CHAPTER 5.0
POTENTIAL EFFECTS, REGULATORY FRAMEWORK, AND BEST MANAGEMENT PRACTICES FOR SYSTEMWIDE OPERATIONS

This chapter provides an overview of the potential effects of PCWA raw water distribution systemwide operations on natural resource conditions in the study area, the regulatory framework for effects, and potential BMPs to reduce effects of operations' activities on natural resources.

5.1 POTENTIAL EFFECTS OF SYSTEMWIDE OPERATIONS ON NATURAL RESOURCES

The potential effects of the PCWA canal system operations on physical and biological resources in the study area are described below.

5.1.1 Yearly Outages

The yearly outages that occur within the PCWA canal system, typically from mid-October to mid-November, result in reductions in the amount of water available to PCWA's Zone 1 customers. The following sections describe potential effects of the yearly canal outages on natural resources.

5.1.1.1 Physical Resources

Potential effects of PCWA canal system operations during yearly PG&E outages on hydrology, water quality, and soils and sediment quality conditions in the study area are described in the following sections.

Hydrology

PCWA operations during yearly outages do not affect hydrologic conditions in Canyon Creek or Auburn Ravine. During the yearly outages, PCWA canal system contributions to streamflow in Canyon Creek and Auburn Ravine, and/or diversions from Canyon Creek and Auburn Ravine do not change as a result of PCWA operations.

Continuous flow data collected from canal and stream sites within PCWA's lower Zone 1 service area during 2006 were evaluated to determine the effects of yearly outages on hydrologic conditions in Clover Valley Creek, Antelope Creek, Secret Ravine, and Miners Ravine. Continuous flow monitoring locations used for operations' evaluations, and their respective watersheds, are listed in **Table 5-1**.

TABLE 5-1
CONTINUOUS FLOW MONITORING STATIONS IN ZONE 1 FOR OPERATIONS

Secret Ravine Watershed	Miners Ravine Watershed
Secret Ravine at Horseshoe Bar Road	Miners Ravine at Lomida Lane
Tributary to Secret Ravine from Yankee Hill Canal Outlet	Tributary to Miners Ravine from Ferguson Canal Outlet
Tributary to Secret Ravine from Turner Canal Outlet	Tributary to Miners Ravine Stallman Canal Outlet
Boardman Canal Outlet	Tributary to Miners Ravine Baughman Canal Outlet
Secret Ravine at Rocklin Road	Miners Ravine near North Sunrise Avenue

Average daily flows for canal and stream sites evaluated during 2006 outages are shown in **Figure 5-1** for sites within the Secret Ravine watershed, and in **Figure 5-2** for sites within the Miners Ravine watershed.

Based on the average daily flows for sites shown in **Figures 5-1** and **5-2**, streamflow within Secret and Miners ravines is substantially decreased during the yearly outages. Effects on flow conditions in Antelope and Clover Valley creeks are likely similar to conditions shown for Secret and Miners ravines. These data further demonstrate that canal system contributions (including unregulated releases and customer return flows) dominate dry season flows in Secret and Miners ravines. These historic reductions in canal system contributions, and resultant historic decreases in streamflow, are dictated by the PG&E annual water delivery outages.

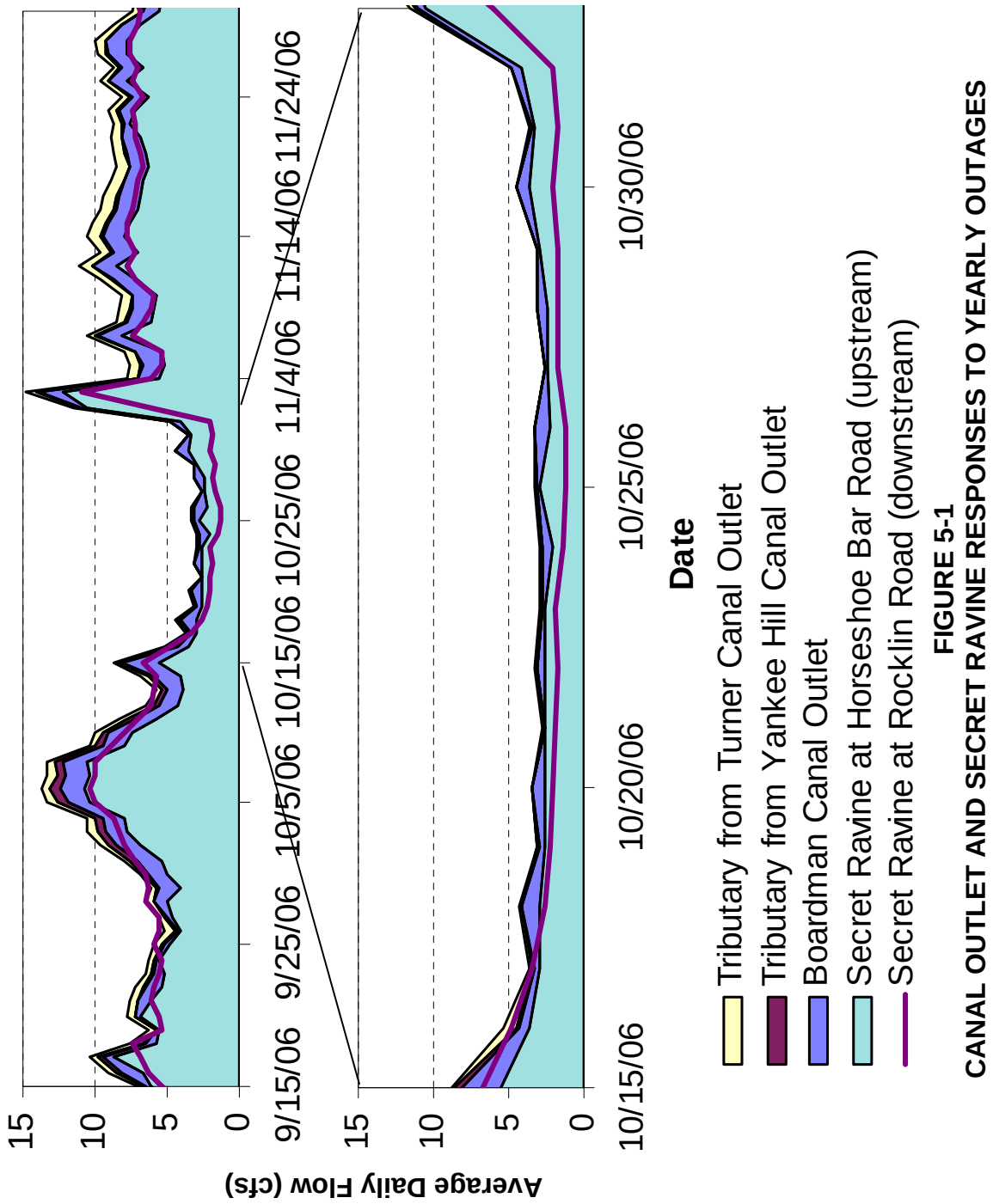

FIGURE 5-1
CANAL OUTLET AND SECRET RAVINE RESPONSES TO YEARLY OUTAGES

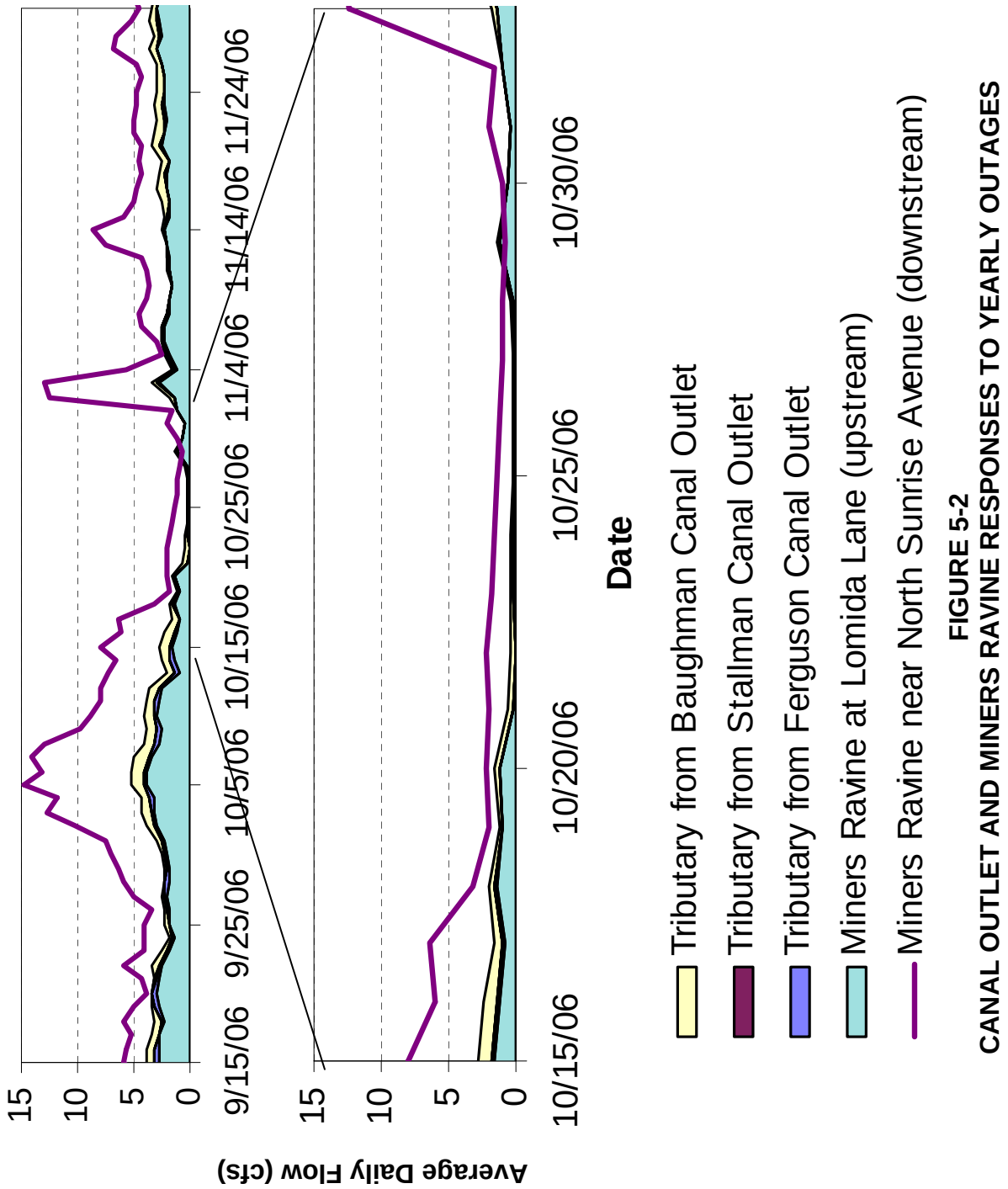

FIGURE 5-2
CANAL OUTLET AND MINERS RAVINE RESPONSES TO YEARLY OUTAGES

Water Quality

The locations listed in **Table 5-2** and shown in **Figures 5-3** and **5-4** were selected to identify potential effects of canal system contributions on water quality conditions in study area streams during yearly outages. The monitoring events targeted outages that occurred at Clover Valley and Mammoth reservoirs, and associated monitoring sites were located in PCWA's Zone 1 service area, within the Antelope Creek, Clover Valley Creek, Secret Ravine, and Miners Ravine watersheds. Outages below the reservoirs occurred on alternate days between the two reservoirs, with outages typically starting at 9:00 a.m., and ending at 9:00 a.m. the following day. Samples were obtained at upstream and downstream locations within the canal system, as well as within the receiving water tributaries and streams downstream of the canal outlets. Monitoring events spanned 2 days for each event. Samples were often collected at each location before, during, and after outage events. Measured water quality parameters are the same as those presented in **Table 3-3** for baseline sampling events, with the exception of mercury. Canal and stream monitoring sites are discussed within their associated watersheds.

