4.4 Water Quality

Affected Environment

Battle Creek, a perennial spring-fed, cold-water stream, drains the western flank of Mount Lassen and enters the Sacramento River from the east approximately 5 miles east of the town of Cottonwood, California. Battle Creek is composed of two main branches, North Fork Battle Creek (approximately 29.5 miles in length from its headwaters to confluence) and South Fork Battle Creek (approximately 28 miles in length from its headwaters to confluence). The two forks join approximately 17 miles east of Battle Creek's confluence with the Sacramento River.

Cold Bluff Springs Enters South Fork Battle Creek and Improves Water Temperatures

Battle Creek is the largest spring-fed tributary to the Sacramento River between Keswick Dam and the Feather River, with a median September flow of 250 cfs. The average flow is 500 cfs. Flows typically remain higher throughout the winter and spring and decrease to about one-half that amount in the summer and fall. Battle Creek flows through remote, deep, shaded canyons and riparian corridors with little development near its banks. Numerous spring flows enter Battle Creek (primarily, North Fork Battle Creek) from the canyon walls along the watercourse, adding significant inflow at a fairly constant rate with a relatively cool temperature. Thick vegetation, rough terrain, and private ownership limit human access. Native vegetation and the land's limited suitability for agriculture, timber harvesting, and urban development protect Battle Creek's watershed from erosion. The watershed is comparatively undisturbed.

Water temperature and turbidity are two water quality factors that are important to chinook salmon and steelhead and that could potentially be affected by Hydroelectric Project operations.

Temperature

Elevated water temperature is often considered the most important water quality factor limiting habitat productivity for fish. The sensitivity and specific effects of elevated water temperatures vary with the life stage of chinook salmon and steelhead (Appendix D).

Several factors influence water temperature in Battle Creek, including air temperature, streamflow, and riparian vegetation. The upstream reaches are naturally cooler because of the lower ambient air temperature. North Fork Battle Creek flows through a steep canyon, which helps shade the water. Numerous springs continually feed cold water into Battle Creek. South Fork Battle Creek is fed by fewer springs and is exposed to more direct sunshine as it flows through a less confined (i.e., less shaded) valley. Therefore, the reaches of South Fork Battle Creek are generally warmer than the North Fork Battle Creek reaches.

The operations of Hydroelectric Project facilities also influence water temperature in Battle Creek. Diversions to these facilities reduce the streamflow, causing the water remaining in the creek to warm more rapidly as it moves downstream. Discharges from South Powerhouse and Inskip Powerhouse cool South Fork Battle Creek water substantially, producing two cool zones in South Fork Battle Creek located below Inskip Diversion Dam and below Coleman Diversion Dam.

A temperature model was developed and verified for the Battle Creek system (PG&E 2001). For calibration, the USFWS stream network temperature model (SNTEMP) was run with daily meteorology and flow data for the summer period of 1999 for each of the seven reaches simulated. Along North Fork Battle Creek these reaches included below North Battle Creek Feeder Diversion Dam, below Eagle Canyon Diversion Dam, and below Wildcat Diversion Dam. Along South Fork Battle Creek these reaches included below South Diversion Dam, below Inskip Diversion Dam, and below Coleman Diversion Dam. The seventh reach was along the mainstem between the confluence of North Fork and South Fork Battle Creek and Coleman Powerhouse. The model simulated average monthly temperature profiles in each reach for baseline conditions, No Action Alternative, and each of the Action Alternatives (Five Dam Removal, No Dam Removal, Six Dam Removal, and Three Dam Removal). However, since the SNTEMP model requires many data files and operates as a separate modeling system, a simplified, yet accurate, temperature prediction method was developed for the monthly fish production model (Appendix M).

Sediment

Excessive sediment can increase turbidity and reduce light penetration, resulting in the reduction in prey capture for sight-feeding predators, reduction in light available for photosynthesis, clogging of gills and filter mechanisms of fish and aquatic invertebrates, reduction in spawning and juvenile fish survival, smothering of bottom-dwelling organisms, changes in substrate composition, and reduction in aesthetic values. Concentrations of nutrients and other pollutants (such as metals and certain pesticides) associated with sediment particles could also increase. Although these effects are usually short-term and greatly diminish after revegetation, sediment and sediment-borne pollutants may be remobilized under suitable hydrologic and hydraulic conditions.

Historical Water Quality Data

Historical water quality (minerals and nutrients) data were obtained for the following Battle Creek locations:

- Below the Coleman National Fish Hatchery from the U.S. Geological Survey (USGS) (1961–1970), EPA (1971–1972), and DWR (1988–1989) (Tables N-1 through N-3 in Appendix N, respectively).
- Below Coleman Powerhouse from the EPA (1971–1972) and the SWRCB (1955–1989) (Tables N-4 and N-5 in Appendix N, respectively).
- Near Coleman Powerhouse from the EPA (1971–1972) (Table N-6 in Appendix N).
- South Fork Battle Creek below the diversion to Coleman Canal from the SWRCB (1960–1982) (Table N-7 in Appendix N).
- North Fork Battle Creek below Volta 2 Powerhouse from the SWRCB (1977–1982) (Table N-8 in Appendix N).
- Battle Creek approximately 300 ft downstream from Jelly’s Ferry Road Bridge from DWR (1996–1998).
- North Fork Battle Creek at Wildcat Road from Larry Walker Associates (2001–2002).
- South Fork Battle Creek at Manton Road from Larry Walker Associates (2001–2002).
- Battle Creek below Coleman National Fish Hatchery from Larry Walker Associates (2001–2002).

