Herbicide application to aquatic vegetation in Mammoth Reservoir

October and January. The tank mix for pre-emergent applications includes Drexel-Diuron (Diuron-80) or Milestone® (aminopyralid), Roundup® (glyphosate), and Dimension® (dithiopyr). Surfactants are also added to the tank mix to enable herbicide penetration of plant cuticles. R-11®, a non-ionic alkylphenol ethoxylate surfactant, is added to the tank mix whenever glyphosate is used in aquatic systems. Alkylphenol ethoxylates may break down into a variety of metabolites, including nonylphenol (Ferguson et al. 2001). Primary contributors of nonylphenol to the environment are wastewater sources. Under aerobic conditions, nonylphenol tends to break down to inert products (Maguire 1999, Staples et al. 1998). Red Top Mor-Act®, a nonphytotoxic paraffin-based petroleum oil, is also used by PCWA. Both R-11® and Red Top Mor-Act® are manufactured by Wilbur-Ellis Company® (Wilbur-Ellis 1999).

Rodeo® and AquaMaster™ are glyphosate herbicides rated for use near water. AquaMaster™ is applied when the targeted growth occurs on the inside edge of the canal berm and when the potential for some herbicide to reach the water is present, because it dissipates in water by binding to soil particles and organic material or through microbial degradation. AquaMaster™, or Reward® (diquat dibromide), is also applied to aquatic vegetation in Lake Alta, Lake Theodore, Clover Valley Reservoir, and Mammoth Reservoir once per year. These herbicides are also applied to control vegetative growth on the downstream faces of dams at these reservoirs, as needed.

The half-life of glyphosate is highly variable, depending on the environmental conditions. In standing water, the half-life is from 12 days to 10 weeks; in soil, it is from 1 to 174 days. Glyphosate has low toxicity to birds and virtually no toxicity to fish (EXTOXNET 1994). Diquat dibromide is persistent (half-life approximately 1,000 days), toxic to fish and wildlife, tightly adsorbed to soil particles, and is unavailable to soil microbes and for plant uptake (Syngenta 2002).

Garlon4™ is a pyridine-based triclopyr herbicide used for the control of woody plants and annual and perennial broadleaf weeds, and is applied to plants on the outside of the canal berm when the potential exposure to canal water is minimal. Garlon4™ contains triclopyr in the form of butoxyethyl ester (TBEE). TBEE is rapidly converted to triclopyr acid through hydrolysis in both natural water and soil in less than a day (Ganapathy 1997, Somasundaram and Coats 1991, Bidlack 1978). In natural waters, triclopyr is degraded by sunlight with a half-life of about 1.3 days. Oxamic acid is the main photodegradation product in water, with low molecular-weight organic acids as minor products (Ganapathy 1997, Woodburn et al. 1993). TBEE has a tendency to adsorb to organic matter and is relatively immobile. TBEE rapidly hydrolyzes to triclopyr acid with a half-life of 3 hours (Ganapathy 1997, Bidlack 1978), and triclopyr is broken down

through microbial degradation. Aerobic degradation in soil produces the intermediate metabolites (3,5,6-trichloro-2-pyridinol and 3,5,6-trichloro-2-methoxypyridine), that eventually convert to carbon dioxide (CO_2) (Ganapathy 1997, Cryer et al. 1993). Triclopyr is listed as "fairly degradable" in soil at reported half-lives ranging from 12 to 27 days (Ganapathy 1997, Linders et al. 1994). TBEE is classified as very toxic to aquatic organisms, but is rapidly degraded to triclopyr, which has a low toxicity to fish, Daphnia, and algae. Garlon4™ is not classified as harmful to game, wild birds, and animals (Dow AgroSciences 2006).

2.4.2 Cleaning and Flushing

As an open channel system, debris that accumulates in the canals can decrease canal flow capacity by raising water levels within the canal, and clog piped sections and delivery points, causing blockages and subsequent canal overtopping. Accumulated debris in the canals may lead to overflowing canals and/or interruptions to customer deliveries. This debris is cleaned and/or flushed from the canal system on an as-needed basis. PCWA conducts comprehensive canal cleaning activities within their system during winter and spring each year, and requires several months to complete.

