Appendix A
Santa Margarita River Watershed Setup Model

Appendix A
Santa Margarita River Watershed Setup Model

A.1 WARMF Overview

WARMF stands for Watershed Analysis Risk Management Framework, which is a decision support system (DSS), designed for a watershed approach and TMDL calculation. WARMF contains *engineering, data, knowledge, consensus*, and *TMDL* modules. The consensus and TMDL modules provide road maps to engage stakeholders in building consensus on a watershed management or TMDL plan. The engineering and data modules furnish scientific information to each step of the road map in a graphical and tabular format understandable to stakeholders. This section discusses default WARMF Model inputs and site-specific data that were imported into the WARMF Model to create the specific WARMF application to the Santa Margarita River Watershed Model (SMRWM).

A.2 WARMF Model Inputs

The following analyses and data were incorporated into the WARMF Model:

- Watershed delineation
- Land use
- Precipitation
- Atmospheric deposition

Each of these items is critical to the application of WARMF to the Santa Margarita River Watershed. The source of each dataset is discussed in the following subsection.

A.2.1 Watershed Delineation

The SMRWM Model was delineated into 254 sub-catchments, 251 river segments, and three reservoirs. Digital elevation models were processed to determine the locations of river segments and their drainage areas. The area, width, aspect, and slope of catchments and length and slope of river segments have been calculated. The three lakes modeled are Skinner Lake, Vail Lake, and O'Neill Lake. Because these reservoirs are operated for water supply and not for flood control, traditional reservoir modeling techniques will not be utilized. Information regarding reservoir controls is presented in Appendix B. East Side Reservoir (Diamond Valley Lake) and smaller impoundments will be included as hydraulic returns or tributaries as necessary.

A.2.2 Land Use

Existing and future land use was derived from three sources: San Diego County, EMWD, and data used in the EPA Better Assessment Science Integrating Point and Nonpoint Sources (BASINS) model. Data from San Diego is reflective of 2000 land

use and data from EMWD represents 1999 data. The BASINS dataset is reflective of land use patterns from the mid 1970s to mid 1980s (Anderson 1976). For future land use, San Diego's and EMWD's data is reflective of year 2020 land uses. Figures A-1 and A-2 show existing and future land use for the SMR watershed. The land use category specified by each land use source is shown on these figures. The percentage in front of each category represents the amount of this land use category by agency.

Figures A-1 and A-2 show the differences in how entities categorize land use data. For the purposes of the SMRWM, a common set of land use codes was derived based on the definitions available for each land use category. These definitions are contained in Appendix C. Table A-1 shows the selected categories for the SMR watershed and the percentage of each land use type in the watershed for current and future land use projections.

Table A-1 Land Use Types for SMRWM and Percentages in Watershed

Land Use Category	Percent of Watershed for Current Land Use (%)	Percent of Watershed for Future Land Use (%)
Commercial/Industrial	8.5	10.0
Transportation, Communication, Utilities	0.7	0.6
Very Low Density Residential	0.6	15.2
Low Density Residential	2.3	7.4
Medium Density Residential	2.1	4.1
High Density Residential	0.2	7.1
Non-Irrigated Open Space	69.0	49.4
Irrigated Open Space	0.5	0.8
Non-Irrigated Cropland	2.1	0.1
Irrigated Cropland	8.0	0.8
Orchards & Vineyards	3.3	2.8
Dairy/Livestock	0.2	0.1
Other Agricultural	0.6	0.1
Water	1.9	1.9

A.2.3 Meteorology

Meteorological data includes daily precipitation, minimum temperature, maximum temperature, cloud cover, dew point temperature, air pressure, and wind speed. The model is extremely sensitive to the first three. The other four are used primarily for performing the heat balance in lakes, but dew point is also used to calculate evapotranspiration.

Data from seven weather stations was imported and linked to specific sub-catchments. Those stations are Anza, Camp Pendleton, Oak Grove Ranger Station, Oceanside Marina, Sun City, Temecula, Palomar Range and Vista. The daily precipitation and daily minimum, average, and maximum air temperature were derived from the National Climatic Data Center (NCDC) Summary of the Day database for Cooperative Stations. The other four parameters were obtained from the

NCDC Global Summary of the Day and Surface Airways databases, but data from those databases were only available for the Camp Pendleton station.

A.2.4 Atmospheric Deposition

Two atmospheric deposition data sources were evaluated for incorporation into the SMRWM: the National Atmospheric Deposition Program (NADP) and Clean Air Status Trends Network (CASTNET). The NADP measures rain concentrations of the major cations and anions in a national network. The CASTNET includes data and model estimates of atmospheric concentrations and dry deposition of the major cations and anions. The nearest NADP station to the SMR watershed is Tanbark Flat in the San Gabriel Mountains on the north side of the Los Angeles basin. The nearest CASTNET station is at Joshua Tree National Park in the Mojave Desert.

The Tanbark Flat station is located in Los Angeles County, California at elevation 853 meters (m) (2,798 feet [ft]) and has been operating from January 12, 1982. This site is most appropriate for use in the SMR WARMF model as it has the influence of an urban setting. Because of its higher elevation, it may not be the most conservative estimate of an urban setting however. Alternatives to the Tanbark Flat station include the site at Joshua Tree and at Palomar Range. The period of record for the Joshua tree site is from September 2000 until present. The Palomar Range site has an elevation of 4,450 feet and period of record of 1983-1988. The short period of record for both of these alternative stations and the absence of phosphorus data at these stations, further supports the Tanbark Flat station as the most appropriate for inclusion into the SMR WARMF model at this time.

