3.2.2.3 Zone 5

Zone 5 comprises the lower portion of the Auburn Ravine watershed where agricultural water deliveries are made to PCWA customers through the Moore and Pleasant Grove canals.

Although water quality measurements were not taken in the Auburn Ravine watershed during this study, some data were collected by other sources and are summarized below.

Water Temperature and Dissolved Oxygen

Water temperature data collected from other sources include hourly temperature monitoring conducted by Bailey Environmental between April 1999 and August 2003 at Fowler Road, the NID gaging station near Highway 65 in Lincoln, Moore Road, and the Aitken Ranch. Temperature data from this project show summer values (May 28 to August 4, 2003) ranging from approximately 62 °F to 82 °F, fall values (September 9 to December 28, 2002) ranging from 48 °F to 69 °F, winter values (January 1 to April 27, 2003) ranging from 43 °F to 64 °F, and spring values (May 1 to July 31, 2003) ranging from 50 °F to 73 °F (Sierra Business Council 2003).

pH, Alkalinity, and Hardness

Data on pH were collected monthly by the DWR in the lower portion of the Auburn Ravine watershed. The data reveal a wide range of pH values (5.6 to 7.7), but the lower end of this range is considered extremely low for the types of streams found in the Sierra Nevada Foothills (Placer County Planning Department 2003).

Results for pH were also measured by the Lincoln High School Water Quality Monitoring Program (funded by NID, Placer County, and the City of Lincoln) at three sites along the Auburn Ravine: Mackenroth Property (September 21, 2002), the Highway 193 Bridge crossing (October 7, 2002) and the Joiner Parkway Bridge crossing (September 23, 2001). Results for pH were 7.7, 7.7, and 7.16, respectively (Placer County Planning Department 2003).

Turbidity and Total Suspended Solids

Turbidity and TSS in the Auburn Ravine were measured at the Lincoln and Auburn WWTPs under NPDES permit requirements. TSS loads were observed to significantly increase in winter and spring, likely from stormwater runoff. During low flows in Auburn Ravine, turbidity was measured at less than 1 NTU. Turbidity loads of greater than 2 NTUs were measured in the effluent from the Lincoln WWTP during this time (Placer County 2002). Turbidity was also measured in the Auburn Ravine by DWR between January 2001 and January 2002. Turbidity results ranged from 5 to 33 NTUs, with one higher value of 136 NTUs in December 2001.

Specific Conductivity and Ions

Previous water quality studies characterizing SC values within the Auburn Ravine watershed in Zone 5 were not identified for this study. Electrical conductivity, not SC, which is normalized to a temperature of 77 °F (25 °C), was measured by the Lincoln High School Water Quality Monitoring Program at three sites along the Auburn Ravine: Mackenroth Property (September 21, 2002), the Highway 193 Bridge crossing (October 7, 2002) and the Joiner Parkway Bridge

crossing (September 23, 2001). Electrical conductivity was measured at 0.152, 0.056, and 0.072 mS/cm, respectively (Sierra Business Council 2003).

Nitrogen and phosphorus were measured at the Auburn WWTP in 1995 (Placer County 2002). Although nitrogen and phosphorus levels in Auburn WWTP effluent averaged 0.5 mg/L, Auburn Ravine downstream from the Auburn WWTP did not show evidence of eutrophication. However, Auburn Ravine downstream from the Lincoln WWTP was observed to be influenced by both wastewater effluent and stormwater runoff.

Nitrates were also measured by the Lincoln High School Water Quality Monitoring Program at three sites along the Auburn Ravine: Mackenroth Property (September 21, 2002), the Highway 193 Bridge crossing (October 7, 2002) and the Joiner Parkway Bridge crossing (September 23, 2001). Nitrates were measured at 0.7 mg/L, 1.1 mg/L, and 1.9 mg/L, respectively (Placer County Planning Department 2003).

Trace Elements

Data collected by Placer County for the Auburn Ravine/Coon Creek Ecosystem Restoration Plan in 1999 and 2000 show cadmium, copper, and zinc levels in the Auburn Ravine all exceed the CTR standards for aquatic life at various times throughout the year (Placer County 2002). Copper exceeded CTR standards in June, July, and October 1999 and in January, February, and April 2000.

3.2.3 Soil and Sediment Quality

The USDA-NRCS soil data indicate that 39 different soil classes and combinations of soil classes are present in PCWA Zones 1, 3, and 5. To facilitate mapping, these soil classes have been generalized into six different soil textures. Details about the distribution of these soil textures and classes are discussed by zone below. Soil permeability for Zones 1 and 3 is also discussed based on a previously published report by PCWA (2005).

3.2.3.1 Zone 3

Zone 3 is dominated by gravelly, cobbly, and stony loams of the Mariposa, Mariposa-Josephine, Cohasset, and Dubakella soil types. These coarse loams are found particularly at the heads of the steep ravines that characterize the zone. Other types of loams including sandy loam, coarse sandy loam, and silt loam are also common. Xerorthents, which include various soil textures, are found in old placer areas and cut-and-fill sites. Soils are listed by texture and classification in the order of their prevalence in **Table 3-9**. **Figure 3-95** is a map of soils by texture in Zone 3.

TABLE 3-9
ZONE 3 SOILS BY GENERALIZED TEXTURE AND CLASSIFICATION

Soil Texture[1]	Soil Classifications[2]
Gravelly, cobbly, and stony loam	Mariposa, Mariposa-Josephine, Cohasset, Dubakella
Loam	Sites, Josephine, Boomer, Cohasset
Sandy loam and coarse sandy loam	Maymen, Boomer
Variable	Xerorthents
Silt loam	Auburn-Sobrante

Source: Soil Survey Staff, Natural Resources Conservation Service (USDA-NRCS). 2008.
Note:
[1] Soil textures provided in order of prevalence
[2]The soil classifications listed in this table account for 95 percent of the total area of Zone 3. The remaining 5 percent of the area is covered by eight additional classes.

Soil permeability is moderate to high (26 to 480 inches per day) within much of lower Zone 3 (PCWA 2005).

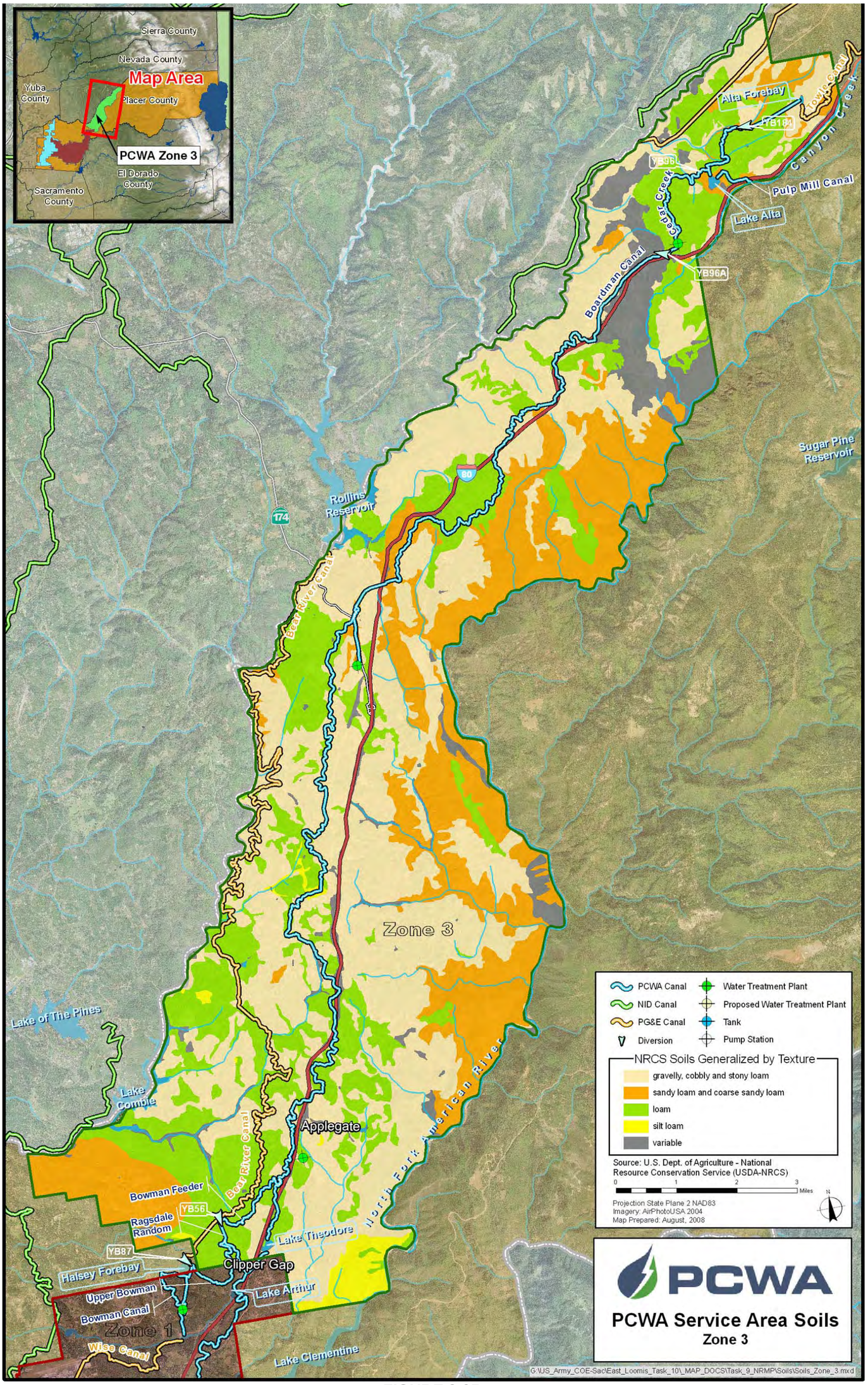

FIGURE 3-95
ZONE 3 SOILS MAP

3.2.3.2 Zone 1

Much of Zone 1 is underlain by the Rocklin Pluton, an igneous formation intruded during the Lower Cretaceous period[1]. The Rocklin Pluton is composed of quartz-diorite (Olmsted 1961, Swanson 1978, Wagner et al. 1987). In southwestern Zone 1, the sedimentary Mehrten Formation overlies the Rocklin Pluton. The Mehrten is a groundwater-bearing formation composed of moderately to well-indurated andesitic sand to sandstone interbedded with conglomerate, tuffaceous siltstone, and claystone. It was deposited in the mid-Cenozoic era[2] (DWR 2006).