Clover Valley Creek Watershed

Water quality monitoring was conducted within the Clover Valley Creek watershed on November 1 and 2, 2006, following the October 31, 2006, outage event. Flows were restored to the PCWA canal system below Clover Valley Reservoir at around 9:00 a.m. on November 1, 2006. The sites monitored within the Clover Valley Creek watershed during the outage event are described below, from the most upstream to the most downstream locations:

- **Clover Valley Reservoir release to Clover Valley Creek (CLVRESR)**
- **Clover Valley Creek at Midas Avenue (CLVRC3)**: located at the Sunset Whitney Country Club on Midas Avenue in Rocklin.

The following section describes water quality conditions at sites in the Clover Valley Creek watershed monitored on November 1 and 2, 2006, during the yearly canal outage. Figures providing a comparison of water quality conditions within the PCWA raw water distribution system and Clover Valley Creek are included in **Appendix B**.

TABLE 5-2
WATER QUALITY MONITORING LOCATIONS IN THE PCWA SERVICE AREA FOR YEARLY OUTAGE EVENTS

Site Name	Site ID	Type	Watershed(s)	Outage Start / End Time	Weather
Mammoth Reservoir Outage				Start: 10/30/2006, 9:00 a.m. End: 10/31/2006, 9:00 a.m. Start: 11/01/2006, 9:00 a.m. End: 11/02/006, 9:00 a.m.	11/01/2006: Clear and dry 11/02/2006: Light rain at 11:22 a.m. Heavy rain at 3:38 p.m.
Boardman Canal at Lubeck Road	YB69A	Canal	NA		
Boardman Canal at Powerhouse Road	YB78	Canal	NA		
Boardman Canal below Mammoth Reservoir	YB81	Canal	Miners Ravine / Secret Ravine		
Yankee Hill Canal Tributary	YHTRIB2	Stream	Secret Ravine		
Boardman Canal Outlet Release	BOARDMANCR	Canal	Secret Ravine		
Secret Ravine at Rocklin Road	SECRETRV3	Stream	Secret Ravine		
Secret Ravine at Roseville Parkway	SECRETRV2	Stream	Secret Ravine		
Baughman Canal Outlet Release	BAUGHMANCR	Canal	Miners Ravine		
Tributary to Miners Ravine from Baughman Canal	BCTRIB1	Drainage	Miners Ravine		
Miners Ravine near N. Sunrise Avenue	MINERSRV3	Stream	Miners Ravine		
Clover Valley Reservoir Outage				Start: 10/31/2006, 9:00 a.m. End: 11/01/2006 9:00 a.m.	11/01/2006: Clear and dry 11/02/2006: Light rain at 10:15 a.m.
Clover Valley Reservoir release to Clover Valley Creek and Antelope Canal	CLVRESR	Canal	Clover Valley Creek		
Clover Valley Creek at Midas Avenue	CLVRC3	Stream	Clover Valley Creek		
Antelope Stub Canal near Antelope Canal	ANTSTUBCR	Canal	Antelope Creek		
Antelope Creek at Midas Avenue	ANTC3B	Stream	Antelope Creek		
Antelope Creek near Sierra College Blvd	ANTC3	Stream	Antelope Creek		
Mammoth Reservoir Outage				Start: 10/27/2007, 9:00 a.m. End: 10/28/2007, 9:00 a.m.	10/27/2007: Clear and dry 10/28/2007: Clear and dry
Boardman Canal below Mammoth Reservoir	YB81	Canal	Miners Ravine / Secret Ravine		
Yankee Hill Canal Outlet Release	YANKEECR	Canal	Secret Ravine		
Boardman Canal Outlet Release	BOARDMANCR	Canal	Secret Ravine		
Yankee Hill Canal Tributary	YHTRIB2	Stream	Secret Ravine		
Secret Ravine at Rocklin Road	SECRETRV3	Stream	Secret Ravine		
Secret Ravine at Roseville Parkway	SECRETRV2	Stream	Secret Ravine		