These data sources represent all available data. The data were collected intermittently and only represent a snapshot of what was actually occurring. Table 4.4-1 presents a summary of the information found in Appendix N, Tables N-1 through N-8. The data for 1955–1989 indicate that the existing surface water quality is excellent. All concentrations of nonmetals and metals were within the limits recommended for aquatic life by the EPA’s aquatic life criteria (EPA 1999). Water quality in Battle Creek is influenced by seasonal changes in flow (i.e., runoff vs. baseflow), precipitation inputs, and biological activity. Flow variation has especially strong effects on metal and nonmetal ion concentrations. On October 6, 1999, Reclamation personnel sampled the water quality and sediment in the Battle Creek watershed one time while Battle Creek was at low flow (Table 4.4-2).

Unfiltered water samples were collected at eight sites in the Battle Creek watershed and assayed for metals, TSS, and oil and grease. The assay results were compared to the EPA's aquatic life criteria (EPA 1999). At each site, pH, specific conductance, turbidity, temperature, and dissolved oxygen were measured. All of the constituents were within the recommended limits for aquatic life. The TSS concentration was also within the recommended limits for aquatic life. The oil and grease concentration was less than 5 milligrams per liter at each site. The concentrations of nonmetals are presented in Table 4.4-2. The surface waters in the Battle Creek watershed have low hardness and alkalinity, which are important for determining the toxicity of several heavy metals (cadmium, chromium, copper, lead, nickel, silver, and zinc). The concentrations of these metals were all below the toxicity limits for aquatic life.

Sediment Data

Reclamation also collected composite sediment samples at Wildcat, South, Coleman, Soap Creek Feeder, and Lower Ripley Creek Feeder diversion dams on October 6, 1999. Little organic material or fine sediment was found at the dams or in their catch basins, except at Lower Ripley Creek Feeder. It is believed that most of the fine sediment that is washed into the creek annually is carried through the watershed and past the dams by high seasonal runoff. Debris in the creek consisted of dead trees, boulders, and sand. The sediments were visually characterized as small rocks, sand, and some silt; organic material was less commonly found. The concentrations of metals in the sediment are presented in Table 4.4-3. Total threshold limit concentration criteria[1] based on wet weight are listed in Table 4.4-3. The metal values for each of the five sediment samples are less than 1% of the criteria. None of the sediments sampled behind the five dams on October 6, 1999, were found to be toxic for aquatic life. The sediment samples were also assayed for polychlorinated biphenyls. None of the aroclors were detected at the reporting limit of 0.033 milligrams per kilogram in any of the sediment samples.

[1] The total threshold limit concentration criteria are described in Title 22, Part 66261.24 of the California Code of Regulations and specify element concentrations in sediment that are classified as potentially toxic.

Table 4.4-2. Water Quality Data for Battle Creek on October 6, 1999

Constituent	Upstream of North Battle Creek Feeder Dam	Confluence of North Fork and South Fork Battle Creek	Coleman Diversion Dam	South Diver-sion Dam	Soap Creek	Inskip Diver-sion Dam	Eagle Canyon	Soap Creek Diver-sion Dam
Temperature, °F	52.0	56.6	54.8	51.3	49.5	53.8	53.4	50.2
Turbidity, NTU	4	3	4	2	29	18	3	7
Electrical conductivity, : mho/cm	137	128	125	108	58	121	137	74
Total suspended solids, mg/L	<3	<3	10	<3	<3	<3	<3	
Dissolved oxygen	10.4	10.2	10.0	10.3	10.4	10.8	11.0	10.3
pH	6.94	7.73	8.07	7.97	8.14	7 .71	7.99	8.14
Total alkalinity, mg/L					30			
Carbonate, mg/L					<10			
Hydroxide, mg/L					<10			
Bicarbonate, mg/L					30			
Calcium, mg/L	11.3	9.5	9.7	9.8	2.7	9.3	10.4	
Magnesium, mg/L	7.0	6.1	5.9	4.3	1.5	5.6	7.5	
Sodium, mg/L	6.4	6.6	6.5	4.2	4.3	6.3	7.1	
Potassium, mg/L	2.5	2.4	2.5	1.8	3.5	2.3	2.5	
Chloride, mg/L					<1			
Sulfate, mg/L					<0.5			
Phosphorus, mg/L	0.044*	0.037*	0.054*	<0.050	0.035*	0.041*	0.046*	
Oil & grease, mg/L	<5	<5	<5	<5	<5	<5	<5	
Aluminum, : g/L	50	68	400	<50	690	83	64	
Antimony, : g/L	<2	<2	<2	<2	<2	<2	<2	
Arsenic, : g/L	<2	<2	<2	<2	<2	<2	<2	
Barium, : g/L	9.5	12.0	16.0	8.3	70.0	12.0	10.0	
Beryllium, : g/L	<1	<1	<1	<1	<1	<1	<1	
Boron, : g/L	24*	37*	38*	<50	11*	43*	33*	
Cadmium, : g/L	<1	<1	<1	<1	<1	<1	<1	
Chromium, : g/L	2.80	1.60*	2.30	1.30*	0.74*	2.00	1.50*	

