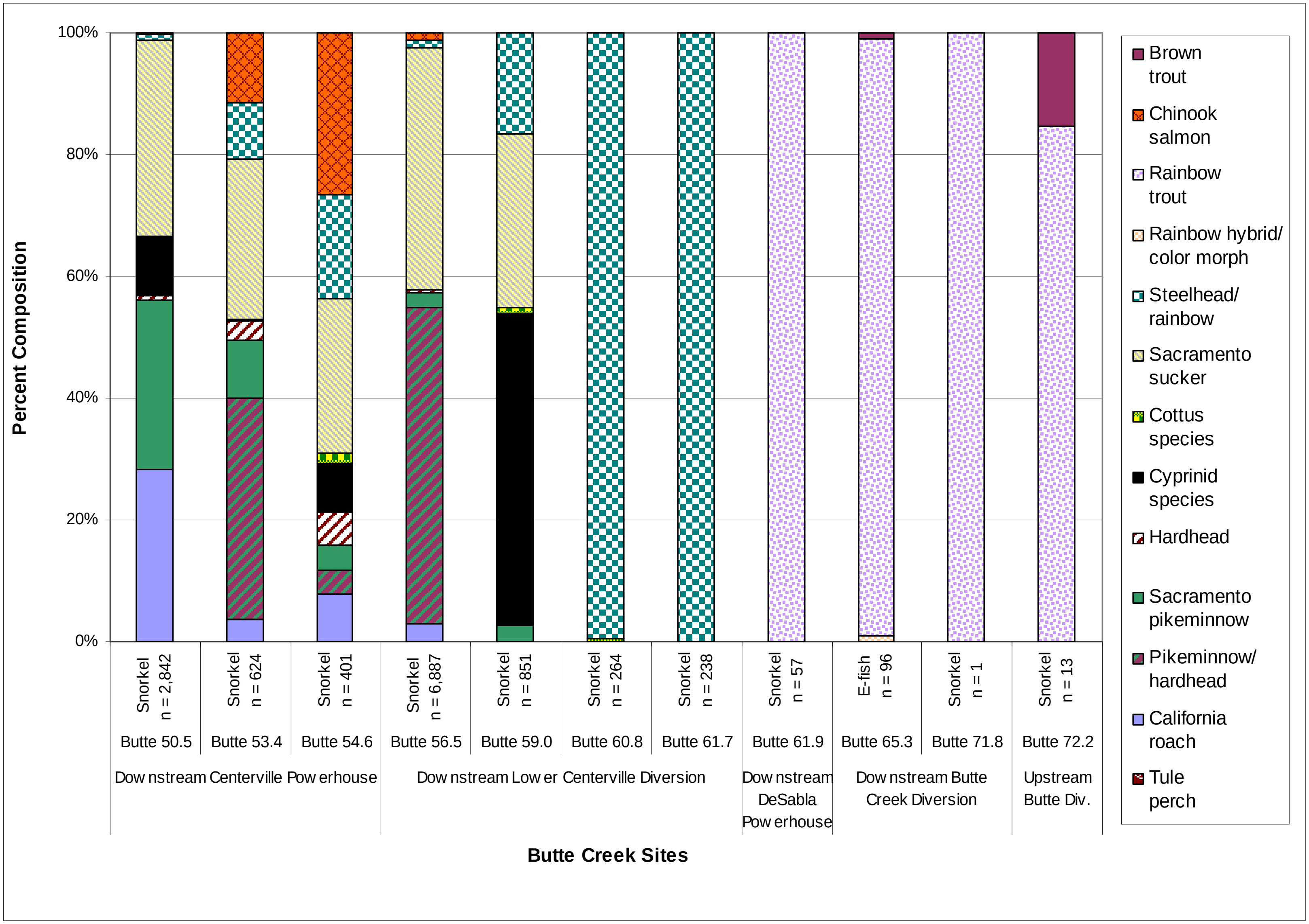


Figure E6.3.2.2-5. Fish species composition in Butte Creek, 2006.

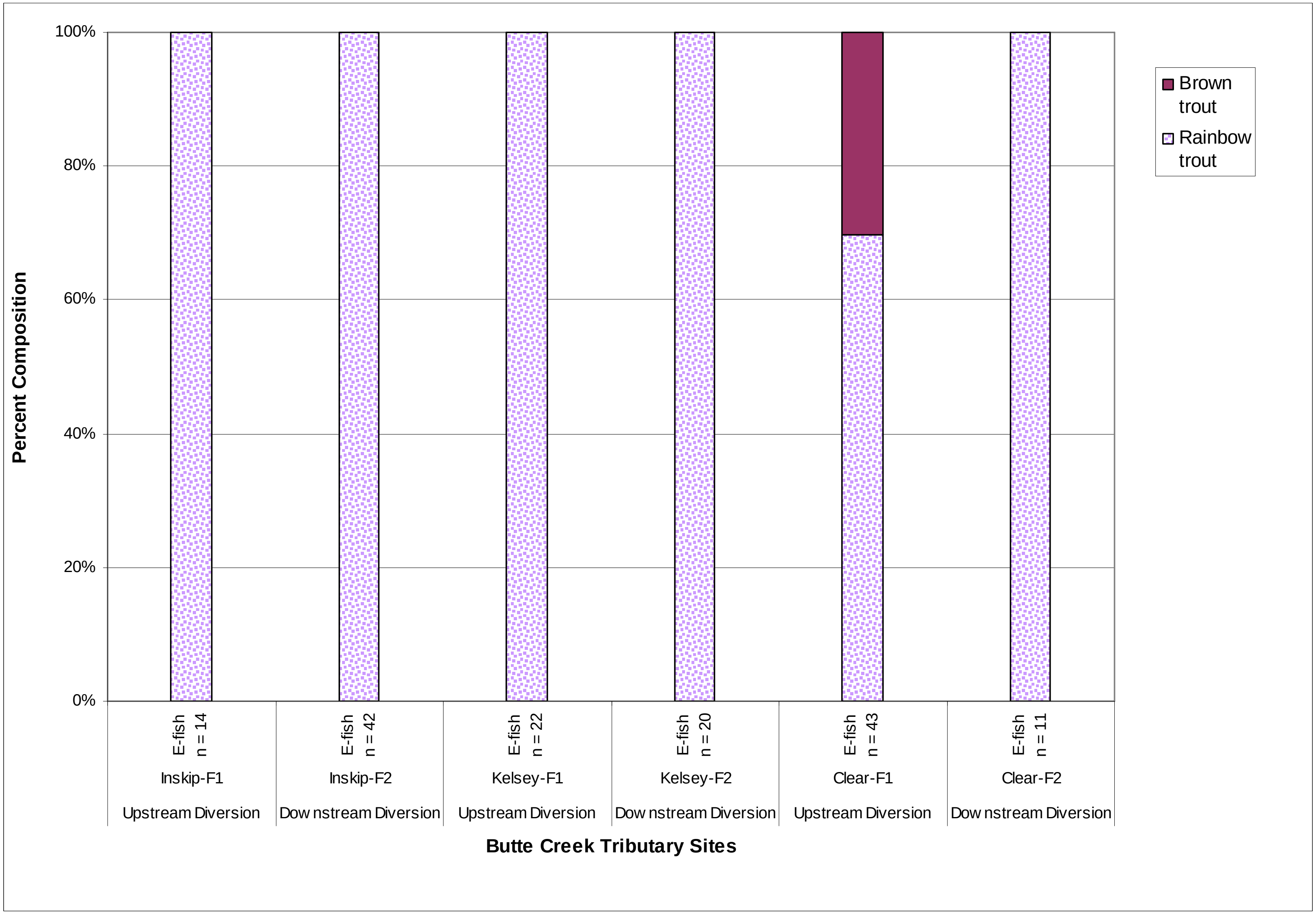


Figure E6.3.2.2-6. Fish species composition in Butte Creek tributary streams, 2006.

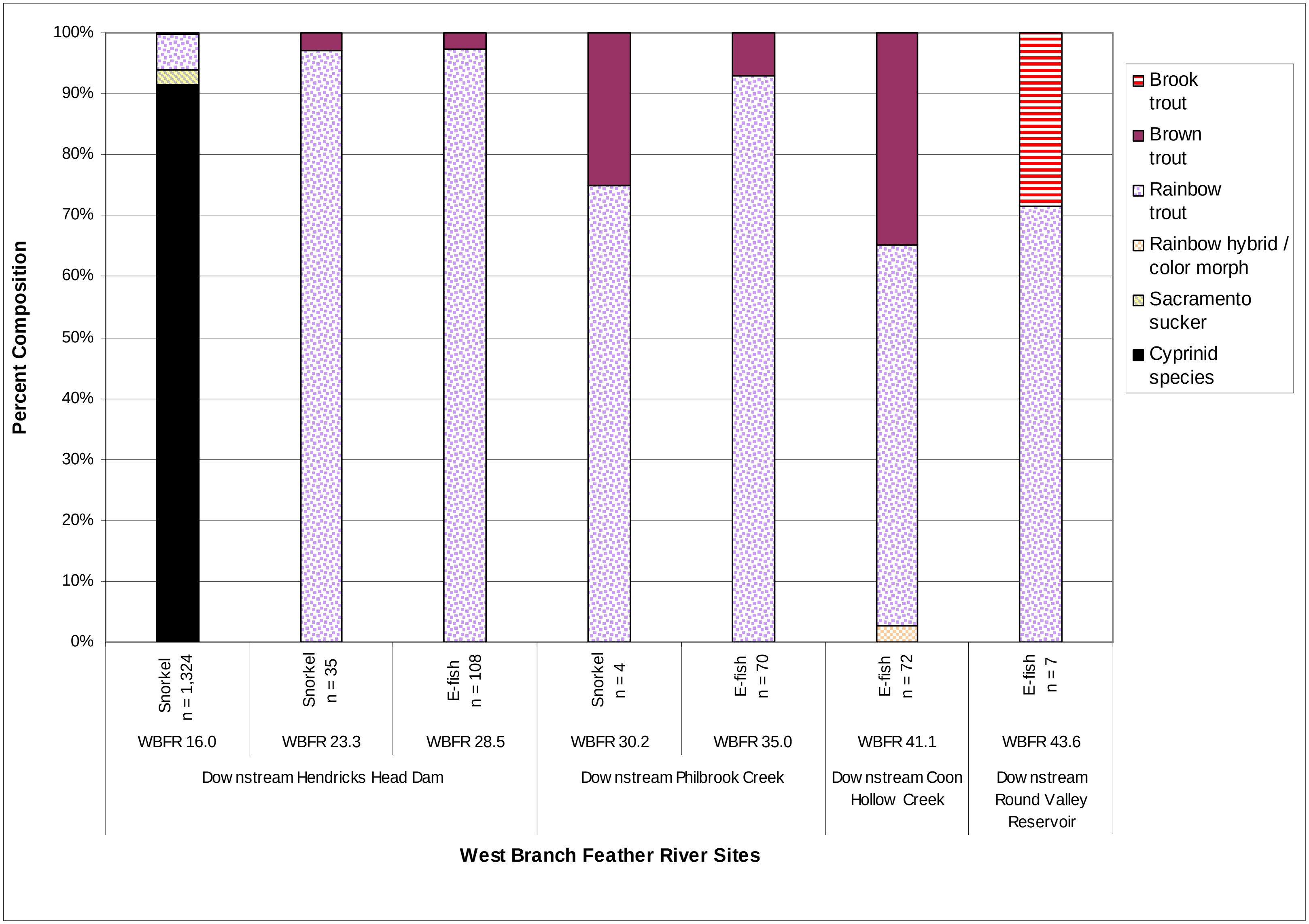


Figure E6.3.2.2-7. Fish species composition in the West Branch Feather River, 2006.

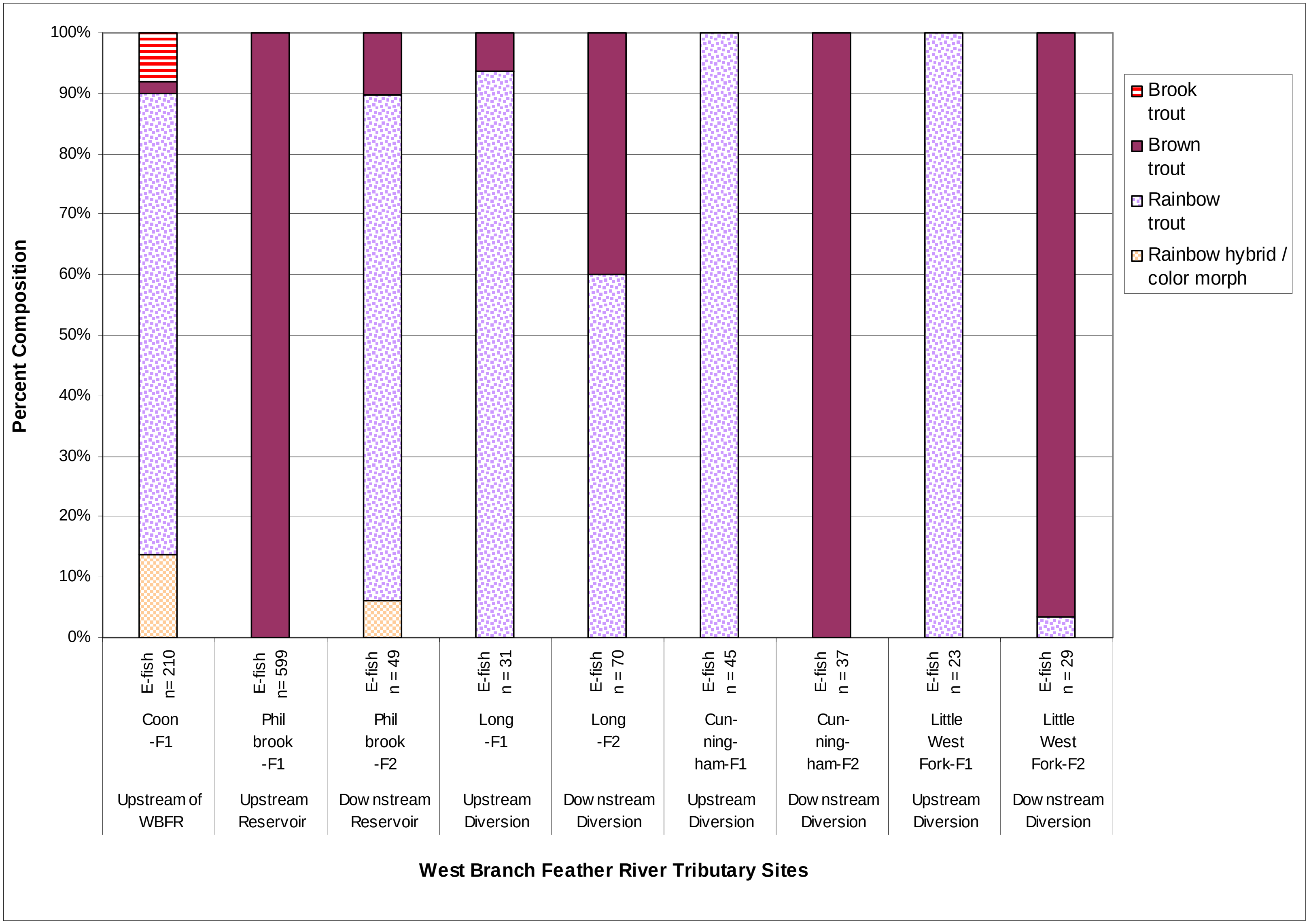


Figure E6.3.2.2-8. Fish species composition in West Branch Feather River tributary streams, 2006.

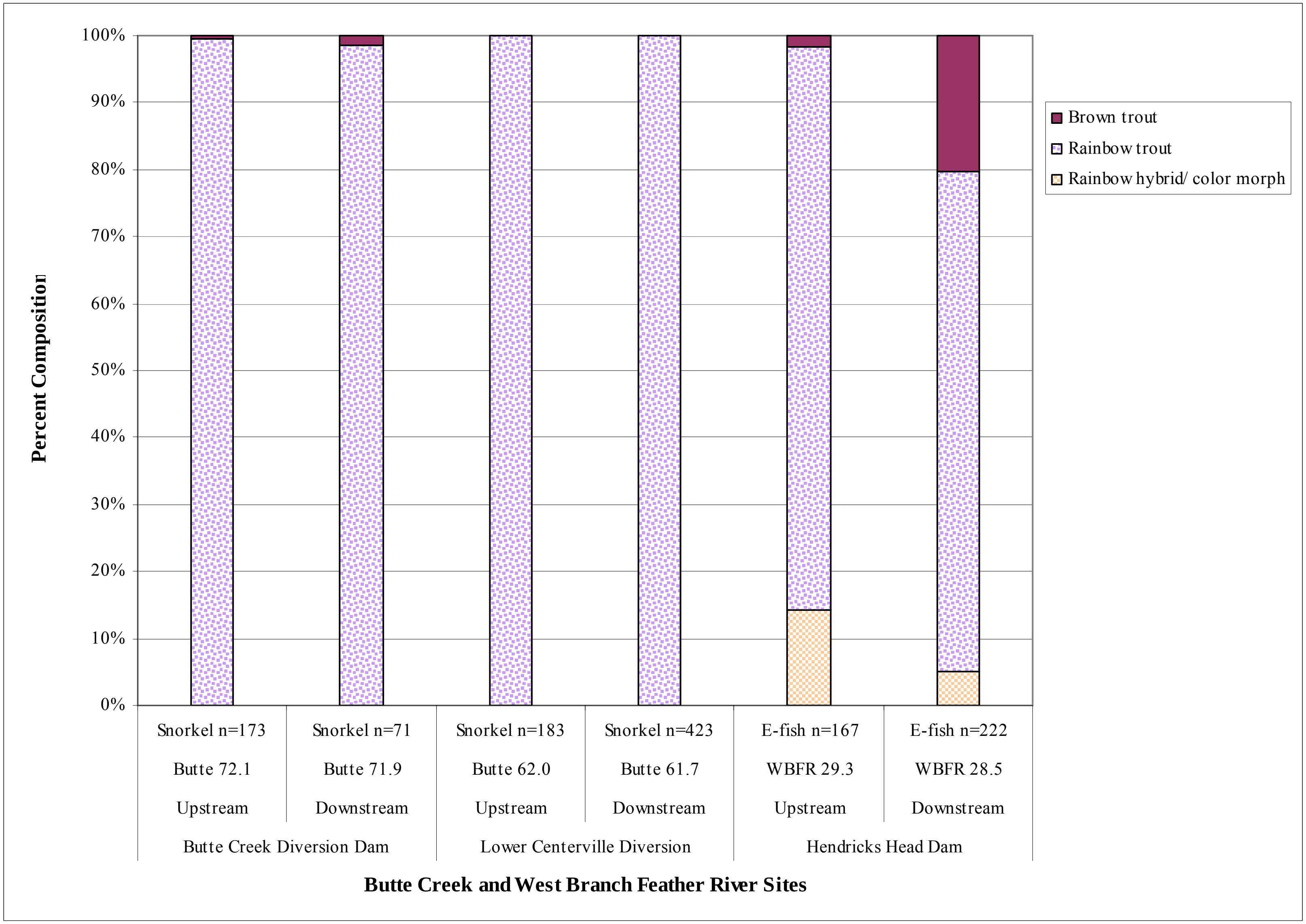


Figure E6.3.2.2-9. Fish species composition in Butte Creek and the West Branch Feather River near Project diversions, 2007.