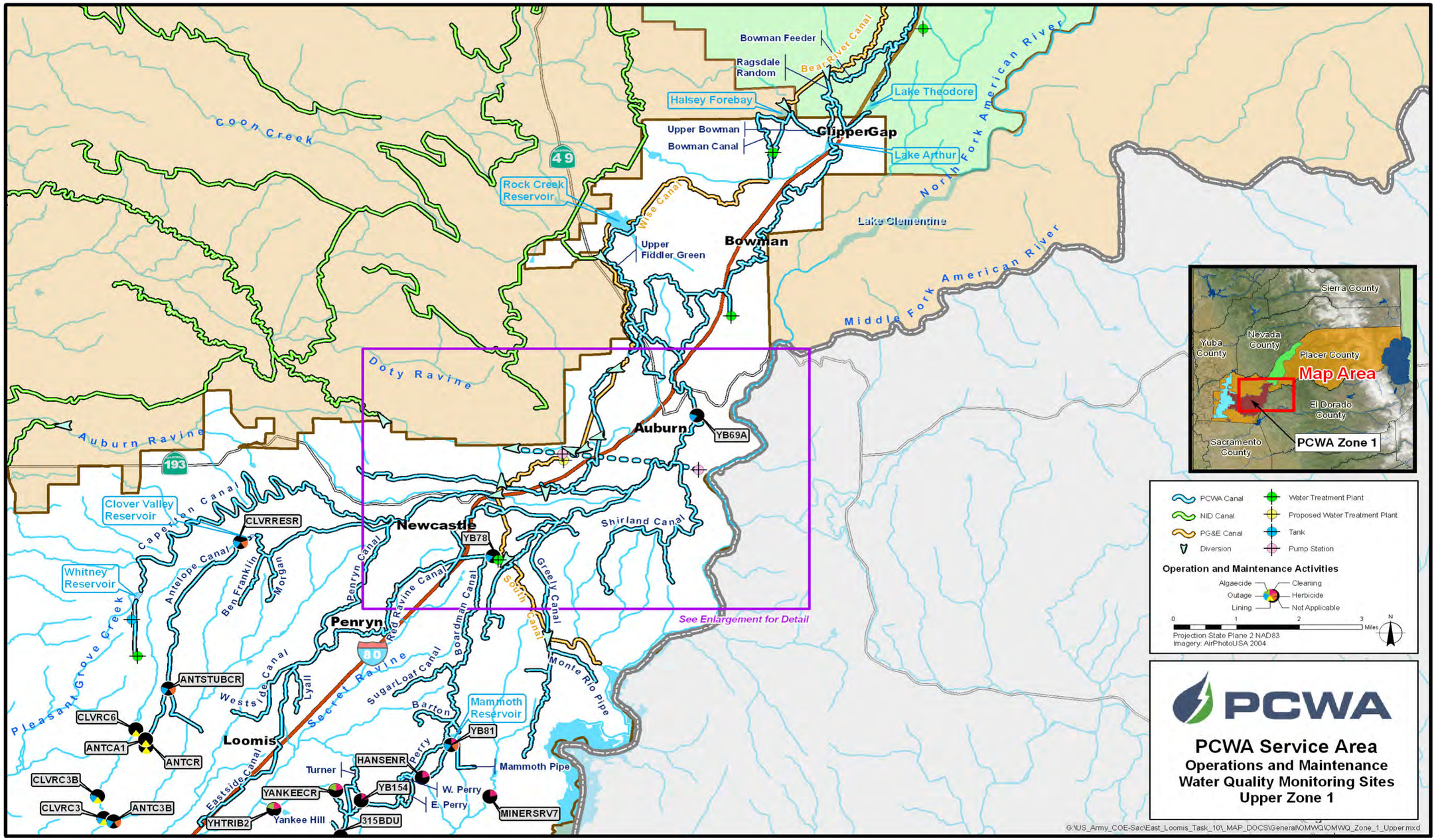

FIGURE 5-3
OPERATIONS AND MAINTENANCE ACTIVITY WATER QUALITY SAMPLING LOCATIONS WITHIN THE UPPER ZONE 1 SERVICE AREA

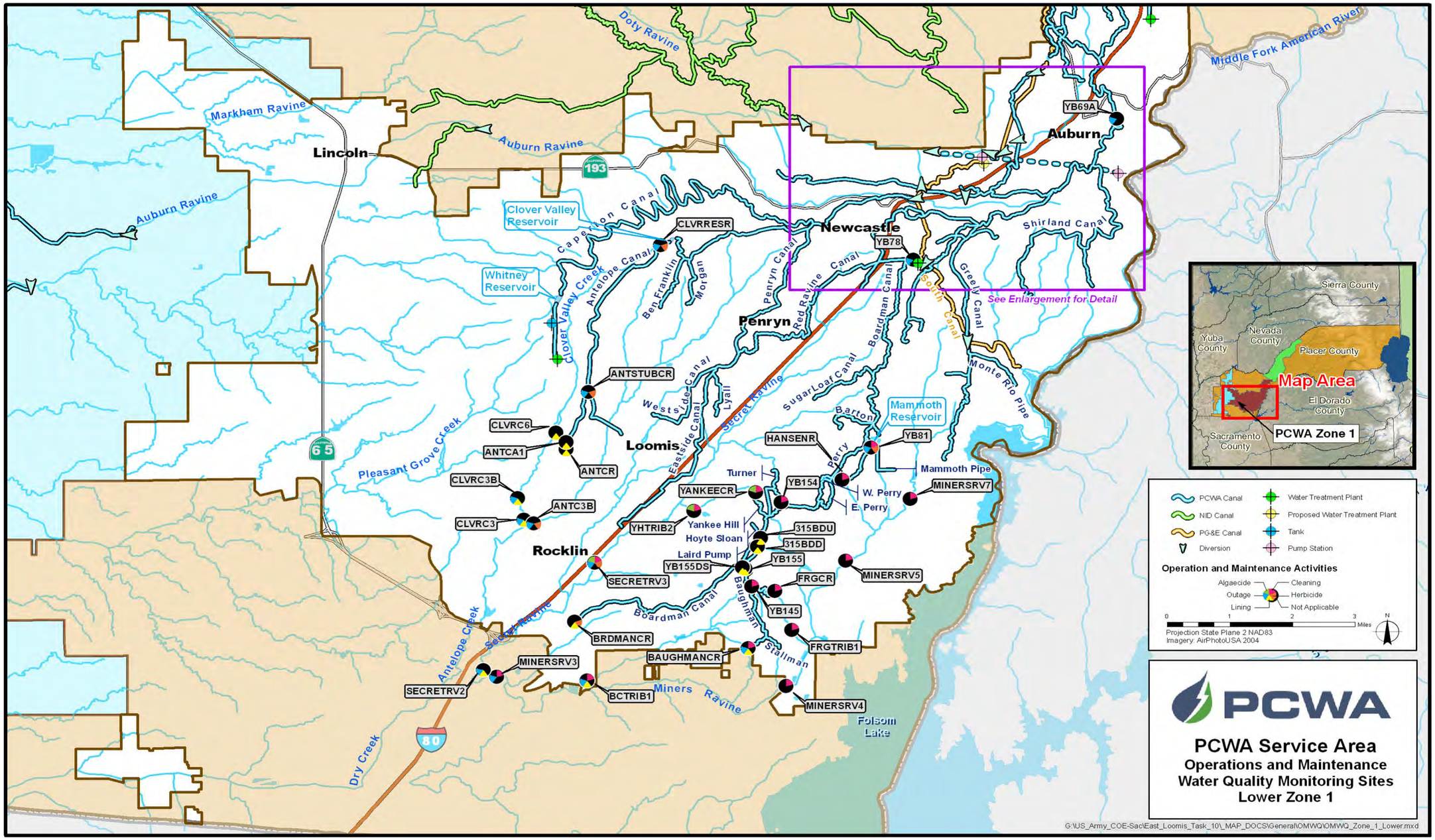

FIGURE 5-4
OPERATIONS AND MAINTENANCE ACTIVITY WATER QUALITY SAMPLING LOCATIONS WITHIN THE LOWER ZONE 1 SERVICE AREA

Water Temperature and Dissolved Oxygen

PCWA operations during the yearly outages did not result in notable effects on water temperature in Clover Valley Creek. Water temperatures in the Clover Valley watershed were higher during the November 1 to 2, 2006, outage event compared to the fall baseline, collected on December 12, 2006. These temperature differences, however, are likely due to the gradual decreases in air temperature observed between the sampling dates.

DO levels across canal and stream sites monitored during the event were relatively high. Based on the water quality data collected before, during, and after the outage, DO levels in Clover Valley Creek did not appear to be affected by the yearly outage.

pH, Alkalinity, and Hardness

Values for pH across sites monitored in the Clover Valley Creek watershed were not affected by the outage. Alkalinity and calculated total hardness levels were generally higher at CLVRC3 than at CLVRESR, suggesting that canal system contributions may decrease alkalinity and hardness conditions in Clover Valley Creek.

Total Suspended Solids and Turbidity

Based on sampling results, TSS concentrations and turbidity in Clover Valley Creek did not appear to be affected by the canal system outage. TSS concentrations and turbidity did increase at Clover Valley Creek on November 2, 2006 (after canal flows were restored below Clover Valley Reservoir), most likely in response to runoff contributions to streamflow during the November 2, 2006, precipitation event.

Specific Conductivity and Ions

Based on water quality data collected across the Clover Valley Creek watershed, SC, calcium, iron, magnesium, sodium, chloride, and sulfate concentrations in Clover Valley Creek did not appear to be affected by the yearly canal outages. Some constituents, including SC, calcium, magnesium, and iron did have higher concentrations in samples collected from Clover Valley Creek on November 2, 2006, most likely in response to runoff contributions to streamflow during the November 2, 2006, precipitation event.

Nitrate and potassium concentrations are not affected by yearly outages. Nitrate levels were at or slightly above the nondetect level (0.1 mg/L) throughout the monitoring period, while potassium concentrations were either below the detection limit (1 mg/L) or very low across all sites. Potassium reached a maximum level of 2.5 mg/L at CLVRC3.

Trace Elements

Barium and zinc concentrations across sites in the Clover Valley Creek watershed showed similar trends as TSS and turbidity in samples obtained during the outage event, and did not appear to be affected by yearly outages. Barium levels at CLVC3 ranged from 73 to 110 µg/L, compared to the maximum observed during routine canal operations, 42 µg/L. Concentrations of barium and zinc were higher at CLVRC3 on November 2, 2006, most likely in response to runoff contributions to streamflow during the to the November 2, 2006, precipitation event. Aluminum concentrations at canal and stream sites monitored during the yearly outage event were comparable for most samples. One sample obtained at Clover Valley Creek on November 2, 2006, had a substantially higher concentration of aluminum compared to previous samples and

samples obtained during baseline sampling events. Copper concentrations were consistently low across canal sites and slightly higher in Clover Valley Creek. The highest measured concentration of copper in Clover Valley Creek during yearly outage sampling event was 8.5 µg/L. All cadmium levels were below the detection limit (0.5 µg/L) at Clover Valley Creek watershed sites during the yearly outage monitoring event.

Antelope Creek Watershed

Water quality monitoring was conducted within the Antelope Creek watershed on November 1 and 2, 2006, following the October 31, 2006, outage event. Flows were restored to the PCWA canal system below Clover Valley Reservoir at around 9:00 a.m. on November 1, 2006. The sites monitored in the Antelope Creek watershed during the outage event are described below, from the most upstream to the most downstream locations:

- **Antelope Stub Canal near Antelope Canal (ANTSTUBCR)**: located at the head of Antelope Stub Canal and Antelope Canal.
- **Antelope Creek at Midas Avenue (ANTC3B)**

The following section describes water quality conditions at sites in the Antelope Creek watershed monitored on November 1 and 2, 2006, during the yearly canal outage. Figures providing a comparison of water quality conditions within the PCWA raw water distribution system and Antelope Creek are included in **Appendix B**.

Water Temperature and Dissolved Oxygen

Based on measurements taken at sites, yearly outages did not appear to affect water temperature conditions in Antelope Creek. Little to no water temperature changes were observed at ANTSTUBCR and ANTC3/ANTC3B during monitoring for the November 1, 2006, outage event at Clover Valley Reservoir. Water temperatures measured within the Antelope Creek watershed ranged from 50.8 to 59.0 °F.

DO concentrations in Antelope Creek during and after the outage at Clover Valley Reservoir were comparable to conditions during baseline sampling events, and are not likely affected by PCWA operations during yearly outages. Overall, DO concentrations were higher at ANTSTUBCR than at ANTC3/ANTC3B.

pH, Alkalinity, and Hardness

Based on water quality data collected, yearly outages did not affect pH, alkalinity, and hardness in Antelope Creek. Results for pH, alkalinity, and hardness across sites in the Antelope Creek watershed were fairly invariable during and after the outage at Clover Valley Reservoir. Alkalinity and hardness values were consistently lower, and pH was consistently higher, within the canal system compared to Antelope Creek.

Total Suspended Solids and Turbidity

TSS concentrations and turbidity levels in samples collected from Antelope Creek were not affected by PCWA canal system operations during the yearly outage sampling event. TSS and turbidity values were consistently low across all sites monitored during the event.

Specific Conductivity and Ions

Based on water quality monitoring during the yearly outage event, SC and ion concentrations did not appear to be affected by PCWA operations during yearly outages. Little SC variation was observed across sites monitored in the Antelope Creek watershed during the yearly outage event. Overall, SC was higher in Antelope Creek compared to the canal system.

Calcium, iron, magnesium, sodium, chloride, and sulfate concentrations were also consistently higher in Antelope Creek, and demonstrated little variation during and after the outage event. Nitrate and potassium concentrations were low across all sites sampled during and after the outage at Clover Valley Reservoir.

Trace Elements

Barium and copper concentrations in samples collected from Antelope Creek increased after flows were restored to Antelope Canal following the Clover Valley Reservoir outage. These increases may be attributed to precipitation in the watershed and runoff contributions to streamflow, or to PCWA operations during the yearly outage. Aluminum concentrations in Antelope Creek also increased, but were comparable to concentrations measured during baseline sampling events. Zinc concentrations in samples were fairly constant during and after the outage, and were comparable across sites sampled in the Antelope Creek watershed. All samples collected had cadmium concentrations below the detection limit (0.5 µg/L).

Secret Ravine Watershed

As shown in **Table 5-2**, water quality monitoring in the Secret Ravine watershed was conducted during two different outage events at Mammoth Reservoir; November 1 and 2, 2006, following the November 1, 2006, outage, and October 28, 2007, following the October 27, 2007, outage. For the 2006 outage monitoring event, flows were restored to the PCWA canal system below Mammoth Reservoir at around 9:00 a.m. on October 31, 2006, and November 2, 2006. Flows were restored to the PCWA canal system below Mammoth Reservoir at around 9:00 a.m. on October 28, 2007, for the 2007 outage monitoring event. Water quality was monitored at three canal sites (Boardman Canal at Lubeck Road (YB69A), YB78, and YB81) and one stream site in Secret Ravine (SECRETRV3), for the November 1 to 2, 2006, monitoring event. On October 28, 2007, monitoring occurred at three canal sites (YB81, YANKEECR, Boardman Canal Outlet Release (BOARDMANCR)) and three stream sites (YHTRIB2, SECRETRV3, Secret Ravine at Roseville Parkway (SECRETRV2)). Only water temperature, DO, pH, SC, turbidity, alkalinity, sulfate, and copper were measured during the October 28, 2007, event. The sites monitored during the yearly outage events are described below, from the most upstream to the most downstream locations:

- **Boardman Canal at Lubeck Road (YB69A)**: located east of the railroad tracks on Lubeck Road in Auburn. This is the most upstream monitoring site for yearly outage events.
- **Boardman Canal at Powerhouse Road (YB78)**
- **Boardman Canal below Mammoth Reservoir (YB81)**

- **Yankee Hill Canal Outlet Release (YANKEECR)**
- **Tributary to Secret Ravine from Yankee Hill Canal (YHTRIB2)**
- **Secret Ravine at Rocklin Road (SECRETRV3)**
- **Boardman Canal Outlet Release (BOARDMANCR)**: located at the end of the Boardman Canal. Unregulated releases from the Boardman Canal currently flow through a planned residential development, and outflow directly to Secret Ravine. This is the most downstream terminal point within the PCWA raw water distribution system.
- **Secret Ravine at Roseville Parkway (SECRETRV2)**: located just upstream from its confluence with Miners Ravine.

The following section describes water quality conditions during the yearly canal outage at sites in the Secret Ravine watershed monitored on November 1 and 2, 2006, and October 28, 2007. Figures providing a comparison of water quality conditions within the PCWA raw water distribution system and Secret Ravine are included in **Appendix B**.

Water Temperature and Dissolved Oxygen

Based on water quality data obtained during sampling events, water temperature and DO conditions in Secret Ravine do not appear to be affected by PCWA operations during yearly outages. Water temperature and DO values at sites monitored in Secret Ravine were comparable to conditions sampled during baseline sampling events. Water temperature and DO fluctuations at sites are likely attributed to natural variability due to diurnal effects, such as photosynthesis and respiration.

pH, Alkalinity, and Hardness

The yearly outages did not appear to affect pH within the PCWA canal system, but measured values for pH in Secret Ravine on November 1 and 2, 2006, fluctuated from 6.67 to 7.51. No effects on pH were observed at sites monitored in the Secret Ravine watershed during the October 28, 2007, sampling event. Alkalinity and hardness are not likely affected by yearly outages. Measured values for all sites in the Secret Ravine watershed were comparable to values measured during baseline sampling events.