Constituent	Upstream of North Battle Creek Feeder Dam	Confluence of North Fork and South Fork Battle Creek	Coleman Diversion Dam	South Diver-sion Dam	Soap Creek	Inskip Diver-sion Dam	Eagle Canyon	Soap Creek Diver-sion Dam
Cobalt, : g/L	<1	<1	<1	<1	<1	<1	<1	
Copper, : g/L	0.74*	1.4*	1.5*	1.2*	1.6*	0.63*	0.62*	
Iron, : g/L	42*	65*	420**	<50	120	83	38	
Lithium, : g/L	3.4*	3.9*	3.7*	1.1*	5.0	4.5*	4.2*	
Lead, : g/L	<1	<1	0.20	<1	0.37*	<1	<1	
Manganese, : g/L	5.4	6.5	21.0	1.0	1.1	5.3	3.2	
Mercury, : g/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	
Molybdenum, : g/L	<1	<1	<1	<1	<1	0.43*	0.59*	
Nickel, : g/L	0.86*	<2.00	0.46*	<2.00	<2.00	<2.00	<2.00	
Selenium, : g/L	<2	<2	<2	<2	<2	<2	<2	
Strontium : g/L	89	66	69	77	25	66	73	
Silver, : g/L	<1	<1	<1	<1	<1	<1	<1	
Titanium, : g/L	3.3	4.4	22.0**	1.6*	16.0	5.4	3.9	
Tin, : g/L	<10	<10	<10	<10	<10	<10	<10	
Thallium, : g/L	<1	<1	<1	<1	<1	<1	<1	
Vanadium, : g/L	5.9*	5.3*	7.3*	3.4*	<10	5.6*	6.3*	
Uranium, : g/L	<5	<5	<5	<5	<5	<5	<5	
Zinc, : g/L	17.0	8.4	16.0	5.2	6.1	34.0	14.0	

Source: Bureau of Reclamation 1999, unpublished data

°F = degrees Fahrenheit; NTU = nephelometric turbidity units; : mhos/cm = micromhos per centimeter; mg/L = milligrams per liter; : g/L = micrograms per liter.

* Estimated result. Result is less than reporting limit.

** Preliminary results pending.

Table 4.4-3. Sediment (Total Digestion) Data for Restoration Project on October 6, 1999 (wet weight, milligram per kilogram)

Constituent	Wildcat Diversion Dam	Coleman Diversion Dam	South Diversion Dam	Soap Creek Diversion Dam	Ripley Diversion Dam	Earth's Crust	Total Threshold Limit Concentration
Calcium	1,250	2,420	2,080	418	1,480	41,500	*
Magnesium	2,870	3,130	3,480	488	1,080	23,300	*
Sodium	236	522	456	99	109	23,600	*
Potassium	208	2254	180	164	214	20,900	*
Phosphorus	128	175	210	45	127	1,050	*
Aluminum	9,190	11,500	8,420	3,760	10,200	83,200	*
Antimony	<0.20	<0.20	<0.20	<0.20	<0.20	0.2	500
Arsenic	1.0	1.1	0.38	0.70	0.54	1.80	500
Barium	43.2	36.3	26.9	24.6	48.4	4,250	10,000
Beryllium	0.22	0.18	0.12	0.16	0.22	2.8	75
Boron	<5.0	<5.0	<5.0	<5.0	<5.0	10	*
Cadmium	<0.10	<0.10	<0.10	<0.10	<0.10	<2	100
Chromium	11.5	13.9	4.7	1.2	21.9	100	2,500
Cobalt	5.0	5.3	3.8	1.0	7.3	25	8,000
Copper	7.4	10.6	8.0	2.3	8.0	55	2,500
Iron	9,150	15,500	7,140	2,490	8,070	56,300	*
Lithium	6.9	5.5	3.5	2.8	5.7	20	*
Lead	2.2	1.7	1.3	1.9	3.1	12.5	1,000
Manganese	147.0	82.6	108.0	46.4	294.0	9,500	3,500
Mercury	<0.04	<0.04	<0.04	<0.04	<0.04	0.08	2,000
Molybdenum	0.13	0.14	0.15	0.18	<0.1	1.5	20
Nickel	17.7	16.6	14.9	1.8	14.2	75	100
Selenium	<0.20	<0.20	<0.20	<0.20	0.071	0.05	*
Strontium	13.1	24.1	22.0	3.3	18.5	375	500
Silver	<0.10	<0.10	<0.10	<0.10	<0.10	0.07	*
Titanium	413	487	380	115	455	5,700	*
Tin	<1.0	<1.0	<1.0	<1.0	<1.0	2	*
Thallium	<0.10	<0.10	<0.10	<0.10	<0.10	0.45	700
Vanadium	33.2	51.1	30.4	7.9	30.4	135	2,400
Uranium	<0.5	<0.5	<0.5	<0.5	<0.5	2.7	*

Zinc	15.2	15.8	11.9	5.6	14.8	70	5,000
% Moisture	38.9	25.2	22.0	25.6	72.6	*	*
Wet Total	23,748.75	34,252.92	22,582.05	7,678.54	22,089.13	*	*
Dry Total	38,869	41,793	28,957	10,665	80,616	270,189	*
Aroclor 1016	<0.033	<0.033	<0.033	<0.033	<0.033	<0.033	**
Aroclor 1221	<0.033	<0.033	<0.033	<0.033	<0.033	<0.033	**
Aroclor 1232	<0.033	<0.033	<0.033	<0.033	<0.033	<0.033	**
Aroclor 1242	<0.033	<0.033	<0.033	<0.033	<0.033	<0.033	**
Aroclor 1248	<0.033	<0.033	<0.033	<0.033	<0.033	<0.033	**
Aroclor 1254	<0.033	<0.033	<0.033	<0.033	<0.033	<0.033	**
Aroclor 1260	<0.033	<0.033	<0.033	<0.033	<0.033	<0.033	**

Source: Bureau of Reclamation 1999, unpublished data
* No value.
** Total polychlorinated biphenyl value is 50 milligrams per kilogram.

Regulatory Setting

The following laws, regulations, or policies are related to water quality management in the stream reaches influenced by the operation of the Hydroelectric Project diversions and canals. Additional descriptions of these are found in Chapter 5, "Consultation and Coordination."