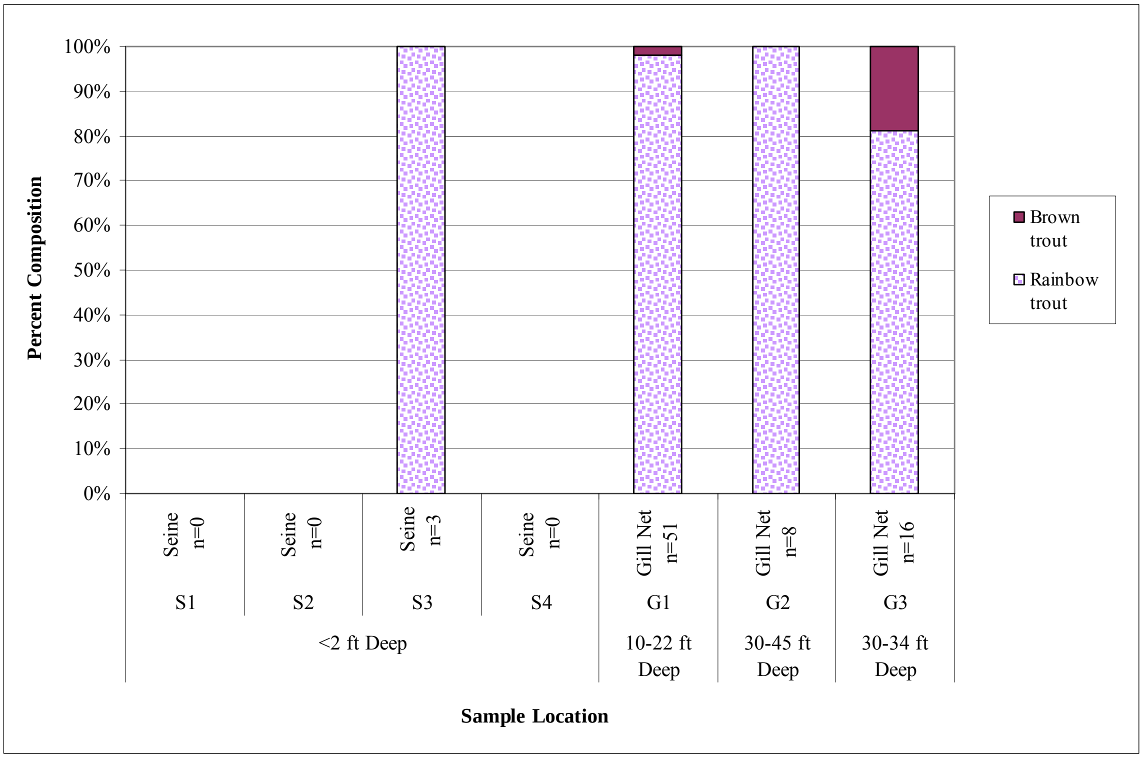


Figure E6.3.2.2-10. Fish species composition in Philbrook Reservoir, 2006.

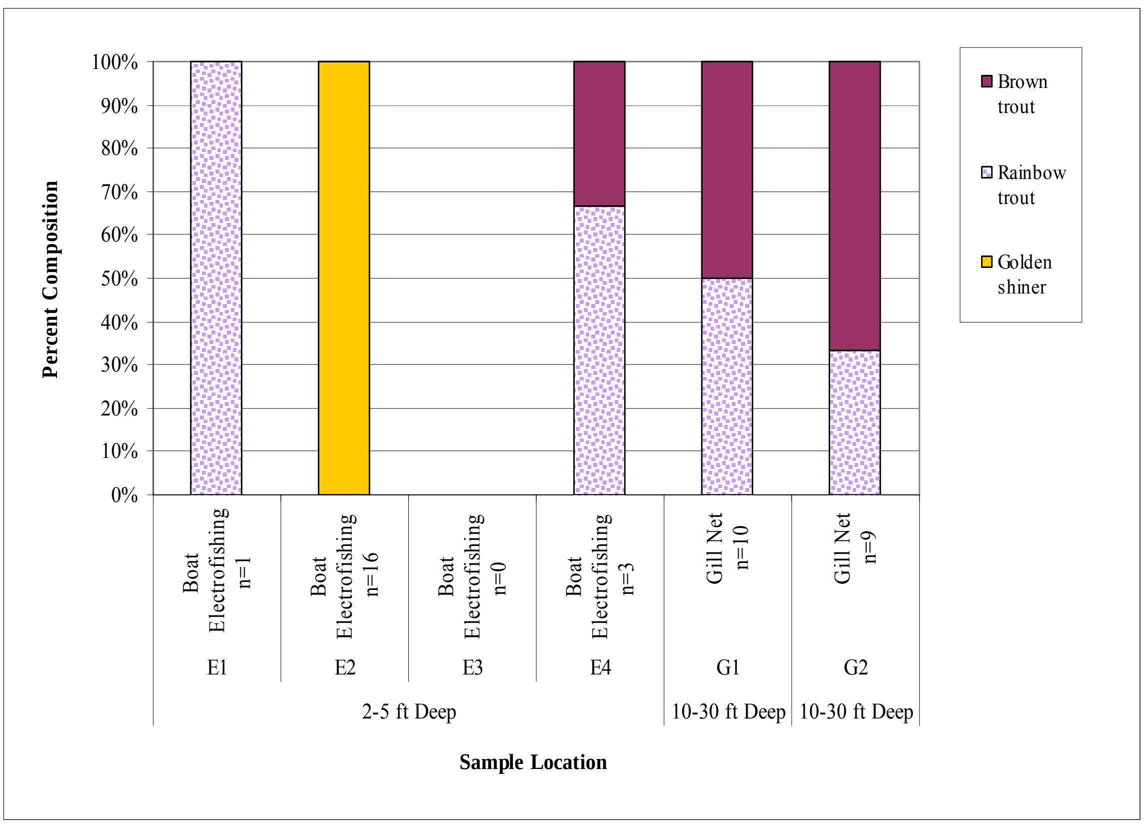


Figure E6.3.2.2-11. Fish species composition in DeSabla Forebay, 2006.

Age Class Distribution

The length frequency histograms for fishes observed in 2006 are included in Appendix E6.3.2.2-D due to the number of figures included. The length frequency histograms for fishes observed in 2007 near Project diversions are shown below in Figures E6.3.2.2-12–E6.3.2.2-17.

Butte Creek Upstream of Lower Centerville Diversion

Rainbow trout were observed throughout this reach including age classes from young-of-year (YOY) up to approximately 3+. Based on analysis of the size group distribution and literature on similar sized streams (Jager et al. 1999 and Moyle 2002), the YOY rainbow trout included fish between 50 and 100 mm, the 1+ rainbow trout included fish between 100 and 150 mm, and the rainbow trout in the 2+ and 3+ age classes were estimated to include fish up to approximately 190 and 270 mm respectively. Three brown trout were observed downstream of the diversion ranging from 150 to 200 mm and are estimated to fall between the 2+ and 3+ age classes. Length frequency histograms for species observed in this reach can be seen in Figures E6.3.2.2-12 through E6.3.2.2-14 for sites sampled in 2007, and Appendix Figures E6.3.2.2-D1 through E6.3.2.2-D4 for sites sampled in 2006.

Butte Creek Downstream of Lower Centerville Diversion

Steelhead/rainbow trout, Chinook salmon, Sacramento sucker, cyprinid (minnow) species, *cottus* (sculpin) species, and tule perch were observed in this reach. The 2006 length frequency histograms for fishes in this reach are shown in Appendix Figures E6.3.2.2-D5 through E6.3.2.2-D22.

Steelhead/rainbow trout observed in this reach included YOY up to adult age classes based on the size distribution of fish observed, with some reaching up to approximately 450 mm (Figure E6.3.2.2-15). Nearly all Chinook salmon observed in this reach in 2006 were adults and measured approximately 450 to 700 mm, with one fish observed at approximately 125 mm. Sacramento suckers were observed in two size ranges with the majority of fish between 25 and 125 mm, and a second group ranging from 250 to 500 mm. California roach were observed between approximately 25 and 150 mm. Sacramento pikeminnow and hardhead included YOY and juveniles between 25 and 150 mm, and a second group measured between approximately 300 and 450 mm with Sacramento pikeminnow observed up to approximately 550 mm. The *cottus* (sculpin) species observed measured between 75 and 125 mm, and two tule perch between 75 and 125mm were observed at the furthest downstream study site (Butte 50.3).

Butte Creek Tributaries

Rainbow trout and brown trout were the only fishes observed in the Butte Creek tributaries. The 2006 length frequency histograms for fishes in Butte Creek Tributaries are shown in Appendix Figures E6.3.2.2-D23 through E6.3.2.2-D28.

Rainbow trout were observed in all Butte Creek tributaries ranging from YOY up to approximately age 2+. Based on analysis of the size group distribution and literature on similar sized streams (Jager et al. 1999 and Moyle 2002), the YOY rainbow trout included fish ranging from 60 to 85 mm, the 1+ rainbow trout ranged from 110 to 150 mm, and the 2+ age rainbow trout measured up to approximately 200 mm. In both Inskip Creek and Kelsey Creek, the age class structures of rainbow trout populations were similar between populations upstream and downstream of diversions. Brown trout were observed only in Clear Creek. The number of brown trout observed was too low to estimate age class distributions; however, compared to other California streams (Jager et al. 1999 and Moyle 2002), the brown trout observed in this stream would fall between the 1+ and 2+ age classes.

West Branch Feather River

Rainbow trout, brown trout, cyprinid species, and Sacramento sucker were observed in the WBFR in 2006. Length frequency histograms for WBFR sites surveyed in 2006 are shown in Appendix Figures E6.3.2.2- D29 through E6.3.2.2- D35. Length frequency histograms for WBFR sites surveyed in 2007 are shown in Figures E6.3.2.2-16 and E6.3.2.2-17.

Rainbow trout observed in the WBFR sites ranged from YOY up to age 2+ with some fish up to approximately age 4+ at the furthest downstream study site near Jordon Hill Bridge (WBFR 16.0). Age classes and approximate lengths for rainbow trout were generated based on analysis of the observed size group distributions and on the literature of similarly sized streams (Jager et al. 1999 and Moyle 2002). YOY rainbow trout included fish between 55 and 100 mm, 1+ age class rainbow trout ranged up to 160 mm, and 2+ and 3+ age classes were estimated to include rainbow trout up to 210 and 250 mm respectively. Brown trout observed in the WBFR ranged from YOY up to approximately age 4+. Age classes and approximate lengths for brown trout were generated based on analysis of the observed size group distributions and on the literature of similarly sized streams (Jager et al. 1999 and Moyle 2002). Brown trout YOY included fish between 49 and 100 mm, 1+ included fish up to 175 mm, and 2+ and 3+ age classes were estimated to include brown trout up to 300 and 400 mm respectively.

Cyprinid species and Sacramento sucker were observed at the furthest downstream site near Jordon Hill Bridge(WBFR 16.0). The cyprinid species lengths were less than 76 mm; the Sacramento suckers were YOY.

West Branch Feather River Tributaries

Rainbow trout, brown trout, and a small number of brook trout were observed in tributaries to the WBFR. The 2006 length frequency histograms for fishes in tributaries to the WBFR are shown in Appendix Figures E6.3.2.2-D36 through E6.3.2.2-D44. In feeder tributaries, the age class structures of the trout populations were typically similar upstream and downstream of the diversions, though the composition was sometimes different.

Rainbow trout observed in WBFR tributaries ranged from YOY to 2+ age class fish. Age classes for rainbow trout and brown trout in the WBFR were based on size group distribution and literature (Jager et al. 1999 and Moyle 2002) and divided into approximate fish lengths. Brown trout ranged from YOY up to age 1+ with some larger fish (230 mm) up to approximately age 2+. Brown trout greater than 150 mm were not observed in high enough numbers to determine age class estimates specific to WBFR tributaries, but based on the 1+ age class sizes and sizes found in literature (Jager et al. 1999 and Moyle 2002), the largest brown trout observed in these tributaries was likely within the 2+ age class. Brook trout were only observed in Coon Hollow Creek and ranged from 80–170 mm.

Project Impoundments

In Philbrook Reservoir, only rainbow trout and brown trout were observed, and rainbow trout was the numerically dominant species. Three YOY rainbow trout were observed at approximately 30 mm; all other rainbow trout were of catchable size (>152 mm). The brown trout observed in Philbrook Reservoir were all of catchable size (170 mm to 250 mm) (Appendix Figure E6.3.2.2-D45). In DeSabla Forebay, rainbow trout, brown trout, and golden shiner were observed. Rainbow trout and brown trout were observed in nearly equal proportion with all fish being of catchable size (160 mm to 380 mm). The golden shiners observed in DeSabla Forebay ranged from approximately 40 to 100 mm (Appendix Figure E6.3.2.2-D46).

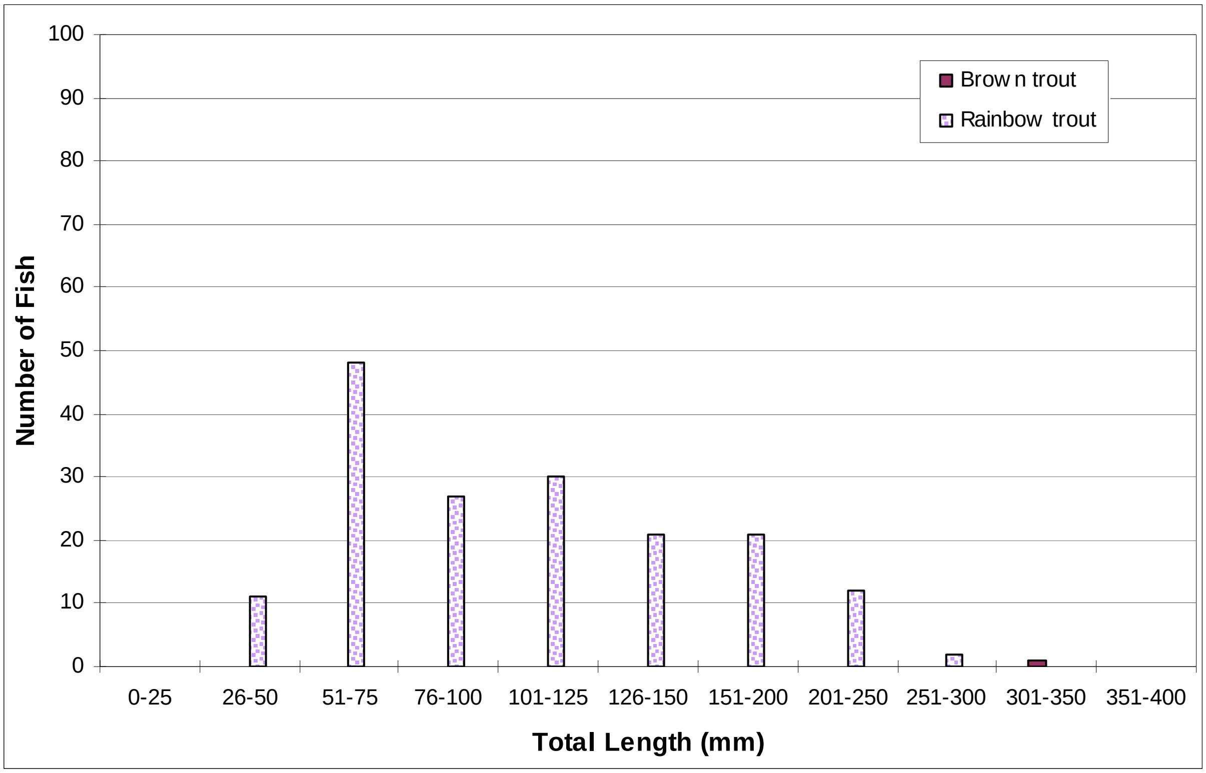


Figure E6.3.2.2-12. Length frequency distribution of fish observed during snorkel surveys in Butte Creek upstream of Butte Creek Diversion Dam (Butte 72.1), October 2007.

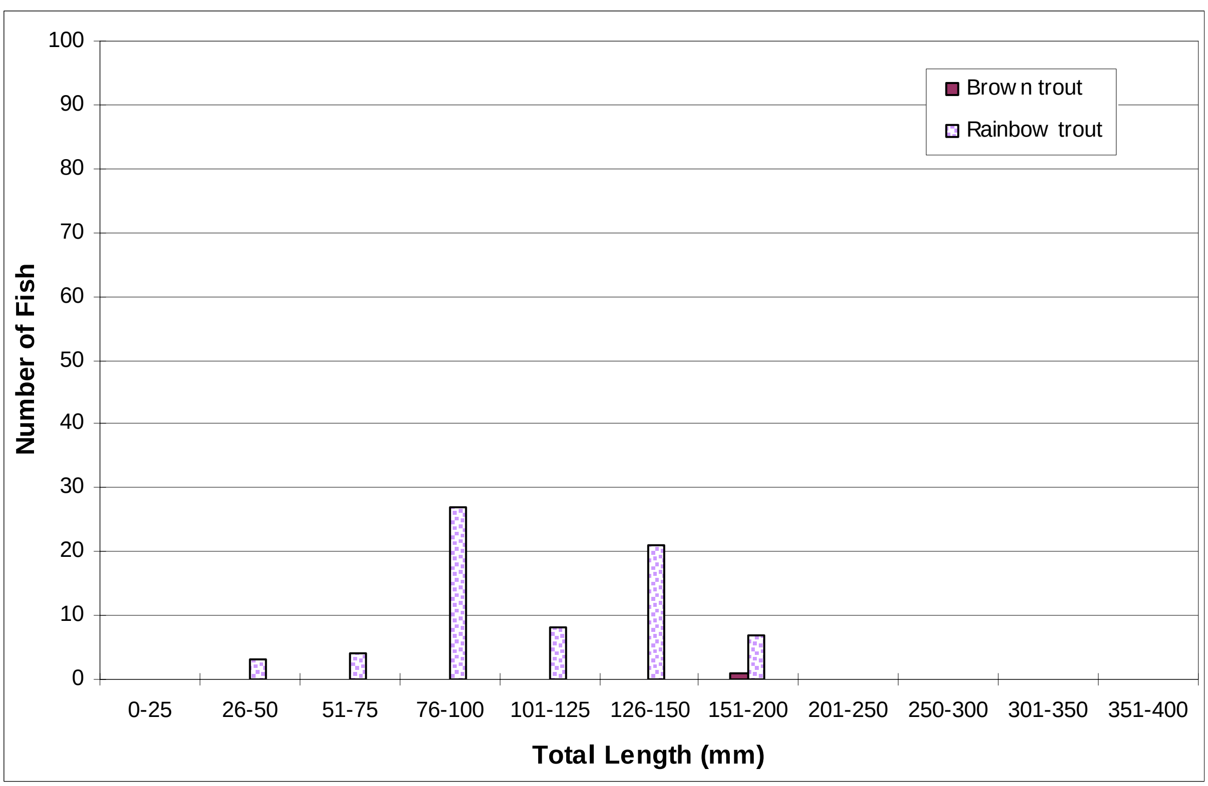


Figure E6.3.2.2-13. Length frequency distribution of fish observed during snorkel surveys in Butte Creek downstream of Butte Creek Diversion Dam (Butte 71.9), October 2007.