Total Suspended Solids and Turbidity

Based on data collected on November 1 and 2, 2006, for the yearly outages, TSS levels in Secret Ravine are not affected by the yearly outages. One sample obtained at SECRETRV2 did have a high concentration of TSS, but the value is most likely associated with heavy rain and runoff contributions to streamflow at the time of sampling. TSS was not evaluated during the October 2007 sampling event.

The yearly outages may affect turbidity conditions in Secret Ravine. Measured values of turbidity at canal sites during the November 2006 sampling event fluctuated during sampling, but did not result in variation in turbidity at Secret Ravine sampling sites. During the October 2007 sampling event, turbidity values at canal and stream sites in the Secret Ravine watershed

increased after flows were restored to the canal system (**Figure 5-5**). These higher values were likely attributed to mobilization of fine sediment and organic material that had settled when canals were dewatered during the outage.

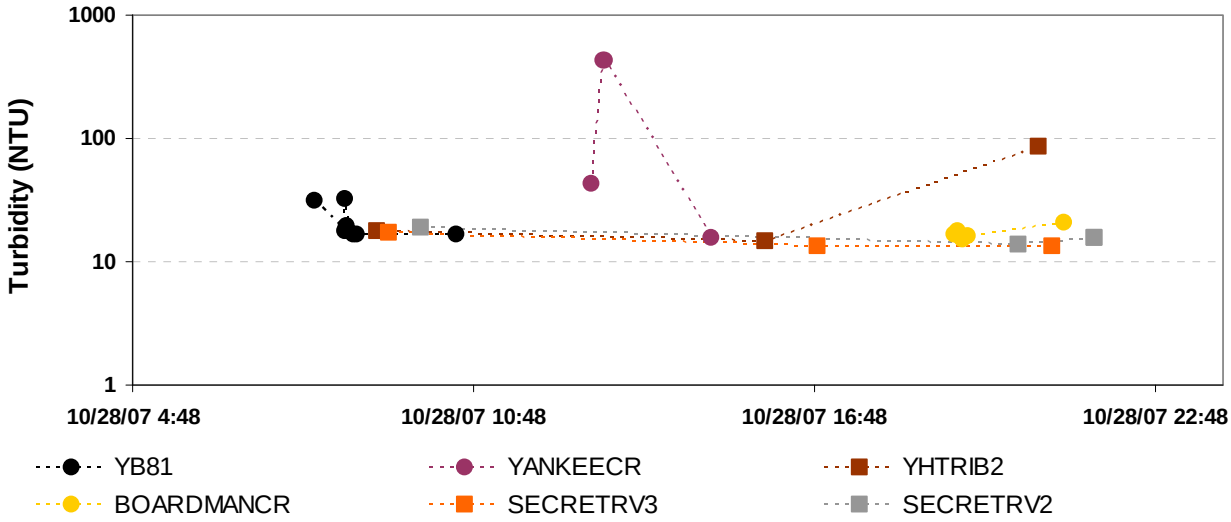

FIGURE 5-5
MEASURED TURBIDITY VALUES AT SECRET RAVINE WATERSHED SITES DURING OCTOBER 2007 YEARLY OUTAGE SAMPLING EVENT

Specific Conductivity and Ions

Based on water quality monitoring during the yearly outage events, SC and ion concentrations at sites sampled in Secret Ravine did not appear to be affected by PCWA operations during yearly outages. Measured SC values remained relatively low at all sites sampled during the November 2006 and October 2007 outages, with Secret Ravine sites exhibiting higher values than canal sites. Calcium, magnesium, sodium, chloride, and sulfate concentrations were also consistently higher in Secret Ravine, and demonstrated little variation during and after the November 2006 outage event. Iron concentrations across canal and stream sites increased after heavy rainfall in the watershed, and are most likely associated with runoff contributions to streamflow at the time of sampling. Nitrate and potassium concentrations were low across all sites sampled in the Secret Ravine watershed during and after the November 2006 outages at Mammoth Reservoir.

Trace Elements

Based on water quality data collected, PCWA operations during the November 2007 yearly outage event did not affect barium, cadmium, copper, or zinc concentrations in Secret Ravine. Barium, copper, and zinc concentrations did increase at canal and stream sites on November 2, 2006, likely due to heavy rain and runoff contributions to streamflow. During the precipitation event, barium and copper concentrations reached 58 µg/L and 21 mg/L, respectively, at SECRETRV3, while zinc concentrations at YB69A and SECRETRV3 measured 71 and 60 µg/L, respectively. All samples had cadmium concentrations below the detection limit (0.5 µg/L) during the 2006 yearly outage monitoring event. Aluminum concentrations at canal sites monitored during the November 2006 yearly outage event were consistently higher than samples

obtained in Secret Ravine, and higher at all sites after heavy rain in the watershed, most likely due to heavy rain and runoff contributions to canal and streamflows at the time of sampling.

During the October 2007 sampling event, measured copper values at canal and stream sites in the Secret Ravine watershed increased after flows were restored to the canal system (**Figure 5-6**). These higher values were likely attributed to mobilization of copper associated with fine sediment and organic material that had settled when canals were dewatered during the outage.

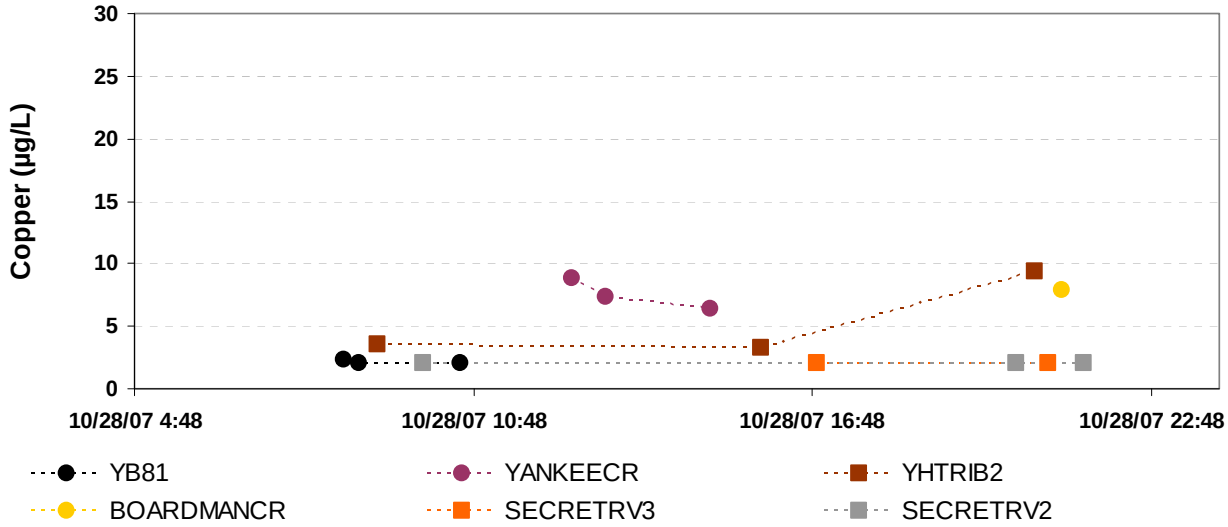

FIGURE 5-6
MEASURED COPPER CONCENTRATIONS AT SECRET RAVINE WATERSHED SITES DURING THE OCTOBER 2007 YEARLY OUTAGE SAMPLING EVENT

Miners Ravine Watershed

As with the Secret Ravine watershed, water quality monitoring in the Miners Ravine watershed was conducted during two different outage events at Mammoth Reservoir; November 1 and 2, 2006, following the November 1, 2006 outage, and October 28, 2007, following the October 27, 2007, outage. For the 2006 outage monitoring event, flows were restored to the PCWA canal system below Mammoth Reservoir at around 9:00 a.m. on October 31, 2006, and November 2, 2006. Flows were restored to the PCWA canal system below Mammoth Reservoir at around 9:00 a.m. on October 28, 2007, for the 2007 outage monitoring event. BAUGHMANCR was monitored along with some canal monitoring sites also used for analysis within the Secret Ravine watershed (YB69A, YB78, and YB81). Water quality was monitored at two stream sites during this event (BCTRIB1 and MINERSRV3). During the October 28, 2007, monitoring sites were located at YB81 and MINERSRV3. Only water temperature, DO, pH, SC, turbidity, alkalinity, sulfate, and copper were measured during the October 28, 2007, event. The sites monitored in the Miners Ravine watershed during the yearly outage events are described below, from the most upstream to the most downstream locations:

- **Boardman Canal at Lubeck Road (YB69A)**
- **Boardman Canal at Powerhouse Road (YB78)**
- **Boardman Canal below Mammoth Reservoir (YB81)**
- **Baughman Canal Outlet Release (BAUGHMANCR)**
- **Tributary to Miners Ravine from Baughman Canal (BCTRIB1)**
- **Miners Ravine near N. Sunrise Avenue (MINERSRV3)**

The following section describes water quality conditions during the yearly canal outage at sites in the Miners Ravine watershed monitored on November 1 and 2, 2006, and October 28, 2007. Figures providing a comparison of water quality conditions within the PCWA raw water distribution system and Miners Ravine are included in **Appendix B**.

Water Temperature and Dissolved Oxygen

Based on results of water quality monitoring, water temperature and DO conditions in Miners Ravine were not affected by PCWA operations during the yearly outages. Water temperature and DO values at BCTRIB1 and MINERSRV3 were comparable to values measured during baseline sampling events. Water temperature and DO fluctuations at sites were likely attributed to natural variability due to diurnal effects, such as photosynthesis and respiration.

pH, Alkalinity, and Hardness

Monitoring results suggest that Miners Ravine pH, alkalinity, and hardness values were not likely affected by PCWA operations during yearly outages. Measured values for pH and alkalinity decreased at BCTRIB1 and MINERSRV3 following the outage at Mammoth Reservoir. These fluctuations were not likely associated with the decreased canal flows because pH and alkalinity values at canal sites remained consistent. Values for pH, alkalinity, and hardness across canal and stream sites in the Miners Ravine watershed were comparable to values measured during baseline sampling events.

Total Suspended Solids and Turbidity

Measured TSS concentrations at stream sites monitored in the Miners Ravine watershed during the November 2006 event were not affected by PCWA operations during the yearly outages. TSS concentrations were close to or below detection limits at all sites monitored on November 1, 2006, and increased at sites sampled during and after heavy rain on November 2, 2006. Higher TSS concentrations at sites sampled on November 2, 2006, are likely associated with heavy rain and runoff contributions to flow at sites during sampling. TSS was not evaluated during the October 2007 sampling event.