Boardman Canal at Hanson Spill dewatered and prepared for cleaning

Debris removal from Baughman Canal

Annual cleaning is performed throughout the raw water distribution system, beginning in early January in the upper (northeastern) portion of Zone 1 and moving downward through the system to the end of Zone 1, then to the upper portion of Zone 3 and moving downward to the end of Zone 3. Canals in PCWA's Zone 5 service area are maintained by South Sutter Water District. During cleaning activities, canal system operations are typically maintained upstream of the canal segment to be cleaned, and water is diverted from the canal segment through an intermediate regulated canal outlet just upstream of the segments being cleaned to dewater the canal. Water deliveries to canal system customers receiving their purchased water downstream from canal segments being cleaned are temporarily interrupted due to the upstream diversions.

Large debris is removed from the channel by machinery (small excavator compact loader), where accessible. Hand crews follow machinery with hand tools to complete debris and accumulated

sediment removal. Where canals are inaccessible to machinery, hand crews alone perform the cleaning. Debris and sediment removed from the canals are typically deposited along canal banks.

After cleaning is completed and before restoring flow to downstream segments, intermediate outlet releases upstream from canal cleaning are closed, and intermediate outlet releases downstream from canal cleaning are opened to flush remaining debris and sediment from the canal. The cleaned canal segments are typically flushed for about 1 hour, but the duration of flushing depends on the length of canal cleaned, amount of debris and sediment remaining in the canal segment, and the flow rate of the water in the canal. After a period of flushing, the outlet release is closed, and canal flows are restored to the system downstream from the cleaned canal segment.

Canal cleaning takes place during normal business hours, and canal flows are restored during the evening, thereby minimizing service interruptions to customers. PCWA Customer Service informs their customers of the expected interruption to service with informational letters distributed through the postal mail in the area affected by canal cleaning activities.

Outlets and siphons may also accumulate debris, and are cleaned year round, as required by debris accumulation and flow restrictions. During the cleaning process, customer delivery points and flow-control structures in canal outlets, and siphons may be removed, and canal flows are conveyed through the outlets and siphons to flush out debris and sediment. Outlet and siphon flushing is typically accomplished in under an hour, but may take longer, depending on the extent of debris and sediment accumulation.

2.4.3 Canal Lining/Guniting

Canal lining is typically performed during winter months, when water demands are lower, to reduce erosion and sloughing of canal banks, improve the efficiency of water delivery in canal segments, and to repair and prevent leaks in canal sections that may cause damage to infrastructure and/or property. Canal sections are also lined outside of winter months in areas that are inaccessible during winter, to address leaks that arise during the year, and to continue canal lining activities that were not completed during winter. Canals are lined with gunite, a dry-mix concrete material blown through a nozzle where water is injected immediately before application. Gunite is applied to canals to reduce seepage from the canal channel to adjacent soils. Small cracks in the gunited canals are repaired with Burke Plug, a hydraulic cement manufactured by Edoco©.

Ponding on landowner property due to seepage visible in background, and recent lining on Baughman Canal

Baughman Canal lining

Water is diverted from the segment to be lined, and the canal segment is dewatered by pumping any remaining water in the canal segment out of the canal and releasing the water to storm drains, ditches, drainage swales, or the ground surface adjacent to the canal. The segment is then cleaned as described above, and reinforced with wire mesh laid into the bottom of the canal before spraying with gunite. Several hundred feet of canal are lined with gunite at a time, and allowed to cure for several hours. Canal flows are restored to the newly lined segments during the evening after the segment has cured. The newly lined canal segment is flushed to remove any accumulated debris and sediment in the canal using the nearest intermediate canal outlet downstream from the lining activities, as described for canal cleaning.

Canal lining requires relatively dry weather and is not performed during or just after heavy rain, as runoff can wash out fresh gunite from the channel. Therefore, the canal-lining schedule, developed a month or more in advance of the activities, is subject to changes and delays according to weather. PCWA Customer Service informs customers of the expected interruption to service with informational letters distributed through the postal mail in the area affected by canal-lining activities.