A.3 Historical Data within the Santa Margarita Watershed

Historical data within the SMR watershed was used for the SMRWM calibration. The U.S. Geological Survey (USGS) has collected historical flow data on the watershed and the SMR Study Partners have collected water quality data. The remainder of this section describes the locations of these data sets and a brief data summary.

A.3.1 Water Quality and Flow Data Locations

Figures A-3 and A-4 show the locations of historic flow and water quality stations within the SMR watershed. Table A-2 provides a station key for the historic flow stations and also presents the period of record for each gage. Table A-3 provides a station key for the historic water quality stations and also presents which entity collected the historic data.

Table A-2 USGS Gages in the Santa Margarita River Watershed

Site Number	Site Name	Period of Record	
		From	To
11042400	TEMECULA C NR AGUANGA CA	8/1/1957	PRESENT
11042490	WILSON C AB VAIL LK NR RADEC CA	10/1/1989	9/30/1994
11042520	TEMECULA C A NIGGER CYN NR TEMECULA CA	2/1/1923	9/30/1948
11042600	TEMECULA C BL VAIL DAM CA	10/1/1977	9/30/1978
11042631	PECHANGA C NR TEMECULA CA	10/1/1987	PRESENT
11042700	MURRIETA C A TENAJA RD NR MURRIETA CA	10/1/1997	PRESENT
11042800	WARM SPRINGS C NR MURRIETA CA	10/1/1987	PRESENT
11042900	SANTA GERTRUDIS C NR TEMECULA CA	10/1/1987	PRESENT
11043000	MURRIETA C A TEMECULA CA	10/1/1930	PRESENT
11044000	SANTA MARGARITA R NR TEMECULA CA	2/1/1923	PRESENT
11044250	RAINBOW C NR FALLBROOK CA	11/1/1989	PRESENT
11044300	SANTA MARGARITA R A FPUD SUMP NR FALLBROOK CA	10/1/1989	PRESENT
11044350	SANDIA C NR FALLBROOK CA	10/1/1989	PRESENT
11044500	SANTA MARGARITA R NR FALLBROOK,CALIF.	10/1/1924	9/30/1980
11044600	SANTA MARGARITA R TRIB NR FALLBROOK CA	10/1/1961	9/30/1965
11044800	DE LUZ C NR DE LUZ CA	10/1/1992	PRESENT
11044900	DE LUZ C NR FALLBROOK CA	10/1/1951	9/30/1990
11045000	SANTA MARGARITA R NR DE LUZ STA CA	10/1/1924	9/30/1926
11045050	SANTA MARGARITA R A USMC DIV DAM NR YSIDORA CA	2/26/1999	9/30/2001
11045300	FALLBROOK C NR FALLBROOK CA	10/1/1993	PRESENT
11045600	ONEILL LAKE OUTLET CH NR FALLBROOK CA	10/1/1998	PRESENT
11045700	ONEILL LK SPILL CH NR FALLBROOK CA	10/1/1998	PRESENT
11046000	SANTA MARGARITA R A YSIDORA CA	3/1/1923	PRESENT
11046025	PLANT 2 DISCHARGE TO POND 2 CA	10/1/1993	PRESENT

A.3.2 Water Quality and Flow Data Summary

For modeling calibration, it is important to have coincident flow data and water quality data. Within the current SMRWM, several USGS flow gages and water quality sampling stations share the same locations. Although these sites have water quality data and flow data, they are not necessarily coincident during the proposed modeling period (1989-2001). During the calibration process, stations with relevant water quality data and coincident flow data was selected.

A major focus of the SMR Study modeling is to evaluate from a watershed perspective, nitrogen and phosphorus concentrations and sources in the SMR. For summary purposes, time series plots of locations with significant amounts of water quality data were created as shown in Figures A-5 and A-6. These figures show total nitrogen and total phosphorus data. In these figures, stations are presented from upstream to downstream (station MC01 is Murrieta Creek near Temecula and station SMR01 is the Santa Margarita River at the estuary). Data is collected near the estuary is not as extensive as data collected near Temecula. Available data suggests that concentrations of nitrogen and phosphorus generally increase from upstream to downstream. The average concentration of total nitrogen and total phosphorus were calculated for the water quality stations in Figures A-5 and A-6. These calculations