- Federal Clean Water Act (33 USC 1251-1376) as administered by the SWRCB and the CVRWQCB. The SWRCB will issue a Clean Water Act Section 401 permit (with technical conditions) for wetland and instream activities. The CVRWQCB will monitor compliance with the NPDES General Permit for Storm Water Discharges Associated with Construction Activities (General Permit). Reclamation and/or the construction contractor will develop and implement SWPPPs as a condition of the General Permit. The CVRWQCB will also require compliance under the General Order for Dewatering and other Low Threat Discharges to Surface Waters.
- Porter-Cologne Water Quality Control Act (California Water Code §13000 *et seq.*), as it governs the Water Quality Control Plan (Basin Plan) for the California Regional Water Quality Control Board, Central Valley Region (Basin Plan) CVRWQCB 1998).

Environmental Consequences

Summary

Water quality in the area surrounding and including the Restoration Project is generally managed in accordance with the Basin Plan (CVRWQCB 1998). The Basin Plan designates beneficial uses for the Sacramento River basin, which includes Battle Creek. Those designated uses potentially impacted by the Restoration Project include municipal, agricultural, hydroelectric, and cold-water habitat. Certain water quality conditions are needed to support these beneficial uses. Because the water quality objectives are most stringent for cold-water habitat uses for spawning and production of fish, implementation of the Restoration Project in a manner that protects this use should protect all other uses. Temperature effects are the most likely water quality changes that may impact cold-water habitat. However, no direct assessment of impacts from temperature changes was performed, because these impacts on cold-water habitat and fish production were addressed under the fish impact analysis. Specific ways in which water quality changes may impact the spawning and rearing of cold-water fish are discussed in Section 4.1, "Fish."

The discharge of coarse sediment from behind the dams during their removal, as proposed under the Five Dam, Six Dam, and Three Dam Removal Alternatives, may result in less-than-significant impacts to water quality. The bulk of the alluvial material behind the dams would be discharged during high flow events, such as major winter storms. These storms provide sufficient energy to transport sediment over spawning areas rather than allow the sediment to form harmful deposits on top of the stream bottom. Synchronizing downstream transport of the alluvial materials with major storm events would be accomplished by excavating a low-flow or pilot channel.

Construction activities associated with the Action Alternatives could have a limited impact on the beneficial uses of Battle Creek's water. Project construction of the Action Alternatives could result in inadvertent spills of hazardous materials used in standard construction practices. Reclamation will implement mitigation measures to reduce potential impacts to a less-than-significant level. Removal of the Coleman Diversion Dam could cause less-than-significant impacts associated with short-term increased turbidity and settleable material load on the Coleman National Fish Hatchery water treatment plant.

Operation-related impacts would produce significant improvements to the water temperature regime for spawning and production of cold-water fish. These improvements would be achieved by substantially increasing the amount of water released to Battle Creek from all dams and major cold-water springs. The proposed modifications in the powerhouse water conveyance system on South Fork Battle Creek would increase water temperatures by isolating the cool powerhouse discharge from South Fork Battle Creek.

Impact Significance Criteria

Water quality constituents that could be impacted by the Restoration Project were selected for analysis. The water quality objectives for each constituent as described in the Basin Plan (CVRWQCB 1998) and the way they have been implemented on similar projects (e.g., Saeltzer Dam Fish Passage and Flow Protection Project) were used to determine if an impact was significant. For this analysis, impacts were considered significant if implementation of the Restoration Project would result in any of the following:

- Turbidity increase in Battle Creek over background levels as measured in nephelometric turbidity units (NTUs) by more than the numerical objectives contained in the Basin Plan:

  According to the Basin Plan (CVRWQCB 1998), an appropriate averaging period may be applied, provided that beneficial uses will be fully protected. Similar projects in the upper Sacramento River basin have had a monitoring requirement that, during in-water working periods, a turbidity increase of 15 NTUs over background turbidity is allowed up to 500 feet downstream of the work site, using a 12-hour averaging interval to determine compliance.

- Increased suspended material concentrations in Battle Creek that may leave deposits on the stream bottom that cause nuisance or adversely affect beneficial uses.

- Cause an increase of more than 5ºF above the natural receiving water temperature.
- A release of toxic substances in concentrations that produce detrimental physiological responses in human, plant, animal, and aquatic life.

For this analysis, the impacts resulting from Restoration Project activities were considered beneficial if they would improve water quality management in Battle Creek to better attain Basin Plan objectives, specifically cold-water habitat for spawning and rearing of fish.

Impact Assessment

As applicable, the General Environmental Protection Measures listed in the introduction to this chapter shall be utilized for this resource. In addition, specific mitigation measures for this resource are identified below.

No Action Alternative

The No Action Alternative would not affect water quality. Under the No Action Alternative, the Hydroelectric Project would continue to operate consistent with the current FERC license. The instream flow releases would be the license-required minimum flows below dams (i.e., 3 cfs in North Fork Battle Creek and 5 cfs in South Fork Battle Creek). The Hydroelectric Project canal system would continue to convey and discharge to the lower elevation reaches of South Fork Battle Creek substantial amounts of cooler waters from North Fork Battle Creek and major springs in the watershed. The temperature regime of Battle Creek under the No Action Alternative would likely not support anything more than remnant populations of coldwater habitat users described in the purpose and need, except for fall-run chinook salmon. No impact would occur on water quality under this alternative.

Five Dam Removal Alternative (Proposed Action)

Impact 4.4-1 Significant—Increased erosion and subsequent discharge of settleable material into Battle Creek as a result of removing diversion dams and constructing fish screens and fish ladders.

Construction of access roads, staging areas, stream crossings, and cofferdams associated with the removal of Wildcat, South, Soap Creek Feeder, Lower Ripley Creek Feeder, and Coleman diversion dams and construction of fish screens and fish ladders at North Battle Creek Feeder, Eagle Canyon, and Inskip Diversion Dams could potentially cause water turbidity and suspended material concentrations to exceed water quality limits for short-term periods. Increases in turbidity and suspended materials would likely occur during work in Battle Creek's channel. The newly disturbed soils upslope from Battle Creek also have the potential to erode and increase water turbidity and settleable material concentrations, if this material enters Battle Creek. Implementing the following mitigation measure would reduce this impact to a less-than-significant level.