Turbidity values measured at sites during the November 2006 outage event followed the same trends described for TSS, demonstrating no effects associated with PCWA operations during the yearly outages. Measured turbidity values during the October 2007 also suggest that the yearly outages are not likely to affect turbidity in Miners Ravine.

Specific Conductivity and Ions

Based on results of water quality monitoring, PCWA operations during yearly outages did not affect SC and ion concentrations in Miners Ravine. Measured SC and ion values at sites were comparable to values measured during baseline sampling events at sites in the Miners Ravine watershed. SC was consistently low (less than 0.2 mS/cm) across all sites during monitoring, with the exception of one sample obtained at the Baughman Canal Outlet Release on November 1, 2006 (0.5 mS/cm). Calcium, magnesium, sodium, chloride, and sulfate concentrations were also consistently higher in Miners Ravine during the November 2006 outage event, and demonstrated little variation during and after the outage event. Iron, nitrate, and potassium concentrations were low across all sites sampled in the Miners Ravine watershed, and had slightly higher concentrations in Miners Ravine during heavy rain. Measured sulfate concentrations during the October 2007 outage event were also consistently higher in Miners Ravine, and demonstrated little variation at canal and stream sites during and after the outage event.

Trace Elements

Barium, zinc, and copper concentrations were consistently low across canal and stream sites during the November 2006 yearly outage, but increased following heavy rain in the watershed. Aluminum concentrations were comparable to values measured during baseline sampling events, but also increased across sites after heavy rain. The higher concentrations of barium, zinc, copper, and aluminum follow the same trend as TSS, and are most likely due to high flows at sites during sampling, which may have may have mobilized sediments and metals bound in sediments. Copper concentrations across canal and stream sites were consistently low during the November 2006 and October 2007 yearly outage monitoring events. All cadmium concentrations were below the detection limit (0.5 µg/L) during the 2006 yearly outage monitoring event.

Soils and Sediment Quality

Soils and sediment quality in the study area are not likely to be affected by PCWA activities during the annual PG&E delivery outages. PCWA operations during the yearly outages do not disturb soils in the study area, or introduce constituents that may affect sediment quality.

5.1.1.2 Biological Resources

The following sections describe effects of PCWA operations during yearly outages to terrestrial and aquatic habitat and species.

Terrestrial Habitat and Species

Yearly outages are not expected to have substantial effects on terrestrial habitats and species. Historic decreases in water delivery during the PG&E outages could result in temporary minimal decreases in the extent of wetland habitats that may be indirectly supported by canal deliveries. This could have minimal effects on species that use wetland habitats such as foraging birds and amphibians by decreasing the amount of available habitat, but these effects are representative of historic conditions within the study area.

Other changes in water quality, such as increased water temperature, decreased DO, and increased pH and alkalinity could have some negative effects on plants and wildlife on the margins of canals and tributaries; however, any effects are expected to be very minimal because these changes are anticipated to be very small.

Aquatic Habitat and Species

PCWA's operations during yearly outages likely affect fish found in the canal system, potentially including brown trout (*Salmo trutta*), rainbow trout (*Oncorhychus mykiss*), catfish (*Ictalurus* or *Ameiurus* sp.), Sacramento sucker (*Catastomus occidentalis*), Sacramento pikeminnow (*Ptychocheilus grandis*), black bass (*Micropterus* sp.), and mosquitofish (*Gambusia affinis*) (PCWA 2004; field observations, MWH). Potential effects to fish in the canal system are associated with canal system dewatering.

Aquatic habitat and species in Canyon Creek and Auburn Ravine are not affected by PCWA operations during the PG&E annual outages since the operations do not alter hydrologic and water quality conditions in Canyon Creek and Auburn Ravine.

As described above and shown in **Figure 5-2**, decreased and intermittent canal system flows during the PG&E yearly outages result in reduced flow contributions from the PCWA canal system and flow reductions in Clover Valley Creek, Antelope Creek, Secret Ravine, and Miners Ravine. These flow reductions likely affect aquatic habitat and species in these streams. The reduced canal system contributions, and resultant decreased flow in Clover Valley Creek, Antelope Creek, Secret Ravine, and Miners Ravine are dictated by the PG&E annual water delivery outages. PCWA's reliance on stored water in surface reservoirs and water delivered through the ARPS to supplement flow to WTPs and canal customers during the yearly outages limits PCWA's ability to maintain canal system flows. Antecedent hydrologic conditions may reduce or accentuate the effects of PCWA's operations during yearly outages on aquatic habitat and species in Clover Valley Creek, Antelope Creek, Secret Ravine, and Miners Ravine.

Special Status Species

PCWA operations during PG&E's yearly outages are not expected to have substantial effects on terrestrial special status species. Historic decreases in water delivery during the PG&E outages could result in temporary minimal decreases in the extent of wetland habitats that may be indirectly supported by the canal system. This could have minimal effects on species that use these habitats wetland habitats, such as foraging special status bird and amphibian species by decreasing the amount of available habitat, but these effects are representative of historic conditions within the study area. The typical timing of the outage period from mid-October to mid-November is outside of the breeding period for special status amphibians. California red-legged frog breeding occurs between late November and March, though most frogs lay eggs in March (USFWS 2002, Stebbins 2003). The foothill yellow-legged frog breeds mid-March through early June, and the western spadefoot toad breeds late January through July (Stebbins 2003).

Other changes in water quality, such as increased water temperature, decreased DO, and increased pH and alkalinity could have some negative effects on plants and wildlife on the

margins of canals and tributaries; however, any effects are expected to be minimal because these changes are anticipated to be small.

Fall-run Chinook salmon and Central Valley steelhead spawn in both Secret and Miners ravines. Because streamflows are typically lower, and water temperatures higher in the Dry Creek watershed, spawning often occurs later than in other Central Valley streams. Historic reductions in streamflow contributions from the canal system during PG&E's yearly outages may also delay the spawning migration.

Fall-run Chinook salmon may begin spawning activities from early November to December, which may, in some years, coincide with the tail end of PG&E's yearly outages and the resulting streamflow reductions. If the reduction of canal system contributions to streamflow occurs after spawning has begun, there is a potential for redd dewatering, providing the flow and stage decrease occurs where spawning has occurred.

Central Valley steelhead typically do not start their upstream migration until after a large storm event, typically after the PG&E yearly outages are completed. Spawning also occurs after the outages, so spawning and egg incubation would not be affected by the outages. Juvenile outmigration typically occurs before the PG&E outages. Steelhead do, however, rear year-round, especially in Secret Ravine, and may be affected by the PG&E yearly outages through the reduction or loss of rearing habitat, and the potential increase in predation rates. The level of effect to the rearing steelhead is dependent upon how low the flows drop during the annual outages, and if the water temperatures increase. If flows decrease too much, or if water temperatures rise too high, steelhead will move to locations more suitable, most likely downstream into Dry Creek.

5.1.2 Seasonal Customer Delivery Schedule Changes

The following sections describe potential effects of PCWA's seasonal customer delivery schedule changes on physical and biological resources in the study area. PCWA's customer delivery schedule changes typically take 1 week to complete, with minimal interruptions to service. Post-irrigation season customer delivery schedule changes coincide with yearly outages.

5.1.2.1 Physical Resources

Potential effects of PCWA seasonal delivery schedule changes on hydrology, water quality, and soils and sediment quality conditions in the study area are described in the below sections.

Hydrology

PCWA customer delivery schedule changes do not affect hydrologic conditions in Canyon Creek. Diversions from Canyon Creek to PCWA's Pulp Mill Canal, and resulting streamflow in Canyon Creek, are maintained during delivery schedule changes.

Hydrologic conditions in Auburn Ravine are not affected by customer delivery schedule changes. PCWA customer delivery schedule changes along Auburn Ravine and in the Zone 5 service area do not require any exchanges of orifices at customer delivery points. PCWA's water diversions to Auburn Ravine are limited to the irrigation season, when natural flows in Auburn

Ravine are low. Also, PCWA contributions to streamflow in Auburn Ravine during the irrigation season are a fairly small fraction of the flow augmentation that occurs through other irrigation conveyance and return flow, hydroelectric generation releases, and treated effluent discharges.

Delivery schedule changes after the irrigation season do not affect the hydrologic conditions in Clover Valley Creek, Antelope Creek, Secret Ravine, or Miners Ravine. As described above, post-irrigation season delivery schedule changes coincide with yearly outages.

Delivery schedule changes during the irrigation season also are not likely to affect hydrologic conditions in Clover Valley Creek, Antelope Creek, Secret Ravine, or Miners Ravine. The orifice changes at customer delivery points do not require canal dewatering and have minimal interruptions to service.

Water Quality

As described above, PCWA's activities associated with delivery schedule changes typically coincide with other O&M activities that require canal dewatering, such as yearly outages, canal lining/guniting, and canal cleaning and flushing. However, because delivery schedule changes do not require dewatering, water quality conditions in study area streams are not likely to be affected by PCWA operations during irrigation season delivery schedules changes. It is possible that sediment and/or debris could enter the canals from canal banks if PCWA personnel need to enter the canals to switch out orifice plates, but would not likely result in water quality effects at canal outlets. Effects of outages during the fall season delivery schedule changes are described above in the yearly outages section.

Soils and Sediment Quality

Soils and sediment quality in the study area are not likely to be affected by PCWA's seasonal customer delivery schedule changes. PCWA operations during seasonal customer delivery schedule changes do not disturb soils in the study area, or introduce constituents that may affect sediment quality.

5.1.2.2 Biological Resources

The following sections describe effects of PCWA operations during seasonal customer delivery schedule changes on terrestrial and aquatic habitat and species.

Terrestrial Habitat and Species

Very minimal effects are likely to occur to terrestrial habitats and species, mostly associated with trampling vegetation while orifices are being changed.

Aquatic Habitat and Species

Aquatic habitat and species are not affected by seasonal customer delivery schedule changes. As described above, hydrology and water quality conditions in study area streams are not likely affected by seasonal customer delivery schedule changes.

Special Status Species

Effects on special status plant species (see **Tables 3-12** and **3-13**) are unlikely to occur because they are not expected to be present along canal banks. Some potential negative effects could occur to special status raptors if they are nesting near work areas that may be disturbed by noise. Special status raptors potentially occurring in the study area include Swainson's hawk, Cooper's hawk (*Accipiter cooperi*), Northern Goshawk (*Accipiter gentiles*), White-tailed Kite, and Northern Harrier. As mentioned above, the nesting period for raptors is generally March 1 to August 15.

Because hydrology and water quality conditions in study area streams supporting salmonids are not altered, Central Valley steelhead and fall-run Chinook salmon are not affected by seasonal customer delivery schedule changes.

5.1.3 Seasonal Flood Management Practices

PCWA's use of selected outlet locations along canals to release stormwater during precipitation events with high canal flows for flood management has the potential to affect natural resource conditions in the study area. The following sections describe potential effects of PCWA's flood management practices on natural resources in the study area.

5.1.3.1 Physical Resources

Potential effects on hydrology, water quality, and soils and sediment quality conditions in the study area are described in the below sections.