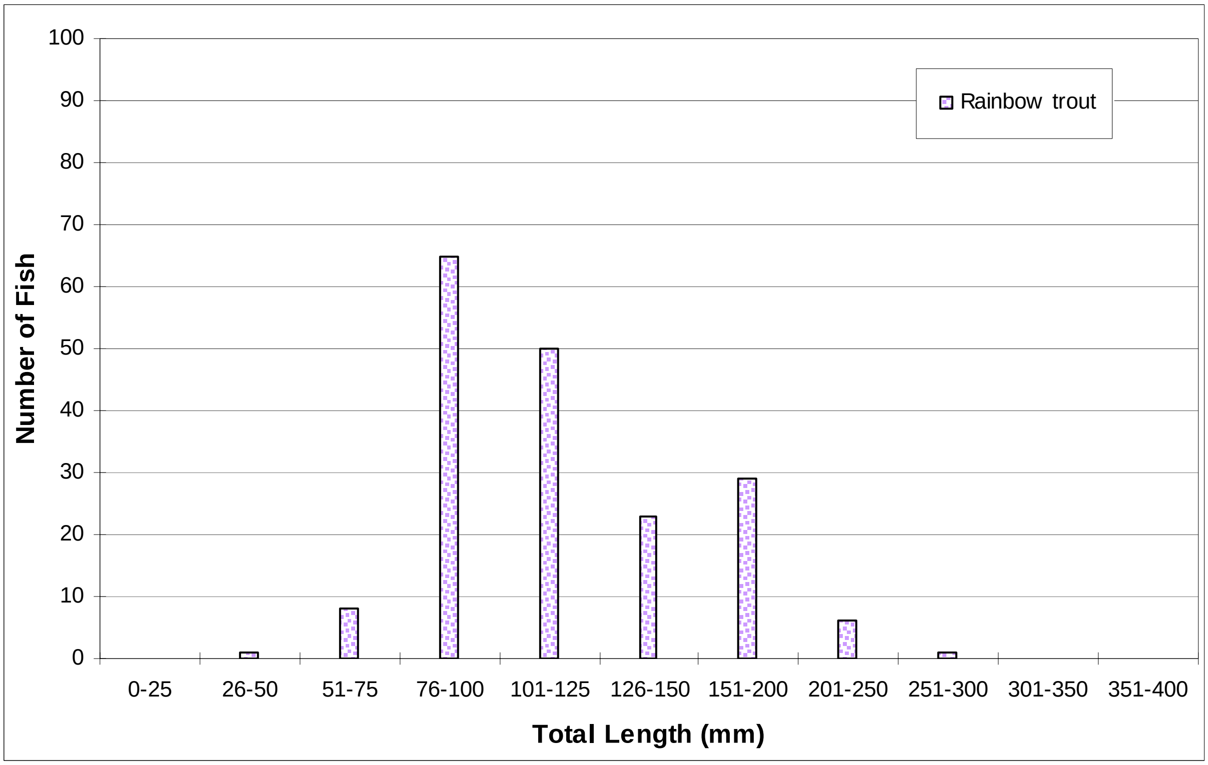


Figure E6.3.2.2-14. Length frequency distribution of fish observed during snorkel surveys in Butte Creek upstream of Lower Centerville Diversion (Butte 62.0), October 2007.

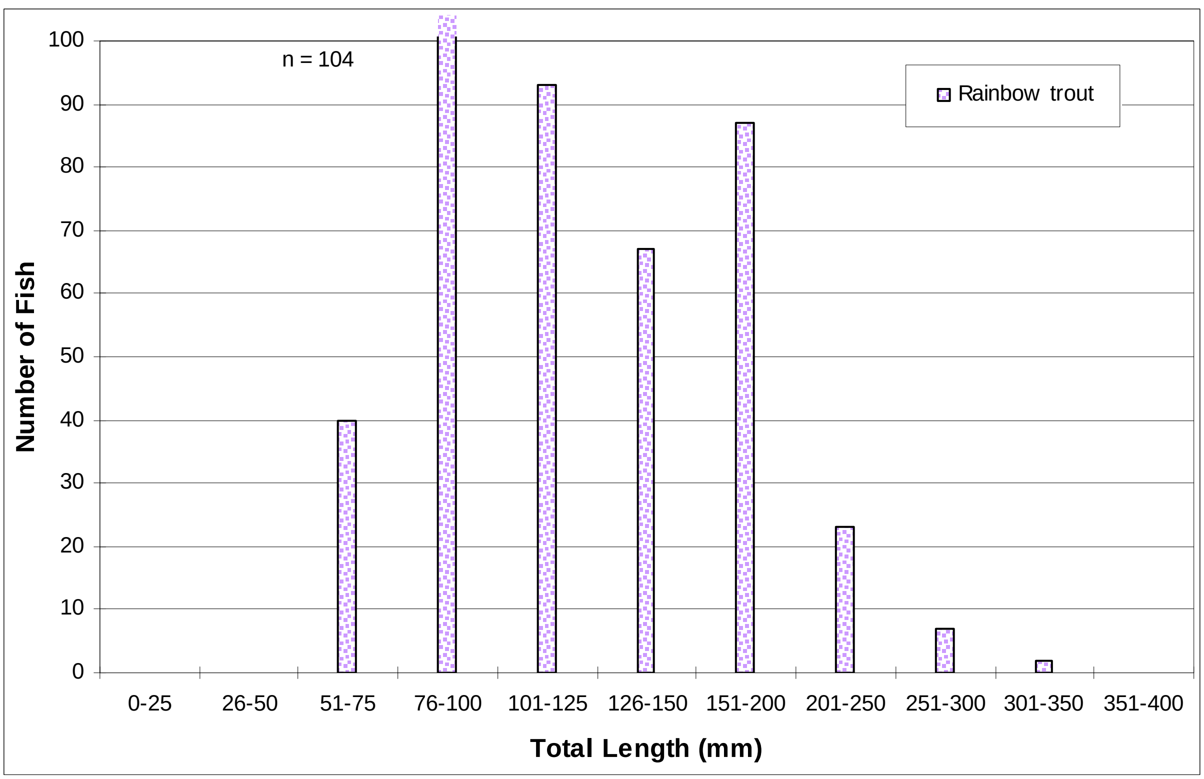


Figure E6.3.2.2-15. Length frequency distribution of fish observed during snorkel surveys in Butte Creek downstream of Lower Centerville Diversion (Butte 61.7), October 2007.

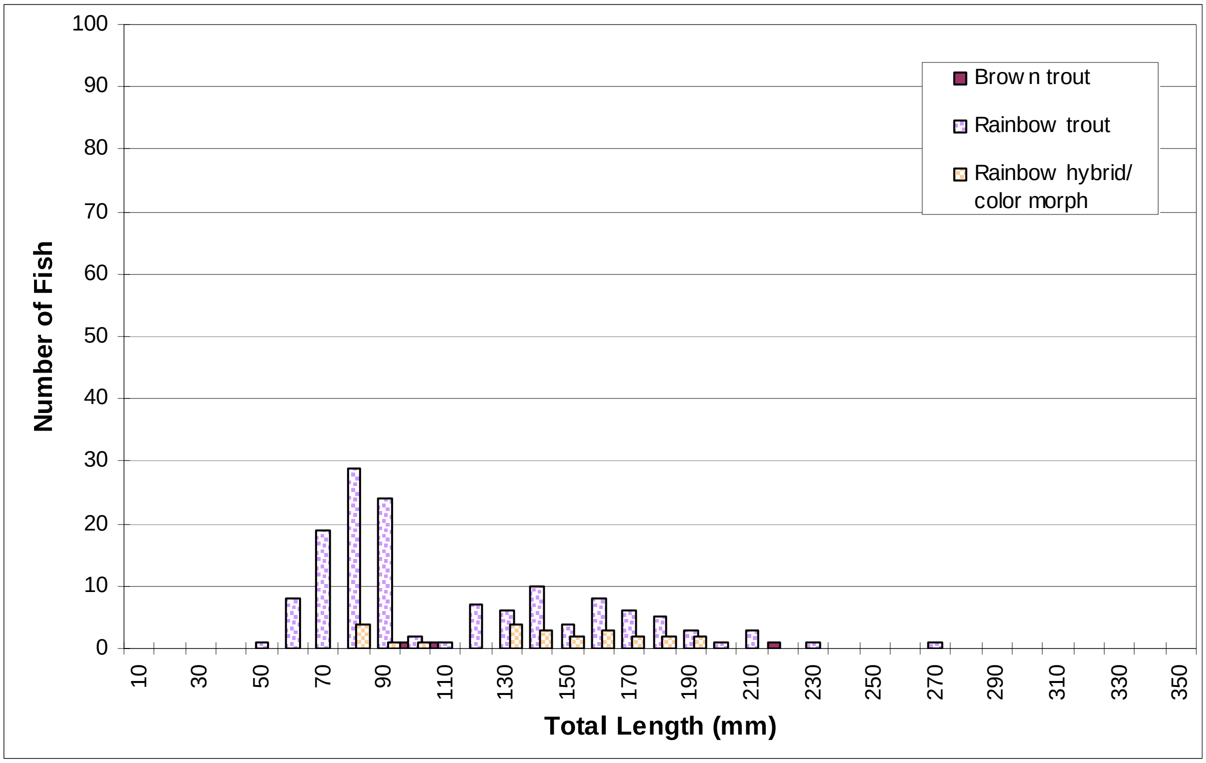


Figure E6.3.2.2-16. Length frequency distribution of fish captured during electrofishing in the West Branch Feather River upstream of Hendricks Diversion (WBFR 29.3), September 2007.

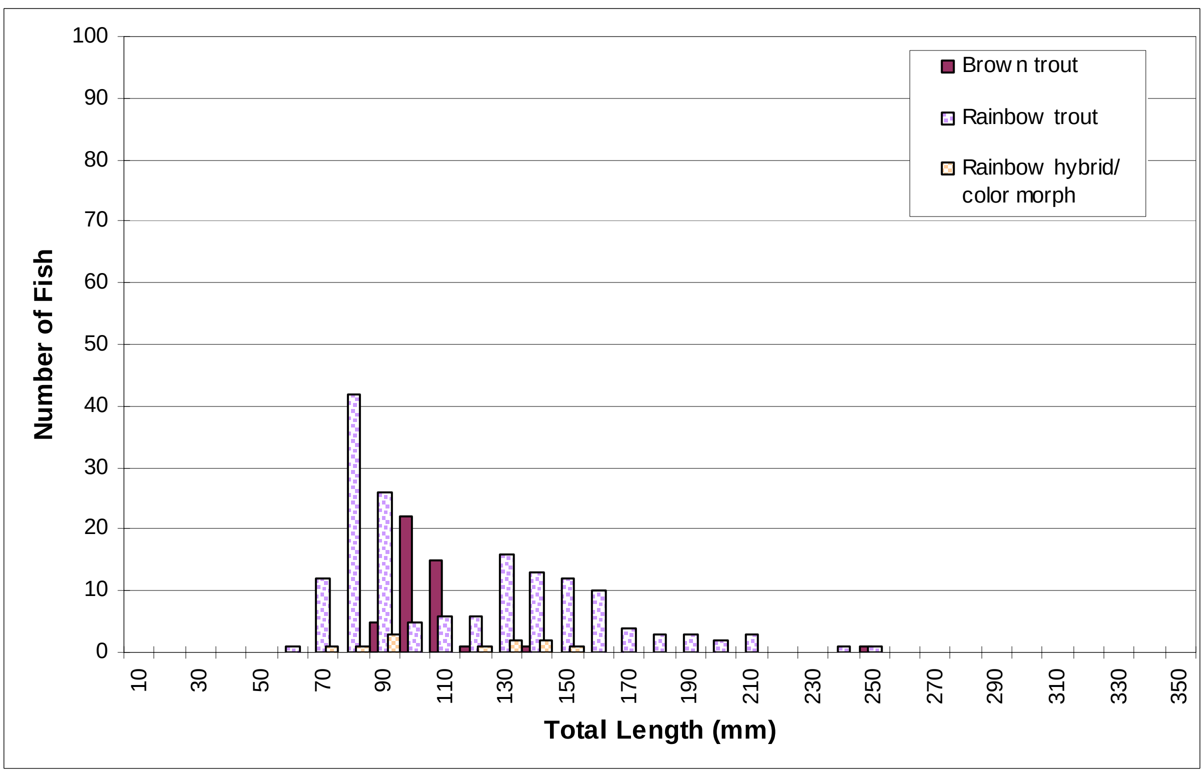


Figure E6.3.2.2-17. Length frequency distribution of fish captured during electrofishing in the West Branch Feather River downstream of Hendricks Diversion (WBFR 28.5), September 2007.

Density, Trout Biomass, and Catchable Trout Estimates

Linear fish abundance was estimated for sites in Butte Creek surveyed in 2006 (Figure E6.3.2.2-18). Upstream of the lower fish passage barrier on Butte Creek (Quartz Bowl at RM 60), only trout species were present, whereas populations downstream included anadromous species, Sacramento sucker, and pikeminnow/hardhead assemblage fishes. Trout were most abundant in the reach between Quartz Bowl (RM 60) and below Butte Creek Diversion Dam (RM 65), and rainbow trout were relatively the most abundant trout species at all sites where multiple trout species were present. In 2006, the lowest trout abundance was observed above and just below Butte Creek Diversion Dam (Butte 72.7, Butte 71.8).

Similarly in 2006, in the WBFR, trout were most abundant in "middle reaches" (RM 28 to 41), whereas minnow species were most abundant at the lower study site near Jordon Hill Bridge (WBFR 16.0). As in Butte Creek, rainbow trout in the WBFR were more abundant than brown trout at all sites where both species were present (Figure E6.3.2.2-19).

In tributary streams to Butte Creek and the WBFR, fish populations were composed of trout species only. Trout abundance estimates in feeder tributaries were similar between sites and within each tributary stream (Figure E6.3.2.2-20). In the two higher order tributary streams (Coon Hollow Creek and Philbrook Creek), trout abundance estimates were higher than all other study sites. Notably, the trout population upstream of Philbrook Reservoir was considerably higher than all other sites (770 per 100 m). The population at this site was limited to YOY and juvenile brown trout, and the fish appeared to be concentrated in small isolated runs and pools as there was no surface flow in the stream at the time of sampling. Thus, the linear fish abundance results are not directly comparable to continuous stream sections with a full compliment of life stages.

Catchable trout were defined as those with lengths greater than 152 mm TL. In Butte Creek, the abundance of catchable trout was highest above and below Lower Centerville Diversion (RM 61.8), and relatively low abundances were observed above Butte Creek Diversion (RM 71.9) (Figure E6.3.2.2-21). No catchable trout were observed just below Butte Creek Diversion. Below Lower Centerville Diversion (RM 61.8), *O. mykiss* are potentially anadromous; however, based on appearance and size, no returning adult steelhead were observed upstream of Quartz Bowl (RM 60) in 2006.

In the WBFR, the abundance estimates of catchable trout varied between sites, with relatively low abundances between Philbrook Creek and Hendricks Diversion (WBFR 30.2 and 35.0) and higher abundances below Coon Hollow Creek (WBFR 41.1), Hendricks Diversion (WBFR 28.5), and at the lowest study site at RM 16 near Jordon Hill Bridge (Figure E6.3.2.2-22).

In tributary streams to Butte Creek and the WBFR, the abundance of catchable trout was consistently low at all sites (Figure E6.3.2.2-23).

Trout biomass was estimated at sites that were electrofished in 2006. Trout biomass varied both within sites as well as among sites in the Study Area in 2006 (Figure E6.3.2.2-24). Trout density observed at stream monitoring sites sampled by electrofishing and direct observation is summarized by age class in Appendix E6.3.2.2-E. Trout biomass observed at stream monitoring sites sampled by electrofishing is summarized by age class in Appendix E6.3.2.2-F.

In 2007, surveys were conducted near the three primary Project diversions on Butte Creek and the WBFR to allow comparison of fish populations above and below each of the diversions. Linear abundance estimates are summarized in Tables E6.3.2.2-7 and E6.3.2.2-8 and are shown in Figures E6.3.2.2-25 and E6.3.2.2-26. Fish population estimates did not show a consistent trend indicating depressed populations upstream or downstream of Project diversions. In 2007, fish populations downstream of Butte Creek Diversion Dam were slightly lower than the populations upstream (considering the estimate and CI), whereas the fish populations downstream of Lower Centerville Diversion Dam were slightly higher than the populations upstream. Populations upstream and downstream of Hendricks Diversion in 2007 were similar.

Similar to overall trout abundance, the abundance of catchable trout and trout biomass did not show a consistent trend in 2007 that indicated depressed populations upstream or downstream of Project diversions (Figures E6.3.2.2-26 – E6.3.2.2-27). Trout biomass appeared to be controlled by the number of larger (catchable) fish. In 2007, catchable trout abundance and trout biomass downstream of Butte Creek Diversion Dam were lower than estimates for the populations upstream, whereas catchable trout abundance and trout biomass downstream of Lower Centerville Diversion Dam were higher than estimates for the populations upstream. Catchable trout abundance and trout biomass near Hendricks Diversion was slightly lower downstream than upstream in 2007 (Figures E6.3.2.2-26 – E6.3.2.2-27).

Within Philbrook Reservoir and DeSabla Forebay, relative abundance was quantified by catch per unit effort (CPUE) (Table E6.3.2.2-9). In Philbrook Reservoir, the CPUE of rainbow trout captured by gillnet decreased as depth increased; rainbow trout were abundant at 10–20 foot depths and were less abundant at 30–40 foot depths (Figure E5.3.2.2-28). Conversely, the CPUE of brown trout captured by gillnet increased as depth increased, although brown trout had a low CPUE at all depths sampled in Philbrook Reservoir. Because DeSabla Forebay is relatively shallow, the gillnet depths did not vary; however, the CPUE of both rainbow trout and brown trout were low.

Table E6.3.2.2-7. Trout population linear abundance and biomass summary for the DeSabla-Centerville Hydroelectric Project Area, 2007.