Mitigation Measures for Impact 4.4-1. To avoid or minimize potential impacts related to erosion and subsequent discharge of settleable material and runoff, Reclamation will develop an erosion control plan in coordination with the CVRWQCB through the Section 401, Clean Water Act permitting process in obtaining the storm water management approval for the Restoration Project. The CVRWQCB will use this plan in developing the SWPPP approval for the Restoration Project. The plan would contain the following BMPs for all areas disturbed by the Restoration Project:

- Monitoring of water turbidity would be conducted immediately above and 500 feet downstream of the construction site a minimum of two times each workday. If downstream turbidity levels are found to exceed a turbidity increase of 15 NTUs over background turbidity, construction activities will cease until turbidity decreases to acceptable levels.
- During work in a flowing stream, the entire streamflow will be diverted around or under the work area by a barrier, culvert, channel, or berm constructed of clean gravel 1 to 6 inches in diameter (clean is defined as meeting the California Department of Transportation's cleanliness specification 85). The barrier and/or new channel will be constructed in a manner that will minimize sediment discharges and facilitate any necessary fish rescue operations and fish escape from the work area.
- Small sediment catchment basins or traps will be installed to prevent sediment from being transported away from development sites. These basins will be sized and sited to minimize any impacts on riparian areas and wet areas. Types of sediment traps to be considered will include filter berms, straw bales, filter inlets, vegetative filter strips, and culver risers.
- Disturbed soils will be revegetated and stabilized. Reseeding and mulching work will be completed by October 1 of the year following the completion of activities at each dam site. If erosion control practices are not installed by that date, exposed soils could require additional treatment following seasonal rains and subsequent erosion.
- Disturbed areas will be seeded with native plant species approved by a revegetation specialist or erosion control specialist. Special emphasis will be given to native plant assemblages that were characteristic of the site prior to construction.
- Temporary sediment control measures (i.e. Straw bale dikes or filter fabric barriers) will be located downslope of disturbed areas to act as sediment traps. These measures will detain sediment-laden runoff until disturbed areas are stabilized.

These erosion control measures will be completed in coordination with the revegetation activities needed to mitigate impacts to native vegetation, as discussed in Section 4.2, "Botanical, Wetland, and Wildlife Resources."

Implementation of the erosion control plan measures would reduce impacts to less-than-significant levels.

Impact 4.4-2 Significant—Potential spills of hazardous materials could occur.

Project construction could result in inadvertent spills of hazardous materials used in standard construction practices. Construction would require the transport and use of potentially hazardous materials, such as gasoline, diesel, concrete, cement, industrial chemicals, and other hazardous chemicals. Implementing the following mitigation measure would reduce this impact to a less-than-significant level.

Mitigation Measure for Impact 4.4-2. To avoid or minimize potential impacts related to potentially hazardous spills, Reclamation will implement the following measures.

- Reclamation will develop a spill prevention control and countermeasures plan in coordination with the CVRWQCB through the Section 401, Clean Water Act permitting process in obtaining approval for the Restoration Project.
- Soils contaminated with fuels or chemicals will be disposed of in a suitable location to prevent discharge to surface waters.
- Temporary cofferdams will be used to separate construction areas from flowing waters.
- On-site fuels and toxic materials will be placed or contained in an area protected from direct runoff.
- If hazardous materials were released, the Coleman National Fish Hatchery will be immediately notified.
- Cement and concrete delivery and transfer equipment will be washed in contained areas protected from direct runoff until the material sets.

Implementation of the spill prevention control and countermeasures plan would reduce impacts resulting from potential spills of hazardous materials to a less-than-significant level.

Impact 4.3-3 Less than Significant—Removal of South and Coleman Diversion Dams could cause erosion of minor amounts of sediment from behind the dam.

The amount of sediment that would be eroded from behind South and Coleman Diversion Dams after their removal was calculated based on the simulated changes in cross-sectional geometry for each year (Reclamation 2001b). Most of the sediment would be moved and redistributed within the first year of normal winter flows. The amount of additional sediment moved downstream would not substantially increase the sediment movement that occurs over the South and Coleman Diversion Dams. The sediment deposits behind Eagle Canyon, Wildcat, Lower Ripley Creek Feeder, and Soap Creek Feeder Diversion Dams are not considered large enough to be an impact.

Modeling conducted by Reclamation (2001b) predicts that, after dam removal, the bed elevation immediately below South and Coleman Diversion Dams would increase and the stream gradient would stabilize within a few years. Previous field studies of sediment release in similar streams indicate that the fine sediment would be deposited in the upstream pools first and then gradually transported downstream. Each large flow event, expected under normal winter and spring flow conditions, would likely scour the fine sediment from the pool and deposit it in downstream reaches. At each successive pool downstream, the maximum amount of deposition would become less (Wohl and Cenderelli 2000). Eventually, the stream would return to normal sediment equilibrium conditions.

As part of the Five Dam Removal Alternative, Reclamation would construct a pilot channel through the sediments behind Coleman and South Diversion Dams. The pilot channel would facilitate the distribution of sediments by natural high-flow events and ensure that the mass of sediment would not impede fish passage, should low flows predominate after dam removal. Under low-flow conditions, the pilot channel geometry would provide a sufficient depth of water and keep flow velocities low enough to support fish passage. Under typical winter flow conditions, sediments would quickly begin to move and redistribute downstream.