Hydrology

PCWA's use of select canal outlets for stormwater releases during precipitation events likely results in temporary increases in streamflow in many unnamed drainages within the study area. Flow conditions in study area streams, however, are not expected to be affected by stormwater releases from PCWA's canal system due to the effects of other runoff contributions to streamflow within the watersheds of study area streams. Hydrologic conditions in study area streams during PCWA flood management activities are likely similar to conditions generally exhibited across study area streams during periods of high precipitation runoff.

Water Quality

As described previously, the tributaries and streams in the PCWA raw water distribution area are naturally prone to flooding. High flows during storm events can cause excessive erosion and may carry debris, such as tree branches and trash, into canals and streams. PCWA's flood management practices during these events likely have minimal effects on water quality conditions in study area streams. Additional flow releases from canal outlets may result in a short-term increase in erosion downstream from canal outlets in areas with soils of high erodibility and little riparian vegetation. The increased flows in many unnamed drainages within the study area may result in bank erosion near the canal outlet releases, and potential sediment loading to receiving waters. The potential for bank erosion near the canal outlets may result in increased sediment transport downstream, increased TSS and turbidity, and increased loading of

constituents associated with soils at eroded banks. Water quality conditions in study area streams during PCWA's flood management activities are likely similar to conditions generally observed during periods of high precipitation runoff.

Soils and Sediment Quality

PCWA flood management practices likely have minimal effects on soils and sediment quality in the study area. Unregulated releases from canal outlets during periods of high canal flows would reduce the effects of bank erosion along unlined canals, and the increased flows in unnamed drainages downstream from canal outlets may result in bank erosion near the canal outlet releases, and potential sediment loading to receiving waters.

5.1.3.2 Biological Resources

The following sections describe potential effects of PCWA's flood management practices on terrestrial and aquatic habitat and species, and special-status species.

Terrestrial Habitat and Species

Direct effects to terrestrial habitats and species are not expected. Stormwater releases would reduce the effects of bank erosion along canals and would therefore lessen potential negative impacts resulting from flood flows. The increased flows in many unnamed drainages within the study area may result in bank erosion near the canal outlet releases, and potential sediment loading to receiving waters. This would have the potential to wash away amphibian eggs, if present in the outlet areas, or bury wetland or riparian vegetation. These effects are expected to be minimal due to the limited area affected and similar to conditions generally exhibited across study area streams during periods of high precipitation runoff.

Aquatic Habitat and Species

PCWA's seasonal flood management practices are not likely to affect aquatic habitat and species in the study area. High flows within the PCWA canal system that occur as a result of precipitation runoff are indicative of high flows in study area streams.

Special Status Species

Direct effects to special status species are not expected to result from PCWA flood management practices. Stormwater releases from the canal system would reduce the effects of bank erosion along canals and would therefore lessen potential negative impacts resulting from flood flows. The increased flows in many unnamed drainages within the study area may result in bank erosion near the canal outlet releases, and potential sediment loading to receiving waters. This would have the potential to wash away special status amphibian eggs, if present in the drainages downstream from canal outlets, or bury any special status plant species that may be present. California red-legged frog breeding occurs between late November and March, though most frogs lay eggs in March (USFWS 2002, Stebbins 2003). The foothill yellow-legged frog breeds mid-March through early June, and the western spadefoot toad breeds in late January through July (Stebbins 2003). Special status species are not known to occur in the area of the canal

outlets, and these potential effects are expected to similar to conditions generally exhibited across study area streams during periods of high precipitation runoff.

Steelhead and fall-run Chinook salmon are not likely affected by PCWA flood management practices. As described above, high flows in study area streams are more likely to affect aquatic habitat and species compared to PCWA operations during precipitation events.

5.1.4 Routine Operations

The following sections describe potential effects of PCWA's routine canal system operations on physical and biological resources in the study area.

5.1.4.1 Physical Resources

Potential effects on hydrology, water quality, and soils and sediment quality conditions in the study area are described in the below sections.

Hydrology

PCWA's routine raw water distribution system operations affect hydrologic conditions in Canyon Creek during summer and fall through direct diversions from the stream; however, these effects are negligible in comparison to effects of PG&E hydroelectric operations. During winter and spring, PCWA's routine operations are not likely to affect Canyon Creek hydrology due to potentially high streamflows associated with snowmelt and runoff in the watershed.

PCWA's water diversions to Auburn Ravine during the irrigation season have a positive effect on hydrologic conditions within portions of Auburn Ravine upstream from diversions to Zone 5 customers during late summer and early fall when natural flows in Auburn Ravine are low (Reclamation and PCWA 2002). As described in **Chapter 3**, natural flows in Auburn Ravine decline to very low levels during spring months, with no natural flow during summer months (Reclamation and PCWA 2002, City of Lincoln 1999). PCWA contributions to streamflow in Auburn Ravine during the irrigation season, however, are a fairly small fraction of the flow augmentation in Auburn Ravine during the dry season that occurs through other irrigation conveyance and return flow, hydroelectric generation releases, and treated effluent discharges. Routine PCWA operations do not affect hydrologic conditions in Auburn Ravine outside of the irrigation season.

Based on water balance results for the PCWA canal system and streams from the East Loomis Basin Canal Efficiency Study, routine canal system operations contribute to flows in Secret and Miners ravines year-round (USACE and PCWA 2008). The PCWA canal system provides direct contributions to flows within study area streams through regulated releases to streams used for conveyance and unregulated releases from canal outlets, and indirect contributions through customer return flows. These flow contributions have a positive effect on hydrologic conditions in study area streams.

Water Quality

PCWA's routine raw water distribution system operations likely have minimal effects on water quality conditions in Canyon Creek during summer and fall, such as water temperature, as a result of direct diversions from the stream. However, these effects are negligible in comparison to effects of PG&E hydroelectric operations on water quality. During winter and spring, PCWA's routine operations are not likely to affect water quality in Canyon Creek due to potentially dominating effect of high streamflows associated with snowmelt and runoff in the watershed.

Water quality conditions in Auburn Ravine are likely improved through PCWA's water diversions to Auburn Ravine during the irrigation season. As described in **Chapter 3**, water quality conditions measured at Auburn Ravine below the Auburn Ravine Tunnel outlet were generally better during spring and summer compared to fall and winter sampling events, exhibiting lower concentrations for many constituents in samples collected.

Based on water quality results obtained from canal and stream sites within the Clover Valley Creek, Antelope Creek, Secret Ravine, and Miners Ravine watersheds during baseline sampling events, water temperatures at canal sites were lower than stream sites during late spring and late summer. Water temperatures observed at canal and stream sites during winter and late fall were variable, but remained below 50 °F. DO concentrations measured at canal and stream sites inversely followed water temperature trends described above, exhibiting higher DO concentrations at canal sites during late spring and late summer.

TSS was very low, often below detection limits, and turbidity values were variable across all canal and stream sites monitored in the Clover Valley Creek, Antelope Creek, Secret Ravine, and Miners Ravine watersheds during baseline sampling events. These data suggest that PCWA routine operations do not affect TSS or turbidity in Clover Valley Creek, Antelope Creek, Secret Ravine, or Miners Ravine. Measured pH values were variable across canal and streams sites, while alkalinity and hardness were lower in canal sites compared to stream sites.

SC, ion, and trace element concentrations in samples obtained during baseline sampling events were also consistently lower at canal sites compared to stream sites. These lower constituent concentrations for ions and trace elements suggest that PCWA routine operations potentially provide a water quality benefit to Clover Valley Creek, Antelope Creek, Secret Ravine, and Miners Ravine through flow contributions to streamflow.

Figures providing a comparison of water quality conditions within the PCWA raw water distribution system and Clover Valley Creek, Antelope Creek, Secret Ravine, and Miners Ravine are included in **Appendix B**.

Soils and Sediment Quality

Soils and sediment quality in the study area are not likely to be affected by PCWA's routine operations. PCWA's routine operations do not disturb soils in the study area, or introduce constituents that may affect sediment quality.

5.1.4.2 Biological Resources

Studies conducted through the East Loomis Basin Canal Efficiency Study (USACE and PCWA 2008) suggest that the condition of existing aquatic and terrestrial resources in the study area are dependent on the canal system. While canal operations (including unregulated releases and customer return flows) contribute to flows in Secret Ravine and Miners Ravine, and their tributaries year-round, the canal system contributions dominate dry season flows.

Terrestrial Habitat and Species

Habitat would not be expected to be adversely affected by changes in flow. Some benefits may be experienced by amphibians and wetland/riparian vegetation from improvements in water quality. Some minor damage could be caused to habitats by placement of debris and soil near canals.

Aquatic Habitat and Species

Routine PCWA operations are not likely to affect aquatic habitat and species in Canyon Creek. Flow augmentation in Auburn Ravine by PCWA during spring and summer increases streamflows and supports greater habitat diversity, increased quantity and quality of habitats, and lower summer water temperatures that would be found under natural conditions (Reclamation and PCWA 2002, City of Lincoln 1999). Therefore, current water management practices in Auburn Ravine, including routine PCWA operations, enhance aquatic habitat conditions and potential anadromous salmonid production in Auburn Ravine (Reclamation and PCWA 2002, City of Lincoln 1999).

As described above, routine PCWA canal system operations contribute to flows in Clover Valley Creek, Antelope Creek, Secret Ravine, and Miners Ravine year-round. The PCWA canal system provides direct contributions to flows within these streams through unregulated releases from canal outlets, and indirect contributions through customer return flows, especially during the dry season. These flow contributions have a positive effect on aquatic habitat and species conditions in Clover Valley Creek, Antelope Creek, Secret Ravine, and Miners Ravine.

Special Status Species

Habitat would not be expected to be adversely affected by changes in flow. Some benefits may be experienced by special status amphibians and vegetation from improvements in water quality. Some minor damage could be caused to special status species plants, if present, by placement of debris and soil near canals.

Routine PCWA operations within the Auburn Ravine watershed are beneficial for Chinook salmon and steelhead (Reclamation and PCWA 2002). Increased flows in Auburn Ravine as a result of PCWA's streamflow augmentation (up to 50 cfs), especially during late summer and early fall, support more consistent habitat conditions to rearing steelhead.

As described above, hydrologic and water quality conditions in Clover Valley Creek, Antelope Creek, Secret Ravine, and Miners Ravine are generally improved through routine PCWA operations. Populations of fall-run Chinook salmon and Central Valley steelhead in Secret and

Miners ravines likely benefit from consistent contributions to streamflow from the PCWA canal system during routine operations.

The infrequent presence of special status fish in Clover Valley Creek and Antelope Creek, is likely affected by PCWA routine operations.

5.2 REGULATORY FRAMEWORK FOR POTENTIAL EFFECTS OF SYSTEMWIDE OPERATIONS

The following sections provide the regulatory framework for the potential effects of PCWA operations activities described above. The regulatory framework discussion is organized by Federal, State, and local regulations, and is summarized in **Table 5-3**.

5.2.1 Federal Regulations

Federal laws and regulations associated with the potential effects of PCWA operations activities are described below.

