CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY

Central Coast Regional Water Quality Control Board

Total Maximum Daily Loads for Nitrate in Streams of the San Antonio Creek Watershed

Santa Barbara County, California

Final TMDL Report

Prepared October 2015

Total Maximum Daily Loads for Nitrate in Streams of the San Antonio Creek Watershed

APPROVALS

Adopted by the
Central Coast Regional Water Quality Control Board
Resolution No. R3-2015-0032
on _____________, 2015

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on _____________, 2015

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http://www.waterboards.ca.gov/centralcoast/water_issues/programs/tmdl/docs/san_antonio/nutrients/index.shtml

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and with input provided by
Stakeholders, including agencies, organizations, and individuals who have a special interest
in the San Antonio Creek Watershed

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LIST OF ACRONYMS

CCAMP	Central Coast Ambient Monitoring Program
CFR	Code of Federal Regulations
CWA	Clean Water Act
DHS	California Department of Health Services
DO	Dissolved oxygen
FMMP	Farmland Mapping and Monitoring Program
GIS	Geographic Information System
HSG	Hydrologic Soil Group
HUC	Hydrologic Unit Code
HUA	Hydrologic Unit Area
MRLC	Multi-Resolution Land Characterization
MS4s	Municipal Separate Storm Sewer Systems
NHD	National Hydrography Dataset
NMFS	National Marine Fisheries Service (NOAA)
NOAA	National Oceanic and Atmospheric Administration
NH_3	Un-ionized ammonia
NH_3^+	Ammonium
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
OEHHA	California Office of Environmental Health Hazard Assessment
OSDS	Onsite Waste Disposal System
PHG	Public Health Goals
RCD	Resource Conservation District
SBFCD	Santa Barbara Flood Control District
SSURGO	Soil Survey Geographic Database
SWRCB	State Water Resources Control Board (State Board)
TMDL	Total Maximum Daily Load
TN	Total Nitrogen
TP	Total Phosphate
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USGS	United States Geologic Survey
Water Board	Central Coast Water Quality Control Board (Region 3)
WDR	Waste Discharge Requirements
WWTP	Waste Water Treatment Plant

EXECUTIVE SUMMARY

The following draft total maximum daily load (TMDL) Report provides information pertaining to development of a nitrate TMDL for waters of San Antonio Creek, in Santa Barbara County, and is intended for public review and comment.

San Antonio Creek is on the 2008-2010 303(d) List of impaired waters due to excessive levels of un-ionized ammonia and nitrite, as well as low dissolved oxygen levels. The 2008-2010 303(d) List is based on an assessment of water quality data that was available up through December 2006. Central Coast Water Board staff (staff) obtained more recent water quality data and an analysis of this data indicates that San Antonio Creek is no longer impaired due to exceedances of un-ionized ammonia and nitrite water quality objectives. As such, Central Coast Water Board staff will propose delisting San Antonio Creek for un-ionized ammonia and nitrite during the next listing cycle. Recent water quality data also indicates that the upper portion of San Antonio Creek is impaired due to high nitrate concentrations. San Antonio Creek is not listed for nitrate impairment and, as a result, the following draft TMDL Report will address this newfound nitrate impairment. It is important to note that, during development of this TMDL, staff identified a high nitrate discharge into San Antonio Creek via an agricultural subsurface drainage system. Nitrate concentrations within this subsurface drainage discharge, as well as close proximity to the nearest downstream water quality monitoring site, has led staff to conclude that this discharge is most likely the only source responsible for the nitrate impairment. Staff and the cooperative agricultural operator have since coordinated and the high nitrate subsurface drainage discharge into San Antonio Creek has been eliminated. This TMDL and associated allocations for nitrate are being developed in the event that other sources from agricultural operations contribute to the nitrate impairment, while also protecting unimpaired waters from degradation by reiterating provisions of the anti-degradation policy.

Staff also evaluated potential biostimulatory conditions that may lead to low dissolved oxygen conditions within San Antonio Creek, such as nutrient enrichment and resulting elevated algal biomass (chlorophyll *a,* excessive algae). Staff concluded that low dissolved oxygen conditions are most likely due to natural conditions rather than nutrient enrichment. San Antonio Creek will remain on the 2008-2010 303(d) List of impaired waters due to low dissolved oxygen and staff will evaluate this impairment in a future TMDL or water quality standards action.

Total Maximum Daily Load

Information contained in this draft TMDL Report will be used to develop a nitrate TMDL for waters of San Antonio Creek. TMDL is a term used to describe the maximum amount of pollutants, in this case, nitrate, that a waterbody can receive and still meet water quality standards. This TMDL report identifies the probable sources of pollution, establishes the maximum amount of pollution a waterbody can receive and still meet water quality standards, and allocates that amount to all probable contributing sources. By “allocating” an amount to a contributing source, we are assigning responsibility to someone, an agency, group, or individuals, to reduce their contribution in order to meet water quality standards.

The federal Clean Water Act requires every state to evaluate its waterbodies and maintain a list of waters that are considered “impaired” either because the water exceeds water quality standards or does not achieve its designated use. For each waterbody on the Central Coast’s 303(d) Impaired Waters List, the Central Coast Regional Water Quality Control Board (Central Coast Water Board) must develop and implement a plan to reduce pollutants so that the waterbody is no longer impaired and can be de-listed.

San Antonio Creek was listed as impaired on the 2008-2010 303(d) List due to excessive levels of un-ionized ammonia and nitrite, as well as low dissolved oxygen levels. For un-ionized ammonia, 16 of 86 samples exceeded the Water Quality Control Plan for the Central Coastal Basin (Basin Plan) general water quality objective (WQO) for toxicity which is 0.025 milligrams per liter (mg/L) as nitrogen. For nitrite, 5 of 52 samples exceeded the California Office of Environmental Health Hazard Assessment (OEHHA) nitrite public health goal (PHG) as it applies to municipal drinking water beneficial uses. The OEHHA PHG is 1 mg/L nitrite as nitrogen. For dissolved oxygen, 26 of 95 samples exceed the dissolved oxygen water quality objective for Cold Freshwater Habitat (COLD) beneficial uses and 6 of the 95 samples also exceed the dissolved oxygen water quality objective for Warm Freshwater Habitat (WARM) beneficial uses. The dissolved oxygen water quality objectives are a minimum of 7 mg/L for COLD beneficial uses and a minimum of 5 mg/L for WARM beneficial uses. In addition, 49 of 95 samples do not meet the general water quality objective for oxygen saturation (when applied as a single sample maximum). The Basin Plan general water quality objective states that the median oxygen saturation value shall not fall below 85%.

Impaired Waterbody

The geographic scope of this TMDL (the project area) includes the San Antonio Creek Watershed (Hydrologic Unit Code # 1806000901), which encompasses approximately 152.6 square miles (97,651 acres) in northern Santa Barbara County. San Antonio Creek watershed lies between the Santa Maria River watershed to the north and the Santa Ynez watershed to the south.

Land cover and land use within the watershed is composed primarily of shrubs, scrubs, grasslands, and forested lands, which are often used for cattle grazing, as well as cultivated crops, and low density urban development.

Numeric Targets and Allocations

Numeric targets are water quality targets developed to ascertain when and where water quality objectives are achieved, and hence, when beneficial uses are protected. The numeric target for these TMDLs is identical to the Basin Plan numeric water quality objective for nitrate protective of the municipal and domestic supply beneficial use.

Discharges of nitrate from irrigated agriculture can potentially exceed water quality objectives for municipal and domestic supply. Owners and operators of irrigated lands are assigned allocations for nitrate to achieve the TMDL. Responsible parties are assigned allocations for nitrate equal to the numeric targets as represented in the table below.

This TMDL is a concentration-based TMDL equal to the numeric target.

The table below identifies the allocations assigned to responsible parties and the affected waterbodies.

LOAD ALLOCATIONS		
Waterbodies Assigned TMDLs (including all tributaries)	**Responsible Party Assigned Allocation (Source)**	**Receiving Water Allocation**
• San Antonio Creek (CAR3130001020020918211049)	Owners/operators of irrigated agricultural lands (Discharges from irrigated lands)	10 mg/L Nitrate as Nitrogen

TMDL Implementation, Monitoring, and TMDL Timeline
Owners and operators of irrigated lands in the project area are required to comply with the conditions and requirements of the *Conditional Waiver of Waste Discharge Requirements For Discharges from Irrigated Lands* (Agricultural Order) and any renewals thereof. Owners and operators are required to comply with the requirements described in the Agricultural Order, which may include:

- Enroll in and comply with the Agricultural Order.
- Implement monitoring and reporting requirements described in the Agricultural Order.
    - o Current reporting requirements include a description of discharges leaving the growers field, including the concentration of nitrate discharges and the volume of discharge. Reporting requirements also require a description of management practices used to mitigate nitrate loading.
- Implement, and update as necessary, management practices to reduce nitrate loading.
- Maintain existing, naturally occurring, riparian vegetative cover in aquatic habitat areas.
- Develop/update and implement Farm Plans. The Farm Plans should incorporate measures designed to achieve load allocations assigned in this TMDL.
- Develop, and initiate implementation of an Irrigation and Nutrient Management Plan (INMP) or alternative certified by a Professional Soil Scientist, Professional Agronomist, or Crop Advisor certified by the American Society of Agronomy, or similarly qualified professional (current requirements for tier-3 dischargers only).

Owners and operators of irrigated agricultural lands must perform monitoring and reporting in accordance with Monitoring and Reporting Program Orders R3-2012-0011-01, R3-2012-0011-02, and R3-2012-0011-03, as applicable to the operation.

The timeline to achieve this TMDL is by November 2020. Staff concludes that the TMDL is achievable by this date because the most likely source of nitrate impairment has been identified and eliminated, it provides enough time for other potential irrigated agricultural sources to control their discharges of nitrate, and CCAMP data will be available in 2020 to verify that no other sources are contributing to nitrate impairment.

1 INTRODUCTION

San Antonio Creek is listed on the 2010 303(d) List of impaired waterbodies due to high levels of un-ionized ammonia and nitrite, and low levels of dissolved oxygen. Due to these listings the Central Coast Regional Water Quality Control Board (Water Board) is required to address surface water quality impairments in accordance with Clean Water Act Section 303(d) and the Porter-Cologne Water Quality Control Act §13242 (see Section 1.1 for requirements).

The 2010 303(d) listings for San Antonio Creek are based on water quality data obtained up through December 2006. Water Board staff (staff) obtained more recent water quality data and performed an updated water quality assessment as part of this report. Based on this updated assessment staff has concluded that San Antonio Creek is no longer impaired for un-ionized ammonia and nitrite and, as a result, staff is recommending to de-list San Antonio Creek for un-ionized ammonia and nitrite. In addition, based on this updated assessment, staff has concluded that the upper portion of San Antonio Creek is impaired due to excessive levels of nitrate (see Section 4 for Data Analysis). San Antonio Creek is not on the 2010 303(d) List due to excessive nitrate concentrations, therefore the following TMDL report will address nitrate impairment. It should be noted that impairments due to low dissolved oxygen are not directly addressed in this TMDL report because staff has concluded that these conditions are most likely a result of natural conditions (See Section 4.10).

This report provides information pertaining to development of nitrate TMDLs for waters of San Antonio Creek in Santa Barbara County and is intended for public review and comment. TMDL reports are best characterized as plans or strategies to improve water quality, and thus a TMDL report is a type of planning document.

This TMDL report addresses surface water quality impairments in the San Antonio Creek watershed that are due to exceedances of water quality criteria for nitrate. This impairment impacts designated beneficial uses of surface waters that include drinking water supply, groundwater recharge, and agricultural supply.

Figure 1-1 shows the San Antonio Creek watershed relative to the Central Coast region and state of California.

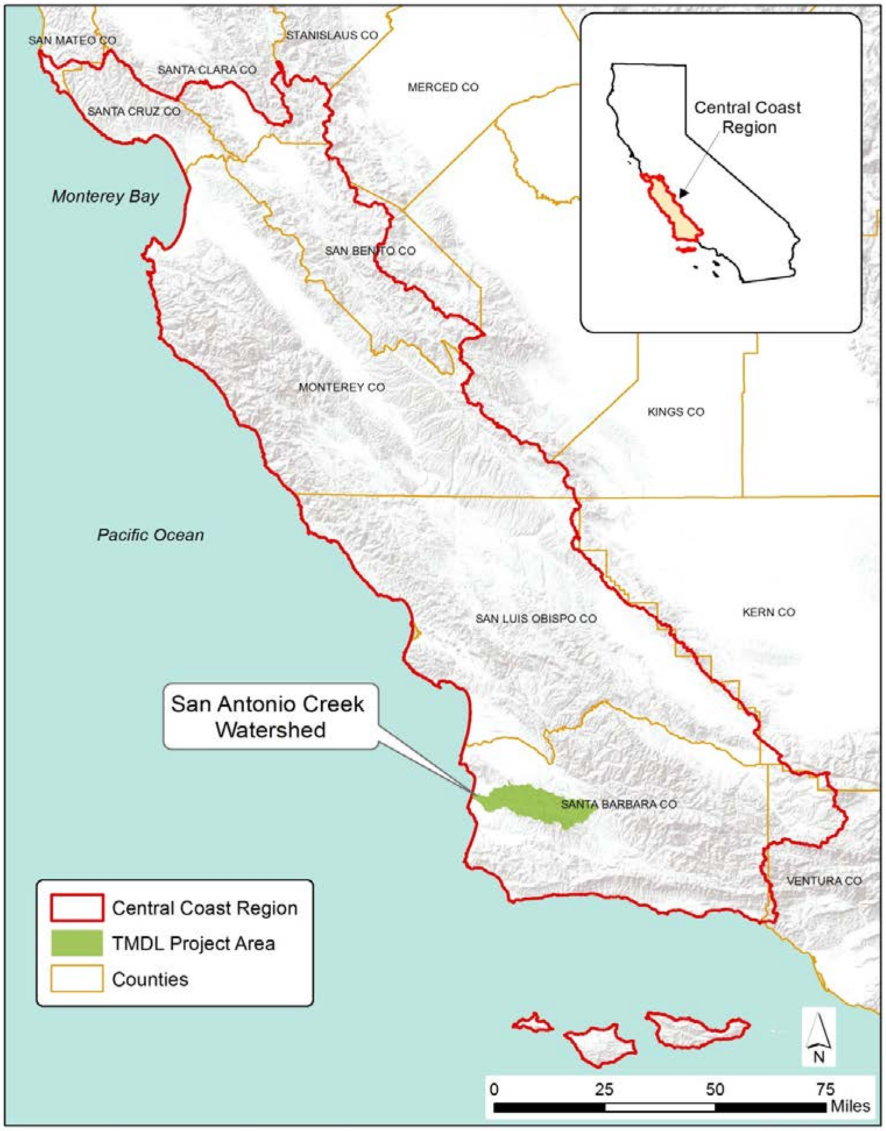


Figure 1-1. San Antonio Creek watershed (TMDL Project Area).