The minerals composing the parent material for soils throughout the Zone 1 service area include quartz, plagioclase feldspar, alkali feldspar, biotite, and hornblende. Common chemical constituents in these minerals include aluminum, oxygen, and silica. Additional chemical constituents, depending on the parent material, may include calcium, iron, magnesium, potassium, and sodium.

Upper Zone 1 is characterized by silt loams, while lower Zone 1 is dominated by the coarser Andregg and other sandy loams. Gravelly, cobbly, and stony loams are found in western Zone 1, along with small areas of Alamo clay soil. Xerofluvents with variable textures are located along unlined canals, drainages, and along Auburn, Secret and Miners ravines. Xerorthents, also with variable textures, are present in cut and fill areas in western Zone 1. Soils in Zone 1 are listed by texture and classification in the order of their prevalence in **Table 3-10**. Zone 1 soils are mapped by texture in **Figures 3-96** and **3-97**.

TABLE 3-10
ZONE 1 SOILS BY GENERALIZED TEXTURE AND CLASSIFICATION

Soil Texture[1]	Soil Classifications[2]
Sandy loam and coarse sandy loam	Andregg, Sierra, Cometa-Ramona, Caperton-Andregg, Boomer
Gravelly, cobbly, and stony loam	Exchequer, Inks, Inks-Exchequer,
Loam	Fiddyment-Kaseberg, Boomer, Cometa-Fiddyment
Silt loam	Auburn, Auburn-Sobrante
Clay	Alamo
Variable	Xerorthents, Xerofluvents

Source: Soil Survey Staff, Natural Resources Conservation Service (USDA-NRCS). 2008.
Notes:
[1] Soil textures provided in order of prevalence
[2] The soil classifications listed in this table account for 85 percent of the total area of Zone 1. The remaining 15 percent of the area is covered by 18 additional classes.

Soil permeability is moderate to high (26 to 480 inches per day) within much of lower Zone 1. Soils of moderately low permeability (9 inches per day) to low permeability (1 to 3 inches per day) lie along the center of lower Zone 1, from the northeast head of the system to the head of Dry Creek in the southwest (PCWA 2005).