<table>
<tr><th>Diversion</th><th colspan="2">Site Location</th><th>Method</th><th>Linear site Abundance (trout/100m)</th><th>Linear Abundance Lower 95% C.I.</th><th>Linear Abundance upper 95% C.I.</th><th>Biomass (kg/acre)</th></tr>
<tr><td rowspan="2">Butte Creek Diversion</td><td colspan="2">Upstream</td><td>Snorkel</td><td>202.5</td><td>175.2</td><td>550.7</td><td>20.1</td></tr>
<tr><td colspan="2">Downstream</td><td>Snorkel</td><td>92.6</td><td>85.5</td><td>165.6</td><td>11.7</td></tr>
<tr><td rowspan="2">Lower Centerville Diversion</td><td colspan="2">Upstream</td><td>Snorkel</td><td>392.9</td><td>382.4</td><td>528.5</td><td>52.8</td></tr>
<tr><td colspan="2">Downstream</td><td>Snorkel</td><td>628.1</td><td>554.0</td><td>1754.7</td><td>86.3</td></tr>
<tr><td rowspan="4">Hendricks Diversion</td><td colspan="2">Upstream</td><td>E-fish</td><td>213.7</td><td>188.2</td><td>239.3</td><td>20.4</td></tr>
<tr><td rowspan="3">Downstream</td><td>Upper Segment</td><td>E-fish</td><td>266.3</td><td>256.8</td><td>275.8</td><td>21.0</td></tr>
<tr><td>Lower Segment</td><td>E-fish</td><td>226.6</td><td>204.2</td><td>249.0</td><td>14.1</td></tr>
<tr><td>Entire Site</td><td>E-fish</td><td>250.8</td><td>**</td><td>**</td><td>16.8</td></tr>
</table>

** Overall trout linear abundance for the site was calculated using a weighted average of the segment results due to unequal number of passes between the segments (3 passes on the upper segment, 4 passes on the lower sgment) which does not allow for a combined confidence interval calculation.

Table E6.3.2.2-8. Trout population abundance estimates for the DeSabla-Centerville Hydroelectric Project Area, 2007.

Site	Location	Method	Site / Segment	Length (ft)	Average Width (ft)	Maximum Number Observed\ Number Captured[c]	Trout Species	All Age Classes – Linear Abundance (trout/100m) – Estimate	All Age Classes – Density Lower 95% C.I.	All Age Classes – Density Upper 95% C.I.	Young of Year – Linear Abundance (trout/100m) – Estimate	Young of Year – Density Lower 95% C.I.	Young of Year – Density Upper 95% C.I.	Juv/Adult – Linear Abundance (trout/100m) – Estimate	Juv/Adult – Density Lower 95% C.I.	Juv/Adult – Density Upper 95% C.I.	Catchable Trout – Linear Abundance (trout/100m) – Estimate
Butte Creek Diversion Dam	Upstream	Snorkel	2	114.0	47.5	89	All trout	293.5	256.1	967.0	155.4	143.9	362.6	135.3	112.2	549.7	40.3
						0	Brook	0.0	-	-	0.0	-	-	0.0	-	-	0.0
						2	Brown	11.5	5.8	115.1	0.0	-	-	11.5	5.8	115.1	5.8
						89	Rainbow	293.5	256.1	967.0	155.4	143.9	362.6	135.3	112.2	549.7	40.3
			1	210.0	47.5	84	All trout	153.1	131.2	546.8	59.4	57.8	87.5	92.2	75.0	401.5	43.7
						0	Brook	0.0	-	-	0.0	-	-	0.0	0.0	0.0	0.0
						2	Brown	4.7	3.1	32.8	0.0	-	-	4.7	3.1	32.8	4.7
						83	Rainbow	151.5	129.7	545.2	59.4	57.8	87.5	92.2	73.4	429.6	43.7
			Site	324.0	47.5	173	All trout	202.5	175.2	550.7	93.2	88.1	168.3	107.3	88.1	355.2	42.5
						0	Brook	0.0	-	-	0.0	-	-	0.0	-	-	0.0
						4	Brown	7.1	4.1	47.8	0.0	-	-	7.1	4.1	47.8	5.1
						172	Rainbow	201.5	174.2	549.7	93.2	88.1	168.3	107.3	87.1	370.2	42.5
	Downstream	Snorkel	3	145.0	43.5	40	All trout	95.0	90.5	176.5	43.0	40.7	83.7	83.7	67.9	368.8	22.6
						0	Brook	0.0	-	-	0.0	-	-	0.0	-	-	0.0
						1	Brown	4.5	2.3	45.3	0.0	-	-	4.5	2.3	45.3	0.0
						40	Rainbow	97.3	90.5	219.5	43.0	40.7	83.7	79.2	65.6	323.6	22.6
			2	85.0	19.8	18	All trout	77.2	69.5	216.1	54.0	38.6	331.9	38.6	38.6	75.3	15.4
						0	Brook	0.0	-	-	0.0	-	-	0.0	-	-	0.0
						1	Brown	3.9	3.9	40.5	0.0	-	-	3.9	3.9	40.5	3.9
						17	Rainbow	73.3	65.6	212.3	54.0	38.6	331.9	42.5	38.6	111.9	11.6
			1	50.0	7.3	15	All trout	111.5	98.4	347.8	59.1	52.5	177.2	65.6	52.5	301.8	0.0
						0	Brook	0.0	-	-	0.0	-	-	0.0	-	-	0.0
						0	Brown	0.0	-	-	0.0	-	-	0.0	-	-	0.0
						15	Rainbow	111.5	98.4	347.8	59.1	52.5	177.2	65.6	52.5	301.8	0.0
			Site	280.0	26.8	71	All trout	92.6	85.5	165.6	49.2	42.2	138.7	66.8	56.2	220.7	16.4
						0	Brook	0.0	-	-	0.0	-	-	0.0	-	-	0.0
						2	Brown	3.5	2.3	27.4	0.0	-	-	3.5	2.3	27.4	1.2
						70	Rainbow	92.6	84.4	179.5	49.2	42.2	138.7	65.6	55.1	200.7	15.2

Table E6.3.2.2-8. Trout population abundance estimates for the DeSabla-Centerville Hydroelectric Project Area, 2007.

Site	Location	Method	Site / Segment	Length (ft)	Average Width (ft)	Maximum Number Observed\ Number Captured[c]	Trout Species	All Age Classes			Young of Year			Juv/Adult			Catchable Trout
								Linear Abundance (trout/100m)			Linear Abundance (trout/100m)			Linear Abundance (trout/100m)			Linear Abundance (trout/100m)
								Estimate	Density Lower 95% C.I.	Density Upper 95% C.I.	Estimate	Density Lower 95% C.I.	Density Upper 95% C.I.	Estimate	Density Lower 95% C.I.	Density Upper 95% C.I.	Estimate
Lower Centerville Diversion Dam	Upstream	Snorkel	1	127.0	32.3	120	All trout	317.8	310.0	457.3	219.6	175.7	1010.1	229.9	178.3	1159.9	67.2
						0	Brook	0.0	-	-	0.0	-	-	0.0	-	-	0.0
						0	Brown	0.0	-	-	0.0	-	-	0.0	-	-	0.0
						120	Rainbow	317.8	310.0	457.3	219.6	175.7	1010.1	229.9	178.3	1159.9	67.2
			2	30.0	30.0	63	All trout	710.8	689.0	1,104.5	382.8	317.1	1563.9	524.9	437.4	2099.7	153.1
						0	Brook	0.0	-	-	0.0	-	-	0.0	-	-	0.0
						0	Brown	0.0	-	-	0.0	-	-	0.0	-	-	0.0
						63	Rainbow	710.8	689.0	1,104.5	382.8	317.1	1563.9	524.9	437.4	2099.7	153.1
			Site	157.0	31.2	183	All trout	392.9	382.4	528.5	250.8	202.7	928.9	286.3	227.8	1096.5	83.6
						0	Brook	0.0	-	-	0.0	-	-	0.0	-	-	0.0
						0	Brown	0.0	-	-	0.0	-	-	0.0	-	-	0.0
						183	Rainbow	392.9	382.4	528.5	250.8	202.7	928.9	286.3	227.8	1096.5	83.6
	Downstream	Snorkel	1	198.0	46.5	332	All trout	629.7	550.1	2,061.3	188.9	188.9	204.6	440.8	361.2	1872.4	162.4
						0	Brook	0.0	-	-	0.0	-	-	0.0	-	-	0.0
						0	Brown	0.0	-	-	0.0	-	-	0.0	-	-	0.0
						332	Rainbow	629.7	550.1	2,061.3	188.9	188.9	204.6	440.8	361.2	1872.4	162.4
			2	59.0	34.0	102	All trout	622.8	567.2	1,623.7	333.6	289.2	1134.4	400.4	339.2	1501.4	244.7
						0	Brook	0	-	-	0	-	-	0	-	-	0
						0	Brown	0	-	-	0	-	-	0	-	-	0.0
						102	Rainbow	622.8	567.2	1,623.7	333.6	289.2	1134.4	400.4	339.2	1501.4	244.7
			Site	257.0	41.5	423	All trout	628.1	554.0	1,754.7	222.1	211.9	406.4	431.5	356.2	1563.1	181.3
						0	Brook	0.0	-	-	0.0	-	-	0.0	-	-	0.0
						0	Brown	0.0	-	-	0.0	-	-	0.0	-	-	0.0
						423	Rainbow	628.1	554.0	1,754.7	222.1	211.9	406.4	431.5	356.2	1563.1	181.3

Table E6.3.2.2-8. Trout population abundance estimates for the DeSabla-Centerville Hydroelectric Project Area, 2007.

Site	Location	Method	Site / Segment	Length (ft)	Average Width (ft)	Maximum Number Observed\ Number Captured[c]	Trout Species	All Age Classes			Young of Year			Juv/Adult			Catchable Trout
								Linear Abundance (trout/100m)			Linear Abundance (trout/100m)			Linear Abundance (trout/100m)			Linear Abundance (trout/100m)
								Estimate	Density Lower 95% C.I.	Density Upper 95% C.I.	Estimate	Density Lower 95% C.I.	Density Upper 95% C.I.	Estimate	Density Lower 95% C.I.	Density Upper 95% C.I.	Estimate
Hendricks Diversion Dam	Upstream	E-fish	Upper	100.0	34.6	81	All trout	290.3	259.2	321.5	168.0	149.5	186.5	124.2	94.5	153.9	56.4
						0	Brook	0.0	-	-	0.0	-	-	0.0	-	-	0.0
						1	Brown	3.3	3.3	3.3	3.3	3.3	3.3	0.0	-	-	0.0
						80	Rainbow	287.8	255.7	320.0	165.2	145.9	184.4	124.2	94.5	153.9	56.4
			Lower	200.0	32.7	86	All trout	183.0	134.5	231.5	87.0	57.3	116.8	96.6	56.6	136.5	43.9
						0	Brook	0.0	-	-	0.0	-	-	0.0	-	-	7.6
						2	Brown	3.3 [b]	-18.0	24.6	0.0	0.0	0.0	3.3 [b]	-18.0	24.6	1.6 [b]
						84	Rainbow	177.0	131.3	222.7	87.0	57.3	116.8	90.0	55.0	125.1	40.8
			Site	300.0	33.3	167	All trout	213.7	188.2	239.3	111.1	96.6	125.6	104.0	80.1	127.8	47.3
						0	Brook	0.0	-	-	0.0	-	-	0.0	-	-	0.0
						3	Brown	3.3 [b]	0.0	6.6	1.1 [b]	1.1	1.1	2.2 [b]	-12.0	16.4	1.1 [b]
						164	Rainbow	209.5	184.5	234.5	110.3	95.4	125.2	100.2	78.0	122.4	45.4
	Downstream	E-fish	Upper	185.0	39.3	146	All trout	266.3	256.8	275.8	131.3	127.0	135.5	136.2	126.0	146.4	35.4
						0	Brook	0.0	-	-	0.0	-	-	0.0	-	-	0.0
						18	Brown	101.1 [b]	-289.1	491.3	24.8 [b]	-7.1	56.8	56.8 [b]	-409.7	523.2	1.8 [b]
						128	Rainbow	229.6	224.6	234.7	112.2	110.3	114.0	118.3	112.3	124.2	32.7
			Lower	119.0	30.9	76	All trout	226.6	204.2	249.0	126.9	111.9	141.8	100.1	82.6	117.5	12.1
						0	Brook	0.0	-	-	0.0	-	-	0.0	-	-	0.0
						27	Brown	107.5 [b]	30.3	184.7	46.9 [b]	27.6	66.2	57.9 [b]	-46.9	162.7	0.0
						49	Rainbow	138.0	131.0	145.0	79.3	73.1	85.5	58.8	55.1	62.4	11.2
			Site	304.0	35.1	222	All trout	250.8	**	**	129.5	**	**	122.1	**	**	26.3
						0	Brook	0.0	-	-	0.0	-	-	0.0	-	-	0.0
						45	Brown	103.6 [b]	**	**	33.5 [b]	**	**	57.2 [b]	**	**	1.1 [b]
						177	Rainbow	193.8	**	**	99.3	**	**	95.0	**	**	24.3

[a] Number observed from snorkel methods is reported as maximum number observed of the three passes.
[b] This estimate was calculated using maximum-likelihood method for increased confidence due to a low capture number or insufficient depletion.
[c] Reported number observed for snorkel surveys is recorded as the maximum number of fish observed for any given pass by specis or total of fish observed.
** Overall trout linear abundance for the site was calculated using a weighted average of the segment results due to unequal number of passes between the segments.

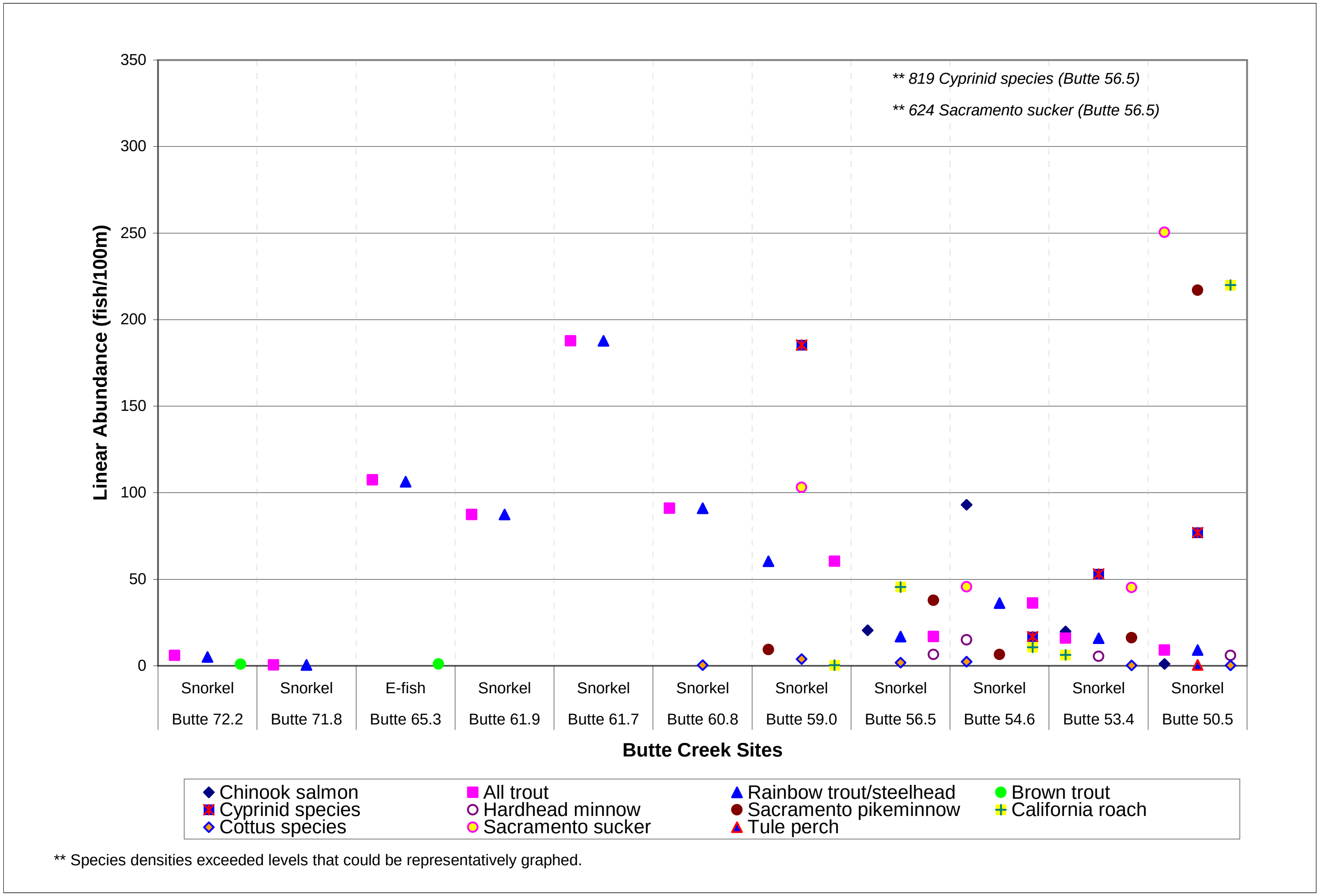


Figure E6.3.2.2-18. Linear abundance estimates by species in Butte Creek, 2006.