To confirm that sediment is distributed downstream of South and Coleman Diversion Dams following the removal of these dams, Reclamation would implement a sediment monitoring plan, as described in the General Environmental Protection Measures listed in the introduction to this chapter. In the dry season before South and Coleman Diversion Dams are to be removed, Reclamation would initiate the sediment monitoring plan, which would include the following items. Monitoring would continue after dam removal, as discussed below.

- **Perform surveys during the dry season preceding the dam removal to provide a baseline for changes induced by the dam removal.** Cross-sections would be surveyed every 100 feet for 0.5 mile downstream of South and Coleman Diversion Dams. The surface layer of bed material would be sampled either by the pebble-count procedure or grab samples. Cross-sectional information would also be collected near structures that would potentially be affected.
- **For the first wet season, collect a sequence of photographs in the reservoir region to provide important insights into the behavior of the sediment previously trapped behind the dam.** A still camera installed at each dam site would be set to take pictures once a day immediately following dam removal. Once the reservoir region sediments change more slowly, the interval for pictures can be reduced to once a week.
- **Continue monitoring turbidity and TSS downstream of Coleman Diversion Dam at the County Road Bridge and upstream of the intakes to the Coleman National Fish Hatchery.** Samples would be collected as close as possible to the peak flow of each high-flow period. At a minimum, sampling should be performed monthly.

Impact 4.4-4 Less than Significant—Minor amounts of sediment released by the removal of Coleman Diversion Dam would be deposited at the County Road Bridge.

Sediment released from behind Coleman Diversion Dam may be deposited at the County Road Bridge, which is located approximately 0.8 mile downstream of the dam. Because the creek bed is mobile, it is scoured during each large flow event, and the subsequent low-flow periods refill the scoured regions. Therefore, the creek bed exhibits natural variations. Simulations conducted by Reclamation (2001a) showed a slight alteration in streambed elevation (less than 1 foot over 6 years) near the bridge during the years following dam removal. A change of 1 foot over 6 years is considered less than significant, and the bed is considered stable in the reach near the bridge.

No significant impact to the hydraulics near the County Road Bridge would occur because the minor amounts of sediment released and the minor change in bed stability would not substantially alter the course of Battle Creek and the minor amounts of sediment released would not expose people to an increased risk of bridge failure.

Other simulations under varying types of water years gave similar results (Reclamation 2001b). In particular, for both the normal and dry water year simulations, the magnitude of bed elevation change was less near the bridge. This impact is considered less than significant.

Impact 4.4-5 Less than Significant—Short-term increased turbidity and settleable material load on the Coleman National Fish Hatchery water treatment plant as a result of removing Coleman Diversion Dam.

The amount of fine sediment behind Coleman Diversion Dam likely would not increase turbidity at the Coleman National Fish Hatchery water intakes because less sediment is trapped behind the dam (Table 4.3-1). The Coleman National Fish Hatchery water supply is taken from Battle Creek and Coleman Canal at three locations that are 10 stream miles downstream of Coleman Diversion Dam. The water supply intakes are taken from Coleman Canal via the Coleman Powerhouse tailrace connector and from two locations directly on Battle Creek.

Because it has the best water quality, the Coleman Powerhouse tailrace is the Coleman National Fish Hatchery's primary water supply (Intake 1) (USFWS 1999). The Coleman National Fish Hatchery water demands are the lowest during the summer, and the Coleman Powerhouse tailrace becomes the sole water supply for the Coleman National Fish Hatchery, except during emergencies when the powerhouse is shut down. The water quality of the Coleman Powerhouse tailrace would not be impacted by any construction activity on either North Fork or South Fork Battle Creek because the Coleman Canal would be isolated from the creek by the tailrace connector between the Inskip Powerhouse and the Coleman Canal. The tailrace connector would be constructed before dam removal and screen and ladder construction.

The two additional intakes that supply water to Coleman National Fish Hatchery directly from Battle Creek would be subject to increased turbidity during emergencies that shut off the primary intake at the Coleman Powerhouse tailrace. These intakes are located directly on Battle Creek approximately 10 miles downstream of Coleman Diversion Dam, where the maximum sediment concentrations are predicted to be approximately one-half of those at the confluence of North Fork and South Fork Battle Creek. Prior to its use, water diverted to the Coleman National Fish Hatchery is filtered to remove settleable material and turbidity. The water treatment system includes a settling pond and an oversized sand filter to process sediment-laden and turbid water produced by extreme winter storms. The capacity of the sand filter is 20% greater than the capacity of the ozone plant used to sterilize the water (USFWS 1997a).

The increased turbidity and sediment load resulting from the Five Dam Removal Alternative could affect the Coleman National Fish Hatchery water treatment plant. Hatchery personnel would be notified of substantial erosion events during screen and ladder construction, dam removal, and observations of significant fluvial erosion of alluvial deposits during winter storms. Construction activity would cease if flow to the Coleman National Fish Hatchery were interrupted. This notification would allow the Coleman National Fish Hatchery personnel to prepare and properly maintain the water treatment plant. This impact is considered less than significant because increased turbidity would be minor and temporary, and hatchery personnel would be notified if substantial erosion at the Coleman Diversion Dam occurs during construction.

No Dam Removal Alternative

Impacts to water quality resulting from the construction of fish screens and ladders would be similar to those described for the Five Dam Removal Alternative.

Impact 4.4-6 Significant—Increased erosion and subsequent discharge of settleable material and runoff into Battle Creek as a result of constructing fish screens and fish ladders.

This impact is similar to Impact 4.4-1 described above for the Five Dam Removal Alternative. Construction of access roads, staging areas, stream crossings, and cofferdams associated with construction of fish screens and fish ladders at North Battle Creek Feeder, Eagle Canyon, Wildcat, South, Inskip, and Coleman diversion dams could potentially cause water turbidity and suspended material concentrations to exceed water quality limits for short-term periods. Implementing the mitigation measure for Impact 4.4-1 would reduce this significant impact to a less-than-significant level.