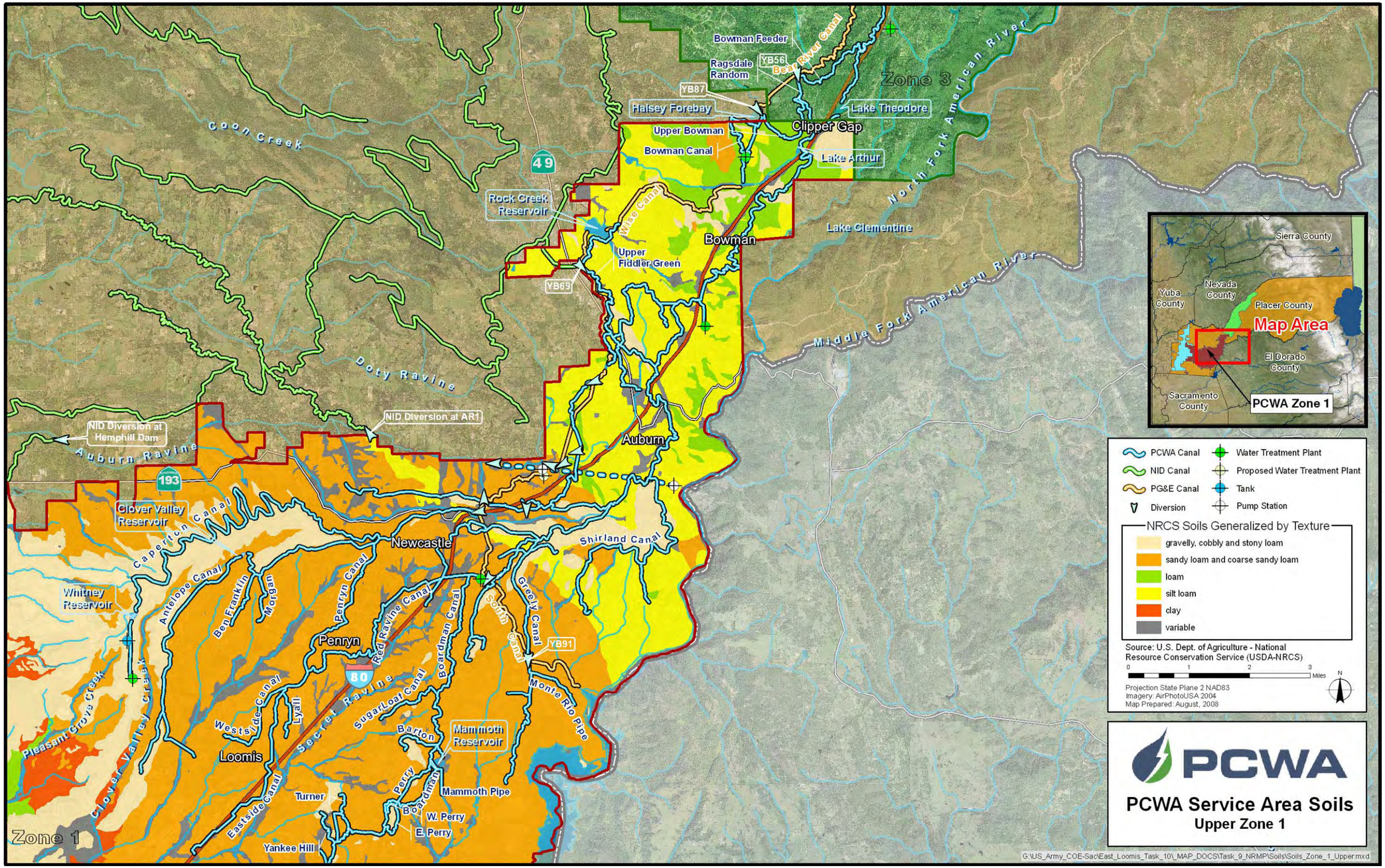

FIGURE 3-96
UPPER ZONE 1 SOILS MAP

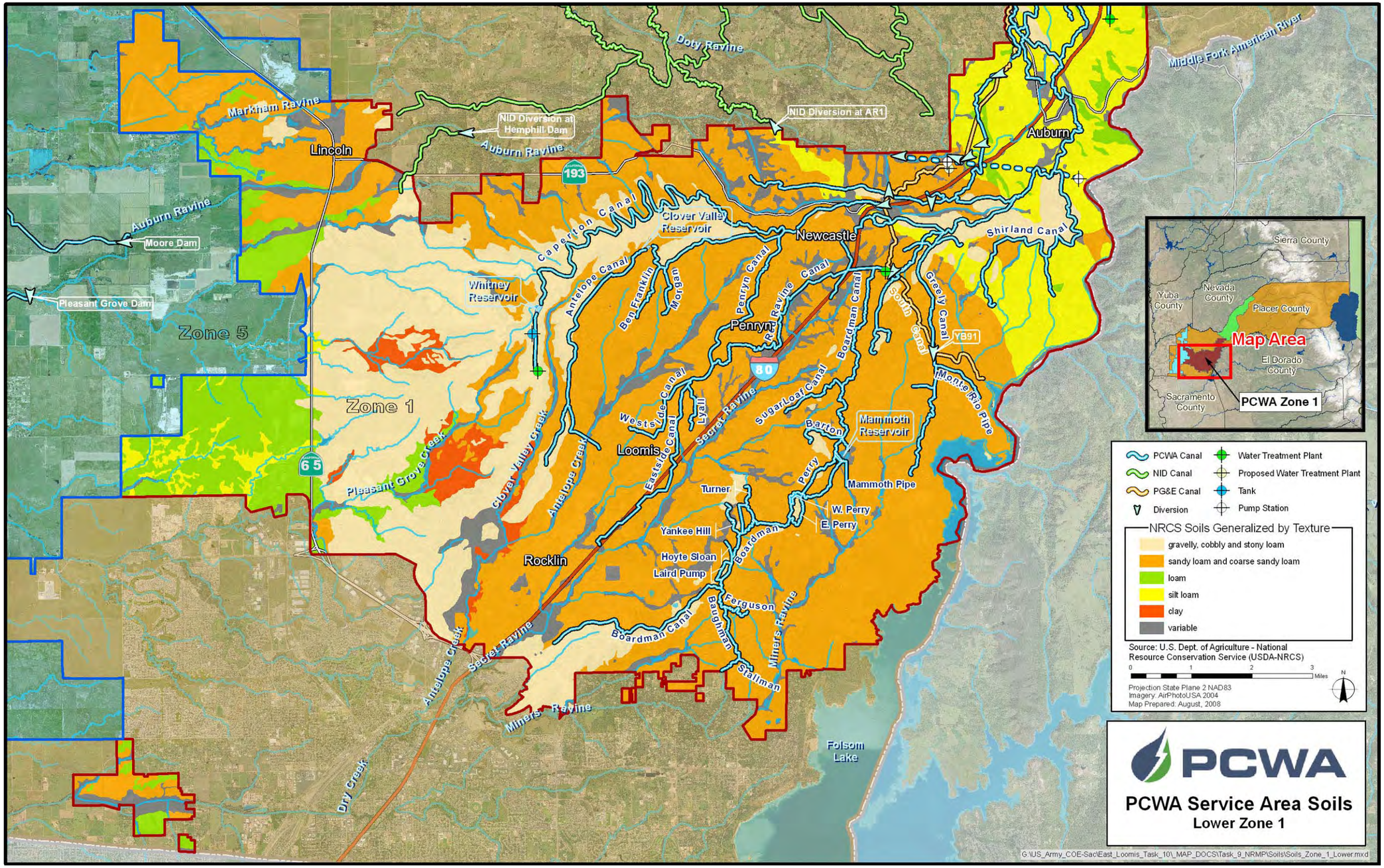

FIGURE 3-97
LOWER ZONE 1 SOILS MAP

3.2.3.3 Zone 5

Zone 5 is dominated by Cometa-Fiddyment, Kilaga, and Fiddyment loams, which are found in the southern part of the zone. Sandy loam and coarse sandy loams are present in central Zone 5, and gravelly, cobbly, and stony loams make up the majority of soils in the northern part of the zone. Xerofluvents with variable textures are found at the bottoms of the major drainages, including Auburn and Doty ravines and Pleasant Grove Creek. Soils in Zone 5 are listed by texture and classification in the order of their prevalence in **Table 3-11**. Zone 5 soils are mapped by texture in **Figure 3-98**.

TABLE 3-11
ZONE 5 SOILS BY GENERALIZED TEXTURE AND CLASSIFICATION

Soil Texture[1]	Soil Classifications[2]
Loam	Cometa-Fiddyment, Kilaga, Fiddyment
Sandy loam and coarse sandy loam	San Joaquin-Cometa, Cometa-Ramona
Gravelly, cobbly, and stony loam	Redding-Corning
Silt loam	Alamo-Fiddyment
Variable	Xerofluvents

Source: Soil Survey Staff, Natural Resources Conservation Service (USDA-NRCS). 2008.
Note:
[1] Soil textures provided in order of prevalence
[2]The soil classifications listed in this table account for 95 percent of the total area of Zone 5. The remaining 5 percent of the area is covered by eight additional classes.

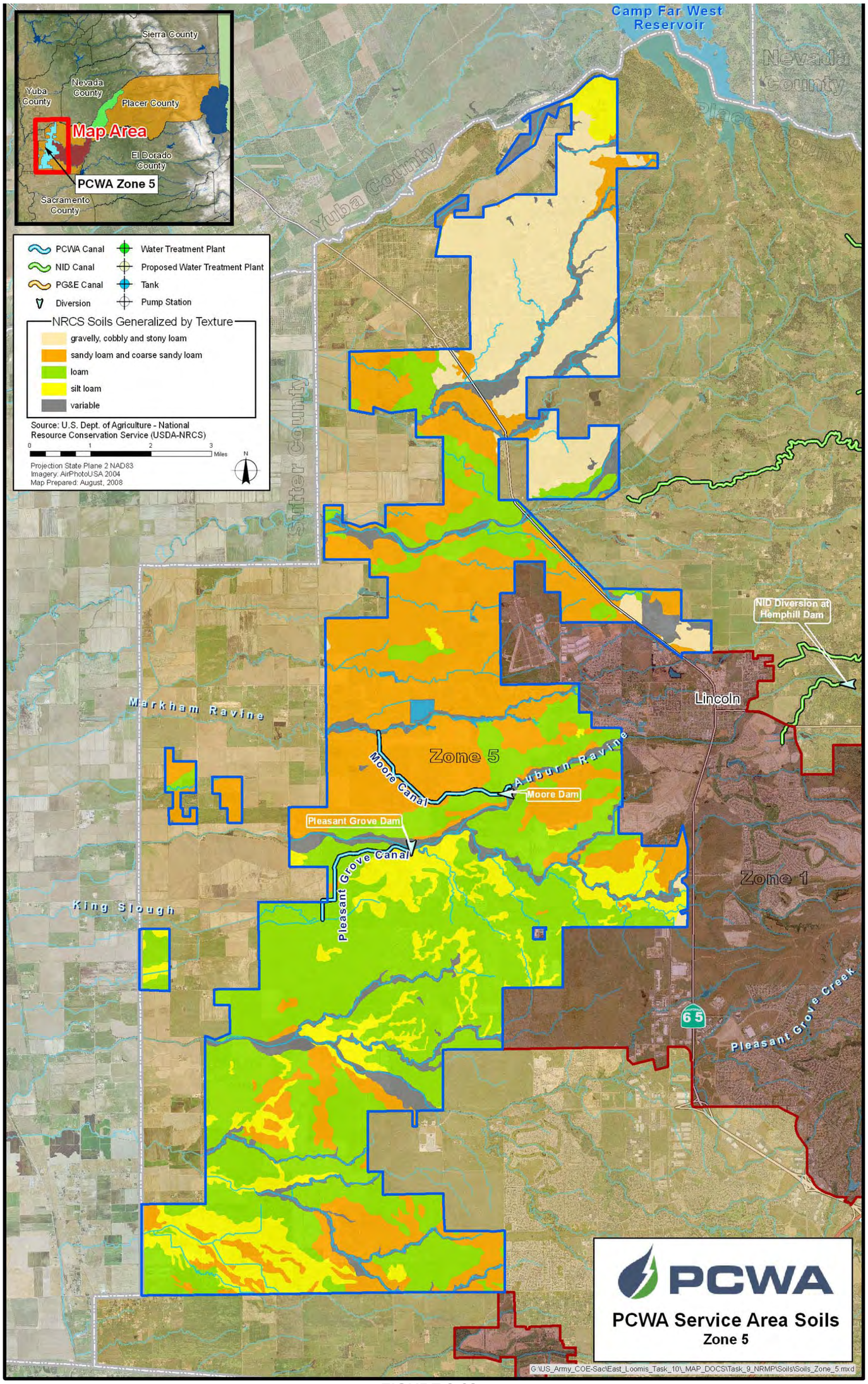

FIGURE 3-98
ZONE 5 SOILS MAP

3.3 BIOLOGICAL RESOURCES SETTING

The following sections describe terrestrial and aquatic habitat and species within the PCWA raw water distribution system area during routine canal operations.

3.3.1 Terrestrial Habitat and Species

Habitat types in the study area vary in structure and composition throughout the study area. The study area ranges from Lake Alta in the Sierra Nevada foothills at an elevation greater than 3,000 feet msl down to nearly sea level at the western boundary of Zone 3, approximately 50 miles to the southwest. In general, forested habitat types are more common in the higher elevations in the eastern portions of Zone 3. Moving west through Zones 1 and 5, agricultural, urban (including rural residential), and herbaceous habitat types become more common. The following sections describe habitats in the areas that may be directly or indirectly affected by O&M activities. Refer to **Section 3.1** for a description of habitat types, including discussions of associated species.

3.3.1.1 Zone 3

Habitat types along canals in Zone 3 (primarily Boardman Canal) are generally forested, with montane hardwood being the most common (**Figure 3-99**). Douglas-fir and ponderosa pine habitats also frequently occur. Less common habitats include urban (forested and rural residential) and annual grassland.

Reservoirs in Zone 3 that could be directly affected by O&M activities include Lake Alta, Lake Theodore, and Lake Arthur. Lake Alta is located within Sierra Nevada montane forest habitat dominated by Douglas-fir. Oaks and incense cedar also occur in the canopy. Habitat surrounding Lake Theodore is mapped as an urban, oak woodland, and annual grassland. The area around Lake Arthur is mapped as oak woodland, montane hardwood, and montane hardwood conifer.

Canyon Creek traverses a variety of habitats, predominately montane hardwood, montane hardwood conifer, ponderosa pine, urban, and barren.

3.3.1.2 Zone 1

Zone 1 contains the largest number and extent of canals in the study area. Canals traverse a number of different habitat types (**Figures 3-100** and **3-101**). Urban habitats are the most common along canals, specifically rural residential, suburban, and forested urban areas. Forested habitat types are also very common and are largely dominated by oaks. Other less common habitat types include wetlands, agricultural areas, and chaparral.