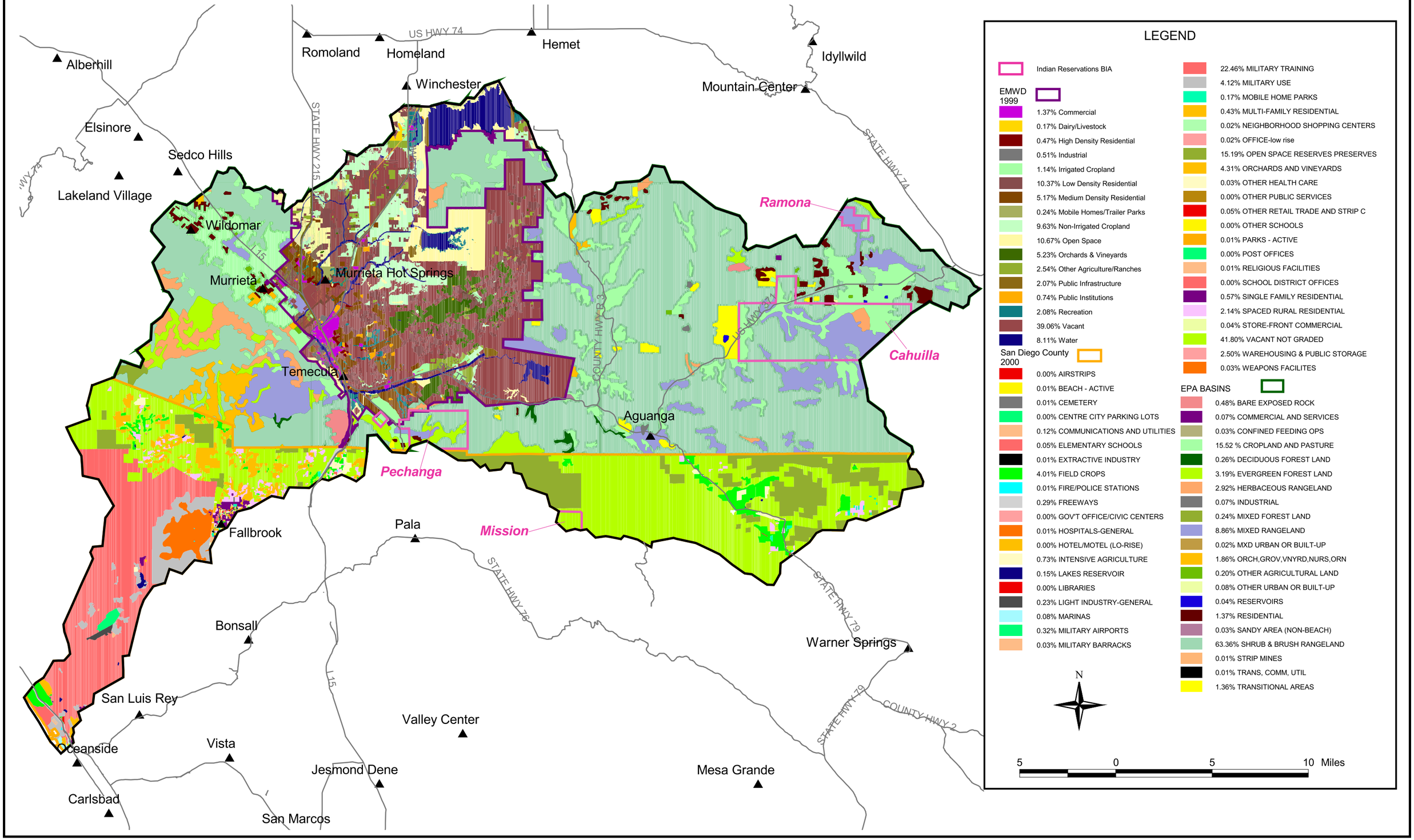
also suggest that concentrations of nitrogen and phosphorus increase from upstream to downstream in the SMR watershed. Average concentrations of total nitrogen from upstream to downstream range from 1.4 mg/L to 4.0 mg/L. For total phosphorus, average concentrations range from 0.2 mg/L to 0.9 mg/L from upstream to downstream. Maximum concentration of total nitrogen and total phosphorus were observed to be 23 mg/L and 2.8 mg/L, respectively.

A.3.3 Water Quality Data Quality

Entities that collected water quality data in the watershed are presented in Table A-3. These data are assumed to be of adequate quality for the current use in the WARMF Model. The majority of this data has been collected as part of permit requirements and thus data quality and assurance was taken into account during collection and analysis process. No formal review of data quality assurance programs for the data provided by study partners was conducted.