5.2.1.1 Clean Water Act

PCWA activities during yearly PG&E outages were found to have minimal effects on water quality conditions in study area streams. In particular, turbidity and copper levels temporarily increased at canal and stream sites after flows were restored to the canal system following reservoir outages. These increases may indicate the transport of fine sediments and potential mobilization of constituents bound to sediments, such as copper, into receiving waters of the U.S. In general, PCWA activities during yearly PG&E outages are subject to the provisions under the CWA, but they are not required to be permitted. Sections 101(a)(2) and 303(c) of the CWA state the national goal of working with states to establish water quality goals that provide for the protection of beneficial uses, such as the propagation of fish, shellfish, and wildlife and for recreation in and on the water, and agricultural, industrial, and other purposes including navigation. These water quality goals are explained further in **Chapter 4** under the Porter-Cologne Water Quality Control Act.

Seasonal PCWA delivery schedule changes potentially have minimal to no water quality effects, and would not likely result in water quality effects at canal outlets. Minimal effects are associated with the potential for sediment and/or debris to enter the canals from canal banks if PCWA personnel disturb soil along canal banks when entering them to switch out orifice plates. If this occurs, TSS and turbidity levels could temporarily increase. However, it is unlikely that these levels could exceed water quality standards promulgated in the CWA and identified in the Porter-Cologne Water Quality Control Act.

PCWA flood management practices may cause minimal effects on the water quality of receiving water tributaries and streams. Stormwater releases from intermediate canal outlets reduce the effects of bank erosion along canals and lessen potential negative effects along unlined canals resulting from flood flows. However, the canal releases and increased flows to unnamed drainages within the study area may result in bank erosion below the canal outlets, and potential sediment loading to receiving waters, and increased TSS and turbidity in study area streams.

Despite these minimal effects, these flood management practices are in compliance with State and Federal flood management requirements and it is unlikely that the effects would be considered an infringement of CWA regulations.

Routine/Daily PCWA operations may have minimal water quality effects. Water quality conditions in canals during routine/daily operations were observed to be generally better than stream water quality conditions. For example, water temperatures measured were lower and DO levels were higher at canal sites compared to stream sites during late spring and late summer. TSS, turbidity, SC, ion, and trace element levels measured were also generally lower year-round at canal sites compared to stream sites. Because these are overall positive potential effects, CWA is not likely to apply to PCWA's routine/daily operations.

TABLE 5-3
SUMMARY OF REGULATORY FRAMEWORK AND POTENTIAL BEST MANAGEMENT PRACTICES THAT MAY APPLY TO PCWA OPERATIONS ACTIVITIES

PCWA Operations Activity				Effect	Natural Resource Areas Potentially Affected											Relevant Regulations									Best Management Practices (BMP)	Type of BMP		
					Physical			Biological								Federal				State				Local				
								Terrestrial Habitat and Species				Special Status																
Yearly Outages	Delivery Schedule Change	Flood Management	Routine Operations		Hydrology	Water Quality	Soils and Sediment Quality	Wetlands	Nesting birds	Other	Aquatic Habitat and Species	Salmonids	Amphibians	Raptors	Plants	Clean Water Act	Endangered Species Act	Magnuson-Stevens and Sustainable Fisheries Act	Migratory Bird Treaty Act	Porter Cologne	California Endangered Species Act	Fully Protected Species	Native Plant Protection Act	Placer County Conservation Plan		Pre-Implementation	Implementation	Ongoing/Post-Implementation
✓		✓		Bank erosion along unlined canals and at canal outlets and sediment loading to receiving waters		✓	✓	✓		✓	✓	✓	✓		✓	✓	✓	✓		✓	✓	✓		✓	**Improve Canal Bank Stability and Install Sediment Traps in Areas of Soil Disturbance** Install Erosion-Control Blankets Install Temporary Fiber Rolls Apply Spray-On Soil Binders Install Velocity Dissipaters at Canal Outlets Line Banks below Canal Outlets	✓		
		✓			✓	✓	✓	✓			✓	✓	✓			✓	✓			✓	✓	✓			**Avoid Potential Wet Weather Effects** Patrol Canals and Remove Potential Obstructions to Prevent Erosion and Property Damage Minimize Water Purchases from PG&E Before and During High Precipitation Events Distribute Flood Releases from Canal System by Releasing Flows at Numerous Intermediate Outlets			
	✓		✓	Disturbance or damage to sensitive species and habitat potentially present in the area.				✓	✓	✓	✓		✓	✓	✓		✓				✓	✓	✓	✓	**Protect Sensitive Species and Sensitive Species Habitat** Provide Staff with Species Identification Training Evaluate Sites with Sensitive Species and Mark/Protect Sensitive Species Habitat	✓		
		✓					✓	✓	✓	✓	✓	✓	✓	✓	✓		✓			✓	✓	✓	✓	✓	**Avoid Species-Sensitive Areas** Avoid Disturbance to Sensitive Species		✓	
✓				Constituent loading to receiving waters from O&M activities		✓		✓			✓	✓	✓			✓	✓	✓		✓	✓	✓		✓	**Prevent Degraded Water from Entering Streams** Modify Reservoir Operations to Gradually Restore Reservoir Releases to Canals at Slower Rate		✓	
✓	✓	✓	✓	All potential effects	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	**Implement PCWA BMP Program**			✓

5.2.1.2 Endangered Species Act

PCWA operations during annual PG&E outages potentially have minimal effects on special status species. PCWA's rotating outages at Clover Valley and Mammoth reservoirs, and resultant canal dewatering below the reservoirs, may result in minimal effects on special status terrestrial species, including slight decreases in the extent of wetland habitats for special status species. For special status aquatic species, canal dewatering during outages and resultant decreased canal system contributions to streamflow in Clover Valley Creek, Antelope Creek, Secret Ravine, and Miners Ravine may affect Central Valley steelhead and/or critical habitat for Central Valley steelhead. The Federal ESA, regulated by USFWS and NMFS, habitat modification or degradation could be considered a "take" of federally listed species. In which case, an incidental take permit, under Section 10 of the Federal ESA, or a Federal interagency consultation, under Section 7 of the Federal ESA, is required.

Seasonal PCWA customer delivery schedule changes are not likely to affect special status species. Special status plants, if present, may be trampled while PCWA personnel access delivery points, and special status raptors, if present, may be affected by PCWA access to canals. Because these effects are likely minimal and easily avoidable if special status species are present, it is unlikely that Federal ESA permits would be required.

PCWA flood management practices potentially have minimal effects on terrestrial special status species. High-flow releases from canal outlets could wash away amphibian eggs downstream from the outlets, if present, and sediment loading to receiving waters may bury wetland or riparian vegetation. Central Valley steelhead are not likely affected by PCWA flood management practices. High streamflows during precipitation events are more likely to affect aquatic habitat and species than PCWA operations. Because these effects are minimal, and easily avoidable, it is unlikely that Federal ESA permits would be required.

Routine/Daily PCWA operations likely have positive effects on special status species within the PCWA raw water distribution area. Contributions from the PCWA raw water distribution system typically augment streamflows in Auburn Ravine, Clover Valley Creek, Antelope Creek, Secret Ravine, and Miners Ravine, which benefits Central Valley steelhead. These streamflow contributions are particularly evident during summer months, and provide more consistent habitat conditions to rearing Central Valley steelhead. Some benefits to amphibians and wetland/riparian vegetation may also be realized through improvements to water quality as a result of canal system contributions to streamflow. Because the potential negative effects of daily routine operations are negligible and easily avoidable, it is unlikely that Federal ESA permits would be required.

5.2.1.3 Magnuson-Stevens Fishery Conservation and Management Act and the 1996 Sustainable Fisheries Act

PCWA operations during yearly PG&E outages have minimal effects on suitable habitat considered essential for the sustenance of commercial fisheries. Historic decreases in streamflow associated with canal dewatering during outages likely contribute to the delayed spawning

migration of fall-run Chinook salmon observed in the Dry Creek watershed, or may cause redd dewatering. Although the concept of EFH is similar to that of "Critical Habitat" under the Federal ESA, measures recommended to protect EFH by NMFS are advisory, not prescriptive.

5.2.1.4 Migratory Bird Treaty Act

PCWA operations during annual PG&E outages potentially have minimal effects on migratory bird species. Canal dewatering may cause slight decreases in the extent of wetland habitats and affect the species that use wetland habitats, such as foraging birds. However, it is unlikely that these effects would constitute a “take” of a migratory bird species or habitat (as defined by the MBTA) and therefore would not be subject to the MBTA.

5.2.2 State Regulations

Laws and regulations governed by the State of California and associated with the potential effects of PCWA operations activities are described below.

5.2.2.1 Porter-Cologne Water Quality Control Act

The regulatory framework for water quality effects resulting from PCWA operations during yearly PG&E outages, seasonal delivery schedule changes, flood management practices, and routine/daily operations, are similar to those described previously under the CWA.

Of the Criteria for Priority Toxic Pollutants in California, cadmium, copper, and zinc were three criteria parameters monitored for during PCWA outage activities. Neither cadmium nor zinc criteria were exceeded. The freshwater CCC for copper (9 µg/L) was exceeded at sites monitored during the PG&E yearly outages (November 2, 2006) within the Antelope Creek, Secret Ravine, and Miners Ravine watersheds, but the exceedances are likely associated with heavy rain and runoff contributions to flow at sites during sampling.

Of the water quality objectives associated with beneficial uses of the Sacramento River in the Sacramento-San Joaquin Basin Plan, barium, copper, iron, zinc, DO, pH, and turbidity were monitored during PCWA outage activities. The water quality objective for copper (based on specific levels of hardness calculated from measured calcium and magnesium levels) was exceeded at the Antelope Creek monitoring site on November 2, 2006 (10 µg/L for an objective of 9.3 µg/L based on the associated hardness of 70 mg/L), but the exceedance is likely associated with heavy rain and runoff contributions to flow at the site during sampling.

5.2.2.2 California Endangered Species Act

Under the California ESA, the effects on special status species from PCWA operations during PG&E yearly outages, seasonal delivery schedule changes, flood management practices, and routine/daily operations, are similar to those described previously under the Federal ESA. However, the California ESA addresses the incidental take of State-listed species as threatened or endangered. DFG is the enforcement agency of the California ESA.

5.2.2.3 California Fish and Game Code-Fully Protected Species

Under the Fish and Game Code-Fully Protected Species, the effects on special status species from PCWA operations of annual PG&E outages, seasonal delivery schedule changes, flood management practices, and routine/daily operations, are similar to those described previously under the Federal ESA. However, this code addresses the incidental take of fully protected species. DFG is unable to authorize incidental take of fully protected species, such as White-tailed Kite and the California Black Rail, when activities are proposed in areas inhabited by those species. Therefore, the take of any fully protected species for project implementation is prohibited.

5.2.2.4 California Native Plant Protection Act

This act applies to endangered and "rare" plant species, subspecies, and varieties of wild native plants in California. Annual PG&E outages, seasonal delivery schedule changes, and routine/daily operations may have minimal effects on endangered and "rare" plant species in the PCWA raw water distribution area if vegetation is damaged during fieldwork. However, these effects are easily avoidable through effective BMP implementation. Routine/daily operations are likely to benefit wetland/riparian vegetation from improvements in water quality and increased flows.