Five reservoirs have been identified in Zone 1 that may be directly impacted by O&M activities. McCrary Reservoir occurs in a rural residential area. Mammoth Reservoir is surrounded by several habitat types including rural residential, rural residential forested, annual grassland, and agricultural. Clover Valley Reservoir occurs in an oak woodland area, with valley foothill riparian forests bordering the Antelope Canal, which drains into and out of the reservoir. Caperton Reservoir is bordered by rural residential, oak woodland, and annual grassland habitat types. Whitney Reservoir is bordered by oak savannah and oak woodland habitats.

Auburn Ravine in Zone 1 lies within the City of Lincoln. In this area, Auburn Ravine is predominately forested, composed of mature trees with canopy cover generally more than 50 percent. Tree species include Fremont cottonwood, Oregon ash, and willow (Placer County Planning Department 2002).

3.3.1.3 Zone 5

Two canals that could be affected by O&M activities fall within Zone 5: Pleasant Grove Canal and Moore Canal. Habitat types along these canals are primarily disturbed, agricultural lands, generally grasslands and croplands, including rice fields (**Figure 3-102**). Some grassland areas adjacent to these canals have been identified as containing vernal pool complexes.

Auburn Ravine in Zone 5 is predominately forested and supports Fremont cottonwood, Oregon ash, and willow. The eastern portion of Auburn Ravine in Zone 5 is more densely forested, with canopy cover generally greater than 50 percent. Canopy cover decreases to less than 50 percent in the western portion of Zone 5 (Placer County Planning Department 2002).