1.1 Clean Water Act Section 303(d) List

Section 303(d) of the federal Clean Water Act requires every state to evaluate its waterbodies, and maintain a list of waters that are considered “impaired” either because the water exceeds water quality standards or does not achieve its designated use. For each water on the Central Coast’s “303(d) Impaired Waters List”, the Central Coast Water Board must develop and implement a plan to reduce pollutants so that the water body is no longer impaired and can be de-listed. Section 303(d) of the Clean Water Act states:

> *Each State shall establish for the waters identified in paragraph (1)(A) of this subsection, and in accordance with the priority ranking, the total maximum daily load, for those pollutants which the Administrator identifies under section 1314(a)(2) of this title as suitable for such calculation. Such load shall be established at a level necessary to implement the applicable water quality standards with seasonal variations and a margin of safety that takes into account any lack of knowledge concerning the relationship between effluent limitations and water quality.*

The State complies with this requirement by periodically assessing the conditions of the rivers, lakes and bays and identifying them as "impaired" if they do not meet water quality standards. These waters, and the pollutant or condition causing the impairment, are placed on the 303(d) List of Impaired Waters referred to hereafter as the "303(d) List". In addition to creating this list of waterbodies that do not meet water quality standards, the Clean Water Act mandates each state to develop TMDLs for each listed water body. Simply put, TMDLs are strategies or plans to address and rectify impaired waters identified on the 303(d) List. The Central Coast Water Board is the agency responsible for developing TMDLs and programs of implementation for waterbodies identified as not meeting water quality objectives pursuant to Clean Water Act Section 303(d) and in accordance with the Porter-Cologne Water Quality Control Act §13242.

1.2 Project Area

The geographic scope of this TMDL (the project area) includes the San Antonio Creek Watershed (Hydrologic Unit Code # 1806000901), which encompasses approximately 152.6 square miles (97,651 acres) in northern Santa Barbara County (see Figure 2-1). San Antonio Creek watershed lies between the Santa Maria River watershed to the north and the Santa Ynez watershed to the south.

1.3 Pollutants Addressed

The pollutant addressed in this TMDL is nitrate. Additional information pertaining to un-ionized ammonia, nitrite, and low dissolved oxygen is included in the data analysis section of his report.

San Antonio Creek from Railroad Bridge near the coast to Rancho del las Flores Bridge at Hwy 135 was listed as impaired on the 2008-2010 303(d) list due to excessive levels of un-ionized ammonia and nitrite, as well as low dissolved oxygen levels. For un-ionized ammonia[1], 16 of 86 samples exceeded the Water Quality Control Plan for the Central Coastal Basin (Basin Plan) general water quality objective (WQO) for toxicity which is 0.025 milligrams per liter (mg/L) as nitrogen. For nitrite[2], 5 of 52 samples exceeded the California Office of Environmental Health Hazard Assessment (OEHHA) nitrite public health goal (PHG) as it applies to municipal drinking water beneficial uses. The OEHHA PHG is 1 mg/L nitrite as nitrogen. For dissolved oxygen[3], 26 of 95 samples do not meet the dissolved oxygen water quality objective for Cold Freshwater Habitat (COLD)

[1] http://www.waterboards.ca.gov/water_issues/programs/tmdl/2010state_ir_reports/00948.shtml#13437
[2] http://www.waterboards.ca.gov/water_issues/programs/tmdl/2010state_ir_reports/00948.shtml#5521
[3] http://www.waterboards.ca.gov/water_issues/programs/tmdl/2010state_ir_reports/00948.shtml#13474

beneficial uses and 6 of the 95 samples do not meet the dissolved oxygen water quality objective for Warm Freshwater Habitat (WARM) beneficial uses. The dissolved oxygen water quality objectives are a minimum of 7 mg/L for COLD beneficial uses and a minimum of 5 mg/L for WARM beneficial uses. In addition, 49 of 95 samples do not meet the general water quality objective for oxygen saturation (when applied as a single sample maximum). The Basin Plan general water quality objective states that the median oxygen saturation value shall not fall below 85%.

As stated earlier, the 2010 303(d) listings for San Antonio Creek are based on water quality data obtained up through December 2006. Staff obtained more recent water quality data and performed an updated water quality assessment as part of this report. Based on this updated assessment staff has concluded that San Antonio Creek is no longer impaired for un-ionized ammonia and nitrite and, as a result, staff is recommending to de-list San Antonio Creek for un-ionized ammonia and nitrite. In addition, based on this updated assessment, staff has concluded that the upper portion of San Antonio Creek is impaired due to excessive levels of nitrate. San Antonio Creek is not on the 2010 303(d) List due to excessive nitrate concentrations, therefore the following TMDL report will address nitrate impairment.

Figure 1-2 shows the 2008-2010 303(d) Listings for San Antonio Creek between Rancho del las Flores Bridge at Hwy 135 to the Railroad Bridge, as well as the Central Coast Ambient Monitoring Program (CCAMP) water quality monitoring sites.

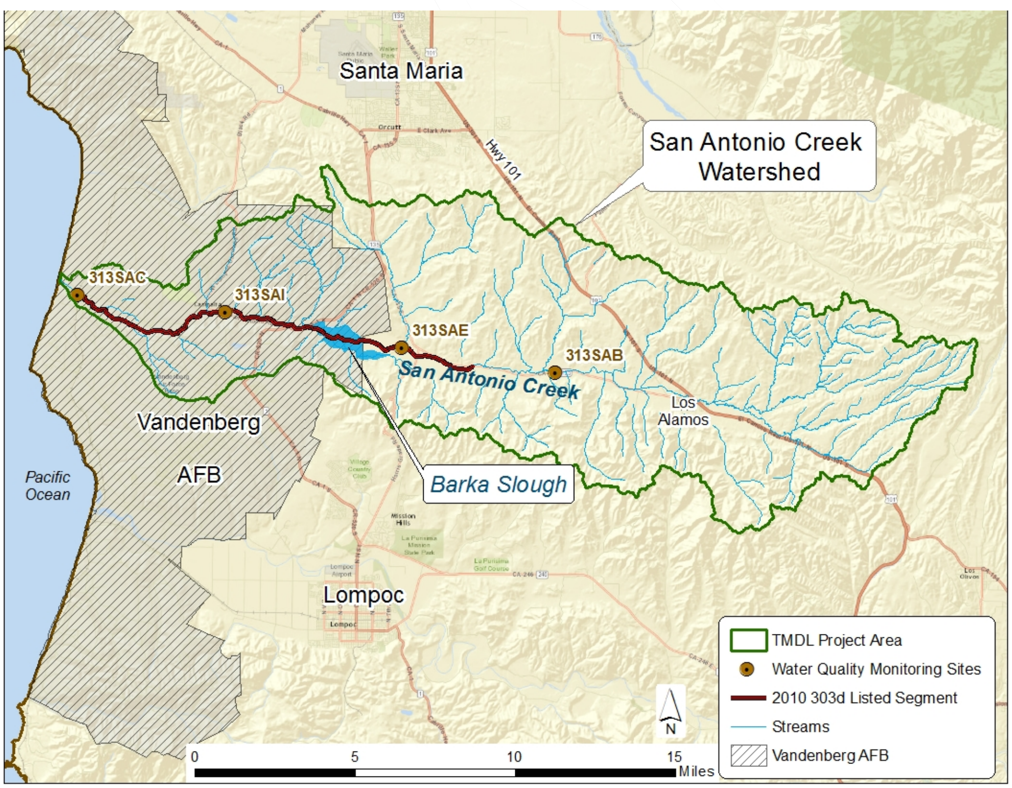


Figure 1-2. San Antonio Creek 2008-2010 303(d)-Listed segment and CCAMP monitoring sites.

2 WATERSHED DESCRIPTION

The San Antonio Creek watershed is an east west trending drainage located in Santa Barbara County. Figure 2-1 shows the watershed, waterbodies, and CCAMP water quality monitoring sites.

San Antonio Creek has a gradient that conforms closely to that of the valley floor; 50 feet per mile above Los Alamos and 25 feet per mile between Los Alamos and the ocean. All creeks in the valley are intermittent except for the portion of San Antonio Creek west of Barka Slough. Consolidated Tertiary rocks that cut across and underlie the valley at a shallow depth just east of Barka Slough form a subsurface barrier that causes almost all ground water to move upward to the land surface, where it discharges into San Antonio Creek. The creek has perennial flow from the subsurface barrier near Barka Slough to the ocean. Narrowing of the Los Alamos Valley in the vicinity of Canada de las Flores, near CCAMP monitoring site 313SAB, also causes ground water to rise to the surface (Muir, 1964).

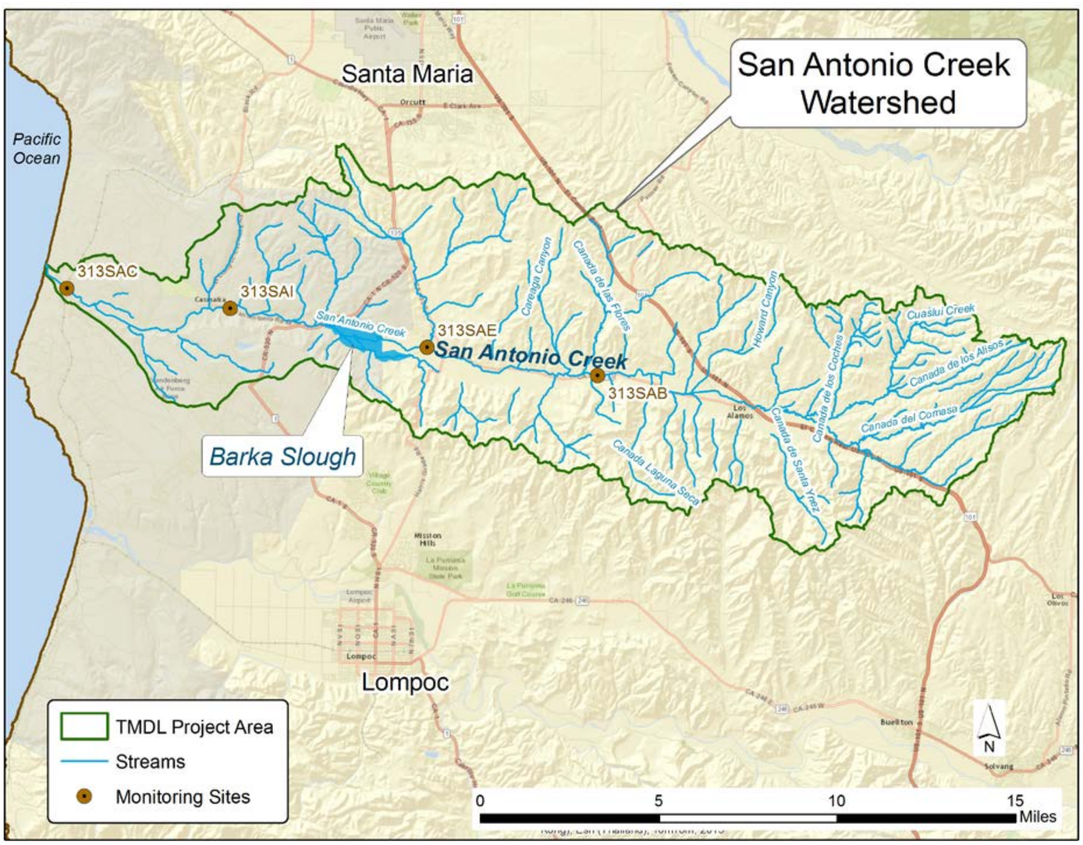


Figure 2-1. Streams and CCAMP monitoring sites.

Barka Slough lies around 10 miles east of the Pacific Ocean and is the largest freshwater wetland in Santa Barbara County. In September of 2000, the Harris Fire ignited the peat bog of Barka Slough and the fire burned for nearly a year. Barka Slough lies almost entirely within the boundary of Vandenberg Air Force Base. Figure 2-2 details the location of Barka Slough.