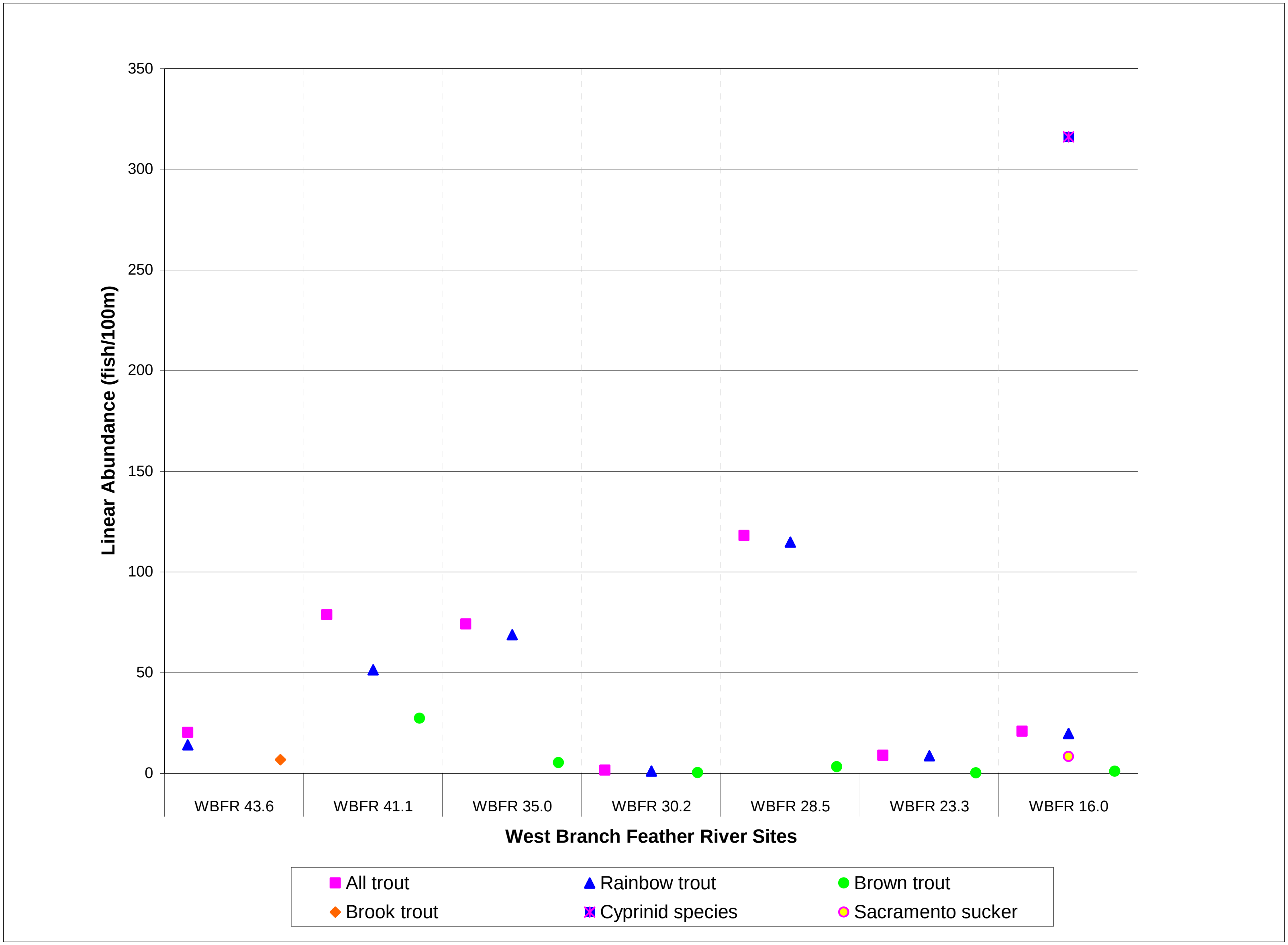


Figure E6.3.2.2-19. Linear abundance estimates by species in the WBFR, 2006.

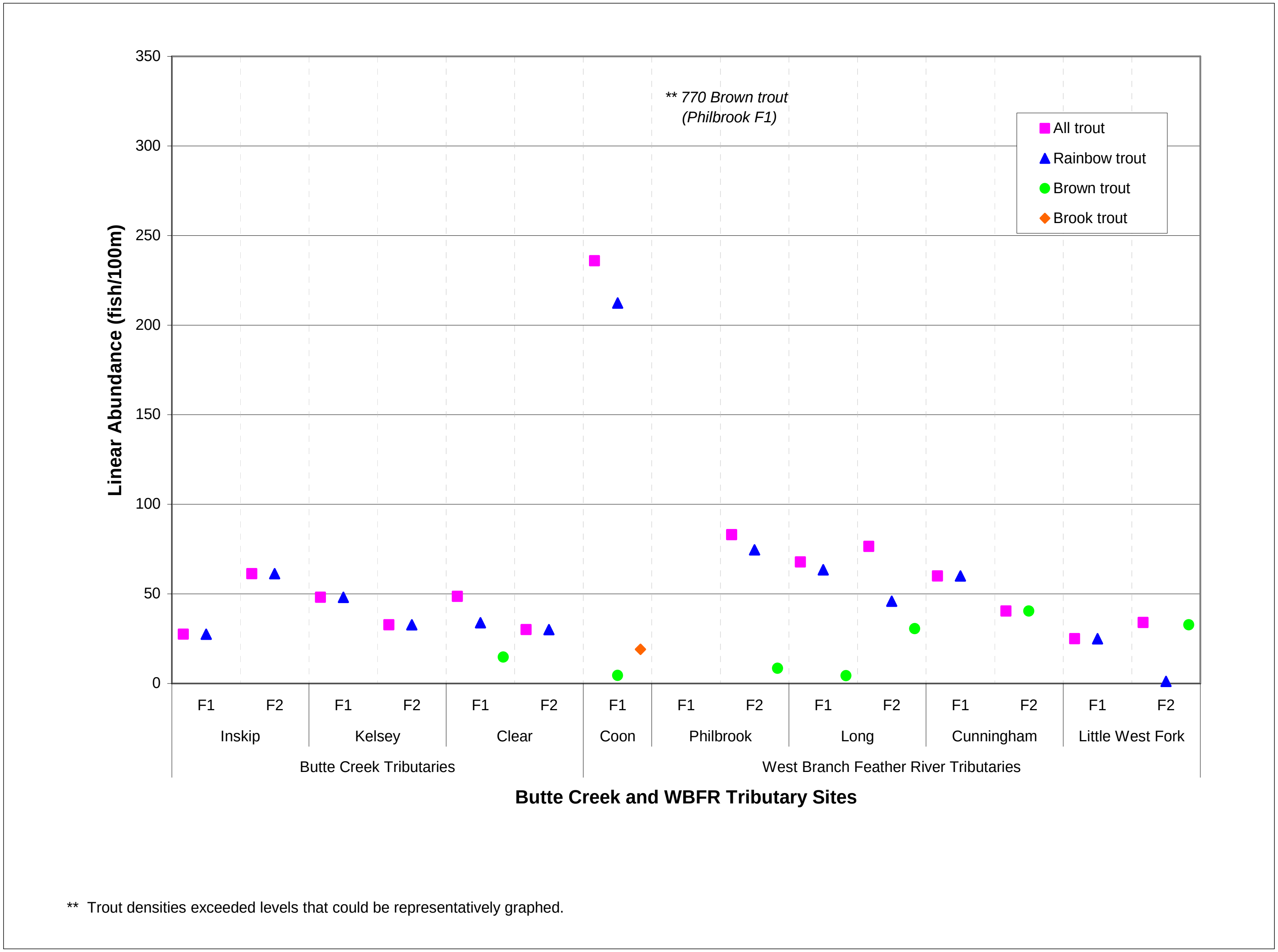


Figure E6.3.2.2-20. Linear abundance estimates by species in WBFR tributaries, 2006.

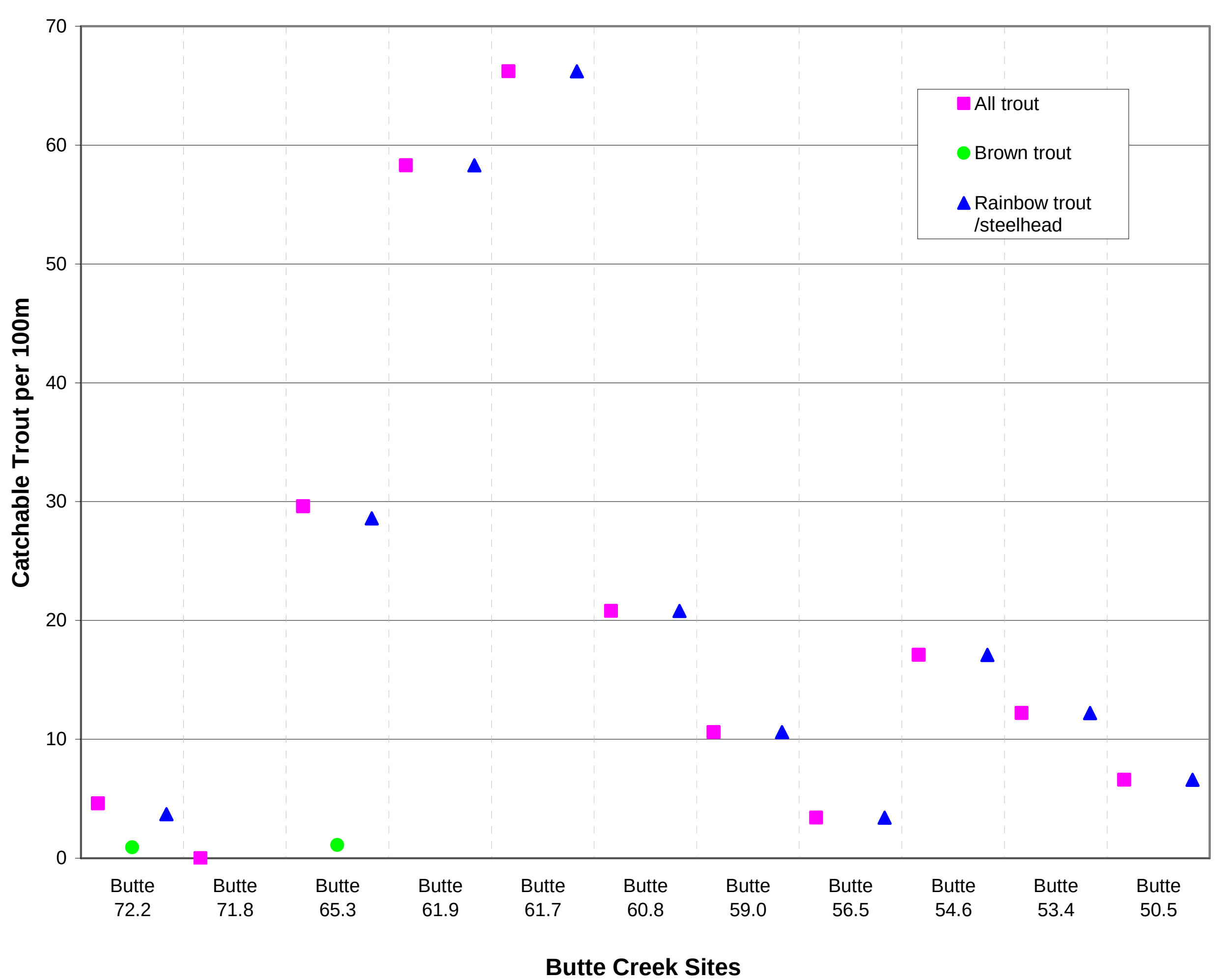


Figure E6.3.2.2-21. Catchable trout abundance estimates in Butte Creek, 2006.

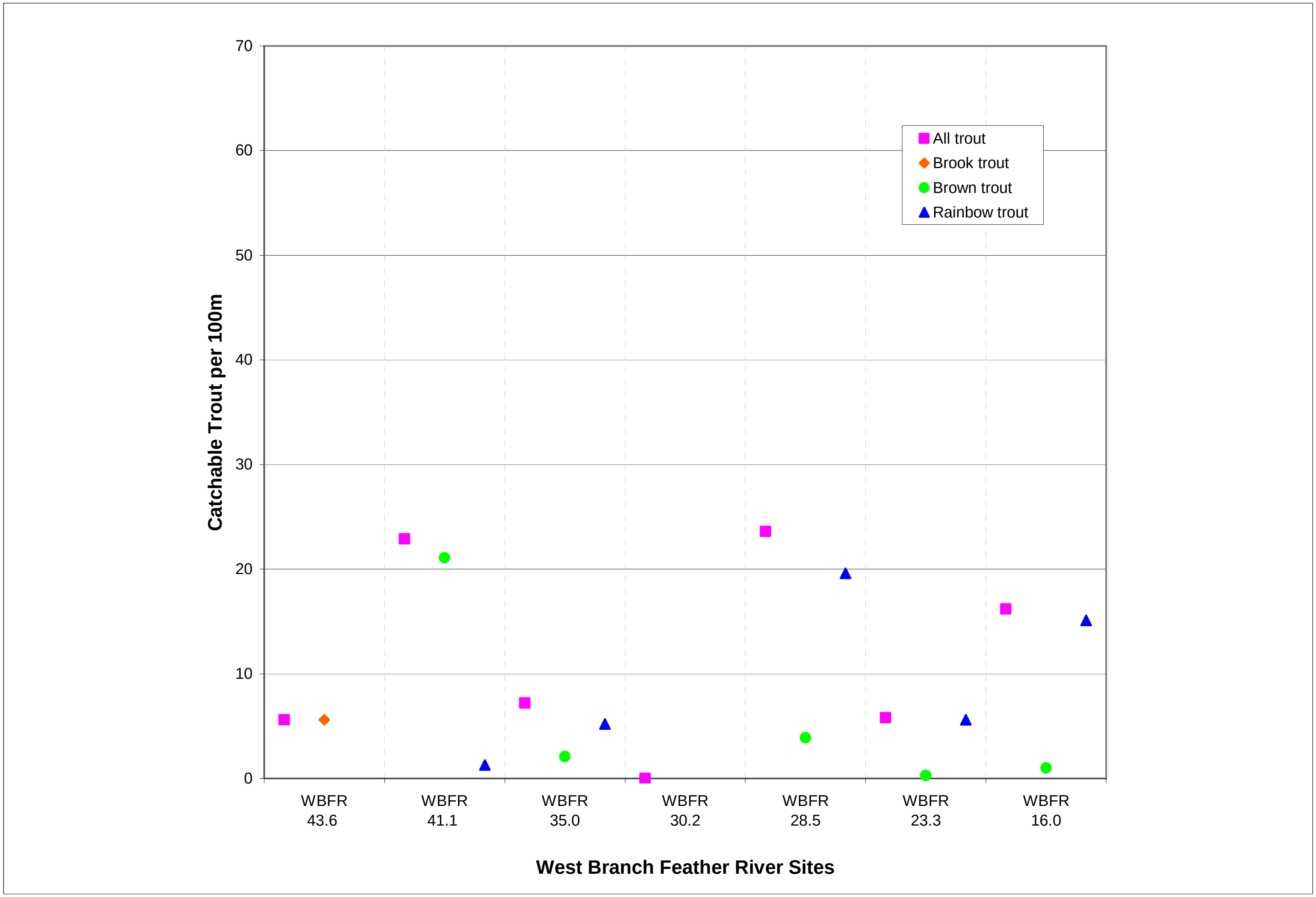


Figure E6.3.2.2-22. Catchable trout abundance estimates in the WBFR, 2006.

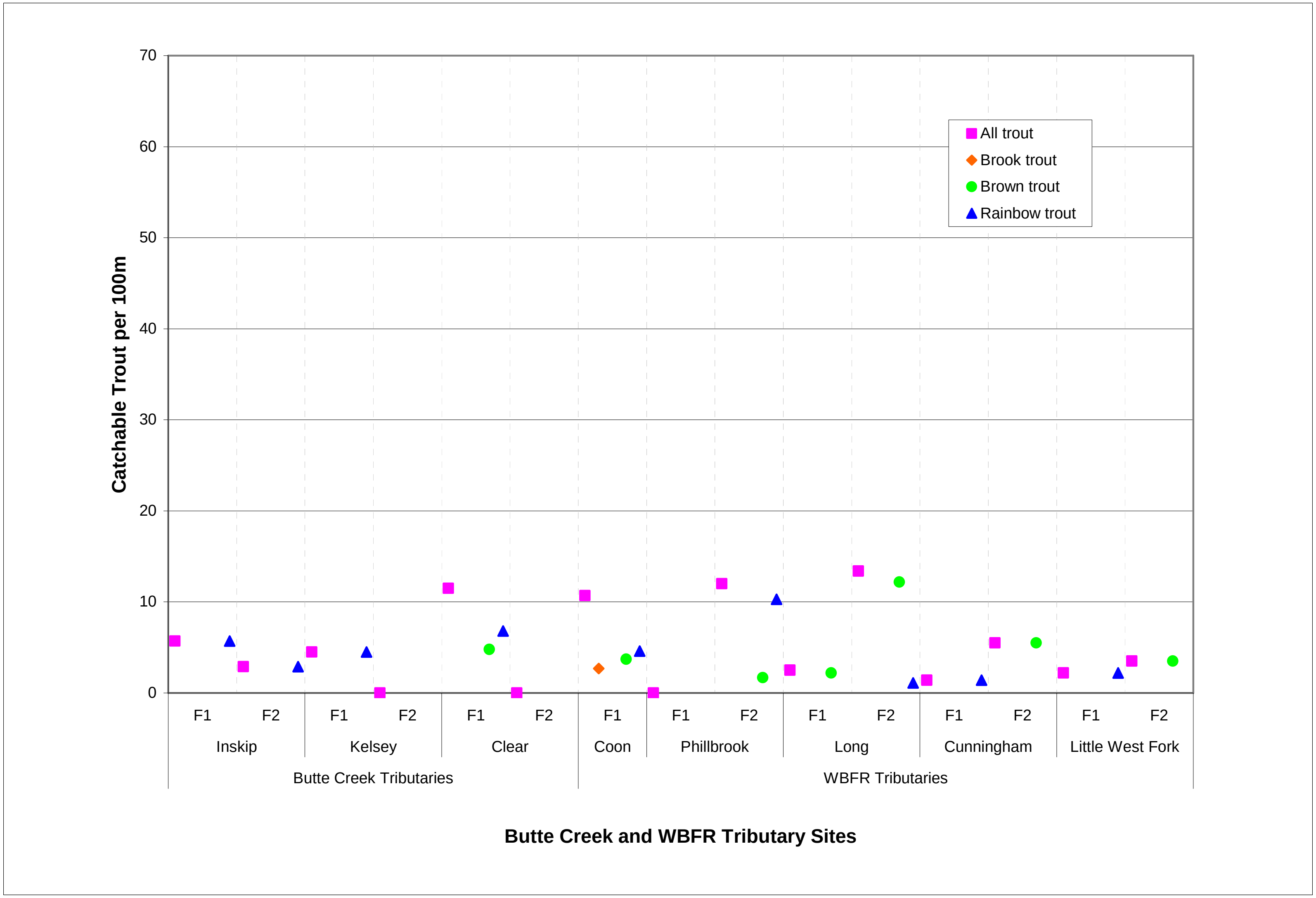


Figure E6.3.2.2-23. Catchable trout abundance estimates for Butte Creek and WBFR tributaries, 2006.