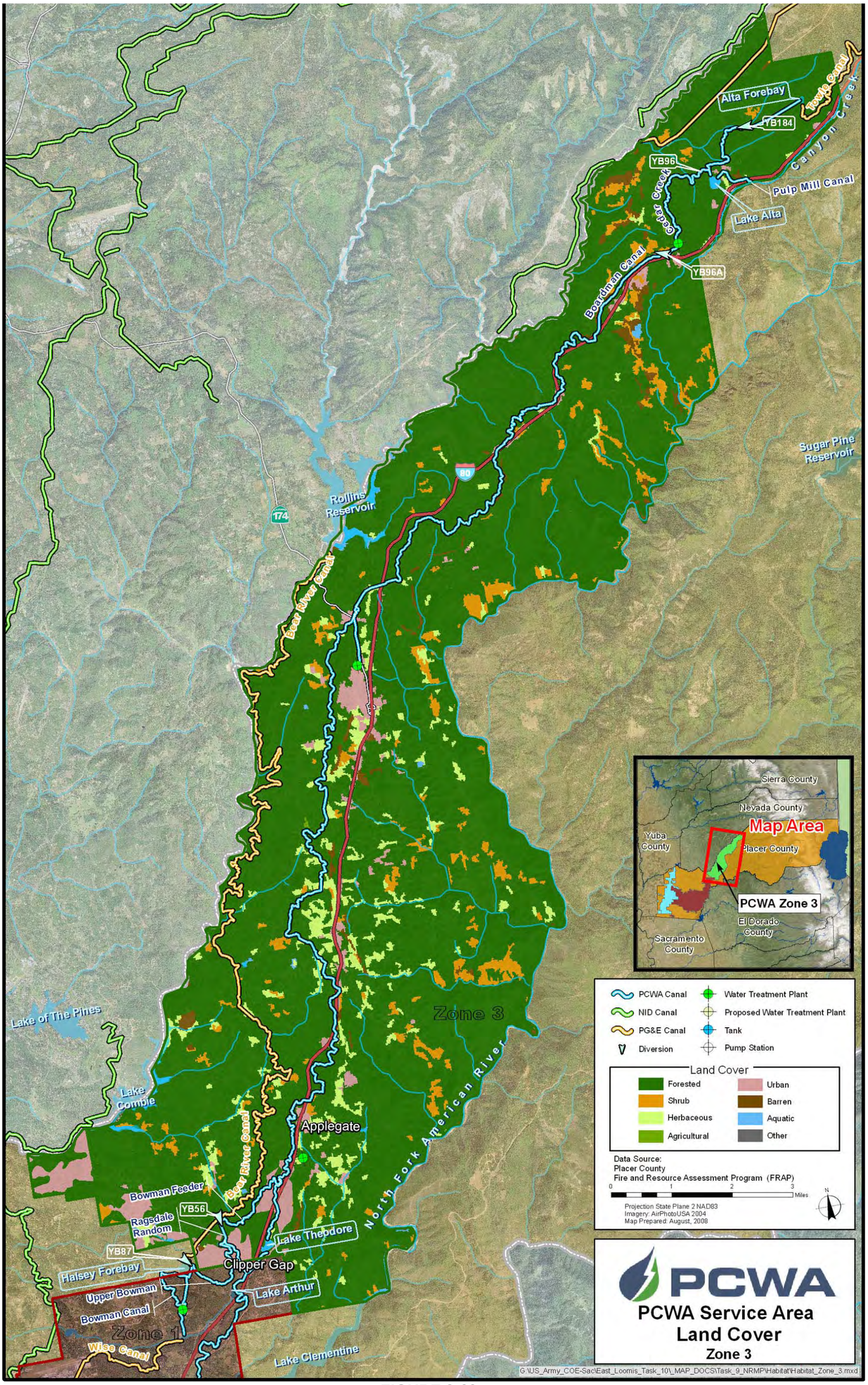

FIGURE 3-99
ZONE 3 LAND COVER TYPES

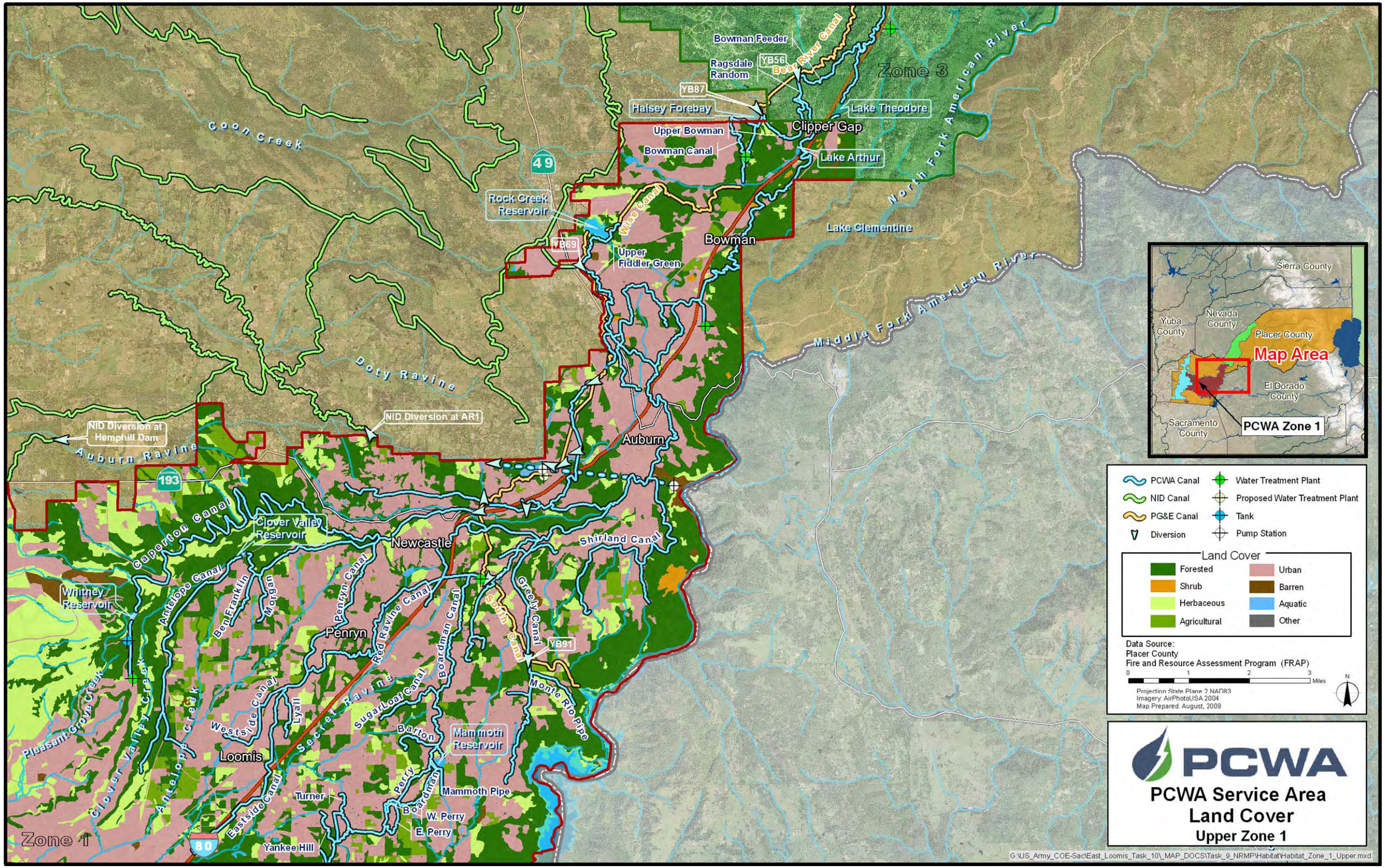

FIGURE 3-100
UPPER ZONE 1 LAND COVER TYPES

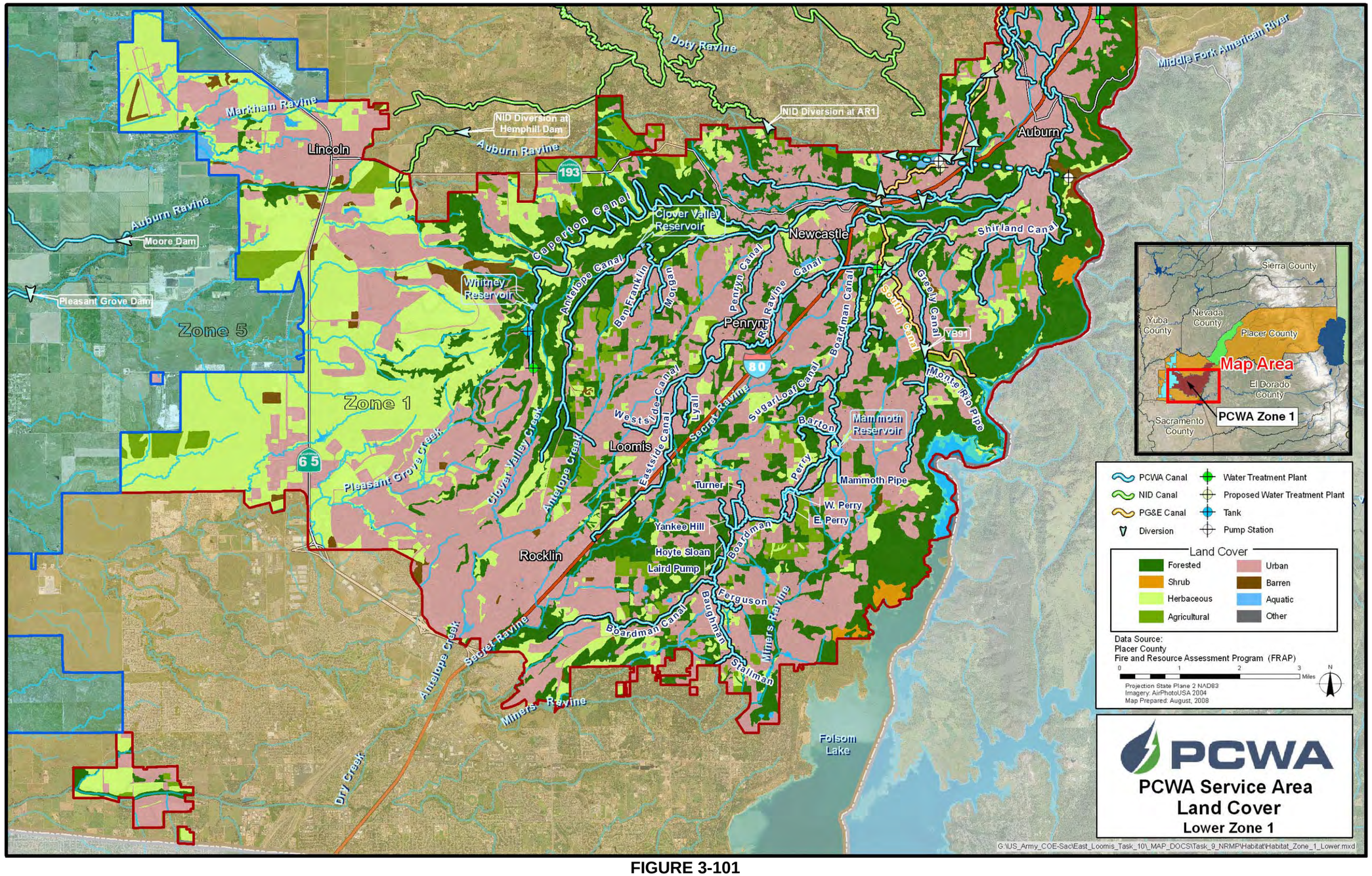

FIGURE 3-101
LOWER ZONE 1 LAND COVER TYPES

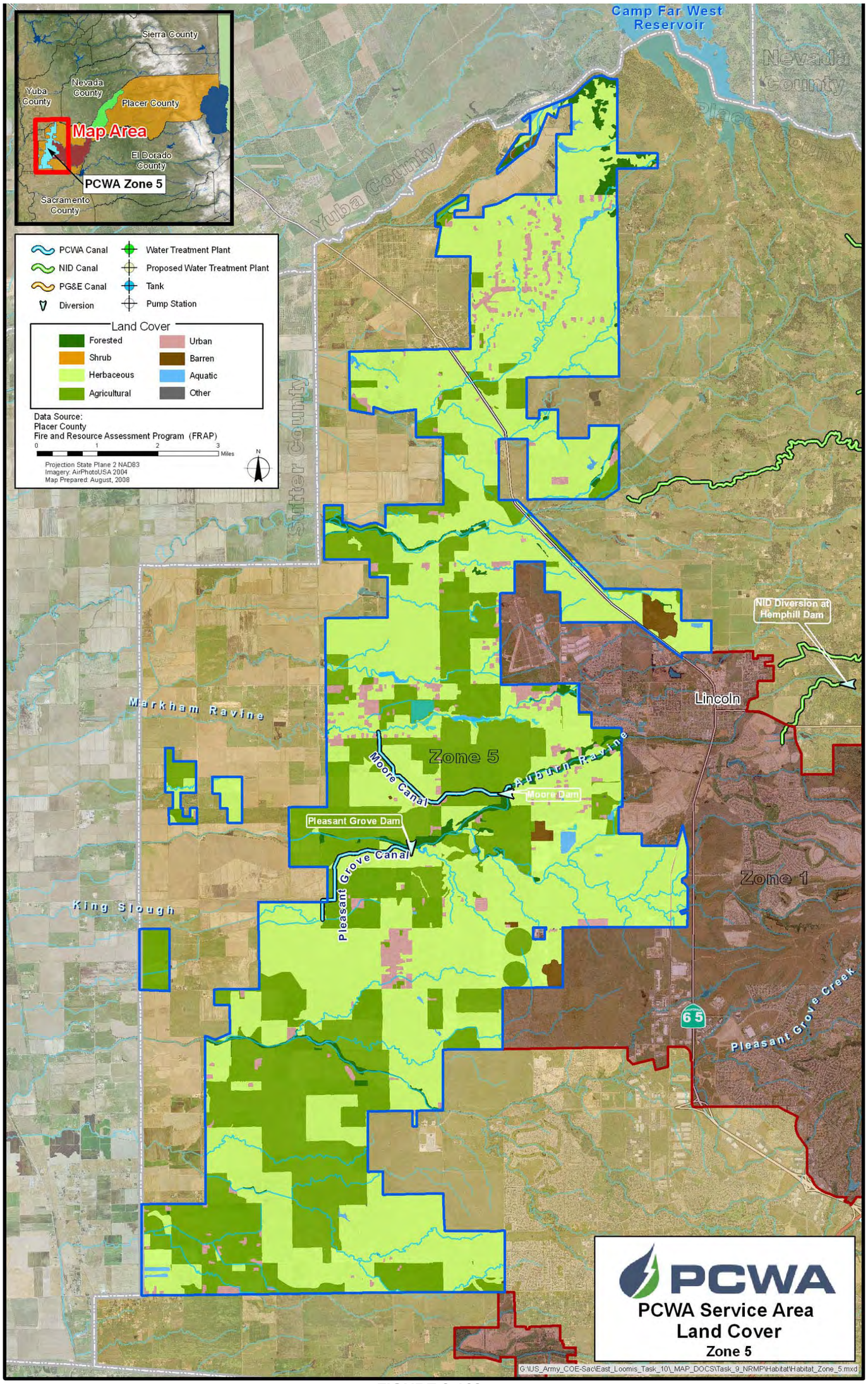

FIGURE 3-102
ZONE 5 LAND COVER TYPES

3.3.2 Aquatic Habitat and Species

Studies in Zones 1, 3, and 5 of the PCWA regarding aquatic habitat conditions and species evaluations have primarily focused on fish communities, including anadromous fall-run Chinook salmon and Central Valley steelhead. Fish observed in the canal system by PCWA enter the canals from the PG&E reservoirs and canals that supply PCWA, and include brown trout (*Salmo trutta*), rainbow trout (*Oncorhychus mykiss*), catfish (*Ictalurus* or *Ameiurus* sp.), Sacramento sucker (*Catostomus occidantalis*), and Sacramento pikeminnow (*Ptychocheilus grandis*) (PCWA 2004). The canals within PCWA's raw water distribution system, however, are not believed to provide consistent suitable habitat for these species.

3.3.2.1 Zone 3

Although no substantial data was found on aquatic habitat and species conditions specific to Canyon Creek, the creek may include aquatic habit and species common to Sierra Nevada montane hardwood streams. Canyon Creek is at approximately 3,543 feet msl in a relatively rural area composed of hiking trails and campgrounds. Several large dams located downstream (Nimbus and Folsom dams on the Lower American River) prohibit potential access to Canyon Creek by Chinook salmon or steelhead. Fish observed in the North Fork American River would likely be found in Canyon Creek, such as the rainbow trout, riffle sculpin, Sacramento sucker, and speckled dace. Nonnative brown trout may also be found in Canyon Creek. The elevation of the creek is too high for fish such as pikeminnow to be present.