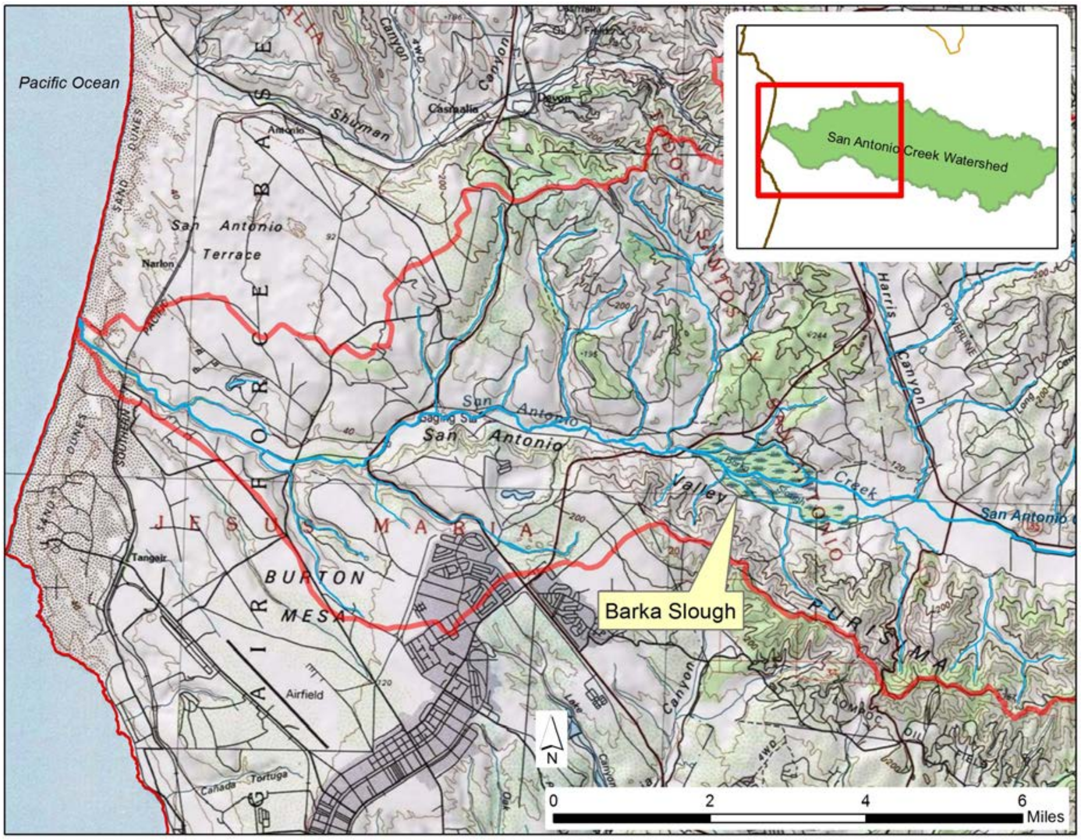


Figure 2-2. Location of Barka Slough.

2.1 Land Use

Other than public road corridors and Vandenberg Air Force Base, most of the land in the watershed is in private ownership, and except for the community of Los Alamos, is used for some form of agriculture (CRMP 2003). According to 2014 parcel information derived from the Santa Barbara County Assessor's Office (see Appendix C, Table C-3), agricultural use in the watershed is primarily comprised of dryland grazing (39%), vineyards (16%), and irrigated crops (8%). All of the irrigated crops use groundwater resources (CRMP 2003). Historically, oil mining was the most important non-farm industry; however, it is largely in decline and most of the upland areas previously used for oil production were converted to beef cattle grazing. In recent years, many of the best grazing sites have been converted to wine grape vineyards. The few urban areas within the watershed include the town of Los Alamos and housing for Vandenberg Air Force Base personnel.

Because the San Antonio Creek watershed is primarily agricultural, staff used Farmland Mapping and Monitoring Program (FMMP, 2010) land use data to characterize land use. The FMMP land use data uses soil properties to characterize county farmlands into categories such as prime farmland, farmland of statewide importance, unique farmland, and farmland of local importance. The FMMP data also contains a characterization of grazing lands and urban lands. FMMP land use is shown in Figure 2-3 and tabulated by area in Table 2-1.

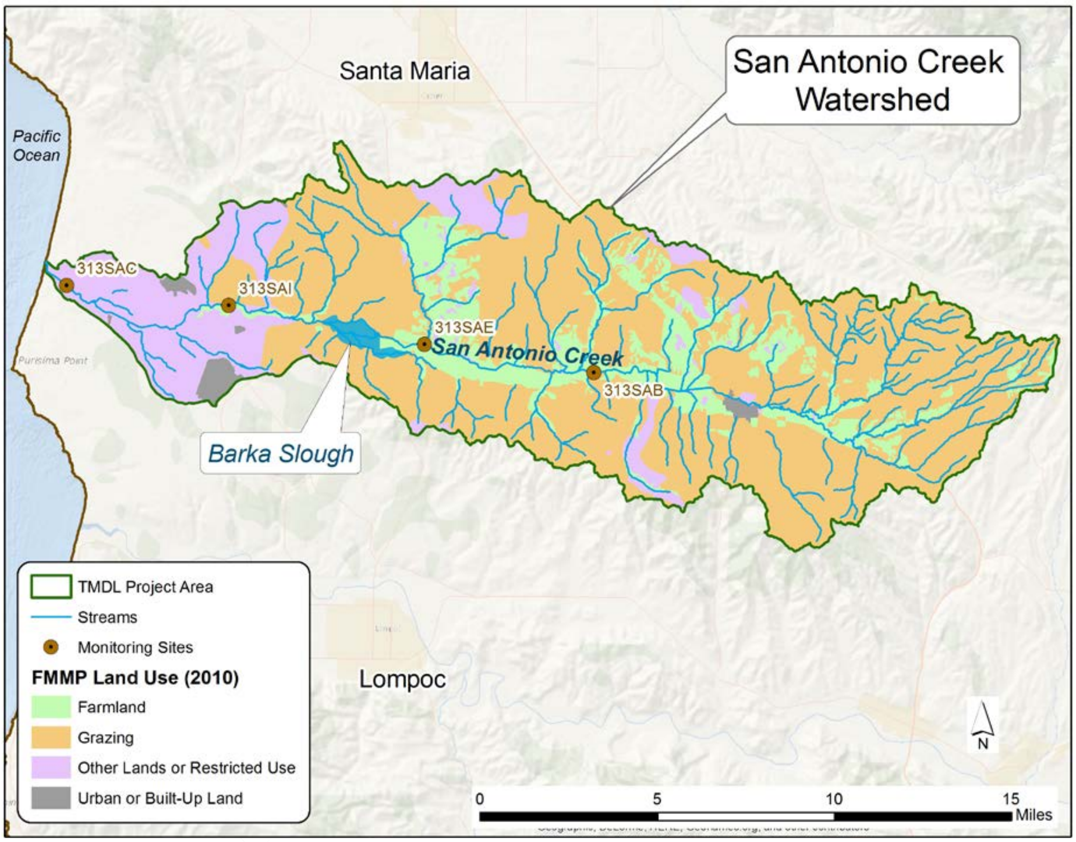
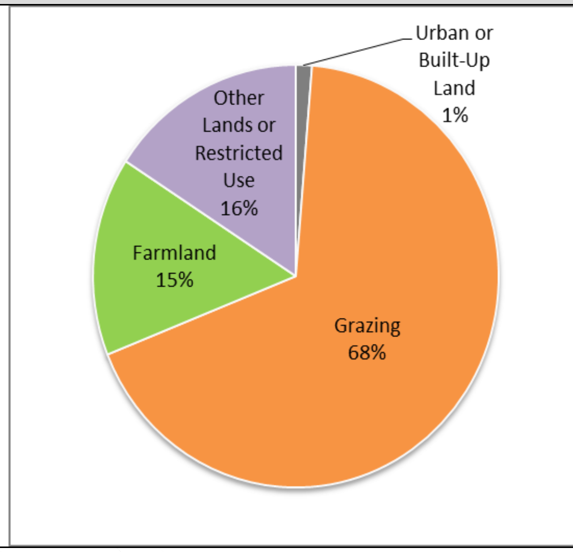


Figure 2-3. Land use and CCAMP monitoring sites.
Spatial data source: Farmland Mapping and Monitoring Program (FMMP 2010).

The “Other Lands or Restricted Use” land use category includes low density rural development, heavily forested land, mined land, or government land with restrictions on use.

Table 2-1. Land use area and percent composition (FMMP 2010).

FMMP Land Cover (Year 2010)	Area (Acres)	Watershed Land Cover Pie Chart
Urban or Built-Up Land	1,245	
Farmland	14,845	
Grazing Land	66,093	
Other Lands or Restricted Use (Forested, mined, or government lands)	15,468	
Total	97,651	

2.2 Stream Flow

All creeks in the valley are intermittent except for the portion of San Antonio Creek west of Barka Slough where stream flow is perennial. For this portion of San Antonio Creek west of Barka Slough, perennial stream flow is due to consolidated Tertiary rocks that cut across and underlie the valley at a shallow depth, forming a subsurface barrier that causes almost all ground water to move upward to the land surface, where it discharges into San Antonio Creek. Table 2-2 contains United States Geological Survey (USGS) stream gage identification numbers along with location descriptions and Figure 2-4 is a graph of mean annual flow for each gage station. It is important to note that USGS gage station 11136100 near Casmalia is collocated with CCAMP water quality monitoring station 313SAI.

Table 2-2. USGS stream gages in San Antonio Creek watershed.

USGS Gage ID	Location Description	Period of Record
11136100	San Antonio Creek near Casmalia (same location as CCAMP site 313SAI)	1956-2003
11136050	San Antonio Creek above Barka Slough	1985
11135800	San Antonio Creek at Los Alamos	1971-1992, 1998-1999, 2004, 2006, 2011-2013

Source: http://waterdata.usgs.gov/nwis/

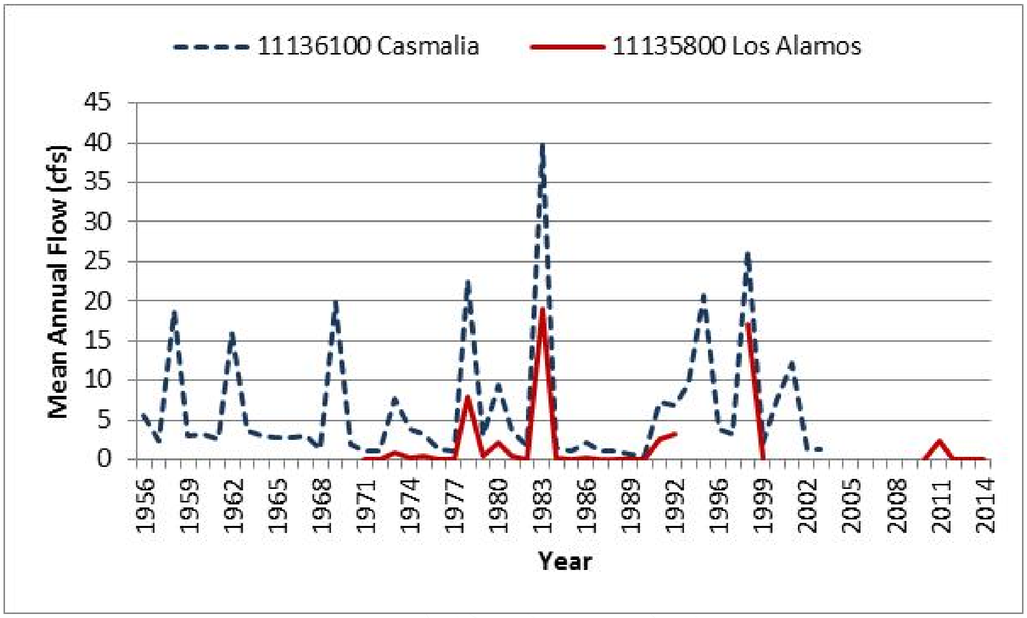


Figure 2-4. USGS mean annual flow.
Not shown, USGS station 11136050 above Barka Slough mean annual flow of 0.106 cfs in 1985.
Source: http://waterdata.usgs.gov/nwis/

Mean annual flow for two of the USGS gage stations is depicted in Figure 2-4. Note that USGS station 11136050, above Barka Slough, is not shown because there is only 1 year of statistics for the calculation of mean annual flow. The highest mean annual flow occurred in 1983, with flows of 39.7 cubic feet per second (cfs) at the Casmalia gage and 18.9 cfs at the Los Alamos gage. In 2012 and 2013 the mean annual flow at the Los Alamos gage was recorded as zero (0) cfs.