Before canal-lining activities, PCWA evaluates the potential impacts to environmental resources, and prepares an environmental compliance document to satisfy CEQA requirements.

2.5 AS-NEEDED REPAIR OR REPLACEMENT

Barton Canal pipe replacement

PCWA repairs and/or replaces pipes, flumes, culverts, siphons, outlet structures, flow-control structures, and customer delivery points throughout the PCWA canal system on a scheduled and as-needed basis. These activities may involve minor repairs with minimal disturbance to customer deliveries and minor effects on environmental resources, while others requiring onsite construction may become more involved.

Pipe repair performed on PCWA canal

In all instances of as-needed repair or replacement, PCWA staff members evaluate the potential impacts to environmental resources, and prepare an environmental compliance document to satisfy CEQA requirements.

2.6 OTHER MAINTENANCE PROJECTS

Other maintenance projects performed infrequently by PCWA and not addressed in this report include:

- Sediment removal from reservoirs
- Sediment removal from Canyon Creek
- Dam, reservoir berm, and canal berm maintenance to address problems due to muskrats, beavers, and otters

For these other maintenance projects, PCWA staff members evaluate the potential impacts to environmental resources, and prepare an environmental compliance document to satisfy CEQA requirements.

CHAPTER 3.0
NATURAL RESOURCES SETTING

This chapter presents methodology for defining natural resources settings and describes physical and biological resources conditions in the NRMP study area.

3.1 METHODOLOGY

This section provides the methodology used to describe the natural resources setting of the NRMP study area during routine operations of the PCWA raw water distribution activities system. Operations activities include routine flow adjustments, seasonal adjustments to delivery points, and annual outages due to PG&E operations.

3.1.1 Physical Resources

The following sections describe the methodology for characterizing physical resource conditions in the NRMP study area. Physical resources evaluated for the NRMP include hydrology, water quality, and soil and sediment quality.

3.1.1.1 Hydrology

This section describes the methodology used to describe the hydrology setting of the PCWA raw water distribution area during routine operations activities within the PCWA raw water distribution area.

Information on the hydrology setting was gathered through discussions with PCWA staff, existing literature, and from U.S. Geological Survey (USGS) stream gaging stations. In addition to information obtained through other sources, extensive flow monitoring performed by PCWA in lower Zone 1 provided data that were valuable to developing a better understanding of the roles of the canals in the hydrology of the interrelated stream systems. This understanding is used here to better describe the hydrology of the rest of Zone 1 as well as Zones 3 and 5.

3.1.1.2 Water Quality

This section describes the methodology for characterizing baseline water quality conditions in the PCWA raw water distribution area. Water quality information was obtained from several reports and studies conducted by various organizations. Water quality data was collected in the study area by PCWA, Central Valley Regional Water Quality Control Board (RWQCB), Dry Creek Conservancy (DCC), and the Central Valley Clean Water Association (CVCWA).

PCWA conducted water quality monitoring at sites within the PCWA raw water distribution system, and receiving water tributaries, streams, and ravines on dates during different seasons intended to provide representative samples of baseline conditions within the study area: December 7, 2006, January 29, 2007, May 30, 2007, and August 30, 2007, representing the fall, winter, spring, and summer seasons, respectively. Data collected during these dates are presumed to be representative of routine canal operations, considered to be baseline activities

within the study area. The Central Valley RWQCB collected water quality information for Secret Ravine and Miners Ravine monthly from December 2000 through February 2002. DCC tested Secret Ravine at multiple locations for a suite of water quality constituents between 2001 and 2005. The constituents tested included heavy metals, nutrients, bacteria, pesticide components, and typical water quality parameters such as pH, alkalinity, and hardness. The CVCWA monitored methylmercury from August 2004 through April 2005 in Miners Ravine below the discharge of the Placer County Sewer Maintenance District (SMD) No. 3 tertiary wastewater treatment plant (WWTP).

Sampling locations, times, and water quality parameters, as well as the baseline concept and its seasonal framework, are described in the following sections.