3.3.2.2 Zone 1

Unregulated outlet releases and seepage along the canal system may contribute to flows in natural watercourses in the basin. Secret Ravine and Miners Ravine are recognized by DFG as the primary production areas in the Dry Creek drainage for fall-run Chinook salmon and Central Valley steelhead (DFG 2001). In the Dry Creek watershed, these ravines appear to be especially important for spawning and rearing of these anadromous fishes (DFG 2001).

Auburn Ravine Watershed

The artificially high flows in Auburn Ravine during summer months due to water supply conveyances from PCWA, PG&E, and NID support more aquatic habitat than would be maintained under natural hydrologic conditions (Placer County Planning Department 2002). Portions of Auburn Ravine are designated as Critical Habitat for Central Valley steelhead (70 Code of Federal Regulations (CFR) 52488, September 2, 2005). Efforts are currently underway to improve habitat conditions in Auburn Ravine for salmonids and other native fishes.

Auburn Ravine's characteristics dramatically vary between its headwaters and the East Side Canal. Fall-run Chinook salmon and Central Valley steelhead spawn and rear in upstream reaches (between its headwaters at the City of Auburn to the City of Lincoln), but the quality of migration habitat for salmonids has been substantially reduced by beaver dams, numerous water diversions, and their associated diversion structures (Placer County Planning Department 2002). On behalf of PCWA, South Sutter District installs two seasonal diversion dams in Auburn

Ravine, Moore Dam and Pleasant Grove Dam, where flows are diverted to the Moore and Pleasant Grove canals, respectively. NID Auburn Ravine 1 Dam is a year-round barrier to migration. Also, NID Hemphill Dam (a seasonal diversion dam) and NID gaging station impair migration of salmonids during most flow conditions. Since water deliveries to agricultural water users are curtailed during the fall, generally before fall-run Chinook salmon attempt to migrate upstream to spawn, the depth of water in the stream channel below some flow-control structures is often insufficient to facilitate adult fish passage.

Table 3-12 lists fish species reported to be present in Auburn Ravine. American River and Feather River hatchery-raised juvenile fall- and spring-run Chinook salmon have been released to Auburn Ravine infrequently since the 1980s. Typically, about 100,000 fall-run Chinook salmon from Nimbus Fish Hatchery were released to Auburn Ravine (Placer County Planning Department 2002, Barngrover pers. comm.), with 140,000 fall-run Chinook salmon released in Auburn Ravine during March 1998 (Placer County Planning Department 2002).

TABLE 3-12
FISH SPECIES PRESENT IN AUBURN RAVINE

Native		Introduced	
Common Name	**Scientific Name**	**Common Name**	**Scientific Name**
Chinook salmon	Oncorhynchus tshawytscha	Black bullhead	Ameiurus melas
Sacramento pikeminnow	Ptychocheilus grandis	Common carp	Cyprinus carpio
Steelhead	Oncorhynchus mykiss	Green sunfish	Lepomis cyanellus
Bluegill	Lepomis macrochirus	Largemouth bass	Micropterus spp.
Spreckled dace	Rhinichthys osculus	Pumpkin seed	Lepomis gibbosus
Sacramento sucker	Catostomus occidentalis	Redear sunfish	Lepomis microlophus
California roach	Hesperoleucus symmetricus,	Golden shiner	Notemigonus crysoleucas
Lamprey spp	Lamperta spp.	Mosquitofish	Gambusia affinis
Prickly Sculpin	Cottus asper	Brown trout	Salmo trutta
Hardhead	Mylopharodon conocephalus		

Source: Placer County Planning Department 2003, 2005b

Fish communities and associated aquatic habitat were assessed in the Auburn Ravine by DFG in fall 2004 and spring 2005. Fish community IBI scores for Auburn Ravine were approximately 80 out of 100 (Titus et al. 2005). The gross ecological health of Auburn Ravine was rated "good to very good" based on its IBI score (Titus et al. 2005).

Summary results of BMI population analyses and B-IBI results, along with physical habitat characteristics during BMI analyses, are shown in **Tables 3-13** and **3-14** respectively. Detailed results of BMI population and B-IBI analyses at Auburn Ravine below Auburn Ravine Tunnel Outlet are provided in **Appendix A**. **Figure 3-103** compares B-IBI results for Auburn Ravine to other stream sites evaluated by DCC in the PCWA service area for this NRMP in 2007, and sites previously evaluated by DCC from 2000 through 2006.

Based on BMI and B-IBI analyses described in **Appendix A**, aquatic habitat quality at Auburn Ravine below Auburn Ravine Tunnel Outlet appeared to better than Miners Ravine below Sierra

College Boulevard, as shown in **Table 3-13**. The Auburn Ravine below the Auburn Ravine Tunnel Outlet had a B-IBI score of 41, which is considered to be "fair," as shown in **Figure 3-103**.

TABLE 3-13
BENTHIC INDEX OF BIOTIC INTEGRITY FOR SITES AT AUBURN RAVINE, SECRET RAVINE, AND MINERS RAVINE

	Auburn Ravine below Auburn Ravine Tunnel Outlet	Secret Ravine at Loomis Basin Park	Miners Ravine below Sierra College Blvd
Coleoptera taxa	4	4	0
EPT taxa	5	6	5
Predator Taxa	2	5	4
Collectors (%)	5	5	4
Intolerant (%)	1	2	1
Non-Insect (%)	4	7	2
Tolerant (%)	8	7	5
Total	29	36	21
B-IBI Score	41	51	30
Ranking	Fair	Fair	Poor

TABLE 3-14
PHYSICAL HABITAT SCORES FOR BENTHIC MACROINVERTEBRATE ANALYSES AT AUBURN RAVINE, SECRET RAVINE, AND MINERS RAVINE

	Auburn Ravine below Auburn Ravine Tunnel Outlet	Secret Ravine at Loomis Basin Park	Miners Ravine below Sierra College Blvd
Flow (cfs)	9.6	3.0	1.7
Temperature (^{o}F)	57.4	55.8	55.2
Habitat Types, % Riffle	41	15	11
Slope (average %)	2.5	0.5	1.4
Instream Habitat[1]	14	11	5
Sediment Deposition[1]	19	11	5
Channel Alteration[1]	15	11	18

Note:
[1]Score is out of possible 20.

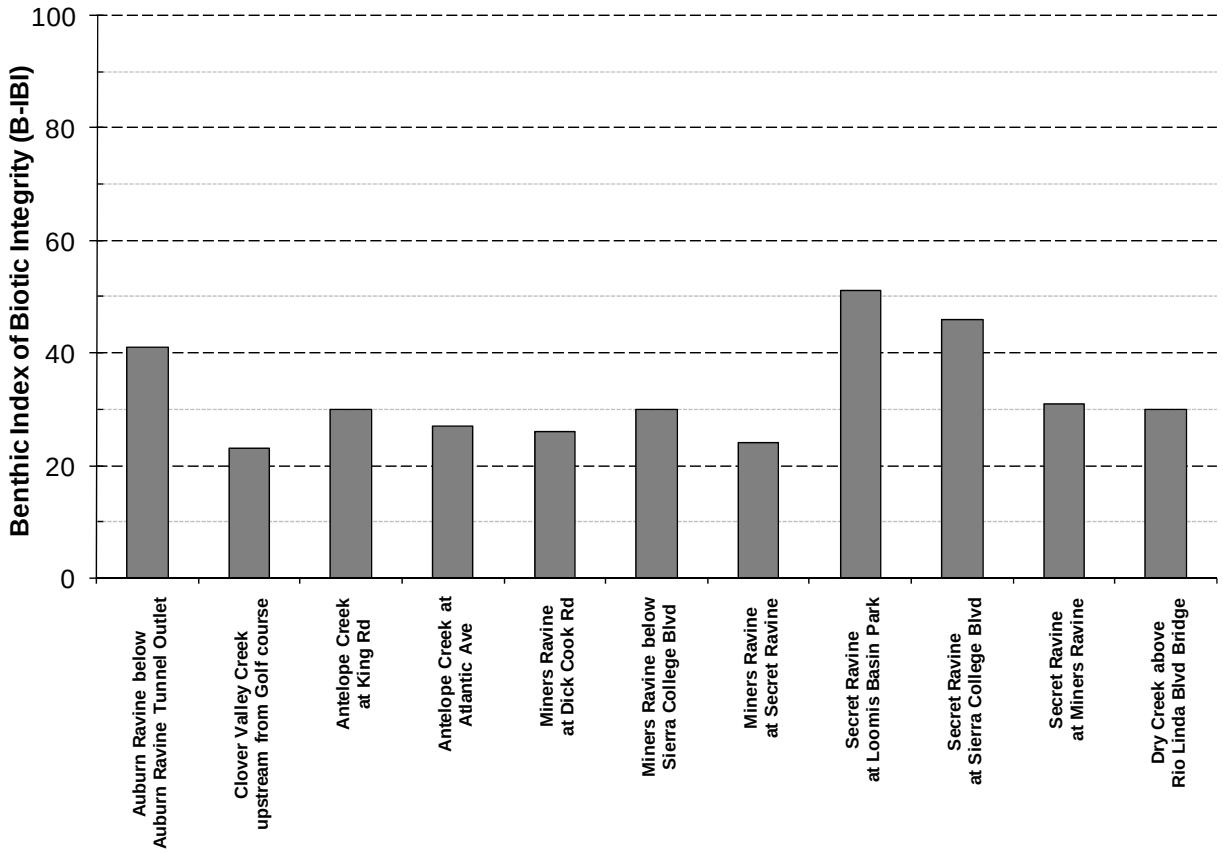

FIGURE 3-103
COMPARISON OF BENTHIC INDEX OF BIOTIC INTEGRITY SCORES AT STREAM SITES IN THE PCWA SERVICE AREA

As for physical habitat, there is a high percentage of riffle habitat, and the cobble and gravel substrate within the segment sampled had very little sediment, as shown in **Table 3-14**. Detailed results of physical habitat analyses at Auburn Ravine below Auburn Ravine Tunnel Outlet are provided in **Appendix A.**