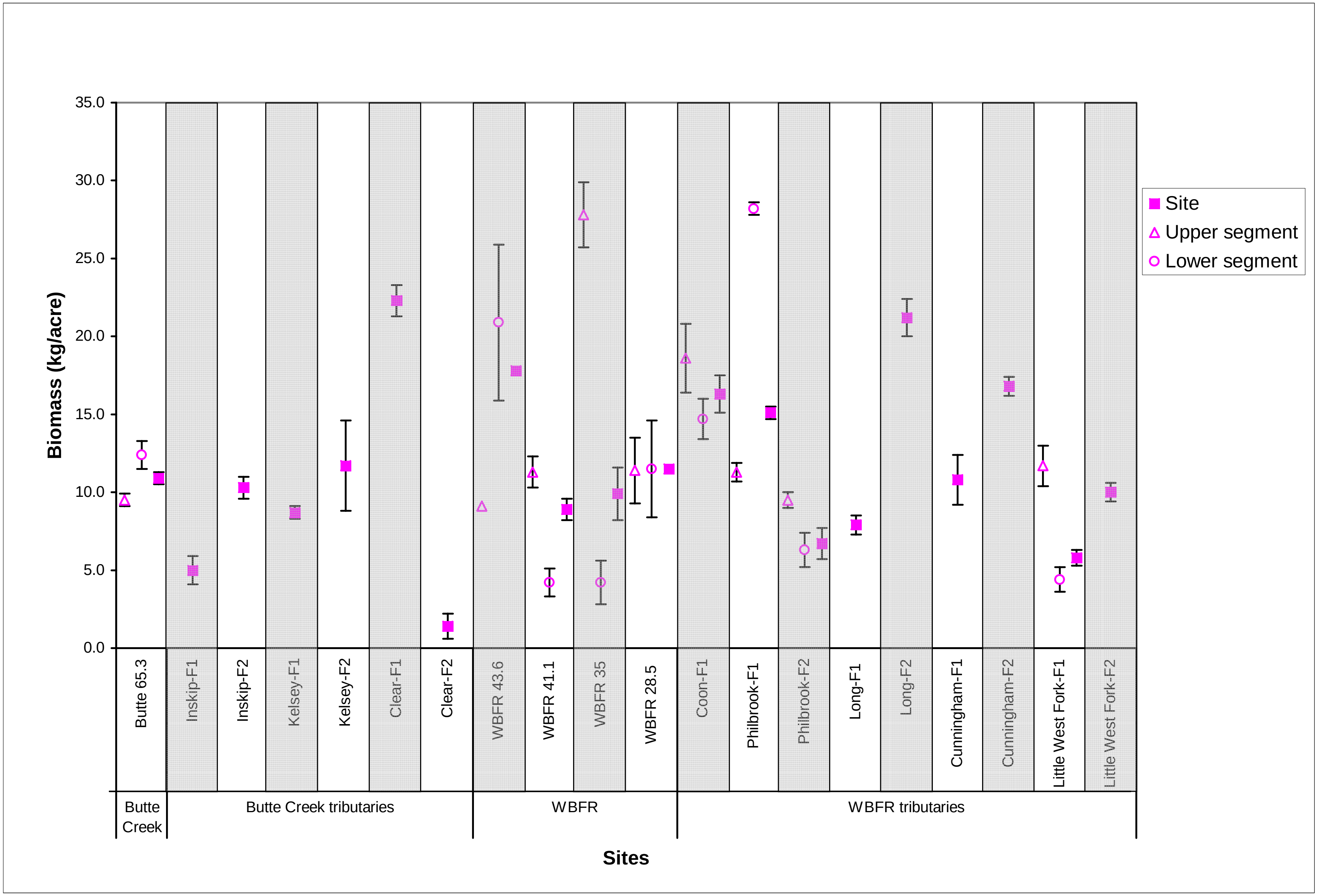


Figure E6.3.2.2-24. Estimated trout biomass, with 95 percent confidence intervals, at fish sampling sites in the Study Area in 2006.

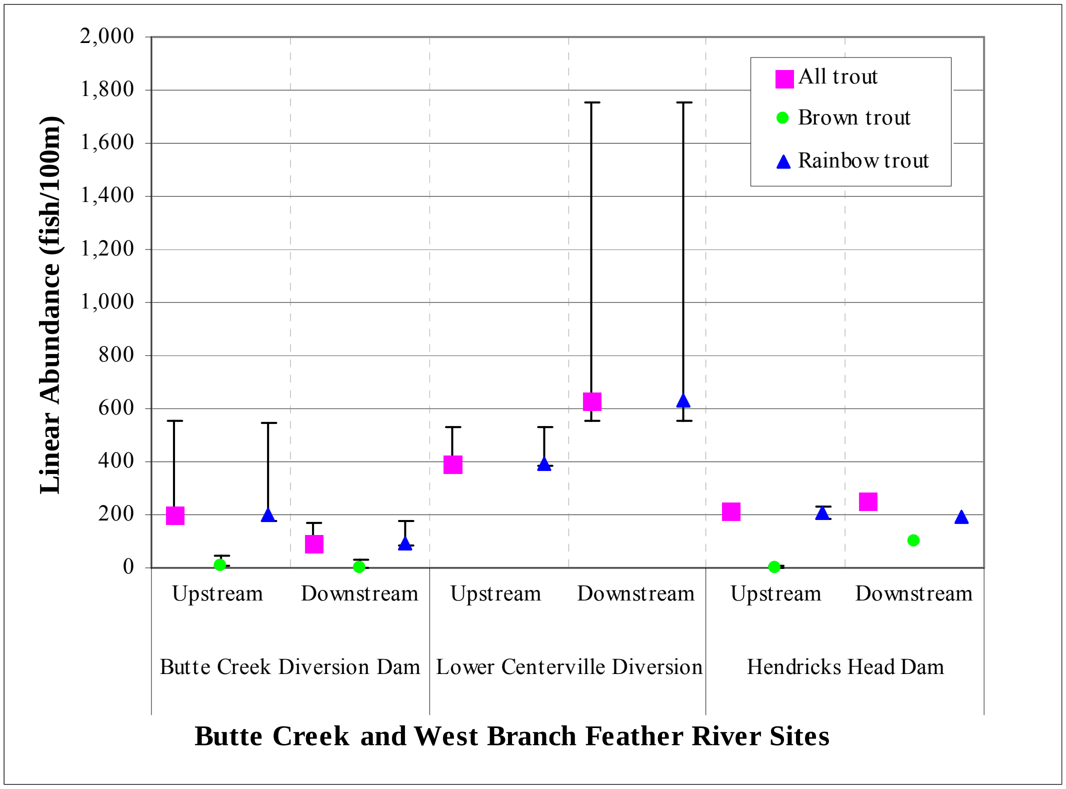


Figure E6.3.2.2-25. Linear abundance estimates, with 95 percent CI, from snorkel and electrofishing surveys at Project diversions in Butte Creek and the West Branch Feather River, 2007.

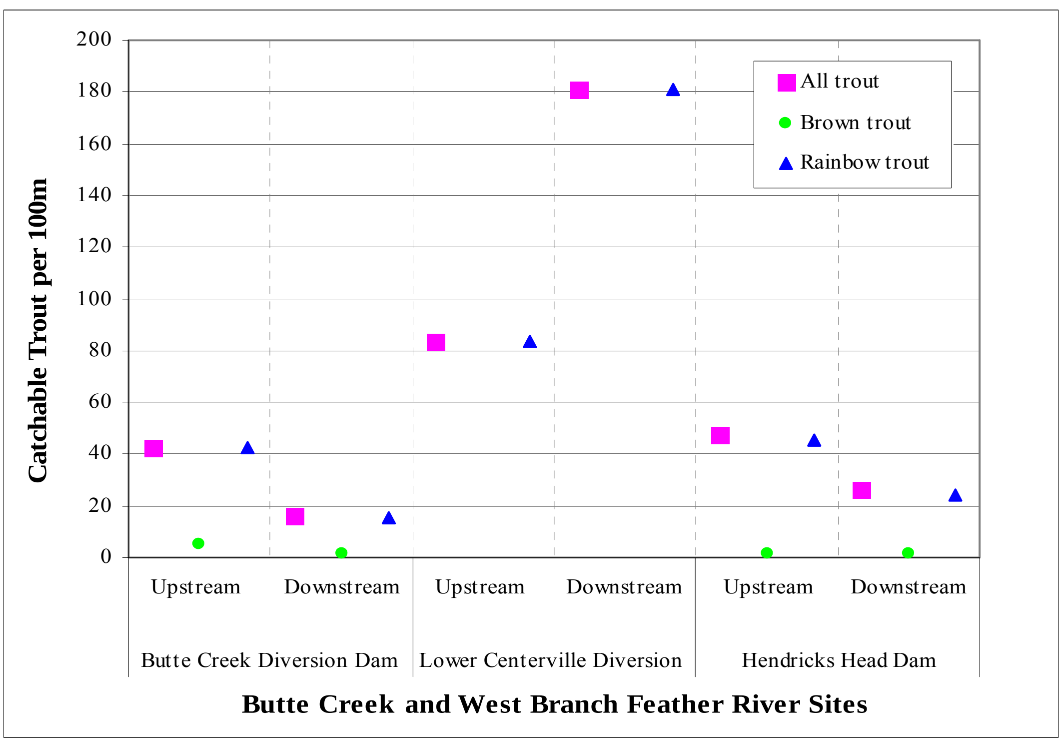


Figure E6.3.2.2-26. Catchable trout estimates from snorkel and electrofishing surveys at Project diversions in Butte Creek and the West Branch Feather River, 2007.

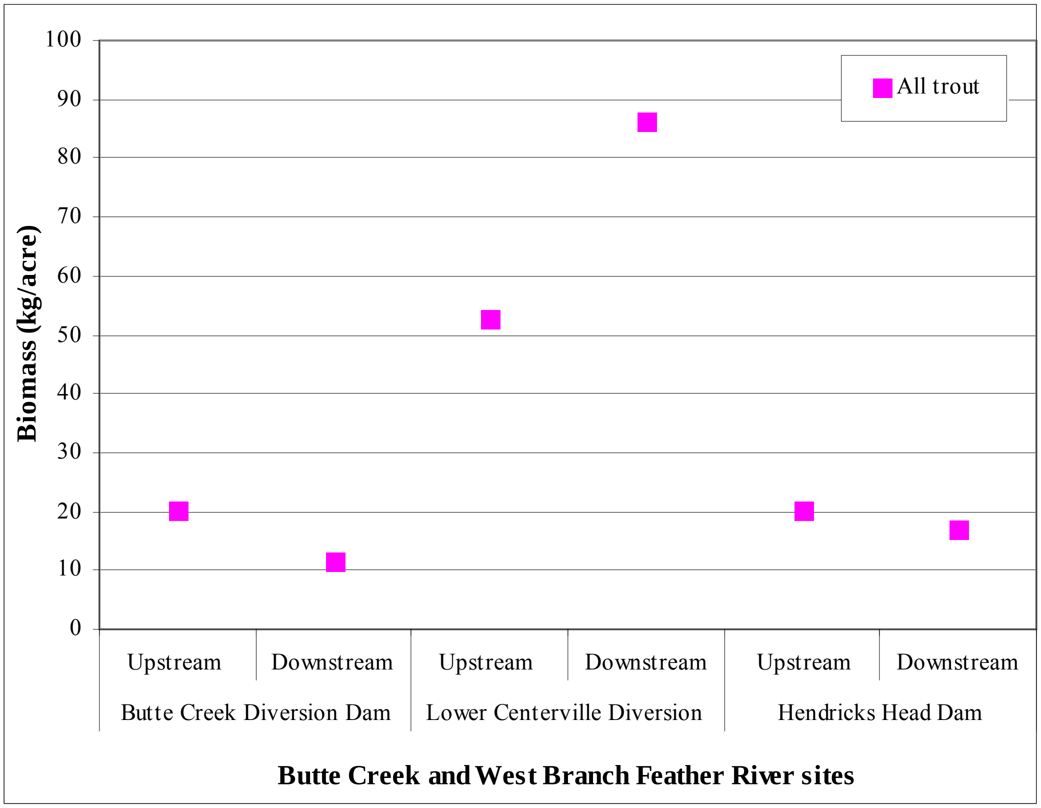
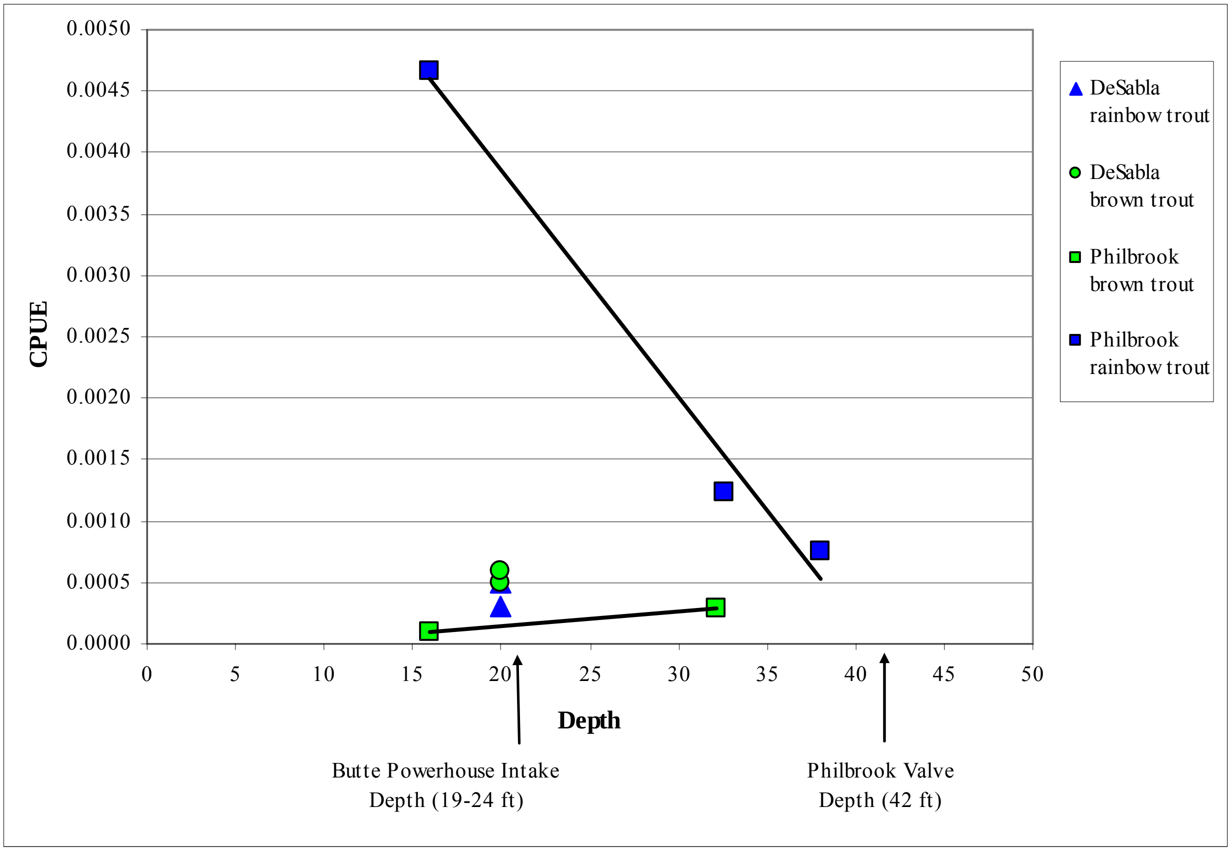


Figure E6.3.2.2-27. Estimated trout biomass from snorkel and electrofishing surveys at Project diversions in Butte Creek and the West Branch Feather River, 2007.



FigureE6.3.2.2-28. Catch per unit effort (CPUE) of fish captured by gillnet at multiple depths in Philbrook Reservoir and DeSabla Forebay during reservoir sampling in 2006.

Table E6.3.2.2-9. Catch Per Unit Effort (CPUE) by reservoir site and species, 2006.

Reservoir	Site Location	Species	No. of Fish	CPUE
DeSabla	G1	Rainbow trout	5	0.0005
DeSabla	G1	Brown trout	5	0.0005
DeSabla	G2	Rainbow trout	3	0.0003
DeSabla	G2	Brown trout	6	0.0006
DeSabla	E1	Rainbow trout	1	0.0008
DeSabla	E2	Golden shiner	16	0.0131
DeSabla	E3	-	0	0.0000
DeSabla	E4	Rainbow trout	2	0.0026
DeSabla	E4	Brown trout	1	0.0013
Philbrook	S1	-	0	0.0000
Philbrook	S2	-	0	0.0000
Philbrook	S3	Rainbow trout	3	0.0207
Philbrook	S4	-	0	0.0000
Philbrook	G1	Rainbow trout	50	0.0047
Philbrook	G1	Brown trout	1	0.0001
Philbrook	G2	Rainbow trout	8	0.0008
Philbrook	G3	Rainbow trout	13	0.0012
Philbrook	G3	Brown trout	3	0.0003

Current Fish Population Comparison to Historical and Regional Fish Populations

Generally, fish assemblages within the Study Area in 2006 were similar to historical observations (Table E6.3.2.2-5). Brook trout, which had not previously been documented in the Study Area, were observed in the WBFR and WBFR tributaries in 2006. Fall-run Chinook salmon and Pacific lamprey which were historically documented in the Butte Creek Study Area, were not observed during the 2006 surveys. The 2006 survey timing did not coincide with the time that those species likely would be in the river.

Despite variability in trout populations within reaches (Table E6.3.2.2-10), the 2006 trout populations in Butte Creek and the WBFR were notably low compared to historical surveys in all but one reach (Centerville Powerhouse to Lower Centerville Diversion) (Table E6.3.2.2-11). Considerable variance in populations sampled between 1977–2007 has also been documented with overall lower trout abundances in 2006, and higher trout abundances observed in 2007. The standard deviations reported in Tables E6.3.2.2-10 and E6.3.2.2-11 were calculated for reaches or years during which at least three sites were sampled. The variance is likely a factor of survey methods as well as population variability.

Rainbow trout and brown trout have historically been the predominant fish species in Philbrook Reservoir and DeSabla Forebay. As mentioned above, CDFG maintains the trout populations in both impoundments through an annual stocking program. The trout population in DeSabla Forebay is maintained as a “put-and-take” fishery with biweekly plantings of catchable rainbow trout during the spring and summer months.

Fish screens were once present at Butte and Hendricks canals, but were removed, due to the ineffective design which lead to clogged screens, with the approval of CDFG. Since the removal of the screens, PG&E has routinely conducted cooperative fish rescues with CDFG in the Butte, Lower Centerville, Hendricks and Toadtown canals when the canals are dewatered for annual maintenance. Fish populations in Project canals are summarized in Section 6.3.2.4 of the FLA (Assessment of Fish Entrainment and Upstream Fish Passage Issues at DeSabla-Centerville Project Facilities).

Table E6.3.2.2-10. Mean trout abundance observed in stream reaches above and below Project diversions in 2006.