Monitoring Locations

In situ water quality conditions were measured using a handheld multi-meter, and grab samples were obtained at eight locations within the PCWA raw water service area during the 2007 water delivery year (WDY) (October 16, 2006, through October 15, 2007). These locations, listed in **Table 3-1** and shown in **Figures 3-1 through 3-4**, were selected to represent the variety of conditions and physical locations within the watersheds downstream from potential flow contributions from the PCWA canal system, while allowing reliable site access through public rights-of-way or easements.

TABLE 3-1
BASELINE WATER QUALITY MONITORING LOCATIONS IN MAJOR STREAMS AND DRAINAGES IN THE PCWA RAW WATER SERVICE AREA

BASELINE MONITORING LOCATIONS		
Site Description	**Site Identification**	**Site Type**
Zone 3		
Boardman Canal below Lake Alta	YB96	Canal
Zone 1		
Boardman Canal at Powerhouse Road	YB78	Canal
Clover Valley Reservoir Release to Clover Valley Creek and Antelope Canal	CLVRESR	Canal
Boardman Canal below Mammoth Reservoir	YB81	Canal
Yankee Hill Canal Outlet Release	YANKEECR	Canal
Baughman Canal Outlet Release	BAUGHMANCR	Canal
Tributary to Secret Ravine from Yankee Hill Canal	YHTRIB2	Drainage
Secret Ravine at Rocklin Road	SECRETRV3	Stream
Tributary to Miners Ravine from Baughman Canal	BCTRIB1	Drainage
Miners Ravine at Dick Cook Road	MINERSRV6	Stream
Miners Ravine near N. Sunrise Avenue	MINERSRV3	Stream
Auburn Ravine below American River Tunnel outlet	AUBRAV3	Stream
Clover Valley Creek near Argonaut Avenue (at Golf Course)	CLVRC3B	Stream
Antelope Creek at Midas Avenue	ANTC3B	Stream