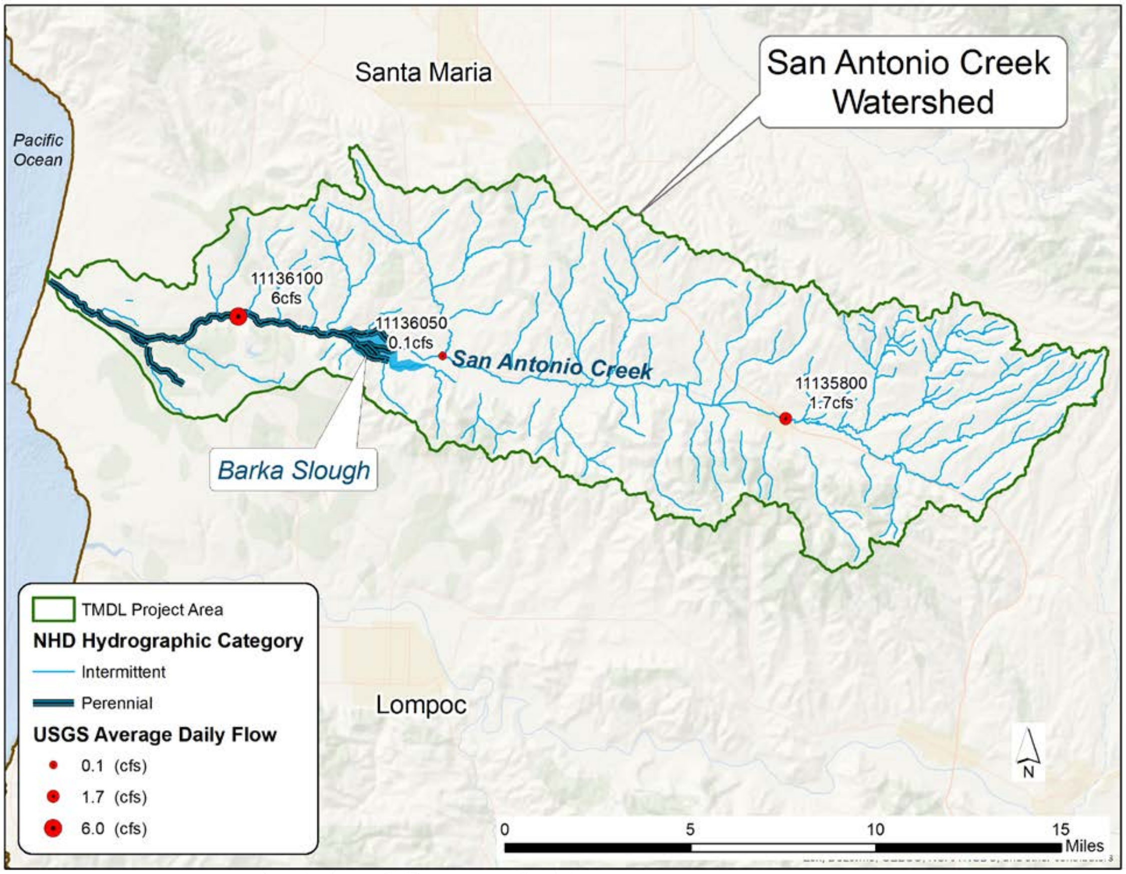


Figure 2-5. USGS gage locations, stream flow characteristics, and stream types.
Spatial data sources: USGS National Hydrography Dataset (NHD), High Resolution (1:24,000) representing hydrographic category. USGS average daily flow based on streamflow characteristics dataset (Wolock, 2003) containing data up through November 2001.

Figure 2-5 shows average daily stream flow[4] for each of the USGS stream gages along with stream types[5] (intermittent or perennial).

[4] USGS average daily flow based on streamflow characteristics (Wolock, 2003). Flow data up through November 2001. http://water.usgs.gov/GIS/metadata/usgswrd/XML/qsitesdd.xml#stdorder
[5] USGS National Hydrography Dataset (NHD), High Resolution (1:24,000).

Table 2-3 shows average daily streamflow characteristics for the three USGS gage stations in San Antonio Creek watershed. Gage station (11136100), located furthest downstream near Casmalia, recorded the highest average daily streamflow of 6 feet per second (cfs). At this downstream location, approximately 43% of streamflow is derived from groundwater baseflow as indicated by the base-flow index (BFI). Base flow is the component of streamflow that can be attributed to ground-water discharge into streams. The BFI is the ratio of base flow to total flow, expressed as a percentage.

Table 2-3. USGS average daily stream flow characteristics (cfs).

Station Number and Name	Period	Ave	Days	Min	P1	P5	P10	P20	P25	P50	P75	P80	P90	P95	P99	Max	Years BFI	BFI
11136100 San Antonio Cr near Casmalia	1955-2000	6.0	15,715	0.1	0.17	0.28	0.38	0.5	0.56	1.0	2.20	2.80	4.6	11.0	94.7	2,040	43	0.430
11136050 San Antonio Cr above Barka Slough	1984-1987	0.1	762	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.12	0.19	0.4	0.64	1.0	1.70	NA	NA
11135800 San Antonio Cr at Los Alamos	1970-1999	1.7	8,401	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.01	0.20	0.66	27.5	1,430	23	0.070

Note: " P" indicates percentile daily streamflow values from 1st through 99th percentiles.
BFI indicates average annual base-flow index value (fraction, ranging from 0 to 1).
Source: Wolock, 2003 – historical data through November 2001.

2.3 Climate

Climate within the watershed is characterized as a warm-summer Mediterranean climate, whereby average monthly temperatures do not exceed 83º Fahrenheit. Precipitation occurs most often between October and April. Table 2-4 provides a climate summary for Los Alamos which is located in the upper portion of the watershed.

Table 2-4. Monthly climate summary for Los Alamos, California (station 045107).

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max. Temperature (F)	64.3	64.5	68.3	71.1	76.2	77.6	81.4	82.9	82.0	77.8	70.1	65.5	73.5
Average Min. Temperature (F)	37.6	39.4	39.8	40.8	45.8	48.9	52.3	52.8	50.7	44.5	40.7	36.4	44.1
Average Total Precipitation (in.)	3.16	3.19	2.82	1.23	0.34	0.06	0.02	0.04	0.25	0.57	1.36	2.46	15.50

Note: Period of Record: 4/27/1894 to 7/31/2008.
Data source: Western Regional Climate Center, Desert Research Center.
http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?ca5107

Average annual precipitation within the watershed ranges from around 15 inches near the coastline to about 23 inches in the upper reaches of San Antonio Creek that lie to the east as shown in Figure 2-6.

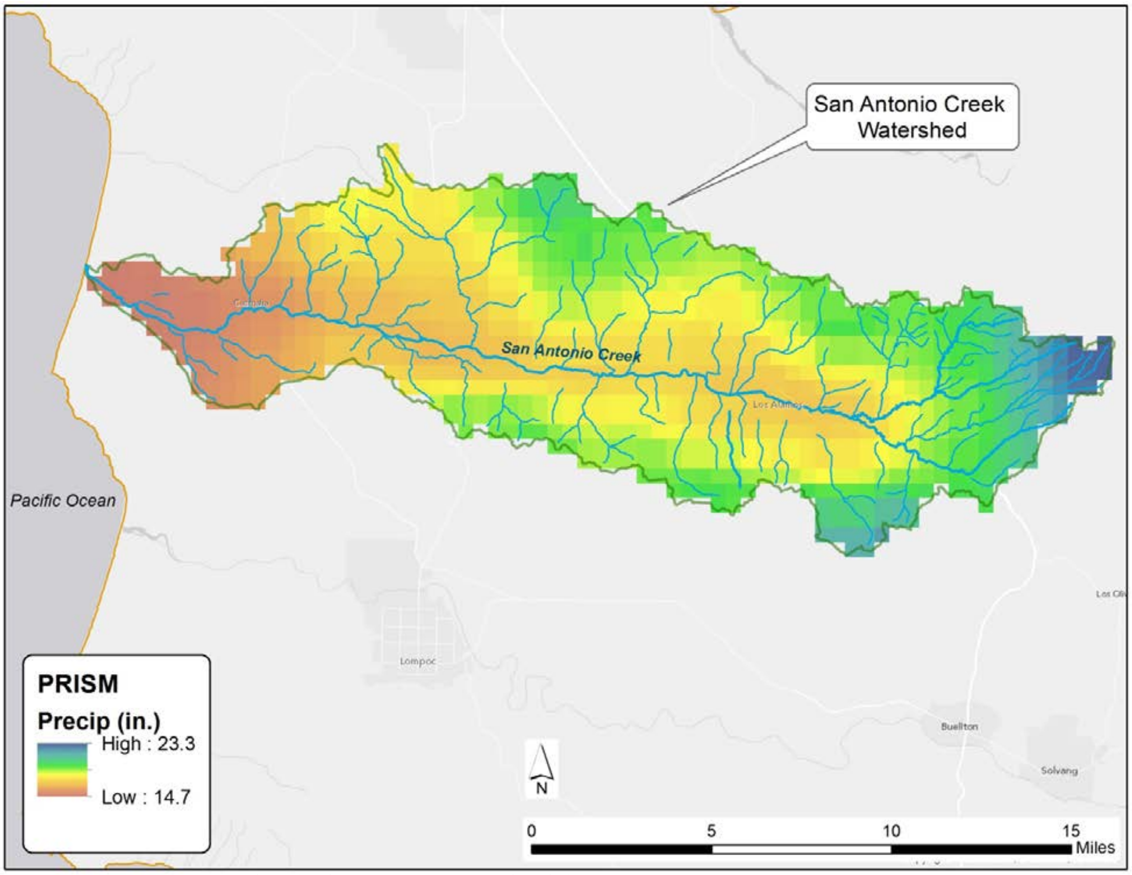


Figure 2-6. Average annual precipitation 1971-2000.
Source: PRISM Climate Group, Oregon State University

2.4 Protected Aquatic Species

Staff used the California Natural Diversity Database (CNDDB) data to obtain information on aquatic species that may be listed under the State or Federal Endangered Species Acts. There are three listed aquatic species within the lower portion of the San Antonio Creek watershed as shown in Table 2-5 and Figure 2-7.

Table 2-5. Federal and State listed species.

Scientific Name	Common Name	Federal List	California List
Gasterosteus aculeatus williamsoni	Unarmored threespine stickleback	Endangered	Endangered
Eucyclogobius newberryi	Tidewater goby	Endangered	None
Rana draytonii	California red-legged frog	Threatened	None

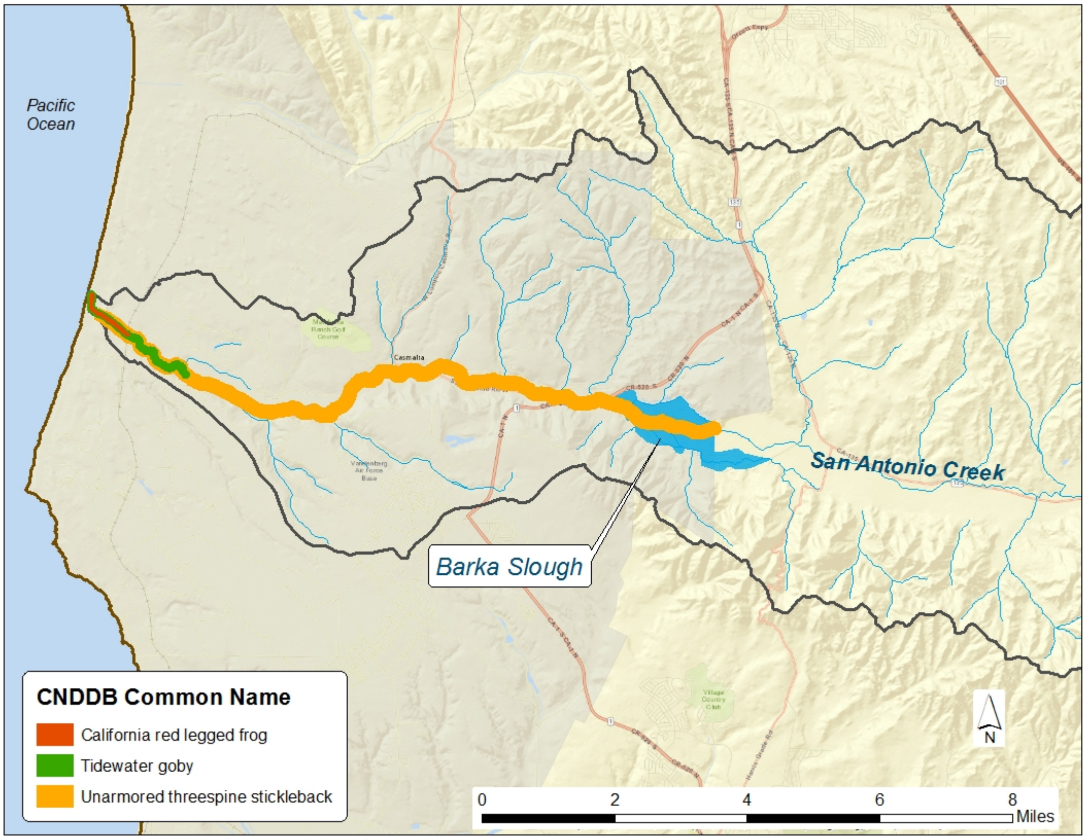


Figure 2-7. Location of sensitive aquatic species and habitat.
Note: All three extents originate from the river mouth at the Pacific Ocean.

The Unarmored threespine stickleback ranges from the mouth of San Antonio Creek at the Pacific Ocean to Barka Slough. The Tidewater goby ranges from the creek mouth at the Pacific Ocean and up 2 miles while the California red-legged frog is found from the creek mouth upstream to the Southern Pacific Railroad track (near CCAMP monitoring station 313SAC). Note that these three species occur within the boundary of Vandenberg Air Force Base. Photos of these species are shown in Figure 2-8.

a). Unarmored threespine stickleback

b). Tidewater goby

c). California red-legged frog

Figure 2-8. Photos of Federal and California listed aquatic species.