5.2.3 Local Requirements and Considerations

The following sections describe the framework for local requirements during PCWA maintenance activities.

5.2.3.1 Placer County Conservation Plan

As described in **Chapter 4**, the PCCP includes plans with goals to protect fish and wildlife and their habitat and protect streams, wetlands, and other water resources, as well as coverage under several environmental permits to be issued to Participating Entities. With PCCP long-term environmental permits, such as ESA and NCCP incidental take, Section 404, a renewable Section 401 certification, "Joint Procedures" approved by the USACE may be used by the Participating Entities for aquatic resource permit processing under the CWA, and a programmatic master streambed alteration agreement, PCWA will be covered for activity projects that require it.

The regulatory framework for PCWA operations activities related to the PCCP are the same as those described for CWA, ESA, Porter-Cologne Water Quality Control Act, California ESA, and California Fish and Game codes.

5.3 BEST MANAGEMENT PRACTICE OPTIONS TO ADDRESS POTENTIAL EFFECTS OF SYSTEMWIDE OPERATIONS ACTIVITIES

BMPs are measures designed to reduce or prevent potential effects of a particular activity on the surrounding environment. The term originated from rules and regulations in Section 208 of the CWA. The "best" practice is cost effective and site specific. BMPs can be both structural and nonstructural. Structural BMPs include facilities constructed to prevent or minimize effects, and nonstructural BMPs include changes in activities or operation management, such as scheduling around periods when potential effects are greatest, and often focus more on controlling pollutants at the source.

BMPs to address potential effects of PCWA operations can be applied during three different stages: (1) pre-implementation, (2) during implementation, and (3) ongoing or post-implementation. Some BMPs can be implemented during more than one stage. The list of BMP options is not comprehensive; instead, it provides examples of BMPs that may be implemented to minimize particular potential effects of PCWA canal operations activities. As part of these BMP recommendations, BMP monitoring and evaluation are recommended for determining BMP effectiveness. Potential BMPs to reduce potential effects of PCWA operations activities on natural resources are summarized in **Table 5-3**, and described below.

5.3.1 Pre-Implementation Best Management Practices

Pre-implementation BMPs are those that are applied in preparation for the activity because they may take more time to develop before they become effective or because they involve complex setup procedures. Below are potential pre-implementation BMPs for reducing potential effects of PCWA operations activities on natural resources in the study area.

5.3.1.1 Improve Canal Bank Stability and Install Sediment Control Measures at Canal Outlets

Canal bank erosion along unlined canals, which may occur after canal flows are restored following dewatering activities (such as PCWA operations during yearly PG&E outages) and by PCWA flood management practices, may be minimized through implementation of BMPs to improve canal bank stability. PCWA is already implementing BMPs to provide canal bank stability by lining canals with gunite. Stabilizing vulnerable or disturbed areas along unlined canal banks can decrease erosion and associated sediment transport and deposition. Areas vulnerable to erosion may be those with steep slopes, little to no vegetation, and loose soil. Areas along canal banks that have been disturbed by previous canal activities, recreation along canals, or storm events, are particularly vulnerable to erosion. Additionally, sediment-control measures may be installed at canal outlets, where possible, to reduce sediment and associated constituents, and loading to receiving waters during PCWA operations activities. Maintaining site stabilization should be implemented year-round by keeping wet season sediment-trapping devices available and operational. The following sections describe potential BMPs to improve canal bank stability and reduce sediment loading to receiving waters.

Install Velocity Dissipaters at Canal Outlets

Velocity dissipaters are strategically placed rock along the flow line in a stream or at a canal outlet to dissipate energy and slow the flow of water released at canal outlets, thereby reducing the potential for erosion and sediment loading downstream. Rocks are often set in mortar in a way that is designed to interrupt water passage and spread concentrated flows over and through protruding rock. For example, rocks could be set in a step pool formation based on natural channel design concepts. Dissipators can be underlain with geotextile fabric to reduce the potential for eroding the underlying soil. Other types of dissipaters include solid concrete structures, riprap, baffles, pipe junctions, and drop boxes.

Line Banks below Canal Outlets

Through lining banks below canal outlets with gunite, where possible, bank stability is improved and the potential for erosion is decreased. Although lining is also addressed in this manual as an O&M activity, it is also considered a BMP as it is applied to areas along the canal system that have been disturbed by previous canal activities, recreation along canals, or storm events, are particularly vulnerable to erosion. PCWA is already implementing this type of BMP, where possible.

5.3.1.2 Avoid Potential Wet Weather Effects

Avoidance of potential adverse effects of PCWA operations activities during wet weather, when and where feasible, can be very effective. Avoided adverse effects may include canal bank erosion and sediment loading into receiving streams during wet weather events. Examples of BMP options are as follows:

Patrol Canals and Remove Potential Obstructions to Prevent Erosion and Property Damage

Large debris that gets into the canals, such as fallen tree limbs, may obstruct water flow within the canal system and may lead to canal bank erosion and/or property damage if not removed. Through implementing this BMP, PCWA staff would periodically patrol the canal system before the wet season and after heavy storm events and remove potential obstructions in a timely manner. PCWA is already implementing this type of BMP.

Minimize Amount of Water Purchased from PG&E During Periods of High Precipitation

Before and during precipitation events likely to cause in substantial precipitation runoff, PCWA may reduce water purchases from PG&E to increase canal capacity for conveyance of precipitation runoff. Through reducing the flow conveyed by PCWA's canal system during precipitation events, PCWA may decrease the potential for canal bank erosion. PCWA is already implementing this type of BMP.

Distribute Flood Releases from Canal System by Releasing Flows at Numerous Intermediate Outlets

During precipitation events when flows and water levels in the canals are high, water can be released from several intermediate canal outlets to dissipate flows throughout the system at lower

flow rates and reduce the potential for downstream erosion and sedimentation. PCWA is already implementing this type of BMP, where possible.

5.3.1.3 Protect Sensitive Species and Sensitive Species Habitat

Taking steps to ensure the protection of sensitive species and sensitive species habitat before an activity occurs involves both structural and nonstructural solutions.

Provide Staff with Species Identification Training

As a nonstructural solution to protecting sensitive species habitat in the PCWA raw water distribution system, PCWA personnel can be trained to recognize special status habitat and species before O&M activities. With this information, potential effects to species, such as trampling special status vegetation and habitat, and effects on raptor nests from noise disturbance, may be prevented. As part of this training program, PCWA field staff will be provided with an identification table with photos and descriptions to assist in identifying special status species known or expected to occur near work areas. PCWA is already implementing this type of BMP.

Evaluate Sites with Sensitive Species and Mark/Protect Sensitive Species Habitat

If special status species and/or associated habitats are identified, temporary fencing, signs, or colored ribbon may be used to mark the known location of the species or habitat, such as rare plants or trees with active raptor nests, to help prevent disturbance to the habitat or species during operations activities. PCWA is already implementing this type of BMP.

5.3.2 Implementation Best Management Practices

Implementation BMPs are management measures applied while the activity is being implemented. The following sections provide potential implementation BMPS to reduce potential effects of PCWA operations activities on natural resources.

5.3.2.1 Avoid Sensitive Species Areas

During operations activities, PCWA personnel can do several things to prevent potential effects on terrestrial species and disturbance to terrestrial species habitat. Examples of BMP options follow.

Avoid Disturbance to Sensitive Species

To avoid potentially disturbing sensitive species in the vicinity of operations activities, PCWA staff may stay on roads, paths, or other previously disturbed areas whenever possible. This BMP option also involves helping equipment and vehicles confined to roads, paths, or other previously disturbed areas to avoid disturbing sensitive species in the vicinity. PCWA is already implementing this type of BMP, where possible.

5.3.2.2 Prevent Degraded Water from Entering Streams

BMPs may be implemented to prevent or reduce the amount of degraded water from PCWA's canal system from entering streams. Based on results from water quality monitoring, water

quality conditions downstream from O&M activities that involve canal dewatering can exhibit high turbidity, TSS, and concentrations of constituents associated with sediment or other material.

Modify Canal Operations to Gradually Restore Reservoir Releases to Canals at Slower Rate

Modifying PCWA reservoir management practices during PG&E yearly outages can be effective for reducing sediment loading into receiving waters. When possible, water releases from Mammoth and Clover Valley reservoirs to canals following outages during the PG&E yearly outages may be restored at a slow and graduated rate. These graduated reservoir releases may decrease the potential mobilization and transport of settled materials and constituent loading to receiving waters after canal flows are restored.

5.3.3 Ongoing or Post-Implementation Best Management Practices

Ongoing or post-implementation BMPs are typically management and preventative measures. One potential ongoing or post-implementation BMP was identified to minimize potential effects of PCWA operations activities, and is described below.

5.3.3.1 Implement PCWA Best Management Practice Program

An ongoing PCWA BMP program would serve to update and maintain BMPs, as well as track BMP effectiveness. The program would also provide staff training for BMP implementation during PCWA O&M activity implementation.

BMP alternatives are continually being developed and information on BMP effectiveness is continually changing. It is important to stay updated on BMP news so as to provide for the most effective BMP implementation.

BMP maintenance increases the durability and effectiveness of structural BMPs. In fact, unmaintained BMPs can increase potential effects. For example, if an erosion-control blanket is not well-maintained it could become dislodged and be swept down a canal as debris.

Staff BMP implementation training would consist of a BMP training manual and periodic training sessions on effective BMP implementation in the field. Several of the pre-implementation BMPs, such as species identification training, would be part of this program.

5.4 SUGGESTIONS FOR FURTHER STUDIES

Based on results of NRMP studies, PCWA operations may affect natural resources conditions within the study area. Higher concentrations of trace metals, particularly aluminum and copper, were observed at sites monitored within the PCWA canal system compared to stream sites for sampling events associated with PCWA's operations during the PG&E yearly outages. These data may inconclusively suggest that the PCWA canal system is a source for loading of some constituents to study area streams.

Additional routine and event-based water quality monitoring should be conducted at sites within the PCWA canal system, and stream sites upstream and downstream from canal system contributions, to characterize potential effects of PCWA operations activities on water quality conditions. One of the focal points for additional studies should be to evaluate aluminum and copper inputs to study area streams from the PCWA canal system. Potential sites for routine and operations event-based water quality monitoring include:

- Boardman Canal below Mammoth Reservoir
- End of Boardman Canal outlet
- End of Yankee Hill Canal outlet
- Secret Ravine at Loomis Basin Park
- Secret Ravine at Rocklin Road
- Clover Valley Reservoir release to Clover Valley Creek and Antelope Canal

Additionally, sediment quality monitoring at numerous sites exhibiting variable soil conditions along the canal system and study area streams may be help to determine potential sources of trace metals in PCWA canals and study area streams. Soil sampling for representative soil types should be coordinated with routine and operations event-based water quality monitoring. Soil samples should be collected from undisturbed sites of representative soil types, as characterized by PCWA (2005), near and upstream from canal and stream water quality monitoring sites, and within watersheds of Clover Valley Creek, Antelope Creek, Secret Ravine, and Miners Ravine.