Table A-3 Historic Water Quality Stations in the Santa Margarita River Watershed

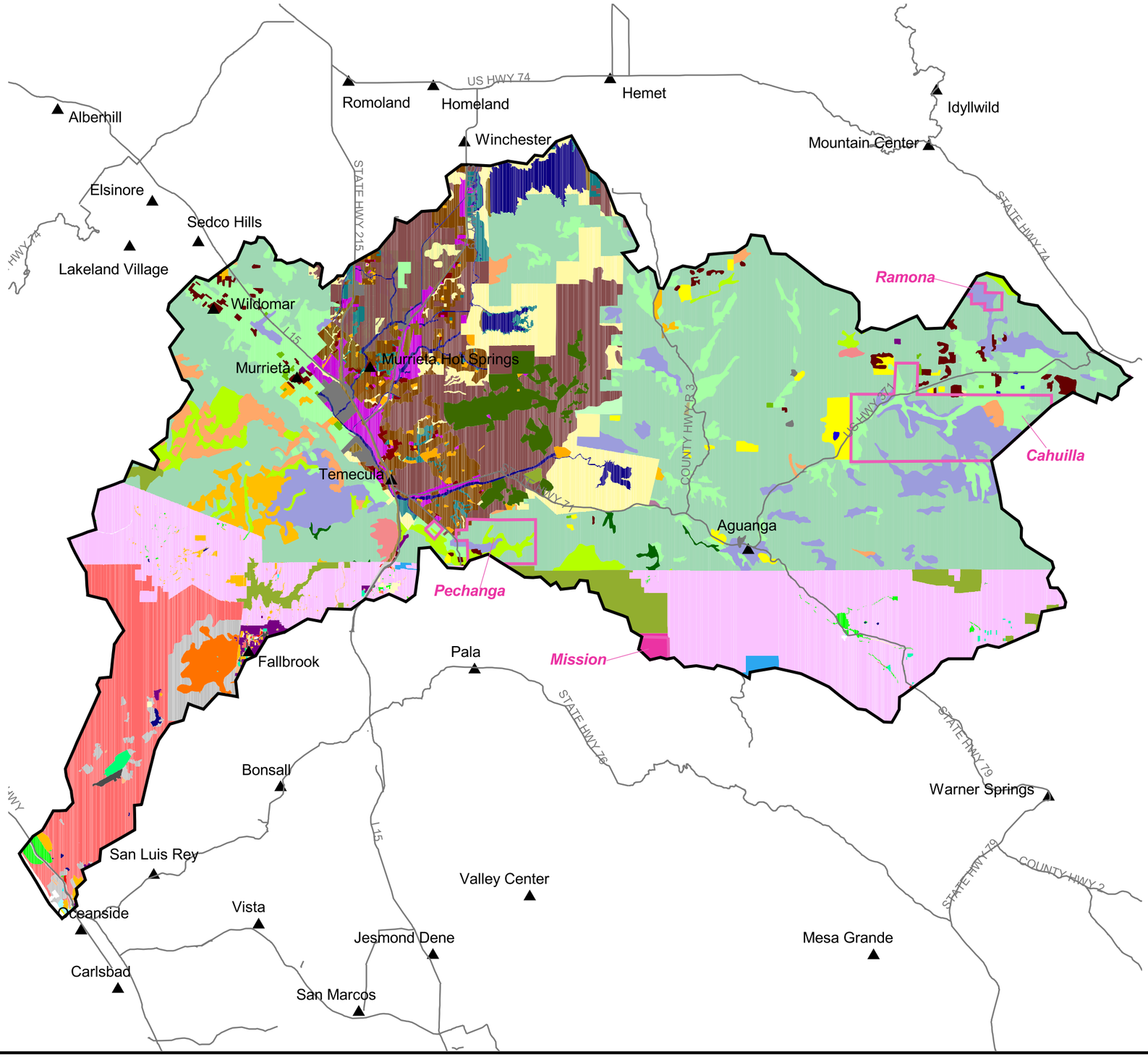
NEW_ID	STATION NAME	CA WATER RES CONTROL BRD	CAMPP	EMWD	RCWD	DWR	METRO WATER DISTRICT	RIVERSIDE COUNTY
DL01	DE LUZ C NR DE LUZ CA		X					
DL02	DELUZ CREEK AT MCDOWELL	X	X					
DL03	DELUZ CREEK AT DOS RIO RD				X			
MC01	MURRIETA AB TEMECULA C	X	X	X	X			
MC02	"C" STREET STORM DRAIN OUTLET @MURRIETA CRK -TE							X
MC03	RANCHO WAY STORM DRAIN OUTLET @MURRIETA CRK -TE							X
MC04	EMPIRE CRK CHAN OUTLET @MURRIETA CRK -TEMECULA							X
MC05	VIA MONTEZUMA STORM DRAIN OUTLET -TEMECULA							X
MC06	TVRWF			X				
MC07	AVENIDA ALVARADO STORM DRAIN OUTLET @ MURRIETA							X
MC08	DOWNSTREAM OF SRWRF				X			
MC09	SRWRF				X			
MC10	UPSTREAM OF SRWRF				X			
MC11	I-215 FB -MURRIETA							X
MC12	MURRIETA LINE F-3 OUTLET NEAR KALMIA & WASHINGT							X
MC13	CAL OAKS CHANNEL- MURRIETA LINE F							X
MC14	HOOVER RANCH POND -MURRIETA, CLINTONKEITHRD							X
MC15	WILDOMAR NPDES CHANNEL OUTLET BELOW CENTRAL AV							X
PC01	PECHANGA CREEK			X				
PC02	PALA POND			X				
SC01	SANDIA C NR FALLBROOK CA		X					
SC02	SANDIA CREEK AT BUENOS CAMPOS				X			
SG01	LATERAL.A OF STA.GERT.CHAN -TEMECULA							X
SMR01	SANTA MARGARITA RIVER AT HWY 101	X		X	X			
SMR02	SANTA MARGARITA AT BRACKISH			X				
SMR03	SANTA MARGARITA R AT YSIDORA	X	X					
SMR04	SANTA MARGARITA R A BASILONE RD	X						
FC01	LAKE ONEILL SOUTH END	X						
SMR05	SANTA MARGARITA RIVER AT CAMP PENDLETON DIVERSION DAM			X				
FC02	FALLBROOK C NR FALLBROOK CA		X					
FC03	SMR AT DELUZ AT "FORD"		X					
SMR06	SANTA MARGARITA RIVER AT DE LUZ ROAD		X	X	X			
SMR07	NAVAL WEAPONS STN AT FALLBROOK CREEK		X					
SMR08	SANTA MARGARITA R NR FALLBROOK	X	X	X		X		
SMR09	SANTA MARGARITA RIVER UPSTREAM FROM RAINBOW C		X					
RC01	RAINBOW C NR FALLBROOK CA		X	X				
SMR10	SANTA MARGARITA RIVER AT WILLOW GLEN			X				
SMR11	MWD CROSSING						X	
SMR12	SANTA MARGARITA R A USGS GAGE 957		X	X	X			
TC01	TEMECULA C AB MURRIETA C	X	X	X	X			
TC02	TEMECULA CREEK AT OLD HWY 395	X		X				
TC03	REDHAWK CHANNEL D/S OF OVERLAND DR							X
TC04	TEMECULA CREEK AT FLOOD CHANNEL			X				
VL01	VAIL LAKE	X						