3 WATER QUALITY STANDARDS

TMDLs are requirements pursuant to the federal Clean Water Act. The broad objective of the federal Clean Water Act is to restore and maintain the chemical, physical and biological integrity of the Nation's waters. Water quality standards are provisions of state and federal law intended to implement the federal Clean Water Act. In accordance with state and federal law, California's water quality standards consist of:

- Beneficial uses, which refer to legally-designated uses of waters of the state that may be protected against water quality degradation (e.g., drinking water supply, recreation, aquatic habitat, agricultural supply, etc.)
- Water quality objectives, which refer to limits or levels (numeric or narrative) of water quality constituents or characteristics that provide for the reasonable protection of beneficial uses of waters of the state.
- Anti-degradation policies, which are implemented to maintain and protect existing water quality, and high quality waters.

Therefore, beneficial uses, water quality objectives, and anti-degradation policies collectively constitute water quality standards. Beneficial uses, relevant water quality objectives, and anti-degradation requirements that pertain to this TMDL are presented below in Section 3.1, Section 3.2, and Section 3.3, respectively.

3.1 Beneficial Uses

California's water quality standards designate beneficial uses for each water body and the scientific criteria to support that use. The Central Coast Water Board is required under both State and Federal Law to protect and regulate beneficial uses of waters of the state.

The Water Quality Control Plan for the Central Coastal Basin (Basin Plan) specifically identifies beneficial uses for the listed water bodies included in this project. The beneficial uses for San Antonio Creek, Barka Slough, and San Antonio Creek Estuary are shown in Table 3-1.

Table 3-1. Basin Plan designated beneficial uses.

Beneficial Use	San Antonio Creek[1]	Barka Slough	San Antonio Creek Estuary
Municipal and Domestic Supply (MUN)	X		
Agricultural Supply (AGR)	X		
Ground Water Recharge (GWR)	X	X	X
Water Contact Recreation (REC-1)	X	X	X
Non-Contact Water Recreation (REC-2)	X	X	X
Wildlife Habitat (WILD)	X	X	X
Cold Fresh Water Habitat (COLD)	X		X
Warm Fresh Water Habitat (WARM)	X	X	X
Migration of Aquatic Organisms (MIGR)	X		X
Spawning, Reproduction, and/or Early Development (SPWN)	X	X	X
Preservation of Biological Habitats of Special Significance (BIOL)			X
Rare, Threatened, or Endangered Species (RARE)	X	X	X
Estuarine Habitat (EST)		X	X
Freshwater Replenishment (FRSH)	X		
Commercial and Sport Fishing (COMM)	X	X	X
Shellfish Harvesting (SHELL)		X	X

[1] San Antonio Creek (San Antonio Watershed, Rancho del las Flores Bridge at Hwy 135 downstream at Railroad Bridge). CAR3130001020020918211049.

Beneficial uses are regarded as existing whether the water body is perennial or ephemeral, or the flow is intermittent or continuous. The beneficial uses of surface waters in the project area are presented below along with relevant water quality objectives pertaining to un-ionized ammonia, nitrite, and nitrate.

3.1.1 Municipal and Domestic Water Supply (MUN)

MUN: Uses of water for community, military, or individual water supply systems including, but not limited to, drinking water supply. According to State Board Resolution No. 88- 63, "Sources of Drinking Water Policy" all surface waters are considered suitable, or potentially suitable, for municipal or domestic water supply except where:

a. *TDS exceeds 3000 mg/l (5000 uS/cm electrical conductivity);*
b. *Contamination exists, that cannot reasonably be treated for domestic use;*
c. *The source is not sufficient to supply an average sustained yield of 200 gallons per day;*
d. *The water is in collection or treatment systems of municipal or industrial wastewaters, process waters, mining wastewaters, or storm water runoff; and*
e. *The water is in systems for conveying or holding agricultural drainage waters*

The nitrate numeric water quality objective protective of the MUN beneficial uses is legally established as 10 mg/L[6] nitrate as nitrogen (see Basin Plan, Table 3-2). This level is established to protect public health.

The OEHHA developed PHGs for drinking water of 45 mg/L for nitrate (equivalent to 10 mg/L nitrate as nitrogen), 1 mg/L for nitrite as nitrogen, and 10 mg/L for joint nitrate/nitrite (expressed as nitrogen) in drinking water (OEHHA, 1997). The calculation of these PHGs is based on the protection of infants from the occurrence of methemoglobinemia, the principal toxic effect observed in humans exposed to nitrate or nitrite. The PHGs are equivalent to California's current drinking water standards for nitrate (45 mg/L nitrate as nitrate), nitrite (1 mg/L nitrite as nitrogen), and 10 mg/L (joint nitrate/nitrite expressed as nitrogen) which were adopted by the California Department of Health Services (DHS) in 1994 from USEPA's Maximum Contaminant Levels (MCLs) promulgated in 1991.

3.1.2 Agricultural Supply (AGR)

AGR: Uses of water for farming, horticulture, or ranching including, but not limited to, irrigation, stock watering, or support of vegetation for range grazing.

In accordance with the Basin Plan, interpretation of the amount of nitrate which adversely affects the agricultural supply beneficial uses of waters of the State shall be derived from the University of California Agricultural Extension Service guidelines, which are found in Basin Plan Table 3-3. Accordingly, severe problems for sensitive crops could occur for irrigation water exceeding 30 mg/L[7]. It should be noted that the University of California Agricultural Extension Service guideline values are flexible, and may not necessarily be appropriate due to local conditions or special conditions of crop, soil, and method of irrigation.

High concentrations of nitrate in irrigation water can potentially create problems for sensitive crops (e.g., grapes, avocado, citrus, sugar beets, apricots, almonds, cotton) by detrimentally impacting crop yield or quality. Nitrogen in the irrigation water acts the same as fertilizer nitrogen and excesses may cause problems just as fertilizer excesses cause problems[8]. For example, according to Ayers and Westcot (1985)[9] grapes are sensitive to high nitrate in irrigation water and may continue to grow late into the season at the expense of fruit production; yields are often reduced and grapes may be late in maturing and have a lower sugar content. Maturity of fruit such as apricot, citrus and avocado may also be delayed and the fruit may be poorer in quality, thus affecting the marketability and storage life. Excessive nitrogen can also trigger and favor the production of green tissue (leaves) over vegetative tissue in sensitive crops. In many

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[6] This value is equivalent to, and may be expressed as, 45 mg/L nitrate as nitrogen.

[7] The University of California Agricultural Extension Service guideline values are flexible, and may not necessarily be appropriate due to local conditions or special conditions of crop, soil, and method of irrigation. 30 mg/L nitrate-N is the recommended uppermost threshold concentration for nitrate in irrigation supply water as identified by the University of California Agricultural Extension Service which potentially cause severe problems for sensitive crops (see Table 3-3 in the Basin Plan). Selecting the least stringent threshold (30 mg/L) therefore conservatively identifies exceedances which could detrimentally impact the AGR beneficial uses for irrigation water.

[8] 1 mg/L NO_3-N in irrigation water = 2.72 pounds of nitrogen per acre foot of applied water.

[9] R.S. Ayers (Soil and Water Specialist, University of California, Davis) and D.W. Westcot (Senior Land and Water Resources Specialist – Central Valley Regional Water Quality Control Board) published in the Food and Agriculture Organization of the United Nations (UN-FAO) Irrigation and Drainage Paper 29 Rev.1.

grain crops, excess nitrogen may promote excessive vegetative growth producing weak stalks that cannot support the grain weight. According to the *Draft Conclusions of the Agricultural Expert Panel* (SWRCB, 2014), the yield and quality of cotton and almonds will suffer from excess nitrogen. These problems can usually be overcome by good fertilizer and irrigation management. However, regardless of the type of crop, many resource professionals recommend that nitrate in the irrigation water should be credited toward the fertilizer rate[10] especially when the concentration exceeds 10 mg/L nitrate as nitrogen[11]. Should this be ignored, the resulting excess input of nitrogen could cause problems such as excessive vegetative growth and contamination of groundwater[12]. It should be noted that irrigation water that is high in nitrate does not necessarily mean that in contains enough nitrate to eliminate the need for additional nitrogen fertilizer; however, the grower may be able to reduce and replace the amount of fertilizer normally applied with the nitrate present in the irrigation water[13].

Further, the Basin Plan provides water quality objectives for nitrate which are protective of the AGR beneficial uses for livestock watering. While nitrate (NO_3) itself is relatively non-toxic to livestock, ingested nitrate is broken down to nitrite ($NO2^-$); subsequently nitrite enters the bloodstream where it converts blood hemoglobin to methemoglobin. This greatly reduces the oxygen-carrying capacity of the blood, and the animal suffers from oxygen starvation of the tissues[14]. Death can occur when blood hemoglobin has fallen to one-third normal levels. Resource professionals[15] report that nitrate can reach dangerous levels for livestock in streams, ponds, or shallow wells that collect drainage from highly fertilized fields. Accordingly, the Basin Plan identifies the safe threshold of nitrate as nitrogen for purposes of livestock watering at 100 mg/L[16].

Also noteworthy is that the AGR beneficial uses of surface water not only applies to several stream reaches of the project area, but can also apply to the groundwater resources underlying those stream reaches. The groundwater in some of these reaches is recharged by stream infiltration. Therefore, the groundwater recharge (GWR) beneficial uses of stream reaches provides the nexus between protection of designated AGR beneficial uses of both the surface waters and the underlying groundwater resource.

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[10] Crediting of irrigation source-water nitrogen may not be a 1:1 relationship as some irrigation water may not be retained entirely within the cropped area.

[11] Colorado State University Extension - Irrigation Water Quality Criteria. Authors: T.A. Bauder, Colorado State University Extension water quality specialist; R.M. Waskom, director, Colorado Water Institute; P.L. Sutherland, United States Department of Agriculture, Natural Resources Conservation Service (USDA/NRCS) area resource conservationist; and J.G. Davis, Extension soils specialist and professor, soil and crop sciences.

[12] University of California, Davis, Farm Water Quality Planning Reference Sheet 9.10. Publication 8066. Author: S. R. Grattan, Plant-Water Relations Specialist, UC Davis.

[13] Monterey County Water Resources Agency – Santa Clara Valley Water District, Fact Sheet 4. *Using the Nitrate Present in Soil and Water in Your Fertilizer Calculations.*

[14] New Mexico State University, Cooperative Exention Service. Nitrate Poisoning of Livestock. Guide B-807.

[15] University of Arkansas, Division of Agriculture - Cooperative Extension. “Nitrate Poisoning in Cattle”. Publication FSA3024.

[16] 100 mg/L nitrate-N is the Basin Plan’s water quality objective protective of livestock watering, and is based on National Academy of Sciences-National Academy of Engineering guidelines (see Table 3-3 in the Basin Plan).

3.1.3 Ground Water Recharge (GWR)

*GWR: Uses of water for natural or artificial recharge of ground water for purposes of future extraction, **maintenance of water quality**, or halting of saltwater intrusion into freshwater aquifers. Ground water recharge includes recharge of surface water underflow.* (Emphasis added.)

Groundwater recharge (GWR) beneficial uses recognize the fundamental nature of the hydrologic cycle, in that surface waters and groundwater are not closed systems that act independently from each other. Underlying groundwaters are, in effect, receiving waters for stream waters that infiltrate and recharge the subsurface water resource. Most surface waters and groundwaters of the central coast region are both designated with the MUN (drinking water) and AGR (agricultural supply) beneficial uses. The MUN nitrate water quality objective (10 mg/L) therefore applies to *both* the stream waters, and to the underlying groundwater. This numeric water quality objective and the MUN and AGR designations of underlying groundwater is relevant to the extent that portions of project area streams recharge the underlying groundwater resource.

The Basin Plan GWR beneficial uses explicitly state that the designated groundwater recharge use of surface waters are to be protected to maintain groundwater quality. Note that surface waters and groundwaters are often in direct or indirect hydrologic communication. As such, where necessary, the GWR beneficial uses of the surface waters need to be protected so as to support and maintain the MUN or AGR beneficial uses of the underlying groundwater resource. Protection of the groundwater recharge beneficial uses of surface waters has been recognized in State Water Resources Control Board–approved California TMDLs[17]. USEPA also recognizes the appropriateness of protecting designated groundwater recharge beneficial uses in the context of California TMDLs (USEPA 2002, USEPA 2003). The Basin Plan does not specifically identify numeric water quality objectives to implement the GWR beneficial uses, however a situation-specific weight of evidence approach can be used to assess if GWR is being supported, consistent with Section 3.11 of the California Listing Policy (SWRCB, 2004, amended in February 2015).

3.1.4 Water Contact Recreation (REC-1)

REC-1: Uses of water for recreational activities involving body contact with water, where ingestion of water is reasonably possible. These uses include, but are not limited to, swimming, wading, water-skiing, skin and scuba diving, surfing, white water activities, fishing, or use of natural hot springs.