Clover Valley Creek Watershed

Studies of aquatic habitat and species conditions in Clover Valley Creek are very limited. Clover Valley Creek is not included in the designated Critical Habitat for Central Valley steelhead (Placer County 2006). An impassable culvert blocks access of salmonids to Clover Valley Creek (Placer and Sacramento Counties 2003). The lack of deep pools and clean riffle habitat limits the potential for biodiversity, which tends to limit food and preferred habitat for rearing salmonids. The potential for salmonid rearing is considered to exist in lower portions of the creek.

In general, substrate and habitat conditions in Clover Valley Creek are considered unsuitable for rearing salmonids (Placer County 2006). Common substrate in the creek consists of fine sediments (sand and silt) with very little gravel and cobbles, particularly in downstream areas. High sediment loads and sediment deposition, degraded water quality, invasive species, and lack

of riparian vegetation contribute to degraded aquatic habitat conditions in Clover Valley Creek. Lower Clover Valley Creek is highly channelized and sometimes impounded.

Although suitable habitat conditions for some salmonid life stages may exist in Clover Valley Creek, there are many significant barriers to upstream passage of anadromous salmonids (City of Rocklin 2006), including an impassable culvert just upstream of its confluence with Antelope Creek (Placer and Sacramento Counties 2003). The Argonaut Bridge crossing, an impoundment structure at Cimarron Court, and an instream impoundment downstream of Midas Way and Rawhide Drive Bridge are all barriers along Clover Valley Creek (City of Rocklin 2006). The total flow of the creek passes through a 30-foot-long culvert, approximately 2 feet in height, and about 3 feet wide. On the downstream side, the culvert hangs 2 feet over the streambed. Migrating salmonids reportedly cannot swim through the flow from the culvert because of its relatively small opening and high flow velocity (Placer and Sacramento Counties 2003).

Because Clover Valley Creek is a tributary to Antelope Creek, fish species present in Clover Valley Creek are likely comparable to the fish species present in Antelope Creek, described below. An Aquatic Habitat Survey and Fisheries Assessment was conducted by ECORP Consulting, Inc. on Clover Valley Creek on June 16 and 19, 2006 (ECORP 2006). The fish community in Clover Valley Creek was found to be dominated by native minnow and hitch (*Lavinia exilicauda*), particularly in the upper portion of the creek. The nonnative western mosquitofish (*Gambusia affinis*) and green sunfish (*Lepomis cyanellus*) were observed in the lower portions of the creek. No salmonids were observed during the survey. The native Sacramento sucker was also found along Clover Valley Creek. Hitch and Sacramento sucker both prefer low-gradient streams with slow water velocities and sandy to gravel substrates, as do green sunfish and mosquitofish. All four species are tolerant of the warm water temperatures characteristic of Clover Valley Creek, particularly during summer and fall.

Based on BMI analyses conducted by DCC (**Figure 3-103**), the site at Clover Valley Creek upstream from the Sunset Whitney Country Club on Midas Avenue in Rocklin had a B-IBI score of 23, which is considered to be "poor," likely due to presence of organisms tolerant to water quality pollutants and a general lack of benthic macroinvertebrate species diversity.

Antelope Creek Watershed

Antelope Creek is not as well studied as other headwater tributaries of Dry Creek (Secret Ravine and Miners Ravine). Although fall-run Chinook have been periodically documented over the past 40 years to use parts of the watershed for spawning, there is no reliable data on whether steelhead are currently present in the watershed. Similar to Clover Valley Creek, Antelope Creek is not designated as critical habitat for Central Valley steelhead.

Aquatic habitat in Antelope Creek is characterized as low in diversity, generally consisting of flatwater (i.e., shallow run and shallow glide) habitat (Placer and Sacramento Counties 2003). Use of Antelope Creek by anadromous salmonids is generally considered to be limited to occasional stray adults during years of at least moderate streamflow during the migration period. Two potential spawning areas have been identified in Antelope Creek, but the associated habitat is generally not favorable to salmonids (Placer and Sacramento Counties 2003). Juvenile

salmonid habitat is generally limited to shallow pool habitat during years of at least moderate streamflow. Low streamflows in Antelope Creek could impede adult anadromous fish passage during critical periods of the year (Sierra Business Council 2003).

Antelope creek is located in a primarily urban and suburban area. Past and ongoing construction activities adjacent to the creek have resulted in significant upland disturbance and sediment contribution to the stream. Accumulated sediment is common in the lower portion of Antelope Creek. Several portions of the creek are incised (City of Roseville 2005), and vulnerable to erosion. Accumulated sediments, such as sand, small cobbles, and exposed granite, are common in the lower portion of Antelope Creek (Placer and Sacramento Counties 2003). A spawning gravel study conducted by Jones & Stokes in 2004 found that 77 percent of substrate in Antelope Creek was fine sediment, in which fish eggs and larvae would unlikely survive (Placer County Planning Department 2005b).

With the exceptions of wide variations in pH, high nutrient levels, and observed copper concentrations in Antelope Creek, most of the watershed's water quality conditions are capable of supporting anadromous fish year-round (Placer and Sacramento Counties 2003). Water temperatures measured in the creek show that approximately 25 to 50 percent of the channel length is suitable for summer rearing for steelhead (**Table 3-15**). However, some sites along the creek have water temperatures too high for salmonid egg incubations and juvenile rearing (Placer and Sacramento Counties 2003).

TABLE 3-15
WATER TEMPERATURE CRITERIA FOR CHINOOK SALMON AND STEELHEAD

Life Stage	Chinook Salmon	Steelhead
Adult Migration	Less than 57°F	Less than 52°F
Spawning	Less than 57°F	Less than 54°F
Incubation	Less than 55°F	Less than 54°F
Juvenile Rearing	Less than 61°F	Less than 65°F

Sources: A. A. Rich and Associates 2007; Bell 1990; DFG 2007 a and 2007b; Marine 1992; McCullough et al. 2001; NMFS 2002 and 2003; Reiser and Bjornn 1979;

Riparian development has also affected instream habitat, and is generally characterized as poor to fair for aquatic resources (Placer and Sacramento Counties 2003). Large riparian trees are sparse and the floodplain is constrained by the Union Pacific railroad tracks, Interstate 80 to the east, and an old landfill to the west (City of Roseville 2005). The riparian corridor of Antelope Creek consists largely of overhanging vegetation, such as Himalayan blackberry, and remnant oak woodland. Nonnative and native grassland uplands are present, as are wetland swales.

Rock dams, beaver dams, diversion dams, and culverts provide barriers to fish passage (Placer and Sacramento Counties 2003). Asphalt-bottomed culverts underneath Sunset Boulevard and a dam at a large wetlands complex upstream of the railroad bridge in Rocklin are particular fish passage concerns (Placer and Sacramento Counties 2003).

Fish species present in Antelope Creek are provided in **Table 3-16**.

TABLE 3-16
FISH SPECIES PRESENT IN ANTELOPE CREEK

Native		Introduced	
Common Name	**Scientific Name**	**Common Name**	**Scientific Name**
Fall-run Chinook salmon	Oncorhynchus tshawytscha	Black bullhead	Ameiurus melas
Hitch	Oncorhynchus mykiss	Brown bullhead	Ameiurus nebulosus
Sacramento sucker	Lavinia exilicauda	Common carp	Cyprinus carpio
Sacramento pikeminnow	Catostomus occidentalis	Mosquitofish	Gambusia affinis
Speckled dace	Ptychocheilus grandis	Green sunfish	Lepomis cyanellus
	Rhinichthys osculus	Golden shiner	Notemigonus crysoleucas
			Micropterus spp.

Source: Sierra Business Council, 2003

Note: A general siting of both Trout and Bass was reported during the 1959 DFG survey, but specific species were not identified (DFG, 1959)

The BMI community observed at Antelope Creek during previous studies was primarily composed of organisms that are moderately to highly tolerant of impaired water quality conditions. BMI analyses were conducted at two sites (King Road and Atlantic Avenue) along the Antelope Creek by the DCC in 2000. As shown in **Figure 3-103,** the I-IBI score for the upstream site at King Road was 30, and the score for the downstream site at Atlantic Avenue was 27, both of which are considered to be "poor." The limited aquatic insect populations found resulted in the "poor" rating at both sites. The data also indicate a high percentage of pollutant-tolerant organisms, with few BMI taxa associated with cleaner waters (Placer and Sacramento Counties 2003). The combination of high seasonal flow fluctuations, water quality conditions, and high sediment loads in the creek may have contributed to the observed results (Placer and Sacramento Counties 2003).