CDM

U.S. DEPARTMENT OF THE INTERIOR BUREAU OF RECLAMATION

Figure A-1
Existing Land Use
Santa Margarita River Watershed



LEGEND

Federal Land
- Indian Reservations BIA

EMWD "Future" Unknown Year
- 5.5% Commercial
- 1.1% High Density Residential
- 1.87% Industrial
- 0.37% Irrigated Cropland
- 33.41% Low Density Residential
- 14.27% Medium Density Residential
- 0.04% Mobile Homes/Trailer Parks
- 0.54% Non-Irrigated Cropland
- 20.35% Open Space
- 7.38% Orchards & Vineyards
- 0.23% Other Agriculture/Ranches
- 1.86% Public Infrastructure
- 1.36% Public Institutions
- 3.44% Recreation
- 8.13% Water

San Diego County 2020
- 0.00% AIRSTRIPS
- 0.01% BEACH - ACTIVE
- 0.00% CEMETERY
- 0.00% CENTRE CITY PARKING LOTS
- 0.15% COMMUNICATIONS AND UTILITIES
- 0.06% ELEMENTARY SCHOOLS
- 1.02% FIELD CROPS
- 0.02% FIRE/POLICE STATIONS
- 0.29% FREEWAYS
- 0.00% GOV'T OFFICE/CIVIC CENTERS
- 0.01% HOSPITALS-GENERAL
- 0.00% HOTEL/MOTEL (LO-RISE)
- 0.19% INTENSIVE AGRICULTURE
- 0.15% LAKES RESERVOIR
- 0.00% LIBRARIES
- 0.25% LIGHT INDUSTRY-GENERAL
- 0.08% MARINAS
- 0.32% MILITARY AIRPORTS
- 0.03% MILITARY BARRACKS
- 22.46% MILITARY TRAINING
- 4.12% MILITARY USE
- 0.17% MOBILE HOME PARKS
- 0.44% MULTI-FAMILY RESIDENTIAL
- 0.02% NEIGHBORHOOD SHOPPING CENTERS
- 0.02% OFFICE-low rise
- 7.20% OPEN SPACE RESERVES PRESERVES
- 0.56% ORCHARDS AND VINEYARDS
- 0.03% OTHER HEALTH CARE
- 0.00% OTHER PUBLIC SERVICES
- 0.08% OTHER RETAIL TRADE AND STRIP C
- 0.00% OTHER SCHOOLS
- 0.01% PARKS - ACTIVE
- 0.00% POST OFFICES
- 0.01% RELIGIOUS FACILITIES
- 0.00% SCHOOL DISTRICT OFFICES
- 0.84% SINGLE FAMILY RESIDENTIAL
- 57.52% SPACED RURAL RESIDENTIAL
- 0.04% STORE-FRONT COMMERCIAL
- 0.01% WAREHOUSING & PUBLIC STORAGE
- 2.50% WEAPONS FACILITES
- 0.60% PUBLIC/SEMI-PUBLIC
- 0.68% INDIAN RESERVATIONS

EPA BASINS
- 0.48% BARE EXPOSED ROCK
- 0.07% COMMERCIAL AND SERVICES
- 0.03% CONFINED FEEDING OPS
- 15.52 % CROPLAND AND PASTURE
- 0.26% DECIDUOUS FOREST LAND
- 3.19% EVERGREEN FOREST LAND
- 2.92% HERBACEOUS RANGELAND
- 0.07% INDUSTRIAL
- 0.24% MIXED FOREST LAND
- 8.86% MIXED RANGELAND
- 0.02% MXD URBAN OR BUILT-UP
- 1.86% ORCH,GROV,VNYRD,NURS,ORN
- 0.20% OTHER AGRICULTURAL LAND
- 0.08% OTHER URBAN OR BUILT-UP
- 0.04% RESERVOIRS
- 1.37% RESIDENTIAL
- 0.03% SANDY AREA (NON-BEACH)
- 63.36% SHRUB & BRUSH RANGELAND
- 0.01% STRIP MINES
- 0.01% TRANS, COMM, UTIL
- 1.36% TRANSITIONAL AREAS