Location related to diversion	Reach description	Reach length (mi)	Site	Linear site abundance (trout/100m)			Mean linear abundance (trout/100m)			Standard deviation of abundance across sites		
				All trout	Brown trout	Rainbow trout	All trout	Brown trout	Rainbow trout	All trout	Brown trout	Rainbow trout
BUTTE CREEK DIVERSION AND BUTTE CANAL												
Upstream	Butte Creek Div. to Butte Meadows	8.0	Butte 72.2	6.0	0.9	5.1	6	1	5	-	-	-
Downstream	Lower Centerville Div. to Butte Creek Div.	10.2	Butte 71.8	0.5	0.0	0.5	66	0	66	57.9	0.6	57.5
			Butte 65.3	110.2	1.1	109.1						
			Butte 61.9	87.4	0.0	87.4						
LOWER CENTERVILLE DIVERSION AND LOWER CENTERVILLE CANAL												
Upstream	Lower Centerville Div. to Butte Creek Div.	10.2	Butte 71.8	0.5	0.0	0.5	66	0	66	57.9	0.6	57.5
			Butte 65.3	110.2	1.1	109.1						
			Butte 61.9	87.4	0.0	87.4						
Downstream	Centerville PH to Lower Centerville Div.	6.6	Butte 61.7	187.7	0.0	187.7	89	0	89	72.5	0.0	72.5
			Butte 60.8	91.0	0.0	91.0						
			Butte 59.0	60.5	0.0	60.5						
			Butte 56.5	16.9	0.0	16.9						
HENDRICKS HEAD DAM AND HENDRICKS / TOADTOWN CANAL												
Upstream	Hendricks Div. to Coon Hollow Creek	13.2	WBFR 41.1	83.5	28.5	55.1	57	11	46	48.0	15.0	41.7
			WBFR 35.0	85.6	5.3	83.2						
			WBFR 30.2	1.5	0.4	1.1						
Downstream	Miocene Div. to Hendricks Div.	14.1	WBFR 28.5	139.7	3.4	136.7	51	2	52	62.4	1.9	65.9
			WBFR 23.3	8.9	0.3	8.6						
			WBFR 16.0	20.9	1.0	19.8						

Table E6.3.2.2-11. Mean trout abundance observed in stream reaches above and below Project diversions between 1977 and 2007.

Reach description	Location related to diversion	Reach length (mi)	Survey year	Site/ Location	Sampling method	Linear abundance at site (trout/100m)			Mean linear abundance by year (trout/100m)			Standard deviation of densities across years		
						All trout	Brown trout	Rainbow trout	All trout	Brown trout	Rainbow trout	All trout	Brown trout	Rainbow trout
Butte Creek Diversion & Butte Canal														
Butte Creek Div. to Butte Meadows	Upstream	8.0	2006	Butte 72.2	Snorkel	6.0	0.9	5.1	6	1	5	-	-	-
			2007	Butte 72.1	Snorkel	202.5	7.1	201.5	203	7	202			
Lower Centerville Div. to Butte Creek Div.	Downstream	10.2	1986	~Butte 69.0	E-fish	140.0	1.5	138.0	148	1	146	41.5	1.6	40.9
				~Butte 65.3	E-fish	155.0	1.0	154.0						
			2006	Butte 71.8	Snorkel	0.5	0.0	0.5	66	0	66			
				Butte 65.3	E-fish	110.2	1.1	109.1						
				Butte 61.9	Snorkel	87.4	0.0	87.4						
			2007	Butte 71.9	Snorkel	92.6	3.5	92.6	93	4	93			
Lower Centerville Diversion & Lower Centerville Canal														
Lower Centerville Div. to Butte Creek Div.	Upstream	10.2	1986	~Butte 69.0	E-fish	140.0	2.0	138.0	148	2	146	170.1	0.8	170.5
				~Butte 65.3	E-fish	155.0	1.0	154.0						
			2006	Butte 71.8	Snorkel	0.5	0.0	0.5	66	0	66			
				Butte 65.3	E-fish	110.2	1.1	109.1						
				Butte 61.9	Snorkel	87.4	0.0	87.4						
			2007	Butte 62.0	Snorkel	392.9	0.0	392.9	393	0	393			
Centerville PH to Lower Centerville Div.	Downstream	6.6	1977	~100 m downstream of LCDD	E-fish	52.0	4.0	48.0	52	2	48	322.5	1.2	323.7
			2006	Butte 61.7	Snorkel	187.7	0.0	187.7	89	0	89			
				Butte 60.8	Snorkel	91.0	0.0	91.0						
				Butte 59.0	Snorkel	60.5	0.0	60.5						
				Butte 56.5	Snorkel	16.9	0.0	16.9						
			2007	Butte 61.7	Snorkel	628.1	0.0	628.1	628	0	628			

Table E6.3.2.2-11. Mean trout abundance observed in stream reaches above and below Project diversions between 1977 and 2007.

Reach description	Location related to diversion	Reach length (mi)	Survey year	Site/ Location	Sampling method	Linear abundance at site (trout/100m)			Mean linear abundance by year (trout/100m)			Standard deviation of densities across years		
						All trout	Brown trout	Rainbow trout	All trout	Brown trout	Rainbow trout	All trout	Brown trout	Rainbow trout
Hendricks DiversionDam & Hendricks / Toadtown Canal														
Hendricks Div. to Coon Hollow Creek	Upstream	13.2	1977	160 m u/s of Fish Cr	E-fish	760.0	274.0	486.0	760	274	486	268.1	112.2	164.6
			1987	Near Coon Hollow	E-fish	187.0	79.8	106.1	211	76	134			
				At road leading to Philbrook Res.	E-fish	234.1	71.7	162.4						
			1988	At road leading to Philbrook Res.	E-fish	320.9	165.2	155.7	361	148	213			
				At road leading to Philbrook Res.	E-fish	393.4	158.8	234.6						
				Upstream of Philbrook Cr.	E-fish	369.2	119.8	249.3						
			2006	WBFR 41.1	E-fish	83.5	28.5	55.1	57	11	46			
				WBFR 35.0	E-fish	85.6	5.3	83.2						
				WBFR 30.2	Snorkel	1.5	0.4	1.1						
			2007	WBFR 29.3	E-fish	213.7	3.3	209.5	214	3	210			
Hendricks Div. to Miocene Div.	Downstream	14.1	1977	0.5 mi d/s of Hendricks Diversion Dam	E-fish	723.0	204.0	519.0	723	204	519	289.2	85.2	210.3
			1978	0.5 mi d/s of Hendricks Diversion Dam	E-fish	471.0	61.0	410.0	471	61	410			
			2006	WBFR 28.5	E-fish	139.7	3.4	136.7	51	2	52			
				WBFR 23.3	Snorkel	8.9	0.3	8.6						
				WBFR 16.0	Snorkel	20.9	1.0	19.8						
			2007	WBFR 28.5	E-fish	250.8	103.6	193.8	251	104	194			

Fish population estimates, derived from the 2007 sampling sites above and below Project diversions, tended to exceed average values for coldwater streams in northern Sierra Nevada. From 289 study sections on 102 streams, a mean late summer standing crop of 41lbs/acre or 224 adult trout per mile was computed for combined trout species (Gerstung 1973). For stream widths that include the 2007 Butte Creek and WBFR survey sites, Gerstung (1973) reported the following values for mean adult linear abundance and biomass (all trout combined):

235 trout/mile (streams 26-39 ft wide)
278 trout/mile (streams 40-70 ft wide)
24 lbs/acre (streams 26-39 ft wide)
13 lbs/acre (streams 40-70 ft wide)

Linear site abundance of adult trout and biomass for all six 2007 sampling locations both above and below Project diversions exceeded mean values for Gerstung (1973) sampling locations of similar width (Table E6.3.2.2-12).

Table E6.3.2.2-12. Trout population linear abundance and biomass for the DeSabla-Centerville Hydroelectric Project Area in 2007, relative to Gerstung, 1973.

Diversion	Site Location	2007 Survey Method	Linear Site Abundance (Adult trout/mile)	Gerstung 1973 Linear Abundance (Adult trout/mile) [1]	Site Biomass (lbs/acre)	Gerstung 1973 Biomass (lbs/acre) [2]
Butte Creek Diversion Dam	Upstream	Snorkel	684.4	278	44.3	13
	Downstream	Snorkel	264.0	211	25.8	24
Lower Centerville Diversion	Upstream	Snorkel	1,345.2	235	116.4	24
	Downstream	Snorkel	2,917.4	278	190.2	24
Hendricks Head Dam	Upstream	E-fish	761.0	235	44.9	24
	Downstream	E-fish	423.2	235	37.1	24

[1] Mean abundance of adult trout in streams of similar width to 2007 sampling sites (Table 4, Gerstung 1973).
[2] Mean biomass of all trout in streams of similar width to 2007 sampling sites (Table 3, Gerstung 1973).

6.3.2.2.5 Summary

Reservoir sampling was conducted in Philbrook Reservoir and DeSabla Forebay in August–September 2006 using gillnetting, beach seine, and/or boat electrofishing methods. Fish species observed included rainbow trout and brown trout in both study impoundments as well as golden shiner within DeSabla Forebay. Both juvenile and adult lifestages of trout were present in Philbrook Reservoir, whereas only adult trout were observed in DeSabla Forebay. In addition, several crayfish were noted at several sites within Philbrook Reservoir.

Stream fish surveys were conducted at 33 sites in September–October of 2006 using backpack electrofishing and snorkel methods. Fish species composition in the lower reaches of Butte Creek included anadromous species (steelhead and Chinook salmon) as well as transitional zone species hardhead and Sacramento pikeminnow, Sacramento sucker, California roach, tule perch, and sculpin species. The upper reaches of Butte Creek contained brown trout, rainbow trout, and rainbow hybrid/color morph fish. Fish species composition in the WBFR contained similar species as Butte Creek, with the exception of the anadromous species.

Additional stream fish surveys were conducted at six sites on Butte Creek and the West Branch Feather River near the Project's primary diversions in September–October of 2007 using backpack electrofishing and snorkel methods. Survey methods in 2007 allowed for better comparisons between populations upstream and downstream of each diversion as well as comparisons between sampling methods. Fish composition at each site observed in the 2006 and 2007 surveys were similar with overall higher trout abundances observed in 2007. No clear trend was observed that would indicate depressed populations upstream or downstream of Project diversions. In 2007, fish populations downstream of Butte Creek Diversion Dam were slightly lower than the populations upstream, whereas the fish populations downstream of Lower Centerville Diversion Dam were slightly higher than the populations upstream. Populations upstream and downstream of Hendricks Diversion in 2007 were similar. It was also noted that trout population estimates, derived from the 2007 sampling sites above and below Project diversions, generally tended to exceed historic average values of trout populations for coldwater streams in northern Sierra Nevada reported by Gerstung (1973) for all trout species combined.

6.3.2.2.7 Literature Cited

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6.3.2.2.7 List of Appendices

- Appendix E6.3.2.2-A: 2006 Fish Population Monitoring Data
- Appendix E6.3.2.2-B: 2006 Fish Population Monitoring Photographs
- Appendix E6.3.2.2-C: Summary of Physical Parameters for Fish Population Monitoring Sites
- Appendix E6.3.2.2-D: 2006 Length Frequency Distribution Figures
- Appendix E6.3.2.2-E: Trout Abundance Estimates for the DeSabla Centerville Project Area, 2006
- Appendix E6.3.2.2-F: Trout Population Biomass Summary for the DeSabla Centerville Hydroelectric Project Area, 2006

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Fish and Aquatic Resources Appendices On Compact Disk

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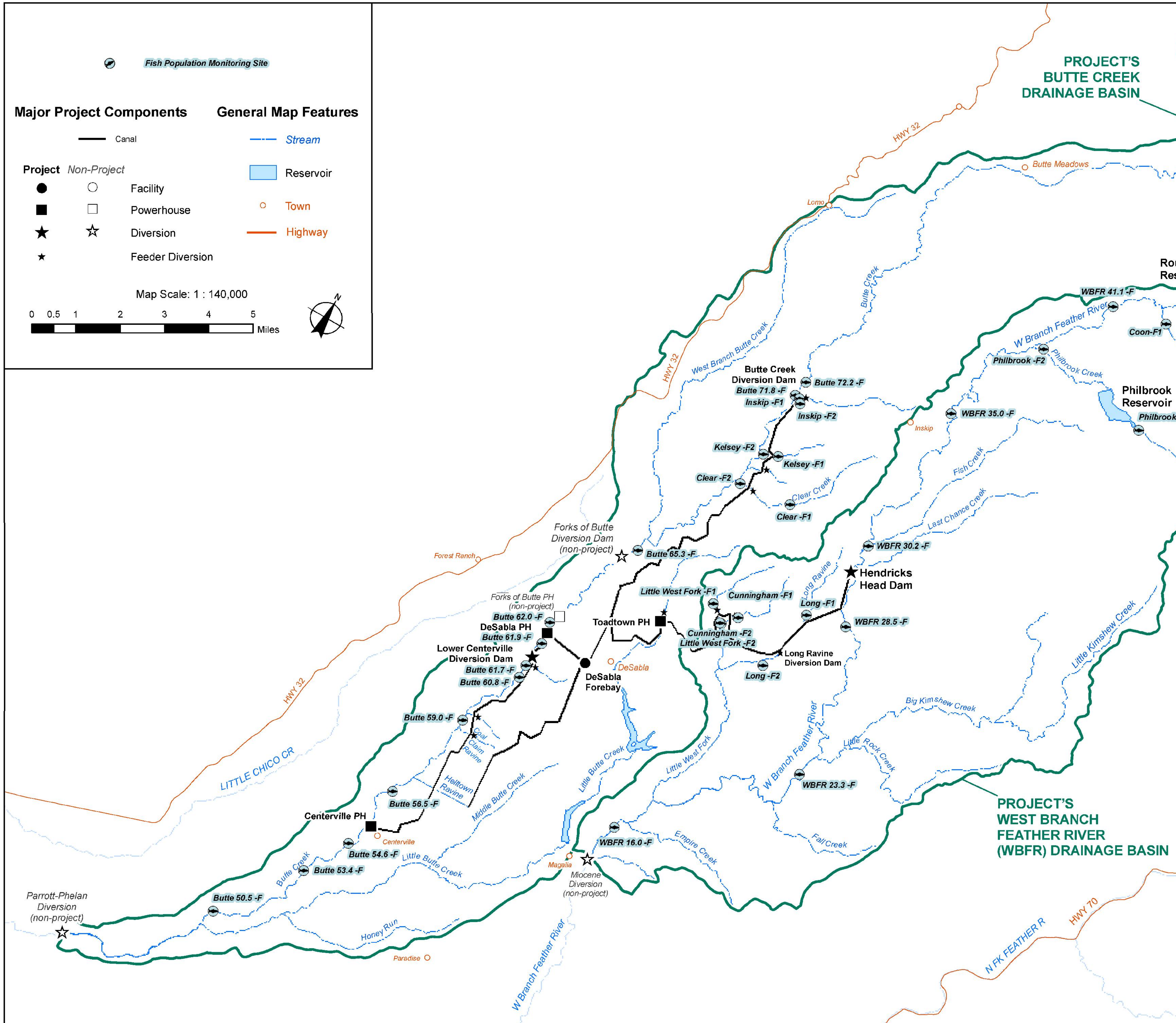