Secret Ravine Watershed

Secret Ravine is a major tributary of Dry Creek, and is designated as Critical Habitat for Central Valley steelhead (70 CFR 52488, September 2, 2005). Secret Ravine is said to be the most productive stream within the Dry Creek watershed for Central Valley fall-run Chinook salmon and Central Valley steelhead, despite urban encroachment and other human-influenced impacts (Fields 1999). Surveys conducted for steelhead in the Dry Creek watershed have shown that most of the suitable spawning and rearing habitat occurs in Secret Ravine (Placer County Planning Department 2005b).

Both fall-run Chinook salmon and steelhead have been documented spawning in Secret Ravine (Placer County Planning Department 2005b). Based on a 2005 survey, estimated spawning habitat area for spawning in Secret Ravine totaled 1,175 square feet, with the capacity for 21 potential redds (nests) for steelhead and 12 potential redds for Chinook salmon (Placer County Planning Department 2005b). Since the late 1990s, an average of 160 adult fish per year have been observed in Secret Ravine (Placer and Sacramento Counties 2003). Juvenile steelhead have

been observed rearing in Secret Ravine near the headwaters around Gilardi Road and downstream to the Brace Road crossing (Sierra Business Council 2003).

Water temperatures in Secret Ravine have been documented as warmer than ideal and suitable ranges for steelhead rearing (**Table 3-15**), which would have a particular effect on juvenile steelhead (Placer County Planning Department 2005b). Water temperatures measured at Gilardi Road during October 2003 to March 2004 (incubation period) were generally lower than criteria identified in **Table 3-15** for sensitive life stages (Sierra Business Council 2003b). Rearing habitat is limited around Sierra College because of high water temperatures and limited thermal refugia are present in the summer. Chinook salmon, however, typically leave within a few months of hatching.

The 2004 spawning gravel study found the amount of fines measured to range from 51 to 82 percent for Secret Ravine (Placer County Planning Department 2005). Adult Chinook salmon and steelhead clean fine sediments from the gravel with their caudal fins during spawning, and as long as fine sediment does not overwhelm the redd, egg and larvae survival is possible.

Well-established beaver dams, from 0.6 to 1.2 meters (2 to 4 feet), were observed during salmonid spawning gravel surveys in Secret Ravine (Placer County Planning Department 2005b). If these observed dams remain intact during the salmonid migration period, then they could represent significant passage impediments or complete passage barriers. Steelhead, however, tend to migrate in winter months when flows are higher, and obstacles are less of a factor to passage. There is also at least one permanent barrier created by a pipeline, and several utility pipe crossings that may be additional obstacles to fish migration (Placer and Sacramento Counties 2003).

Additional fish species that can be found in Secret Ravine (mostly the lower reaches) are listed in **Table 3-17**. The impact of introduced fishes on fall-run Chinook salmon and steelhead in Secret Ravine is not known. However, bass and sunfish (especially spotted bass) are highly predatory species and could be expected to opportunistically feed on rearing and emigrating juvenile Chinook salmon and steelhead. The degree to which this occurs in Secret Ravine, however, is unknown.

TABLE 3-17
FISH SPECIES PRESENT IN SECRET RAVINE AND MINERS RAVINE

Native		Introduced	
Common Name	**Scientific Name**	**Common Name**	**Scientific Name**
Sacramento sucker	Catostomus occidentalis	White catfish	Ameiurus catus
Roach	Hesperolecus symmetricus	Black bullhead	Ameiurus melas
Pacific lamprey	Lampetra tridentate	Brown bullhead	Ameiurus nebulosus
Hitch	Lavinia exilicauda	Common carp	Cyprinus carpio
Hardhead	Mylopharodon conocephalus	Mosquitofish	Gambusia affinis
Steelhead	Oncorhynchus mykiss	Green sunfish	Lepomis cyanellus
Fall-run Chinook salmon	Oncorhynchus tshawytscha	Warmouth	Lepomis gulosus
Sacramento pikeminnow	Ptychocheilus grandis	Bluegill	Lepomis macrochirus
		Redear sunfish	Lepomis microlophus
		Smallmouth bass	Micropterus dolomieui
		Spotted bass	Micropterus punctulatus
		Largemouth bass	Micropterus salmoides
		Fathead minnow	Pimephales promelas
		White crappie	Pomoxis annulauris

Source: DFG 2003.

Fish communities and associated aquatic habitat were assessed in the Secret Ravine by DFG in fall 2004 and spring 2005. Although not as high as Auburn Ravine, both fish IBI scores for Secret Ravine were fairly high, with scores of approximately 75 out of 100 (Titus et al. 2005). The gross ecological health of Secret Ravine was rated "good to very good" by Titus et al. (2005) based on its IBI score.

BMI surveys have been performed in Secret Ravine, including studies by de Barruel et al. (2003), Fields (1999), and DCC (data collected in 1997, 1998, and 2000 through 2006). Although BMI populations reflecting pollution and high water temperatures within Secret Ravine were found in all three studies, overall results suggest that Secret Ravine provides the highest quality fisheries habitat in the Dry Creek watershed (Placer and Sacramento Counties 2003).

Data studies with upstream and downstream sites found more pollutant-tolerant organisms near the confluence with Miners Ravine than at upstream locations. As shown in **Table 3-13** and **Figure 3-103**, the 2007 DCC BMI study found the site at Secret Ravine at Loomis Basin Park to have a B-IBI score of 51, which is considered "fair" (Titus et al. 2005). This score was higher than any previous score recorded for BMI sites in the Dry Creek watershed. During this BMI assessment, physical habitat at Secret Ravine at Loomis Basin Park exhibited low slopes and low flow velocities, and a fairly low percentage of riffle habitat compared to Auburn Ravine (**Table 3-14)**. However instream habitat was fairly high for these conditions, and was measured at 11 out of 20. Sediment deposition and channel alteration results were lower at this site than at Auburn Ravine. Detailed results of BMI population, B-IBI, and physical habitat analyses for Secret Ravine at Loomis Basin Park are provided in **Appendix A.**

DCC also conducted BMI sampling in 2000 and 2001 at two downstream locations along the creek: Secret Ravine at Sierra College Boulevard and Secret Ravine at its confluence with Miners Ravine. The Sierra College Boulevard site received a B-IBI score of 46, which is considered "fair," and the Secret Ravine at Miners Ravine received a rating of 31, which is considered "poor." Results from these studies indicated a high percentage of pollutant-tolerant organisms with almost no taxa associated with cleaner waters. A BMI survey was conducted at Secret Ravine just downstream from Sierra College (upstream site) and at Secret Ravine just upstream from its confluence with Miners Ravine (downstream site) (de Barruel and West 2003). In this study, the percentage of pollutant-tolerant BMI organisms at the downstream site were found to be significantly higher than at the upstream site, indicating higher perturbation and pollution at the downstream site (de Barruel and West 2003).

Miners Ravine Watershed

Like Secret Ravine, Miners Ravine is a major tributary of Dry Creek, and is also designated as Critical Habitat for Central Valley steelhead (70 CFR 52488, September 2, 2005). Both fall-run Chinook salmon and steelhead have been observed spawning in Miners Ravine (DWR 2002). In the 1950s, up to 100 adult Chinook salmon were estimated to occur in Miners Ravine; however, there is little current information regarding the spawner abundance of Chinook salmon in Miners Ravine, though the Dry Creek Conservancy conducts spawning surveys on up to several days per season (Bates pers. com). During some years in the 1980s and 1990s, DFG planted as many as 100,000 juvenile Chinook salmon from the Feather River hatchery in the lower reaches of Miners Ravine. Although mostly inaccessible to salmonids, aquatic habitat along Miners Ravine was observed to be of highest quality upstream of Cottonwood Dam, near Dick Cook Road, where there is a high canopy cover, deep pools, and higher concentrations of spawning gravel (DWR 2002).

Summer water temperatures in Miners Ravine have been documented as higher than the suitable ranges for steelhead rearing (**Table 3-15**). However, deep pools and cool groundwater accretion could provide thermal refugia for juvenile steelhead. Water temperature data was not recorded during the periods when Chinook salmon would be present in Miners Ravine.

Livestock grazing and riparian vegetation removal have caused increased erosion along banks. Substrate found in Miners Ravine was dominated by fines, such as silt, and clay (DWR 2002), with fine sediment measured between 50 and 75 percent. With the ability of adult Chinook salmon and steelhead to clean fine sediments from the gravel during spawning, egg and larvae survival is still possible if the fines are not reintroduced into the redd.

Many barriers in Miners Ravine reduce the quality of migration habitat. These barriers include six road crossings, one culvert, eight dams, and three natural barriers. Cottonwood Dam, built in the 1950s, is considered to be the uppermost limit to anadromous species in Miners Ravine, but steelhead may be able to pass during flood flows (Placer County Planning Department 2005a, Placer and Sacramento Counties 2003). Additionally, 80 beaver dams were observed in Miners Ravine in one survey (DWR 2002).