The Basin Plan water quality objective protective of water contact recreation beneficial uses and which is most relevant to nutrient pollution is the general toxicity objective for all inland surface water, enclosed bays, and estuaries (Basin Plan Chapter 3, section II.A.2.a). The general toxicity objective is a narrative water quality objective that states:

"All waters shall be maintained free of toxic substances in concentrations which are toxic to, or which produce detrimental physiological responses in, human, plant,

[17] for example, RWQCB-Los Angeles Region, Calleguas Creek Nitrogen Compounds TMDL, 2002. Resolution No. 02-017, and approved by the California Office of Administrative Law, OAL File No. 03-0519-02 SR; and RWQCB-Central Coast Region, TMDLs for Nitrogen Compounds and Orthophosphate in the Lower Salinas River and Reclamation Canal Basin and the Moro Cojo Slough Subwatershed, Resolution No. R3-2013-0008 and approved by the California Office of Administrative Law, OAL File No. 2014-0325-01S.

animal, or aquatic life. Compliance with this objective will be determined by use of indicator organisms, analyses of species diversity, population density, growth anomalies, toxicity bioassays of appropriate duration, or other appropriate methods as specified by the Regional Board."

Because illnesses are considered detrimental physiological responses in humans, the narrative toxicity objective applies to algal toxins. Possible health effects of exposure to blue-green algae blooms and their toxins can include rashes, skin and eye irritation, allergic reactions, gastrointestinal upset, and other effects including poisoning. Note that microcystins are toxins produced by cyanobacteria (blue-green algae) and are associated with algal blooms, elevated nutrients, and biostimulation in surface waterbodies. OEHHA has published peer-reviewed public health action-level guidelines for algal cyanotoxins (microcystins) in recreational water uses; this public health action-level for microcystins is 0.8 μg/L[18] (OEHHA, 2012). This public health action level can therefore be used to assess attainment or non-attainment of the Basin Plan's general toxicity objective and to ensure that REC-1 designated beneficial uses are being protected and supported.

3.1.5 Aquatic Habitat (WARM, COLD, MIGR, SPWN, WILD, BIOL, RARE, EST)

WARM: Uses of water that support warm water ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates.

COLD: Uses of water that support cold water ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish or wildlife, including invertebrates.

MIGR: Uses of water that support habitats necessary for migration or other temporary activities by aquatic organisms, such as anadromous fish.

SPWN: Uses of water that support high quality aquatic habitats suitable for reproduction and early development of fish.

WILD: Uses of water that support terrestrial ecosystems including, but not limited to, preservation and enhancement of terrestrial habitats, vegetation, wildlife (e.g., mammals, birds, reptiles, amphibians, invertebrates), or wildlife water and food sources.

BIOL: Uses of water that support designated areas or habitats, such as established refuges, parks, sanctuaries, ecological reserves, or Areas of Special Biological Significance (ASBS), where the preservation or enhancement of natural resources requires special protection.

RARE: Uses of water that support habitats necessary, at least in part, for the survival and successful maintenance of plant or animal species established under state or federal law as rare, threatened, or endangered.

EST: Uses of water that support estuarine ecosystems including, but not limited to, preservation or enhancement of estuarine habitats, vegetation, fish, shellfish, or wildlife (e.g., estuarine mammals, waterfowl, shorebirds). An estuary is generally described as a semi-enclosed body of water having a free connection with the open sea, at least part of the year and within which the seawater is diluted at least

[18] Includes microcystins LR, RR, YR, and LA.

seasonally with fresh water drained from the land. Included are water bodies which would naturally fit the definition if not controlled by tidegates or other such devices.

The Basin Plan water quality objectives protective of aquatic habitat beneficial uses and which is most relevant to nutrient pollution[19] is the biosimulatory substances objective and dissolved oxygen objectives for aquatic habitat. The biostimulatory substances objective is a narrative water quality objective that states "*Waters shall not contain biostimulatory substances in concentrations that promote aquatic growths to the extent that such growths cause nuisance or adversely affect beneficial uses*."

The Basin Plan also requires that in waterbodies designated for WARM habitat dissolved oxygen concentrations shall not be depressed below 5 mg/L and that in waterbodies designated for COLD and SPWN dissolved oxygen shall not be depressed below 7 mg/L. Further, since un-ionized ammonia is highly toxic to aquatic species, the Basin Plan requires that the discharge of waste shall not cause concentrations of un-ionized ammonia (NH_3) to exceed 0.025 mg/L (as nitrogen) in receiving waters.

3.1.6 Freshwater Replenishment (FRSH)

FRSH: Uses of water for natural or artificial maintenance of surface water quantity or quality (e.g., salinity) which includes a water body that supplies water to a different type of water body, such as, streams that supply reservoirs and lakes, or estuaries; or reservoirs and lakes that supply streams. This includes only immediate upstream water bodies and not their tributaries.

3.1.7 Commercial and Sport Fishing (COMM)

COMM: Uses of water for commercial or recreational collection of fish, shellfish, or other organisms including, but not limited to, uses involving organisms intended for human consumption or bait purposes

3.1.8 Shellfish Harvesting (SHELL)

SHELL: Uses of water that support habitats suitable for the collection of filter-feeding shellfish (e.g., clams, oysters, and mussels) for human consumption, commercial, or sport purposes. This includes waters that have in the past, or may in the future, contain significant shellfisheries.

3.2 Water Quality Objectives & Criteria

The Basin Plan contains specific water quality objectives that apply to nutrients and nutrient-related parameters. In addition, the Central Coast Water Board uses established, scientifically-defensible numeric criteria to implement narrative water quality objectives, and for use in Clean Water Act Section 303(d) Listing assessments. These water quality objectives and criteria are established to protect beneficial uses and are compiled in Table 3-2.

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[19] Nutrients, such as nitrate, do not by themselves necessarily directly impair aquatic habitat beneficial uses. Rather, they cause indirect impacts by promoting algal growth and low dissolved oxygen that impair aquatic habitat uses.

Table 3-2. Compilation of Basin Plan water quality objectives and numeric criteria for nutrients and nutrient-related parameters.

Constituent Parameter	Source of Water Quality Objective/Criteria	Numeric Target	Primary Use Protected
Un-ionized Ammonia as Nitrogen	Basin Plan numeric objective	0.025 mg/L	General Objective for all Inland Surface Waters, Enclosed Bays, and Estuaries *(toxicity objective)*
Nitrate as Nitrogen	Basin Plan numeric objective	10 mg/L	MUN, GWR (Municipal/Domestic Supply; Groundwater Recharge)
Nitrate as Nitrogen	Basin Plan numeric criteria (Table 3-3 in Basin Plan)	5 – 30 mg/L *California Agricultural Extension Service guidelines*	AGR (Agricultural Supply – irrigation water) *"Severe" problems for sensitive crops at greater than 30 mg/L* *"Increasing problems" for sensitive crops at 5 to 30 mg/L*
Joint Nitrate/Nitrite as Nitrogen	Basin Plan narrative objective[A]	10 mg/L *California Office of Environmental Health Hazard Assessment Suggested Public Health Goal*	Human Health
Nitrite as Nitrogen	Basin Plan narrative objective[A]	1 mg/L *California Office of Environmental Health Hazard Assessment Suggested Public Health Goal*	Human Health
Dissolved Oxygen	General Inland Surface Waters numeric objective	Dissolved Oxygen shall not be depressed below 5.0 mg/L Median values should not fall below 85% saturation.	General Objective for all Inland Surface Waters, Enclosed Bays, and Estuaries
	Basin Plan numeric objective WARM, COLD, SPWN	Dissolved Oxygen shall not be depressed below 5.0 mg/L (WARM) Dissolved Oxygen shall not be depressed below 7.0 mg/L (COLD, SPWN)	Cold Freshwater Habitat, Warm Freshwater Habitat, Fish Spawning
	Basin Plan numeric objective AGR	Dissolved Oxygen shall not be depressed below 2.0 mg/L	AGR (Agricultural Supply)
Biostimulatory Substances	Basin Plan narrative objective[B]	Nutrient-related constituents that are normally developed based on reach scale characteristics. Values may vary.	General Objective for all Inland Surface Waters, Enclosed Bays, and Estuaries *(biostimulatory substances objective)* -- (e.g., WARM, COLD, REC, WILD, EST)
Chlorophyll *a*	Basin Plan narrative objective[B]	40 µg/L *North Carolina Administrative Code, Title 151, Subchapter 2B, Rule 0211*	Numeric listing criteria to implement the Basin Plan biostimulatory substances objective for purposes of Clean Water Act Section 303(d) Listing assessments

[A] *The Basin Plan toxicity narrative objective states: "All waters shall be maintained free of toxic substances in concentrations which are toxic to, or which produce detrimental physiological responses in, human, plant, animal, or aquatic life." (Toxicity Objective, Basin Plan, Chapter 3)*

[B] *The Basin Plan biostimulatory substances narrative objective states: "Waters shall not contain biostimulatory substances in concentrations that promote aquatic growths to the extent that such growths cause nuisance or adversely affect beneficial uses." (Biostimulatory Substances Objective, Basin Plan, Chapter 3)*

3.3 Anti-degradation Policy

In accordance with Section II.A of the Basin Plan, wherever the existing quality of water is better than the quality of water established in the Basin Plan as objectives, **such existing quality shall be maintained** unless otherwise provided by provisions of the state anti-degradation policy. Practically speaking, this means that where water quality is *better* than necessary to support designated beneficial uses, such existing high water quality shall be maintained and further lowering of water quality is not allowed except under conditions provided for in the anti-degradation policy.

USEPA has also issued detailed guidelines for implementation of federal anti-degradation regulations for surface waters (40 CFR 131.12). To ensure consistency, the State Water Resources Control Board has interpreted Resolution No. 68-16 (i.e., the state anti-degradation policy) to incorporate the federal anti-degradation policy. It is important to note that federal policy only applies to surface waters, while state policy applies to both surface and ground waters.

Indeed, USEPA recognizes the validity of using TMDLs as a tool for implementing anti-degradation goals:

> *"Identifying opportunities to protect waters that are not yet impaired: TMDLs are typically written for restoring impaired waters; however, states can prepare TMDLs geared towards maintaining a "better than water quality standard" condition for a given water body-pollutant combination, and they can be a useful tool for high quality waters."*
>
> From: USEPA, 2014. Opportunities to Protect Drinking Water Sources and Advance Watershed Goals Through the Clean Water Act: A Toolkit for State, Interstate, Tribal and Federal Water Program Managers. November 2014.

3.4 California Clean Water Act Section 303(d) Listing Policy

Water quality standards, such as those discussed previously, play a central role in federally-mandated statewide assessments of impaired waterbodies. The Central Coast Water Board assesses water quality monitoring data for surface waters to determine if they contain pollutants at levels that exceed water quality standards. In accordance with the Water Quality Control Policy for developing California's Clean Water Act (CWA) Section 303(d) List (SWRCB, 2004, amended in February 2015) – hereafter referred to as the *California Listing Policy* – water body and pollutants that exceed water quality standards are placed on the State's 303(d) List of impaired waters. The *California Listing Policy* also defines the minimum number of measured exceedances needed to place a water segment on the 303(d) List for toxicants (Listing Policy, Table 3.1) and for conventional or other pollutants (*California Listing Policy*, Table 3.2). The minimum number of measured exceedances for toxicants is displayed in Table 3-3 and for conventional and other pollutants in Table 3-4.

With regard to the water quality constituents addressed in this TMDL, it is important to note that un-ionized ammonia, nitrite, and nitrate are considered toxicants in accordance with the *California Listing Policy* [20], while low dissolved oxygen is a conventional pollutant. Thus, impairments by un-ionized

[20] See Section 7 Definitions-Toxicants in *Water Quality Control Policy for Developing California's Clean Water Act Section 303(d) List*, SWRCB (2004, amended in February 2015).

ammonia, nitrite, and nitrate are assessed on the basis of Table 3-3, while impairments by dissolved oxygen are assessed on the basis of Table 3-4.

Table 3-3. Minimum number of measured exceedances needed to place a water segment on the 303(d) list for toxicants.

Sample Size	Number of Exceedances needed to assert impairment
2 – 24	2
25 – 36	3
37 – 47	4
48 – 59	5
60 – 71	6
72 – 82	7
83 – 94	8
95 – 106	9
107 – 117	10
118 – 129	11
For sample sizes greater than 129, the minimum number of measured exceedances is established where α and β < 0.2 and where |α - β| is minimized. α = Excel® Function BINOMDIST(n-k, n, 1 – 0.03, TRUE) β = Excel® Function BINOMDIST(k-1, n, 0.18, TRUE) where n = the number of samples, k = minimum number of measured exceedances to place a water on the section 303(d) List.	

Table 3-4. Minimum number of measured exceedances needed to place a water segment on the 303(d) List for conventional and other pollutants.

Sample Size	Number of Exceedances needed to assert impairment
5-30	5
31-36	6
37-42	7
43-48	8
49-54	9
55-60	10
61-66	11
67-72	12
73-78	13
79-84	14
85-91	15
92-97	16
98-103	17
104-109	18
110-115	19
116-121	20
For sample sizes greater than 121, the minimum number of measured exceedances is established where α and β < 0.2 and where |α - β| is minimized. α = Excel® Function BINOMDIST(n-k, n, 1 – 0.10, TRUE) β = Excel® Function BINOMDIST(k-1, n, 0.25, TRUE) where n = the number of samples, k = minimum number of measured exceedances to place a water segment on section 303(d) List	

4 DATA ANALYSIS

This section provides information pertaining to data sources and the analysis of water quality data used to assess water quality conditions and impairment.

Staff used the following water quality data for San Antonio Creek:

- Central Coast Ambient Monitoring Program (CCAMP) sites 313SAC, 313SAI, 313SAE, and 313SAB.