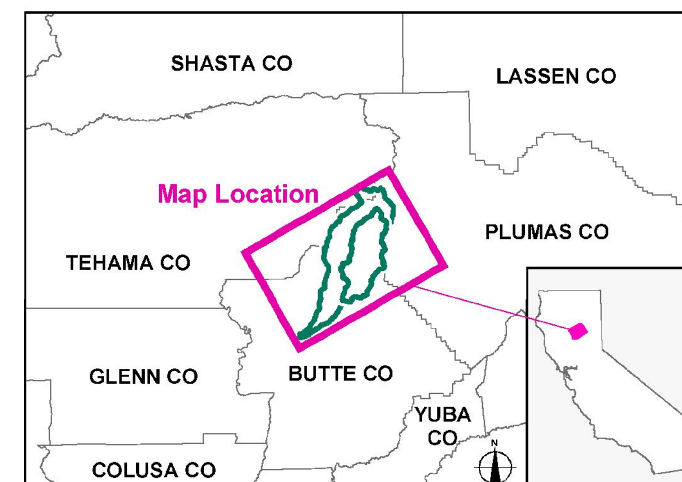

DeSabla-Centerville Project
FERC 803

Figure E6.3.2.2-1
Stream Fish Population Monitoring Sites

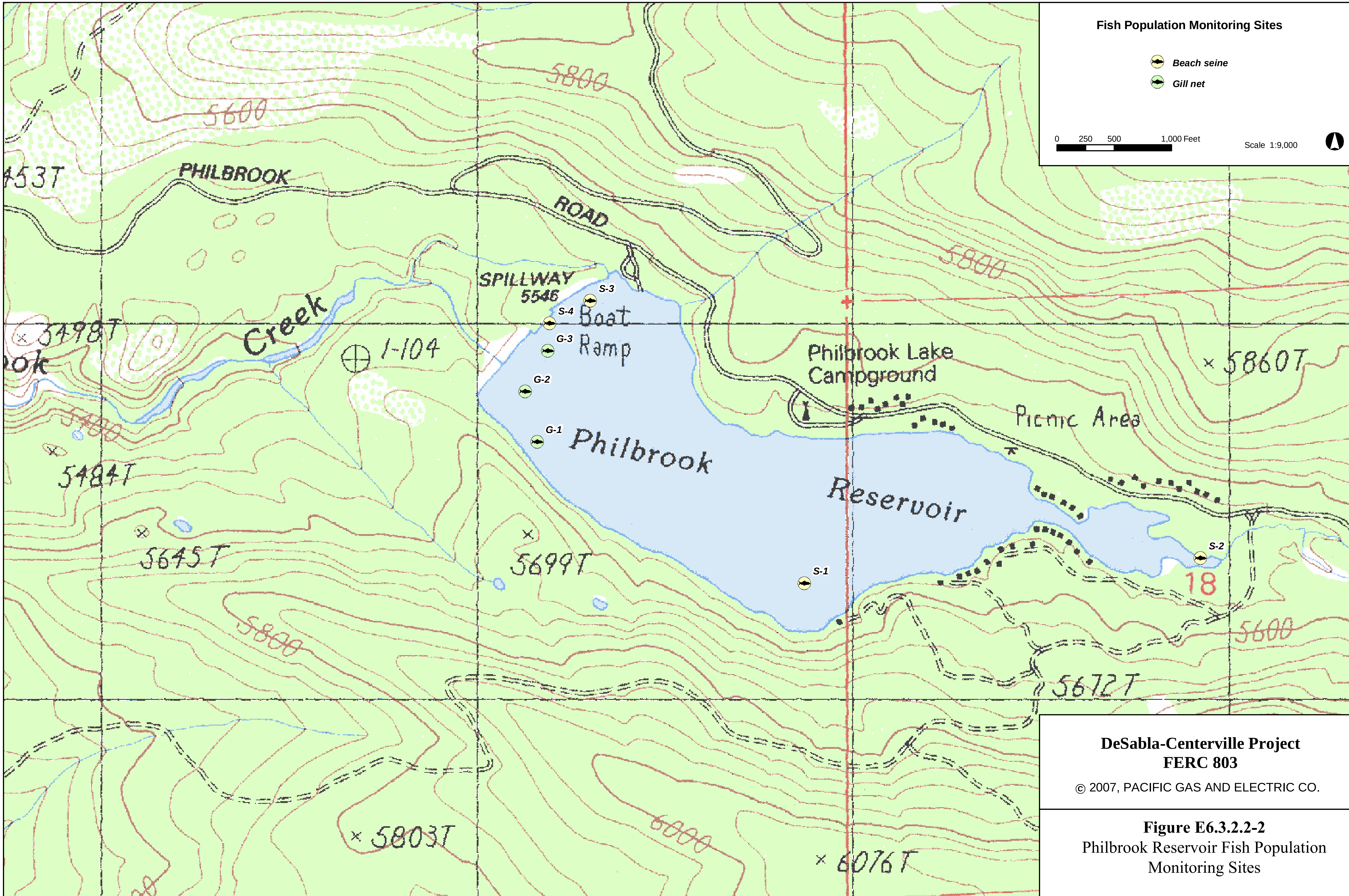

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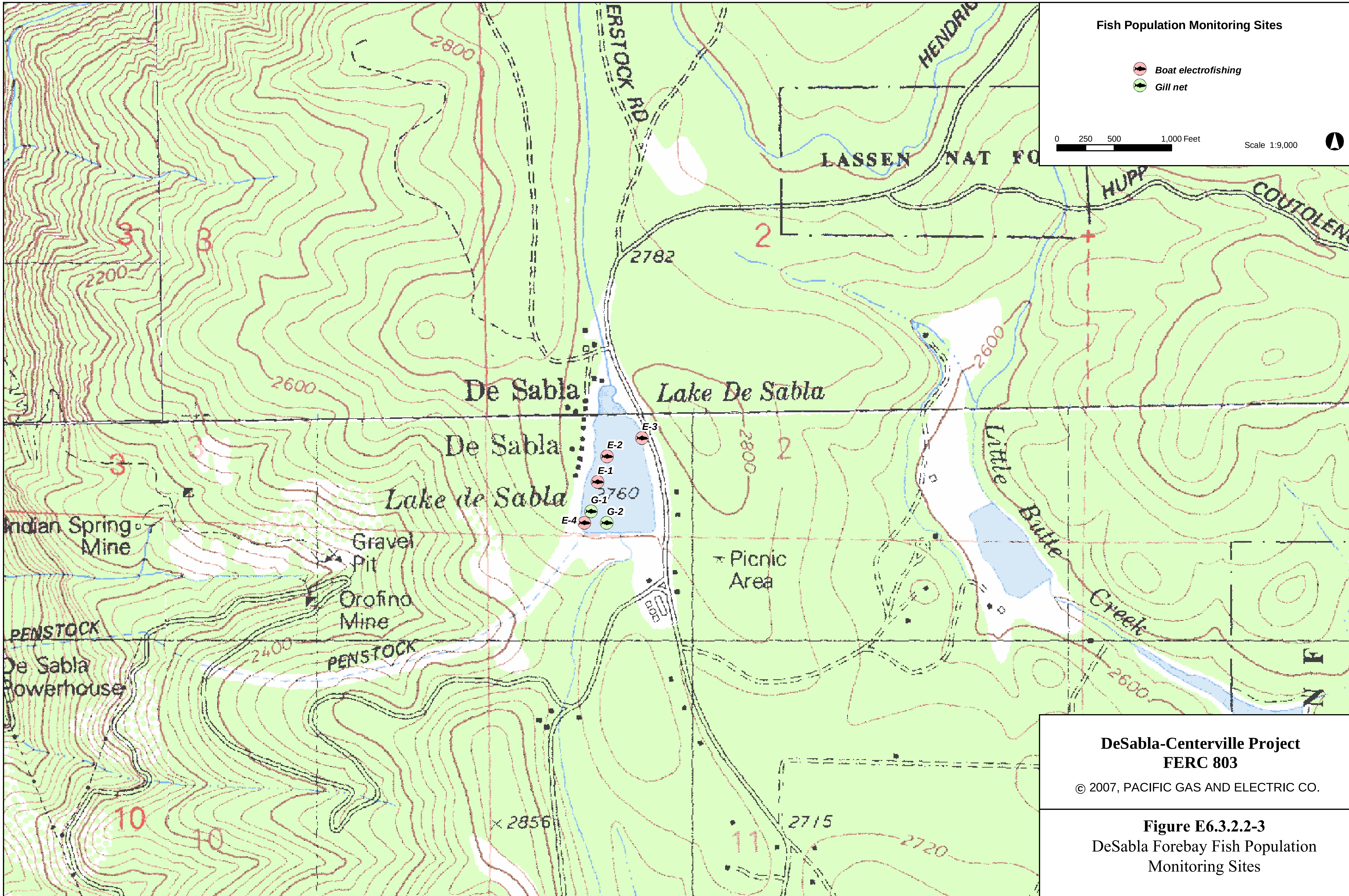
Figure E6.3.2.2-2
Philbrook Reservoir Fish Population Monitoring Sites



DeSabla-Centerville Project
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Figure E6.3.2.2-3
DeSabla Forebay Fish Population Monitoring Sites

file: G:\gis\data\utility\hydro\projects\desabla_centerville\maps_2007SISR\6_3_3-4_fishpop_map3.mxd 300dpi by EJP0 at 12/21/2006 12:30PM

SECTION 7.0
Environmental Analysis

7.2 Water Resources

7.2.1 No Changes to this section

7.2.2 No Changes to this section

7.2.3 No Changes to this section

7.2.4 *Updated* Effects of Project operations on water temperature, contaminants, and other water quality parameters in the Project reservoirs and Project-affected stream reaches

Two studies were conducted by PG&E to address the effects of continued Project O&M upon water temperature, contaminants, and other water quality parameters in the Project reservoirs and Project-affected stream reaches: Study 6.3.2-4, *Develop Water Temperature Model and Monitor Water Temperature*; and Study 6.3.2-5, *Measure and Evaluate Water Quality in Project Reservoirs and Project-Affected Steam Reaches.*

Water Temperature

No changes to the Water Temperature portion of Section 7.2.4

Water Quality

Based on historical information (See Section 6.2.1.7 - Existing Water Quality Data) and results from studies listed above, water quality in the Project Area generally meets Basin Plan Water Quality objectives with minor exceptions. The primary areas for exceedances of Basin Plan criteria identified in 2006 were related to turbidity increases following planned and unplanned canal outages as well as fecal coliform bacteria (Updated Section E6.2.2.4, Table E6.2.2.4-28). Turbidity impacts due to unplanned canal outages are addressed separately in Sections 7.2.5 and 7.2.6 below, while fecal coliform impacts are addressed in Section 7.2.7.

Consequently, with the exception of turbidity and fecal coliform under specific conditions, PG&E considers Project operations to have a beneficial affect on water temperature, with no significant adverse effect on contaminants and other water quality parameters in the Project reservoirs and Project-affected stream reaches with the exception described below.

PG&E proposes to install of a structure at DeSabla Forebay to convey cool water through the forebay for the benefit of Chinook salmon in Butte Creek. Such a structure may result in the unavoidable warming of portions of the forebay, since mixing with cool water entering the forebay would cease. In addition, warmer water may exacerbate bacteria conditions in the forebay in summer. PG&E considers this to be a minor cumulative impact that would occur each year: the impact is considered minor because water contact for recreation is not permitted on DeSabla Forebay. Furthermore, in the balance, the new structure would support a major environmental benefit of the Project - enhanced habitat for Chinook salmon and steelhead in lower Butte Creek.

7.2.5 *Updated* Effects of cleaning Project canals and flumes on water quality

PG&E's Study 6.3.2-5, *Measure and Evaluate Water Quality in Project Reservoirs and Project-Affected Steam Reaches*, addressed the effects of canal cleaning on water quality. Canals are routinely cleared of herbaceous vegetation and sediments through both mechanical means and judicious application of herbicides, both of which could affect water quality by increasing water turbidity or leaving residual chemicals. Based on historical information (See Section 6.2.1.7 - Existing Water Quality Data) collected by PG&E to evaluate the impacts of planned or unplanned operational outages upon turbidity, temporary exceedances of Basin Plan criteria for turbidity were identified at the discharge of Butte and Hendricks canals (Updated Section E6.2.2.4, Table E6.2.2.4-27), lasting from under 1 hour to a maximum of 18.5 hours. Because these canals intercept overland flow and feeder tributaries at a number of locations, canal operation tends to concentrate sediment delivery into brief periods during startup and shutdown when the water velocity along the canal bottoms is higher and/or more erosive. During these events, turbidity levels exceed the Basin Plan water quality objective and there is a potential for impacts to beneficial uses.

Sampling for herbicides used along Project canals conducted by PG&E in 2007 (See Section 6.2.2.4) did not identify herbicide residues or degradation by-products following resumption of canal operation (Updated Section E6.2.2.4, Table E6.2.2.4-38). Use of herbicides within the Project is not likely to cause significant adverse effects upon water quality.

7.2.6 *Updated* Effects of sedimentation and turbidity on water quality caused from Project operations and structural failures, Project spillways, runoff from Project roads, and natural landslides

Several studies were conducted by the Licensee to address the effects of continued Project O&M upon sedimentation and water quality in the Project reservoirs and Project-affected stream reaches:

- Study 6.3.1-1, *Inventory and Assessment of Project and Ancillary Road-Related Erosion*
- Study 6.3.1-2, *Round Valley Reservoir Spillway-Related Erosion and Sediment Transport Survey*
- Study 6.3.1-3, *Canal Spillway-Related Erosion and Sediment Transport Survey*
- Study 6.3.1-4, *Water Conveyance Geologic Hazards Risk Assessment*
- Study 6.3.2-5, *Measure and Evaluate Water Quality in Project Reservoirs and Project-Affected Stream Reaches*

Based on historical information (See Section 6.2.1.7 - Existing Water Quality Data) and results of studies listed above, temporary exceedances of Basin Plan criteria for turbidity were identified at the discharge of Butte and Hendricks canals (Updated Section E6.2.2.4, Table E6.2.2.4-27) due to planned or unplanned operational outages. Butte and Hendricks canals are constructed primarily of earthen materials, intercepting overland flow along the adjacent hillslopes as well as flows from several feeder tributaries. For this reason, sediment delivery to the DeSabla Forebay due to runoff and landsliding above Project canals would have passed through the existing channel network under natural conditions. During these events, turbidity levels exceed the Basin Plan water quality objective and there is a potential for impacts to beneficial uses.

Erosion and turbidity from Project spillways, roads, and natural slopes can cause turbidity in streams. However, these occurrences are likely during high flow events throughout the water shed and do not result in cumulative effects. If reservoirs spill outside of high flow periods, increased turbidity may occur.

7.2.7 *Updated* Effects of informal recreation at Project reservoirs and stream reaches on water quality (such as fecal coliform contamination)

PG&E's Study 6.3.2-5, *Measure and Evaluate Water Quality in Project Reservoirs and Project-Affected Steam Reaches*, examined fecal coliform concentrations in recreation areas. Based on historical information (See Section 6.2.1.7 - Existing Water Quality Data) and water quality sampling conducted by PG&E in 2006 and 2007 (See Section 6.2.2.4), fecal coliform counts exceeding historical ranges and current Basin Plan criteria were found in the DeSabla Forebay consistently from spring through summer 2006 (PG&E 2004 (PAD); Updated Section E6.2.2.4, Table E6.2.2.4-39). During 2007, although two sites exceeded 200 CFU/100mL, the spatially averaged geometric mean across five sites was less than 200 CFU/100ml. Thus, the spatially averaged mean at DeSabla Forebay was below the temporally averaged Basin Plan criterion (that is based on a minimum of five samples) (Updated Section E6.2.2.4, Table E6.2.2.4-39). The Summer 2007 fecal coliform results indicate that fecal coliform levels may be of concern periodically at certain locations in the DeSabla Forebay. However, during both 2006 and 2007, the presence and distribution of waterfowl seems highly correlated with these elevated fecal coliform observations. DeSabla Forebay is designated for non-contact recreational uses only. In 2006, PG&E also inspected the local septic system and found no sources of contamination.

7.2.8 No Changes to this section

7.3 Fish and Aquatic Resources

7.3.1 No Changes to this section

7.3.2 No Changes to this section

7.3.3 No Changes to this section

7.3.4 No Changes to this section

7.3.5 No Changes to this section

7.3.6 *Updated* Effects of Project operations on fish entrainment at Project dams and diversions

Three studies addressed this issue specifically:

- Study Plan 6.3.3-1 — Survey Spring-run Chinook Salmon Pre-spawning Mortality and Spawning Escapement
- Study Plan 6.3.3-4 — Characterization of Fish Populations in Project Reservoirs and Project –Affected Stream Reaches
- Study Plan 6.3.3-6 — Entrainment of Fish in Project Facilities Affecting National Forest and State of California Resources

Fish enter Project canals at diversions on Butte Creek and the WBFR, as well as from several small feeder tributaries. Potential effects from Project operations include mortality from entrainment into diversions, canals and dams, and loss of downstream recruitment, leading to reduced population abundances and viabilities.

There are two primary data gaps for evaluating entrainment impact on fish populations in Project streams: 1) lack of reliable estimates of the total number of fish that move from the Project streams into the various diversion canals, and 2) lack of estimates of the number of fish that leave the diversion canals or suffer mortality due to passage through the powerhouses. Data from entrainment studies (Study Plan 6.3.3-6) provide a census or "snapshot" of fish populations in canal diversions at the time of study. Comparisons of "snapshots" of trout abundances in canals versus streams may be used to evaluate overall fish movement into Project canals, thus addressing data gap No. 1. Data from fish surveys in project reservoirs and stream reaches (Study Plan 6.3.3-4) provide comparisons of fish populations in stream reaches above and below Project diversions. Comparisons of YOY, juvenile and adult trout abundances above and below diversions may be used to indirectly assess declines in population abundances and recruitment due to entrainment mortality, thus addressing data gap No. 2.

Trout abundance in canals versus streams

Canal maintenance dewaterings and rescue operations show that fish do move from the stream into the canal. Brown trout and rainbow trout of all age/size classes have been removed from Project canals. However, comparisons of fish densities between Project streams and canals indicate that, at any one time, the canals contain fewer fish than the streams either above or below Project diversions, although the total numbers of fish that pass through the diversion canals are unknown.

In 2006, all the diversion canals had fewer fish per unit length than the Project streams. Trout density in canals ranged from 1.3 fish per 100 m to 3.5 fish per 100 m. Trout density in streams upstream and downstream of canal diversions ranged from 6 fish per 100 m to 89 fish per 100 m, with high inter-site variability (standard deviation ranged from 48–72). Historical data also indicate that the diversion canals typically have fewer fish per unit length than the Project streams, however variability is high between reaches and sample years.

Differences in the proportion of brown trout to rainbow trout observed in Project canals compared to Project streams indicated that brown trout are entrained at a higher rate than rainbow trout, or rainbow trout are moving through the canals at a faster rate. In Butte Creek in 2007, for instance, brown trout comprised 2% of the population of fish captured in the stream above Butte Creek Diversion Dam, but represented 38% of total fish captured in the Project canal. Likewise at Hendricks Diversion Dam in 2007, brown trout comprised 2% of total fish population in the stream upstream of the diversion, but 46% of total fish in the canal. These differences are likely linked to fundamental behavioral differences between the two specie's movement patterns that ultimately affect their entrainment potential. The large proportion of brown trout in the canals may limit the brown trout population in streams.

Trout abundance in streams above and below Project diversions

Systematic differences in fish abundances between populations upstream and downstream of Project diversions are not apparent. Differences in upstream versus downstream populations at each project diversion were not considerable, suggesting little or no negative impact of Project operations on fish abundance and recruitment due to entrainment. Higher populations upstream of Project diversions suggests little overall diversion effect (due to entrainment mortality) on the upstream populations, while low populations upstream of Project Diversions could suggest overall population effects due to entrainment loss. However, small or variable impacts of entrainment on fish abundance are difficult to tease apart from the effects of other physical and biological variables, such as habitat quantity, productivity, fishing pressure, and food web components.

In 2007, fish populations downstream of Butte Creek Diversion were similar to or lower than populations upstream. Based on average estimates of linear abundance per location, fish downstream comprised 46% of the population upstream. YOY contributed to an estimated 46% (by number) of the trout population upstream of the diversion and 53% (by number) of the trout population downstream of the diversion, suggesting recruitment is occurring within both of these reaches. Higher upstream populations suggest that loss of YOY or other life stages into Butte Creek Diversion does not have a significant effect on the trout population in this reach.

In 2007, fish populations upstream of the Lower Centerville Diversion were slightly lower in abundance than the populations downstream. Although upstream-downstream differences were not considerable, the slightly depressed populations upstream may suggest adverse effects from entrainment. Substantial numbers of YOY trout, however, were collected both above and below the diversion in 2007. YOY made up an estimated 64% by number of the trout population upstream and 35% by number of the trout population downstream, suggesting recruitment is occurring within both of these reaches.

In 2007, fish populations upstream of Hendricks Diversion were similar to the populations downstream. The estimate of linear abundance for all age classes was slightly lower upstream than downstream, although adult trout were proportionally more abundant upstream (22% of total population upstream versus 10% downstream). YOY made up an estimated 52% by number of the trout populations both upstream and downstream, suggesting recruitment is occurring within both of these reaches. These results do not suggest significant project effects on the trout population.

Within feeder tributaries, there were no discernable differences in trout density between upstream and downstream sites that would imply an entrainment effect.

Evaluation of entrainment effects

Fish population estimates, derived from the 2007 sampling sites above and below Project Diversions, tended to exceed average values for coldwater streams in the northern Sierra Nevada. From 289 study sections on 102 streams, a mean late summer standing crop of 41lbs/acre or 224 adult trout per mile was computed (Gerstung 1973). Linear site abundance of adult trout and biomass for all 2007 sampling locations both above and below Project diversions exceeded mean values for Gerstung (1973) sampling locations of similar width.

Because fish can freely move back and forth between each canal and the river at the mainstem diversion points, fish entrance into the canal is more likely the result of voluntary behavioral responses (e.g., density dependence) at the points of entry into the canals. However, the one-way passages through the canal features or powerhouses constitutes entrainment in the strict sense, because fish are subject to intake currents and potential mortality by turbines. Passage into DeSabla Forebay also represents entrainment due to the drop structure at the terminus of the canal, even though initial fish movement downstream may be a behavioral response. Fish passage through the tributary diversions is also considered entrainment because fish cannot return to the tributary streams due to the configuration of the diversion. Hence, fish movement into the canals likely represents a composite entrainment scenario where movement into the canals is behavioral, while passage into the powerhouses or the DeSabla Forebay is entrainment.

Continued Project operations will result in continued fish movement into Project diversions and entrainment into DeSabla Forebay, through powerhouses, and from feeder tributaries. PG&E considers this to be a less than significant continuing impact as the data suggests that fish populations are not greatly affected by mortality from entrainment. Furthermore, data from studies indicate that recruitment is occurring within reaches above and below Project diversions because substantial numbers of YOY trout were collected in each reach in all years of sampling, and annual fish rescues associated with canal maintenance outages also minimize entrainment losses by returning rescued fish to their natal stream.

7.3.7 No Changes to this section

7.3.8 No Changes to this section

7.3.9 No Changes to this section

7.3.10 No Changes to this section

7.3.11 No Changes to this section