N

5 0 5 10 15 Miles

CDM

U.S. DEPARTMENT OF THE INTERIOR BUREAU OF RECLAMATION

Figure A-2
Future Land Use
Santa Margarita River Watershed

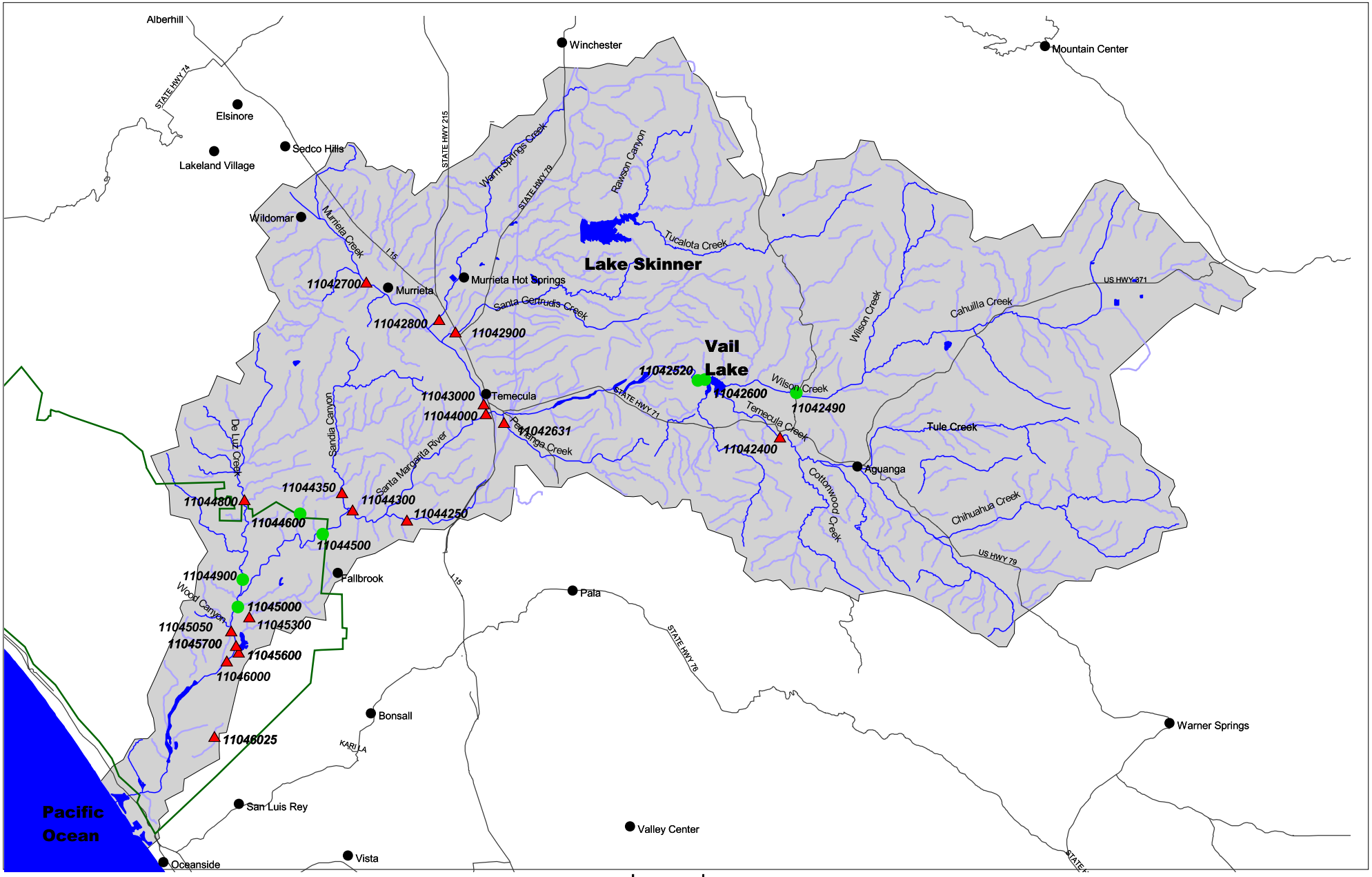
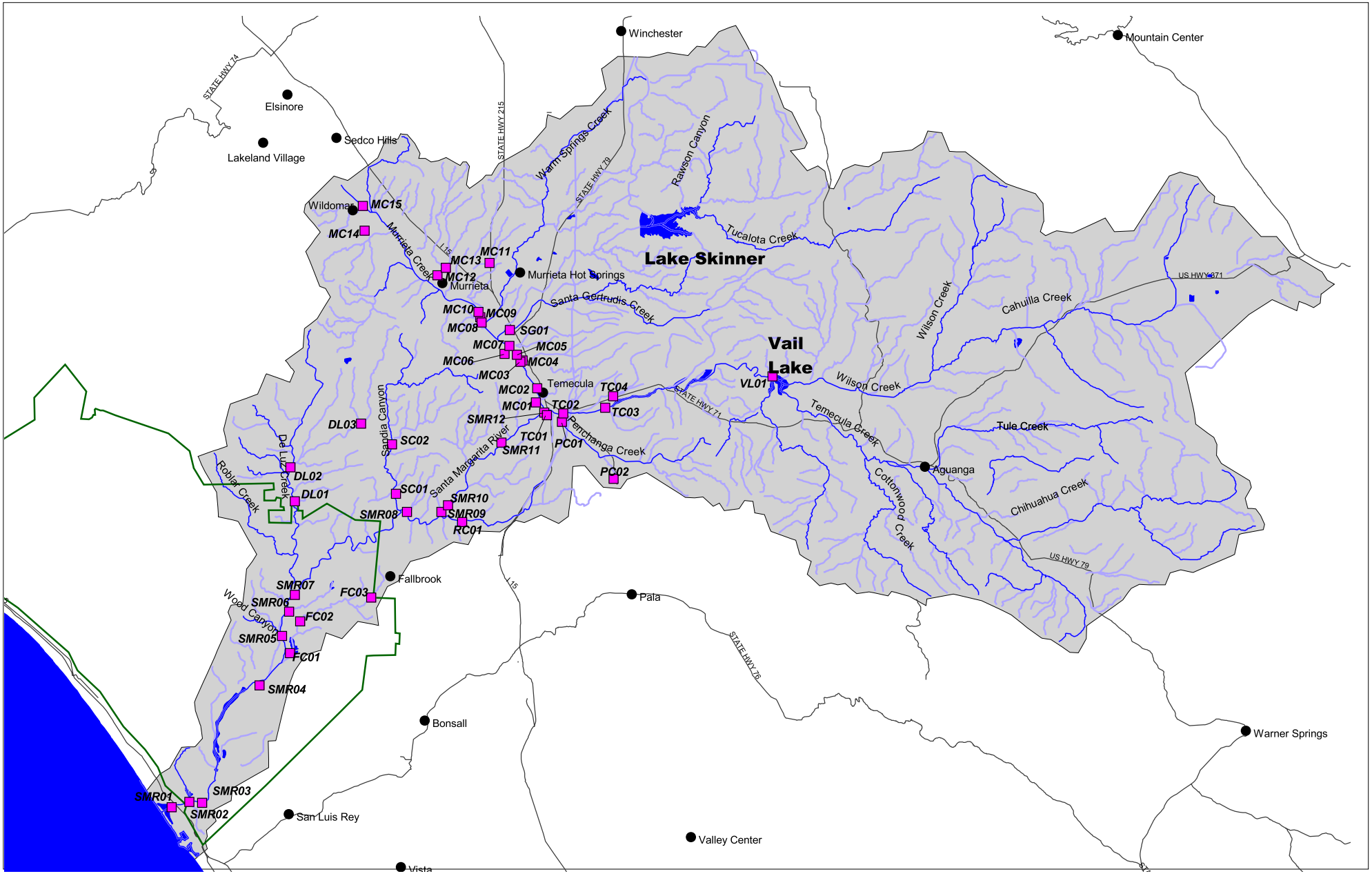