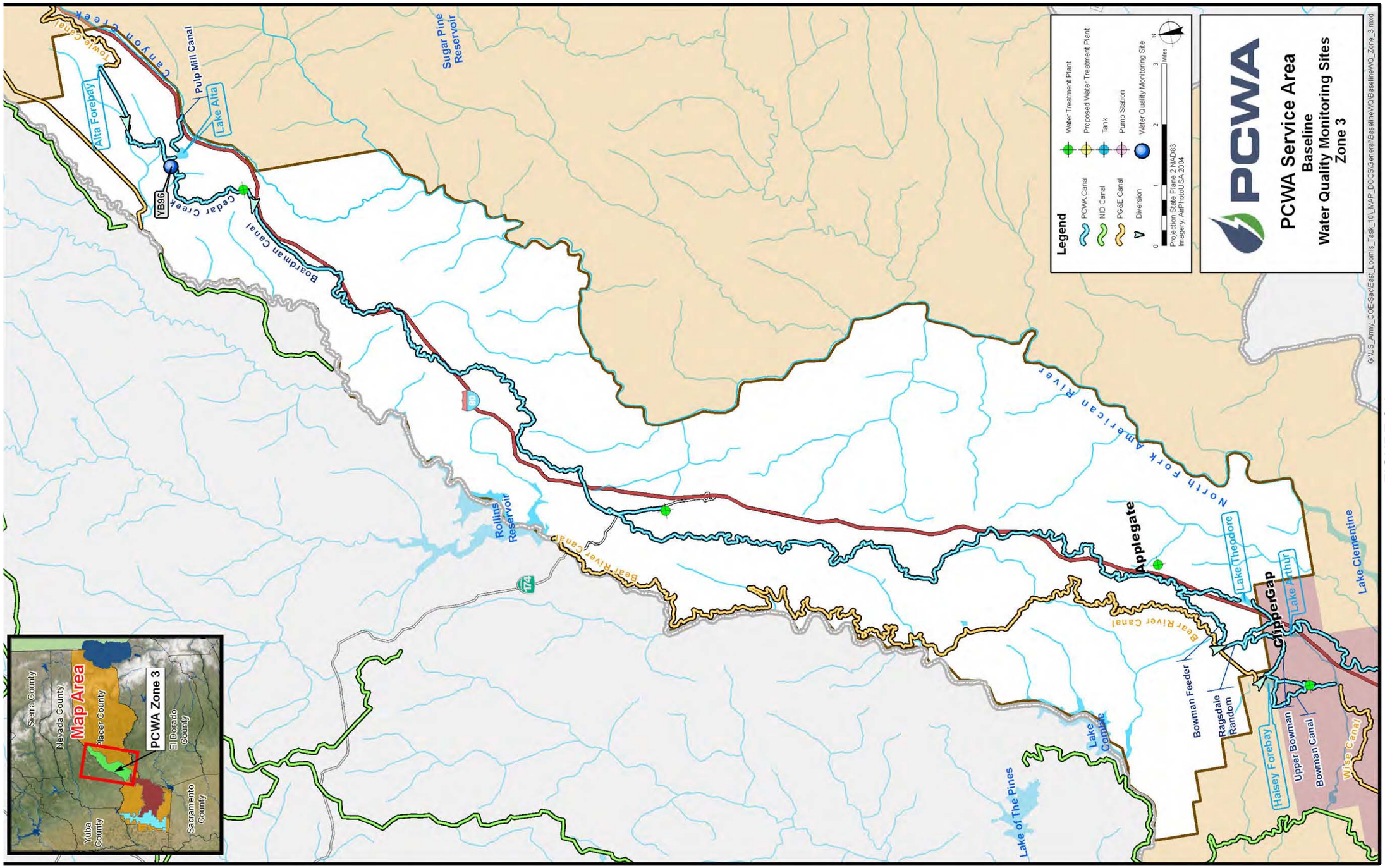

FIGURE 3-1
ZONE 3 BASELINE WATER QUALITY MONITORING SITES

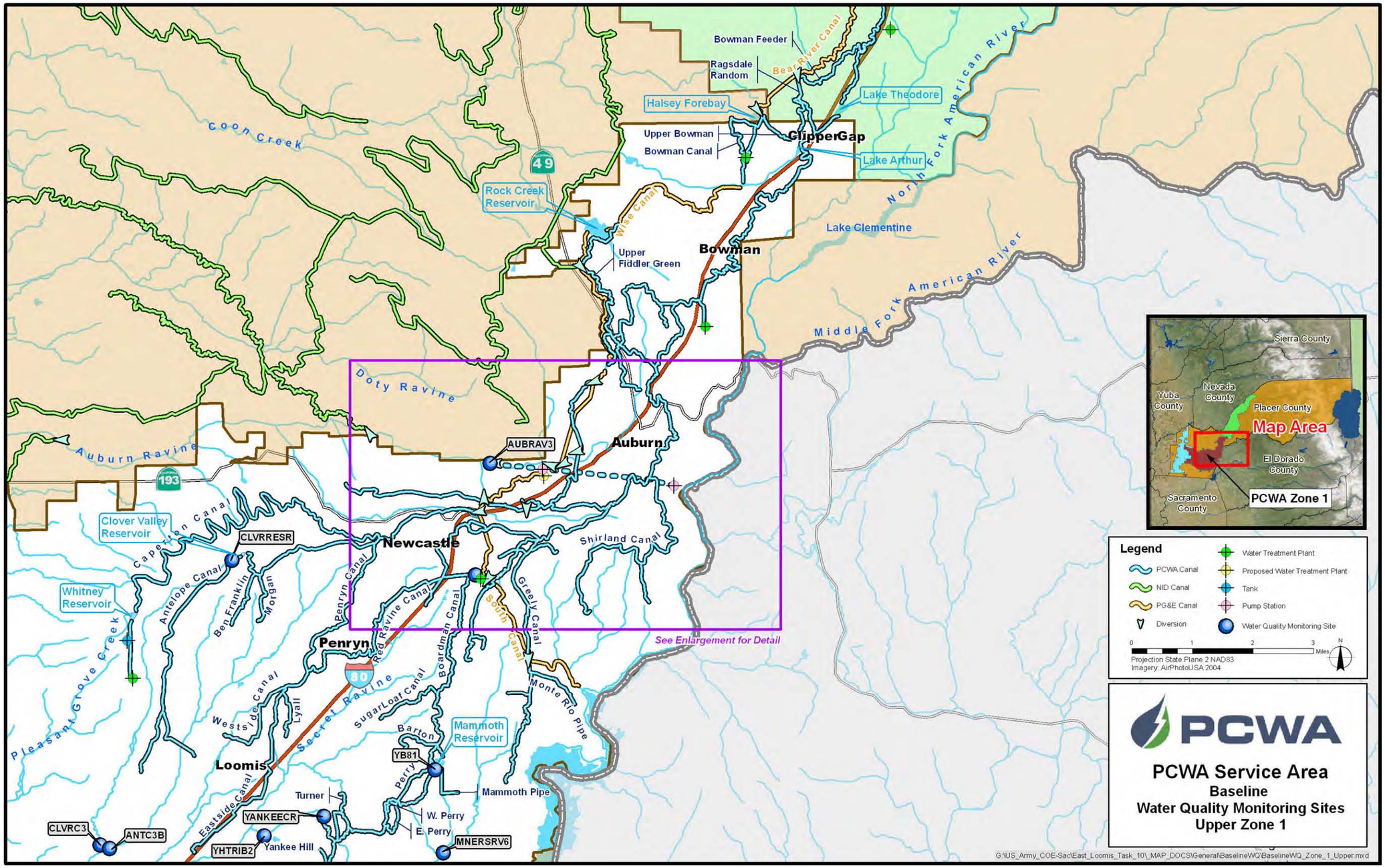

FIGURE 3-2
UPPER ZONE 1 BASELINE WATER QUALITY MONITORING SITES

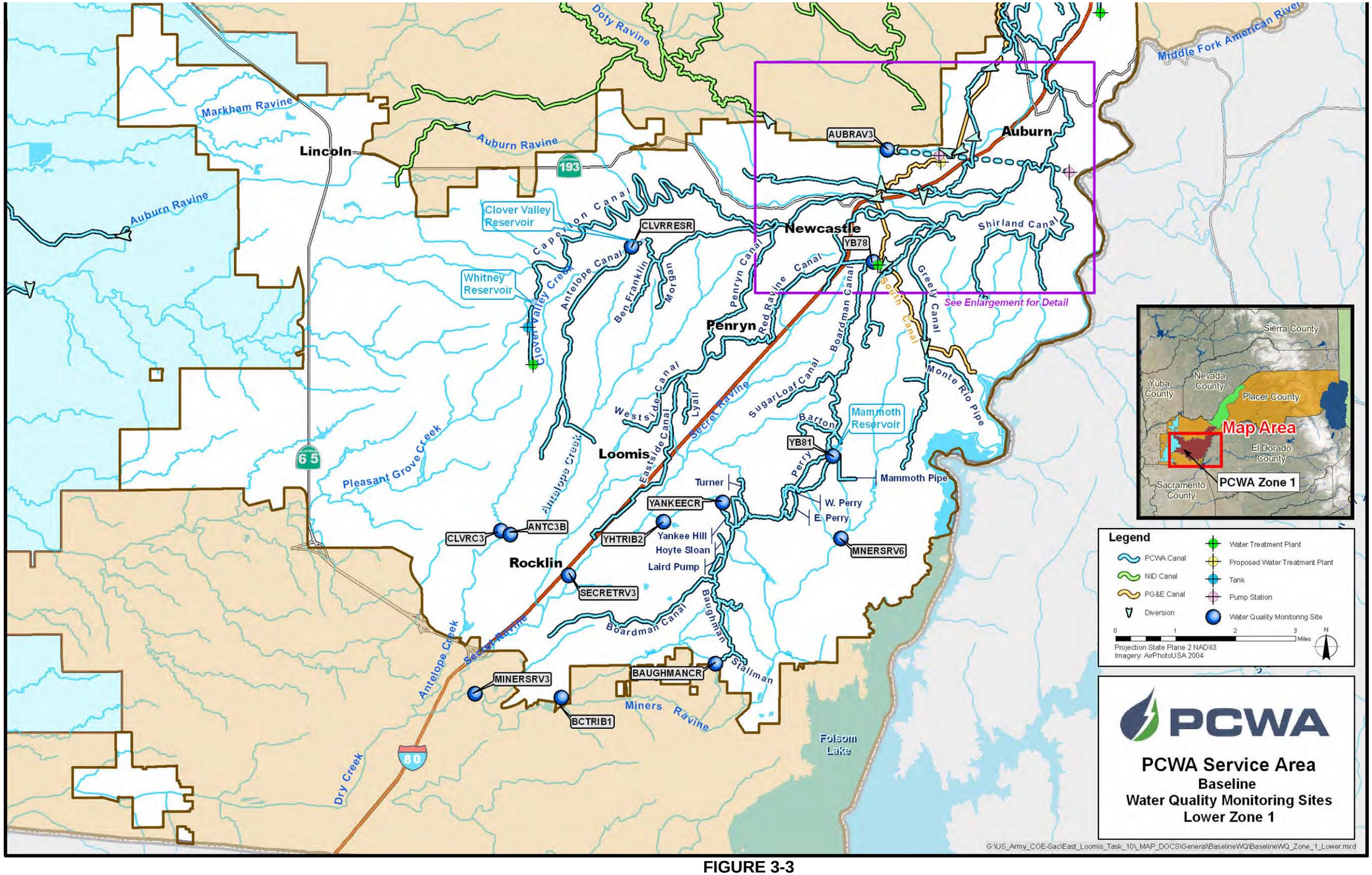

FIGURE 3-3
LOWER ZONE 1 BASELINE WATER QUALITY MONITORING SITES

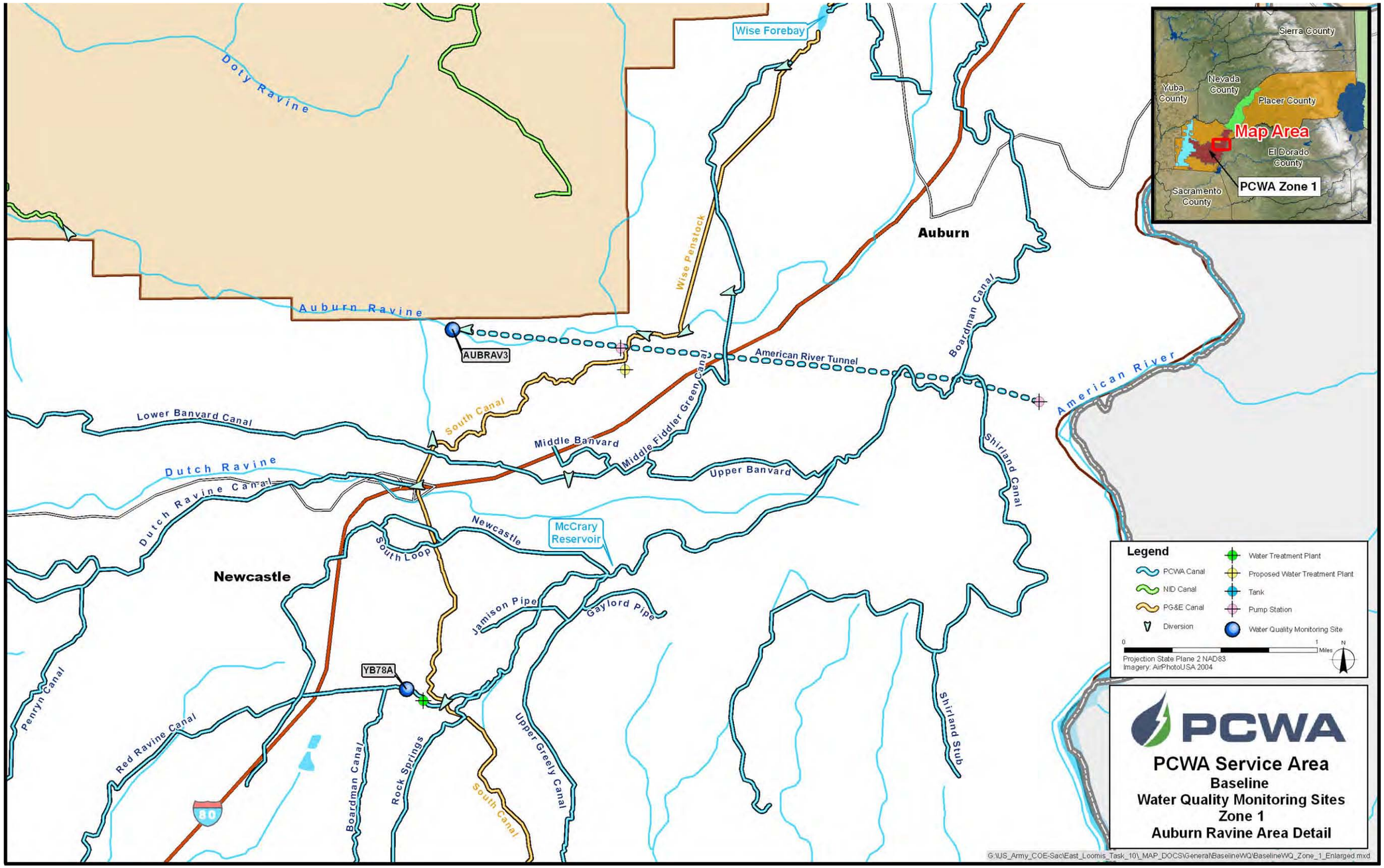

FIGURE 3-4
LOWER ZONE 1 AUBURN RAVINE AREA BASELINE WATER QUALITY MONITORING SITES

Sample Timing

Samples were collected at each location on a day intended to represent the general background water quality and flow conditions in the system during the fall, winter, spring, and summer seasons.[1] Baseline water quality sampling events avoided days with rainfall on the day of, or during the days preceding, sample collection. Timing of water quality