Note that there is only one sampling event for monitoring site 313SAE due to low or no flow at this location. As a result of extremely low or no flow conditions at site 313SAE, sampling was discontinued. Monitoring sites are depicted in Figure 4-1 and site descriptions are contained in Table 4-1.

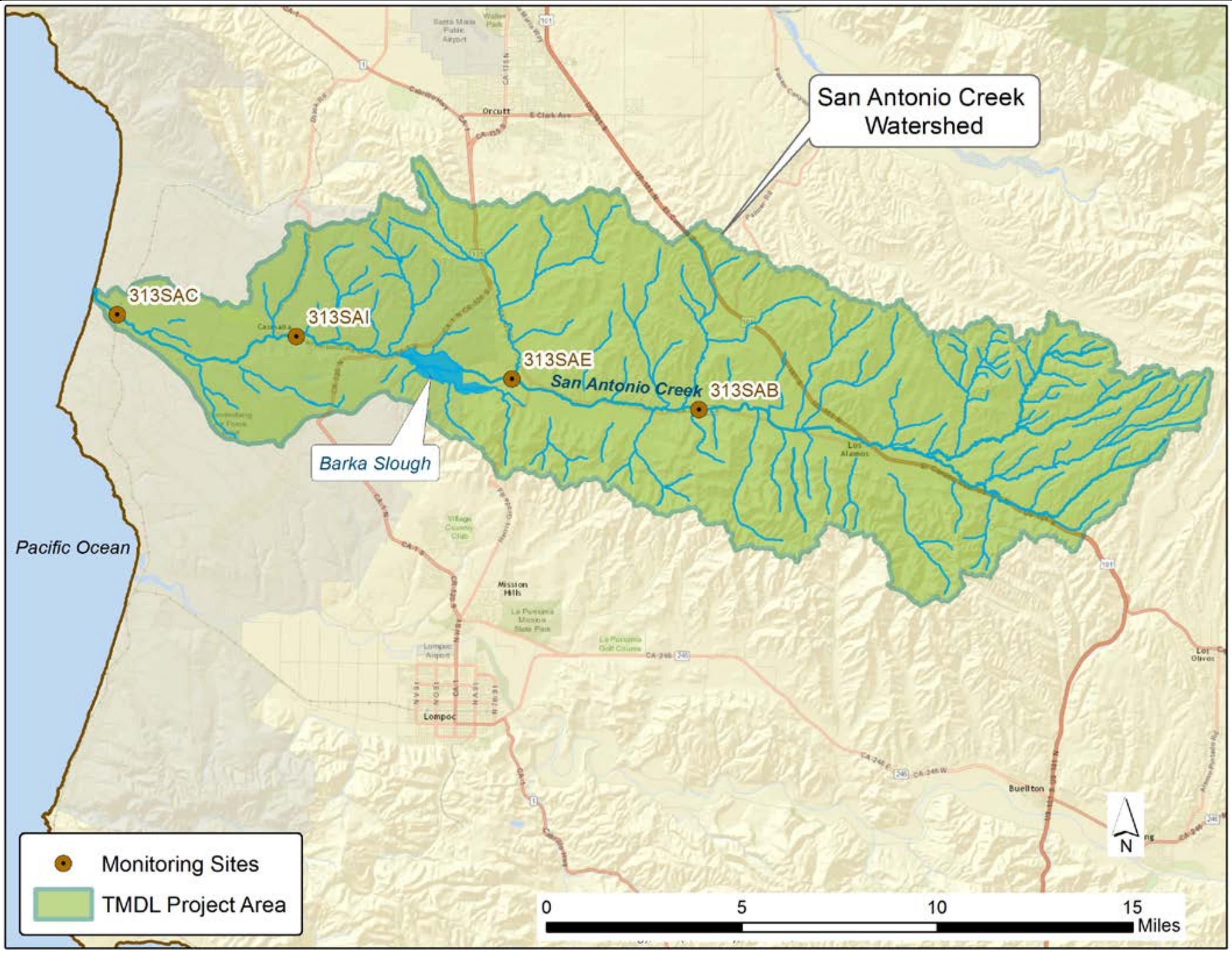
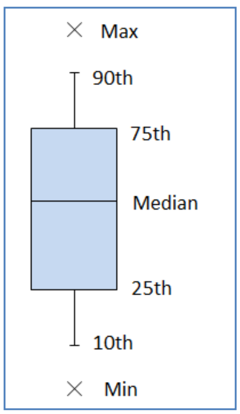


Figure 4-1 Location of CCAMP water quality monitoring stations.

Table 4-1. CCAMP water qualtiy monitoring site informaton

Site ID	Site Description
313SAC	San Antonio Creek at Rail Road Bridge, u/s lagoon and Pacific Ocean
313SAI	San Antonio Creek at San Antonio Road West
313SAE	San Antonio Creek at San Antonio Road East
313SAB	San Antonio Creek at Rancho de las Flores Bridge and Highway 135

In the following sections, staff has endeavored to provide graphical representation of water quality data in an intuitive and orderly fashion, whereby monitoring stations are shown relative to upstream and downstream locations within the watershed. In addition, staff used scatter plots to represent water quality data over time and box plots to present summary statistics for each monitoring station. Note that box plot graphics also show the number of samples in parenthesis on the x-axis (see Figure 4-3 for an example).



For box plots, as shown in Figure 4-2, maximum and minimum values are depicted as exes at the top and bottom of the plot, respectively. Values representing the 90th and 10th percentiles are shown as whiskers, while the 75th, 50th (median), and 25th percentiles comprise the box.

Figure 4-2. Explanation of box plots.

4.1 Un-ionized ammonia as nitrogen

The Basin Plan General Objective, Chapter 3 Section II.A.2 (General Objectives for all Inland Surface Waters, Enclosed Bays and Estuaries) states that the discharge of wastes shall not cause concentrations of un-ionized ammonia (NH_3) to exceed 0.025 mg/l (as nitrogen) in receiving waters. Staff used this objective to assess water quality impairment as presented below.

Table 4-2. Summary of CCAMP monitoring results for un-ionized ammonia as nitrogen (mg/L).

Flow Direction	Station	Dates	Count	Count >0.025	% >0.025	Median	Mean	Max	Min
	313SAB	2/12/01-3/01/02 1/32/08-6/16/08	19	0	0	0.00048	0.00089	0.00555	0.00010
	313SAE	3/06/01	1	0	0	0.00070	0.00070	0.00070	0.00070
	313SAI	1/18/01-3/17/02 3/04/04-4/12/11	101	18	17.8	0.00335	0.03083	0.56437	0.00044
	313SAC	1/18/01-3/18/03 1/31/08-12/09/08	31	0	0	0.00030	0.00049	0.00299	0.00009

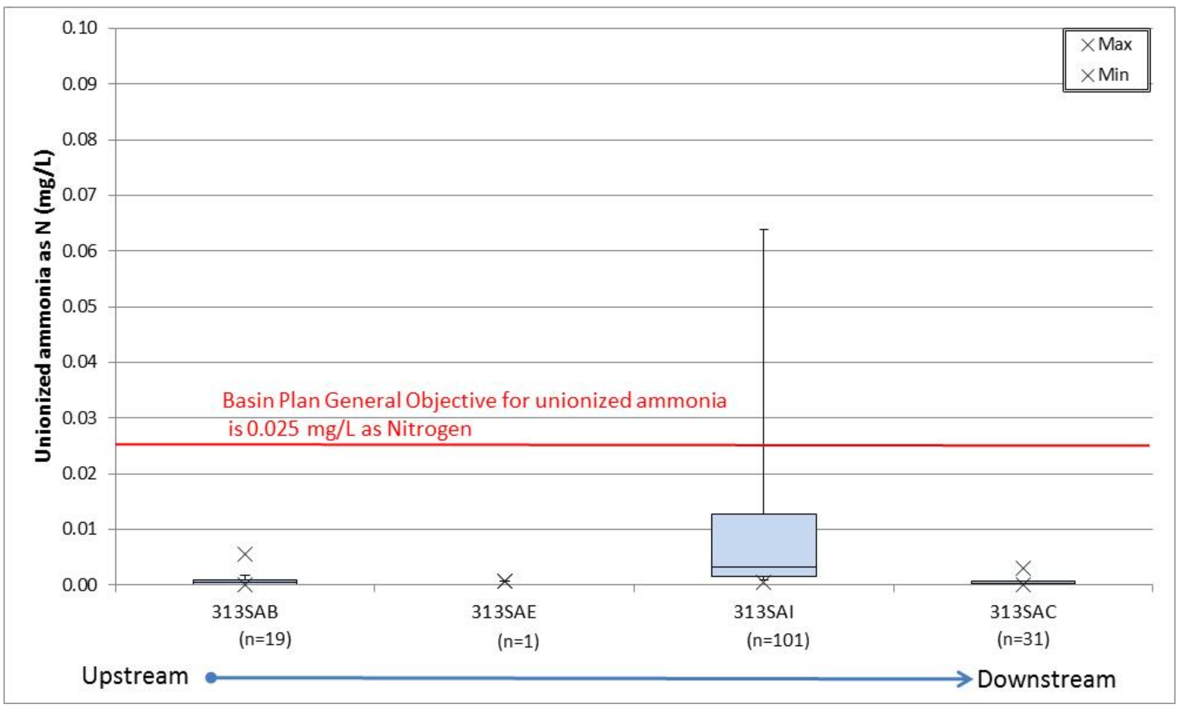


Figure 4-3. Box plots of un-ionized ammonia as nitrogen (mg/L) concentrations.
Not shown: A maximum value of 0.56 mg/L un-ionized ammonia as nitrogen for 313SAI on May 9, 2001.

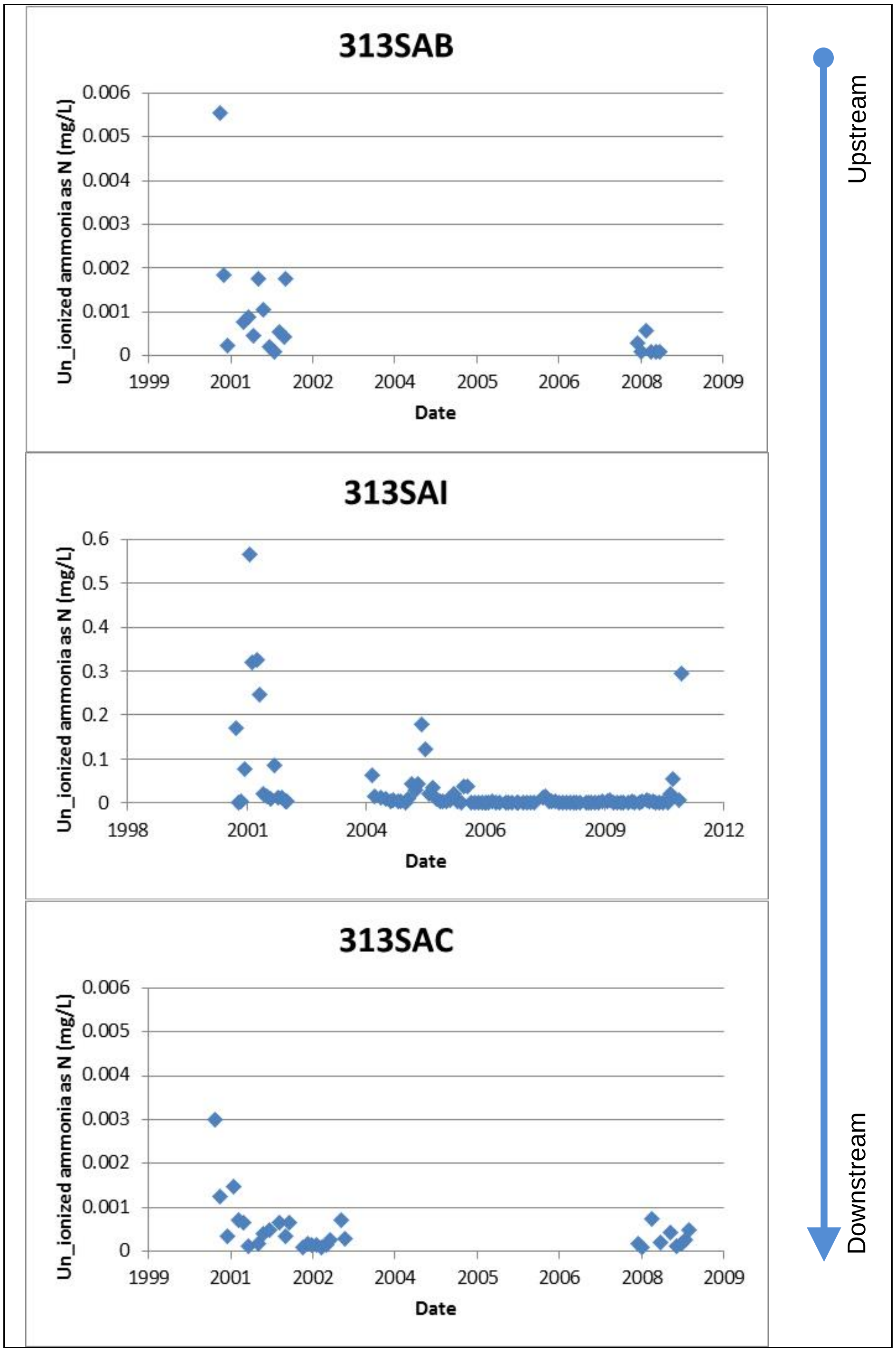


Figure 4-4. Scatter plots of un-ionized ammonia as nitrogen (mg/L) concentrations.
Note that the water quality objective for un-ionized ammonia is 0.025 mg/L as nitrogen and that the vertical axis is different for site 313SAI due to higher maximum values.