Impact 4.4-7 Significant—Potential spills of hazardous materials could occur.

This impact is similar to Impact 4.4-2 described above for the Five Dam Removal Alternative. As described under Impact 4.4-2, project construction could result in inadvertent spills of hazardous materials used in standard construction practices. Construction would require the transport and use of potentially hazardous materials, such as gasoline, diesel, concrete, cement, industrial chemicals, and other hazardous chemicals. Implementing the mitigation measure for Impact 4.4-2 would reduce this significant impact to a less-than-significant level.

Six Dam Removal Alternative

Impacts to water quality resulting from the construction of fish screens and ladders and the six dam removals would be similar to those described for the Five Dam Removal Alternative.

Impact 4.4-8 Significant—Increased erosion and subsequent discharge of settleable material and runoff into Battle Creek as a result of removing of diversion dams and constructing fish screens and fish ladders.
This impact is similar to Impact 4.4-1 described above for the Five Dam Removal Alternative. Construction of access roads, staging areas, stream crossings, and cofferdams associated with the removal of Eagle Canyon, Wildcat, South, Soap Creek Feeder, Lower Ripley Creek Feeder, and Coleman diversion dams and construction of fish screens and fish ladders at North Battle Creek Feeder and Inskip diversion dams could potentially cause water turbidity and suspended material concentrations to exceed water quality limits for short-term periods. Implementing the mitigation measure for Impact 4.4-1 would reduce this significant impact to a less-than-significant level.

Impact 4.4-9 Significant—Potential spills of hazardous materials could occur.
This impact is similar to Impact 4.4-2 described above for the Five Dam Removal Alternative. As described under Impact 4.4-2, project construction could result in inadvertent spills of hazardous materials used in standard construction practices. Construction would require the transport and use of potentially hazardous materials, such as gasoline, diesel, concrete, cement, industrial chemicals, and other hazardous chemicals. Implementing the mitigation measure for Impact 4.4-2 would reduce this significant impact to a less-than-significant level.

Impact 4.4-10 Less than Significant—Removal of South and Coleman Diversion Dams could cause erosion of minor amounts of sediment from behind the dam.
This impact is similar to Impact 4.3-3 described above for the Five Dam Removal Alternative. The sediment deposits behind Eagle Canyon, Wildcat, Lower Ripley Creek Feeder, and Soap Creek Feeder Diversion Dams are not considered large enough to be an impact. This impact is considered less than significant.

Impact 4.4-11 Less than Significant—Minor amounts of sediment released by the removal of Coleman Diversion Dam would be deposited at the County Road Bridge.

This impact is the same as Impact 4.3-4 described above for the Five Dam Removal Alternative and is considered less than significant.

Impact 4.4-12 Less than Significant—Short-term increased turbidity and settleable material load on the Coleman National Fish Hatchery water treatment plant as a result of removing Coleman Diversion Dam.

This impact is similar to Impact 4.4-5 described above for the Five Dam Removal Alternative and is considered to be less than significant. No sediment modeling studies were performed to predict the amount of sediment released by the removal of Eagle Canyon Diversion Dam, which is located upstream from Wildcat Diversion Dam on North Fork Battle Creek. It is assumed that the impacts resulting from the removal of this dam would be less than those associated with the removal of Coleman Diversion Dam; that is, only a minor amount of fine material would be discharged, provided similar mitigation measures are employed.

Three Dam Removal Alternative

Impacts to water quality resulting from the construction of fish screens and ladders and the three dam removals would be the same as those described for the Five Dam Removal Alternative.

Impact 4.4-13 Significant—Increased erosion and subsequent discharge of settleable material and runoff into Battle Creek as a result of removing diversion dams and constructing fish screens and fish ladders.

This impact is similar to Impact 4.4-1 described above for the Five Dam Removal Alternative. Construction of access roads, staging areas, stream crossings, and cofferdams associated with the removal of Eagle Canyon, Wildcat, and Coleman diversion dams and construction of fish screens and fish ladders at North Battle Creek Feeder, South, and Inskip diversion dams could potentially cause water turbidity and suspended material concentrations to exceed water quality limits for short-term periods. Implementing the mitigation measure for Impact 4.4-1 would reduce this significant impact to a less-than-significant level.

Impact 4.4-14 Significant—Potential spills of hazardous materials could occur.

This impact is similar to Impact 4.4-2 described above for the Five Dam Removal Alternative. As described under Impact 4.4-2, project construction could result in inadvertent spills of hazardous materials used in standard construction practices. Construction would require the transport and use of potentially hazardous materials, such as gasoline, diesel, concrete, cement, industrial chemicals, and other hazardous chemicals. Implementing the mitigation measure for Impact 4.4-2 would reduce this significant impact to a less-than-significant level.

Impact 4.4-15 Less than Significant—Removal of Coleman Diversion Dam could cause erosion of minor amounts of sediment from behind the dam.

This impact is the same as Impact 4.3-3 described above for the Five Dam Removal Alternative, except that South Diversion Dam would not be removed under this alternative. The sediment deposits behind Eagle Canyon and Wildcat Diversion Dams are not considered large enough to be an impact (Table 4.3-1). This impact is considered less than significant.

Impact 4.4-16 Less than Significant—Minor amounts of sediment released by the removal of Coleman Diversion Dam would be deposited at the County Road Bridge.

This impact is the same as Impact 4.3-4 described above for the Five Dam Removal Alternative and is considered less than significant.

Impact 4.4-17 Less than Significant—Short-term increased turbidity and settleable material load on the Coleman National Fish Hatchery water treatment plant as a result of removing Coleman Diversion Dam.