sampling during the day may affect concentrations of certain parameters, including water temperature, dissolved oxygen (DO), and pH due to diurnal temperature changes and biogeochemical processes. As a result, to reduce the potential for differences in water quality at a particular site, measurement and sample collection were conducted at approximately the same time for each of the eight sites during the baseline sampling events.

Fall, winter, spring, and summer baseline water quality was measured on December 7, 2006, January 29, 2007, May 30, 2007, and August 30, 2007, respectively. Each event was scheduled after at least 1 week of dry weather so as to adequately represent baseline canal water quality contributions. Weather on the sampling dates was dry, and no precipitation fell in the sampling areas during the weeks preceding the sampling events except a slight rain event during the week preceding the spring baseline sampling. Weather conditions during and before the baseline sampling events are summarized in **Table 3-2**.

TABLE 3-2
WEATHER CONDITIONS DURING AND BEFORE WATER QUALITY BASELINE MONITORING IN THE PCWA RAW WATER DISTRIBUTION AREA

Season	Date	Weather on Sampling Date		Weather During Preceding Week		
		Maximum Air Temperature (°F)	Total Precipitation (inches)	Maximum Air Temperatures (°F)	Minimum Air Temperatures (°F)	Average Daily Precipitation (inches)
Fall	December 7, 2006	67	0.00	56-68	37-45	0.00
Winter	January 29, 2007	55	0.00	51-65	29-42	0.00
Spring	May 30, 2007	80	0.00	79- 80	52- 54	0.16
Summer	August 30, 2007	98	0.00	89-99	59-75	0.00

Key:
°F = degrees Fahrenheit

Water Quality Parameters

Sampled water quality parameters are shown in **Table 3-3**. A maximum of 22 water quality parameters was measured at each baseline location. Most of the basic physical and chemical water quality parameters, including DO, pH, specific conductivity (SC), water temperature, and turbidity, were measured *in situ* with a Hydrolab Quanta handheld water quality instrument at each sampling location. Water samples were collected and analyzed by MWH Laboratories for the following water quality parameters: alkalinity, total suspended solids (TSS), aluminum,

[1] Periodic water quality measurement and grab samples only provide general qualitative information on water quality of the streams. Continual long-term monitoring is required for a more detailed water quality analysis.