Figure A-3
USGS Gage Locations
Santa Margarita River Watershed

c:/santa margarita/santamargarita/finalreportmaps_c.apr
10/22/03 BA



4 0 4 8 Miles

Scale

Legend

- Water Quality Sampling Locations
- Cities
- Roads
- Streams
- Santa Margarita Watershed
- Reservoirs
- Camp Pendleton Boundary

N

CDM

U.S. DEPARTMENT OF THE INTERIOR BUREAU OF RECLAMATION

Figure A-4
Historic Water Quality Sampling Locations
Santa Margarita River Watershed

c:/santa margarita/santamargarita/finalreportmaps_c.apr
4/25/03 BA

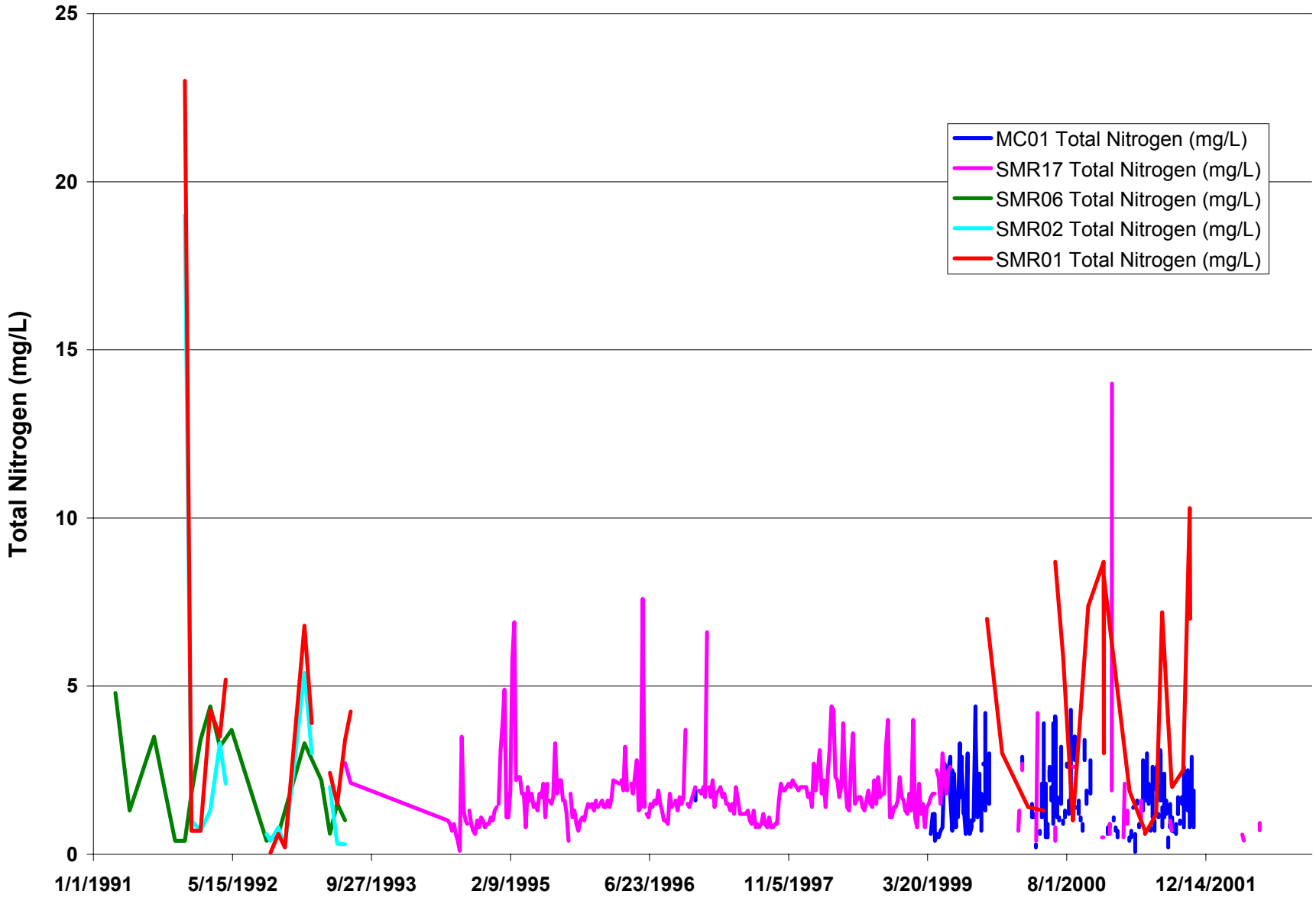


Figure A-5
Historical Total Nitrogen Concentrations in Santa Margarita River Watershed

CDM

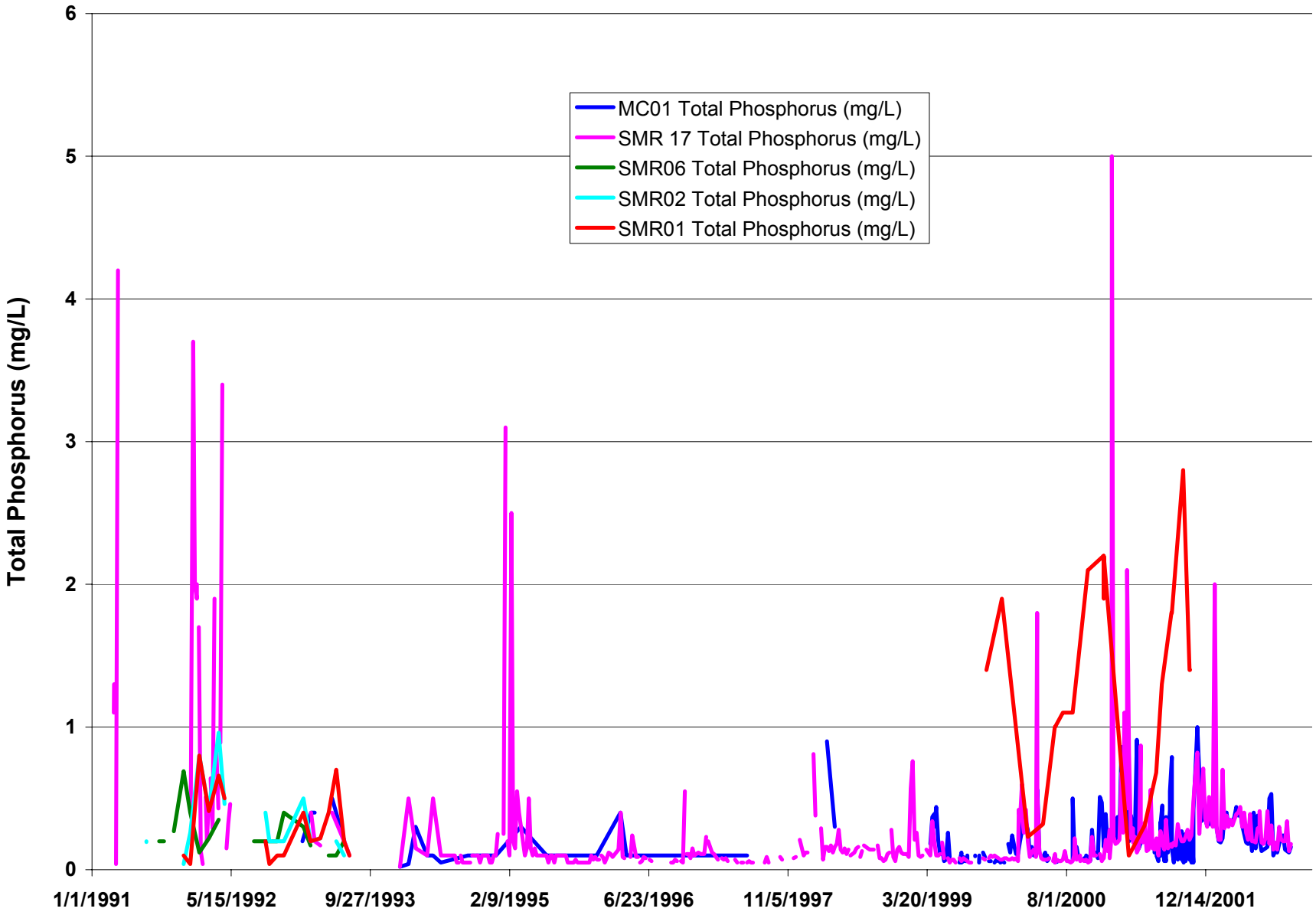


Figure A-6
Historical Total Phosphorus Concentrations in Santa Margarita River Watershed

CDM