This impact is similar to Impact 4.4-5 described above for the Five Dam Removal Alternative and is considered to be less than significant. It is assumed that the impacts resulting from the removal of Eagle Canyon Diversion Dam would be similar to those associated with the removal of Wildcat Diversion Dam; that is, only a minor amount of fine material would be discharged, provided similar mitigation measures are employed.

Cumulative Impacts

Cumulative water quality impacts associated with the Proposed Action and past, present, or probable future projects would not occur in the Battle Creek watershed because no other projects (including related projects described in Chapter 6) would incrementally contribute to degradation of water quality conditions in Battle Creek. The Proposed Action would generally improve water quality conditions, and no other proposed projects could result in cumulative decline in Battle Creek water quality.

Table 4.4-1. Water Quality Data Summary for Various Locations on Battle Creek, 1955–1989

	Below Coleman National Fish Hatchery[1]			Below Coleman Powerhouse[2]			Near Coleman Powerhouse[3]			South Fork Battle Creek[4]			North Fork Battle Creek[5]		
Constituent	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean
Turbidity, NTU	5	1	1	125	0	6				35	1	6	25	0	3
Electrical conductivity, µmho/cm	258	30	129	276	56	127				159	59	108	200	82	130
Total dissolved solids, mg/L	125	86	110	133	63	97									
Total suspended solids, mg/L	722.0	1.0	39.0	16.0	2.0	7.4	2.0	0.2	1.1						
Total residue, mg/L	180	60	99	146	66	101	118	60	95						
Dissolved oxygen, mg/L	12.0	3.2	9.4	13.0	6.3	11.2				11.6	8.5	10.1	11.4	5.7	9.8
Biochemical oxygen demand, mg/L	2.8	1.0	2.1	4.0	1.2	2.6	3.3	0.8	1.6						
PH	8.6	7.1	7.9	8.6	7.2	7.9				8.6	7.1	7.6	8.3	7.2	7.6
Total hardness, mg/L	110	29	52	116	22	55	115	48	73	49	21	35	47	32	39
Alkalinity, mg/l	90	34	65	88	23	66	94	54	72	58	23	41	56	36	45
Calcium, mg/L	12.0	7.0	9.6	12.0	4.0	9.1				7.9	5.0	6.5	9.0	6.0	8.0
Magnesium, mg/L	8.0	3.6	6.5	11.0	3.0	6.5				3.5	2.0	2.8	6.0	4.0	5.0
Sodium, mg/L	9.6	3.9	7.8	30.0	2.7	8.0				7.7	3.0	5.2	6.0	4.0	4.9
Potassium, mg/L	3.1	1.5	2.0	3.5	1.1	2.0				1.7	1.3	1.5	1.9	1.5	1.7
Chloride, mg/L	22.0	0.1	2.1	30.0	0.0	10.1				1.3	1.0	1.1	1.0	0.7	0.9
Fluoride, mg/L	0.10	0.00	0.02	0.2	0.0	0.1									
Sulfate, mg/L	3.4	0.0	2.1	9.5	0.0	2.3				1.5	.15	1.5			
Ammonia + organic nitrogen, mg/L	0.5	0.2	0.4							1.3	0.3	0.7	00.40	0.12	0.27
Ammonia + ammonium, mg/L	0.30	0.03	0.16	0.35	0.01	0.19	0.32	0.02	0.15						

Table 4.4-1. Continued

Constituent	Below Coleman National Fish Hatchery[1]			Below Coleman Powerhouse[2]			Near Coleman Powerhouse[3]			South Fork Battle Creek[4]			North Fork Battle Creek[5]		
	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean
Nitrite + nitrate, mg/L	0.01	0.01	0.01							0.18	0.02	0.11	0.08	0.02	0.06
Nitrite-nitrogen, mg/L	0.01	0.15	0.06	0.20	0.02	0.9	0.06	0.01	0.04						
Nitrate-nitrogen, mg/L	1.00	0.00	0.29	1.40	0.00	0.35	0.22	0.10	0.16	0.30	0.01	0.15	0.11	0.00	0.03
Total Kjeldahl nitrogen, mg/L	0.71	0.22	0.40	0.88	0.14	0.48	0.52	0.23	0.37				0.10	0.00	0.05
Total phosphate, mg/L	0.64	0.15	0.35	0.88	0.23	0.47	0.30	0.20	0.23						
Orthophosphate, mg/L	0.25	0.01	0.07	0.30	0.00	0.09	0.08	0.01	0.04	0.03	0.02	0.03	0.04	0.02	0.02
Total phosphorus, mg/L	0.05	0.04	0.05							0.07	0.04	0.06	0.08	0.03	0.05
Silicon dioxide, mg/L	48	35	42	53	30	42				34	34	34			
Arsenic, µg/L				20	3	0									
Boron, µg/L	300	0	37	470	0	38				100	40	70	100	0	50
Cadmium, µg/L	<5	<5	<5												
Chromium, µg/L				0	0	0									
Copper, µg/L	<5	<5	<5	20	0	2									
Iron, µg/L	0.2	<0.1	0.1	90	10	20									
Lead, µg/L	<5	<5	<5	0	0	0									
Manganese, µg/L	47	37	25	0	0	0									
Mercury, µg/L	<1	<1	<1												
Zinc, µg/L	33	<5	16	30	0	5									

Sources: [1]USGS (1961–1970), USEPA (1971–1972), and DWR (1988–1989); [2]USEPA (1971–1972) and SWRCB (1955–1989); [3]USEPA (1971–1972); [4]SWRCB (1960–1982); [5]SWRCB (1977–1982).

NTU = nephelometric turbidity units; µmho/cm = microhmos per centimeter; mg/L = milligrams per liter; µg/L = micrograms per liter.