Exceedance of the water quality objective for un-ionized ammonia (0.025 mg/l as nitrogen) occurs exclusively for station 313SAI with most exceedances occurring prior to 2006. Between 2007 and 2011, 2 out of 51 samples exceeded the un-ionized ammonia water quality objective; however, this exceedance rate does not meet the minimum number of exceedances needed to place a water segment on the 303(d) List for toxicants (see Table 3-3). As a result staff will propose de-listing San Antonio Creek for un-ionized ammonia in accordance with the Listing Policy.

4.2 Nitrite as nitrogen

OEHHA developed PHGs of 1 mg/L for nitrite as nitrogen. The calculation of this PHG is based on the protection of infants from the occurrence of methemoglobinemia, the principal toxic effect observed in humans exposed to nitrite. The PHGs are equivalent to California's current drinking water standards for nitrite as nitrogen (1 mg/L) which was adopted by the DHS in 1994 from the USEPA's MCLs promulgated in 1991.

Table 4-3. Summary of CCAMP monitoring results for nitrite as nitrogen (mg/L).

	Station	Dates	Count	Count > 1	% > 1	Median	Mean	Max	Min
Flow Direction ↓	313SAB	2/12/01-3/17/02 1/31/08-6/16/08 1/22/14-6/25/14	25	0	0	0.04	0.05	0.29	0.01
	313SAE	3/06/01	1	0	0	0.03	0.03	0.03	0.03
	313SAI	1/18/01-3/17/02 3/04/04-6/25/14	138	12	8.7	0.10	0.29	2.00	0.005
	313SAC	1/18/01-3/18/03 1/31/08-12/09/08 2/27/14-6/25/14	44	0	0	0.02	0.03	0.13	0.01

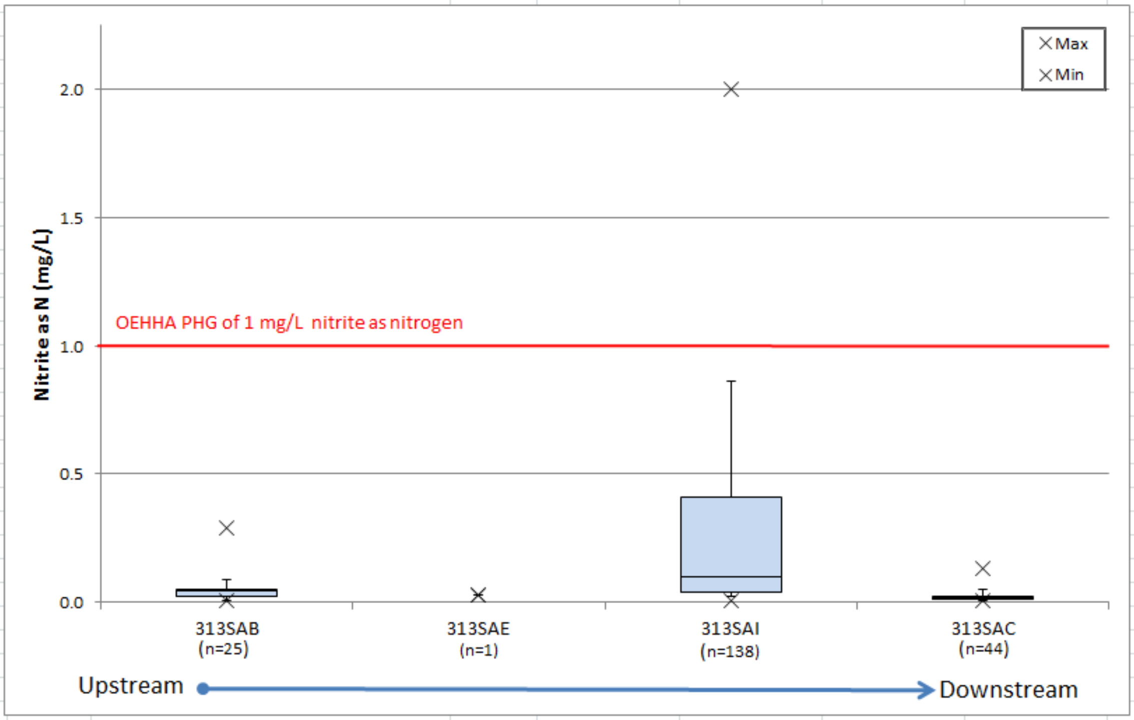


Figure 4-5. Box plots of nitrite as nitrogen (mg/L) concentrations.

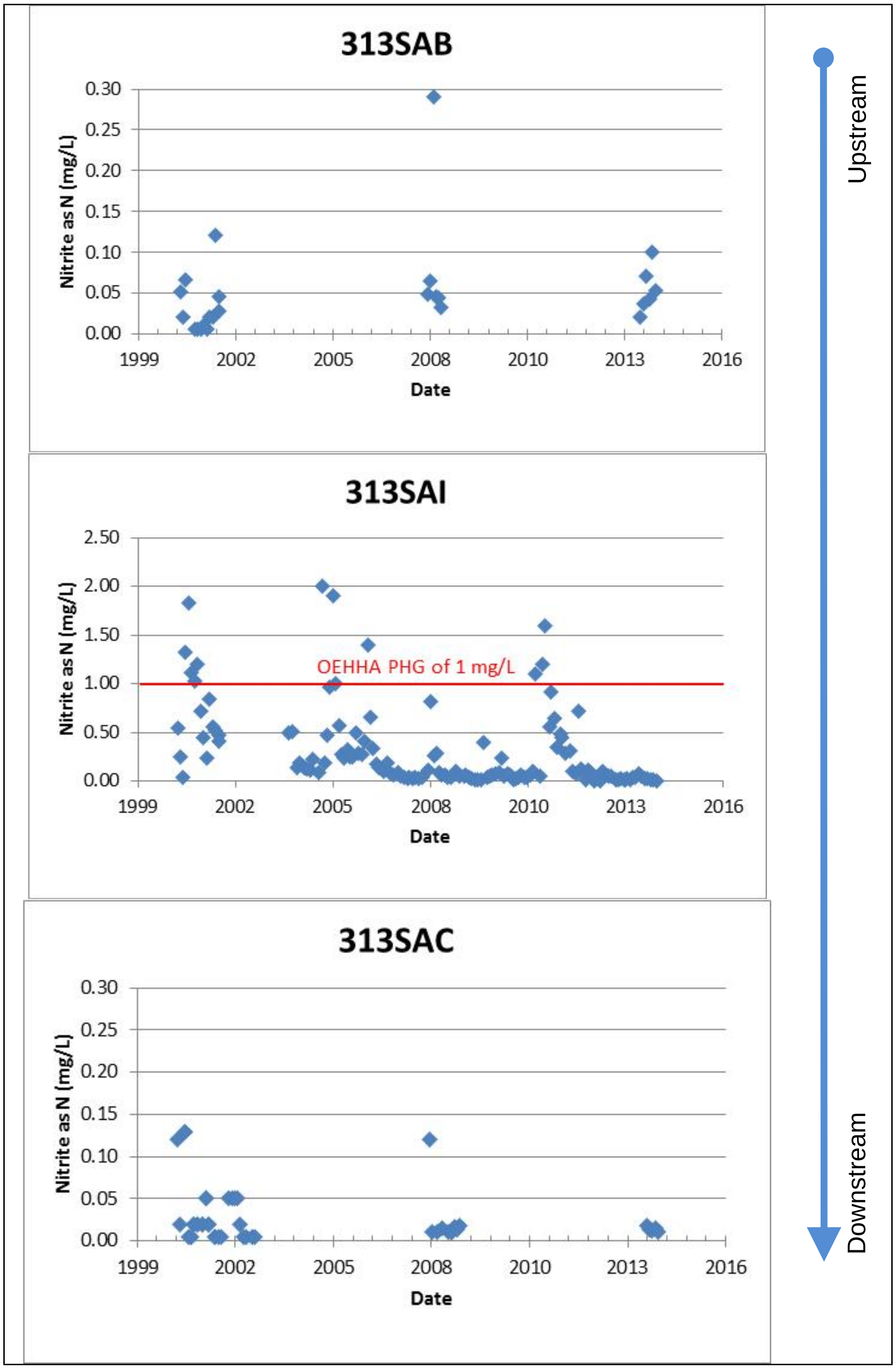


Figure 4-6. Scatter plot of nitrite as nitrogen concentrations (mg/L).
Note that the vertical axis is different for site 313SAI due to higher maximum values

As shown in the figures above, the OEHHA nitrite PHG (1 mg/L nitrite as nitrogen) is exceeded only at monitoring station 313SAI. However, between June 2011 and June 2014, zero (0) out of 36 samples exceeded the nitrite as nitrogen water quality objective. Because this exceedance rate does not meet the minimum number of exceedances needed to place a water segment on the 303(d) List for toxicants (see Table 3-3) staff will propose de-listing San Antonio Creek for nitrite as nitrogen in accordance with the Listing Policy. The other monitoring stations are well below the OEHHA goal for nitrite.

4.3 Nitrate as nitrogen

The nitrate numeric water quality objective protective of the MUN beneficial use is 10 mg/L nitrate as nitrogen. This level is established to protect public health.

In accordance with the Basin Plan, interpretation of the amount of nitrate which adversely affects the agricultural supply (AGR) beneficial of waters of the State shall be derived from the University of California Agricultural Extension Service guidelines, which are found in Basin Plan Table 3-3. Accordingly, severe problems for sensitive crops could occur for irrigation water exceeding 30 mg/L.

Table 4-4. Summary of CCAMP monitoring results for nitrate as nitrogen (mg/L).

	Station	Dates	Count	Count > 10	% > 10	Count > 30	% > 30	Median	Mean	Max	Min
Flow Direction	313SAB	2/12/01-3/17/02 1/31/08-6/16/08 1/22/14-6/25/14	25	13	52.0	6	24	15.0	19.4	55.0	1.9
	313SAE	3/06/01	1	0	0	0	0	2.3	2.3	2.3	2.3
	313SAI	1/18/01-3/17/02 3/04/04-6/25/14	139	4	2.9	0	0	4.5	4.5	15.0	0.013
	313SAC	1/18/01-3/18/03 1/31/08-12/09/08 2/27/14-6/25/14	36	0	0	0	0	1.2	1.2	5.5	0.004

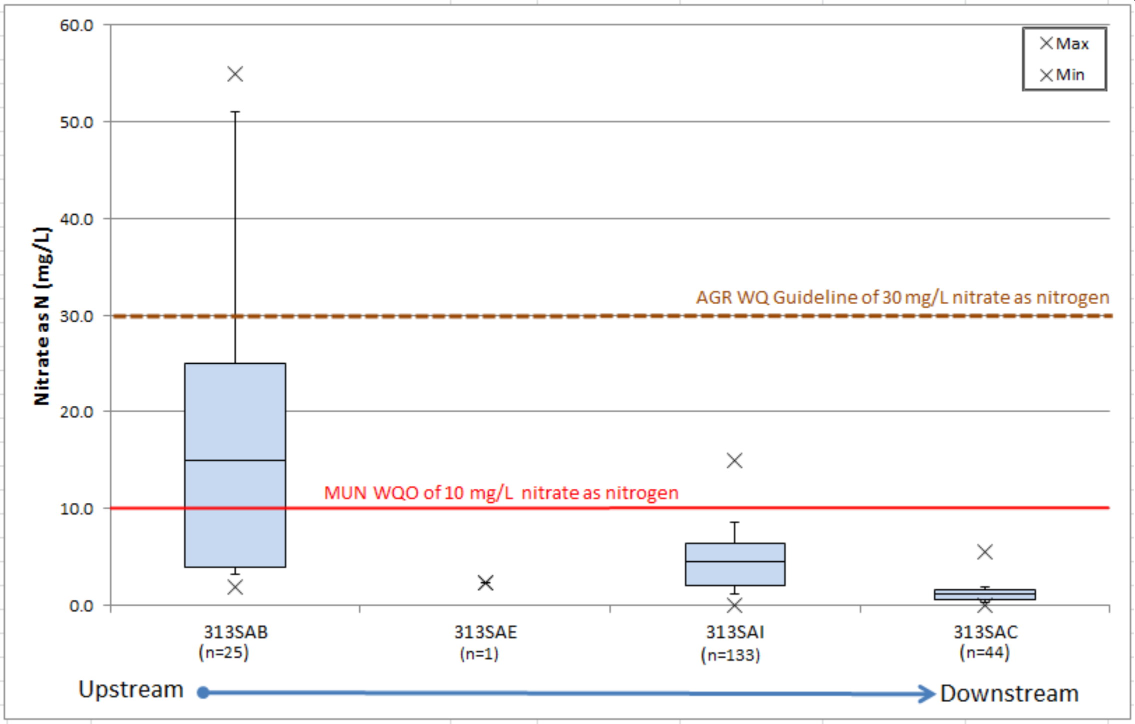


Figure 4-7. Box plots of nitrate as nitrogen (mg/L) concentrations.

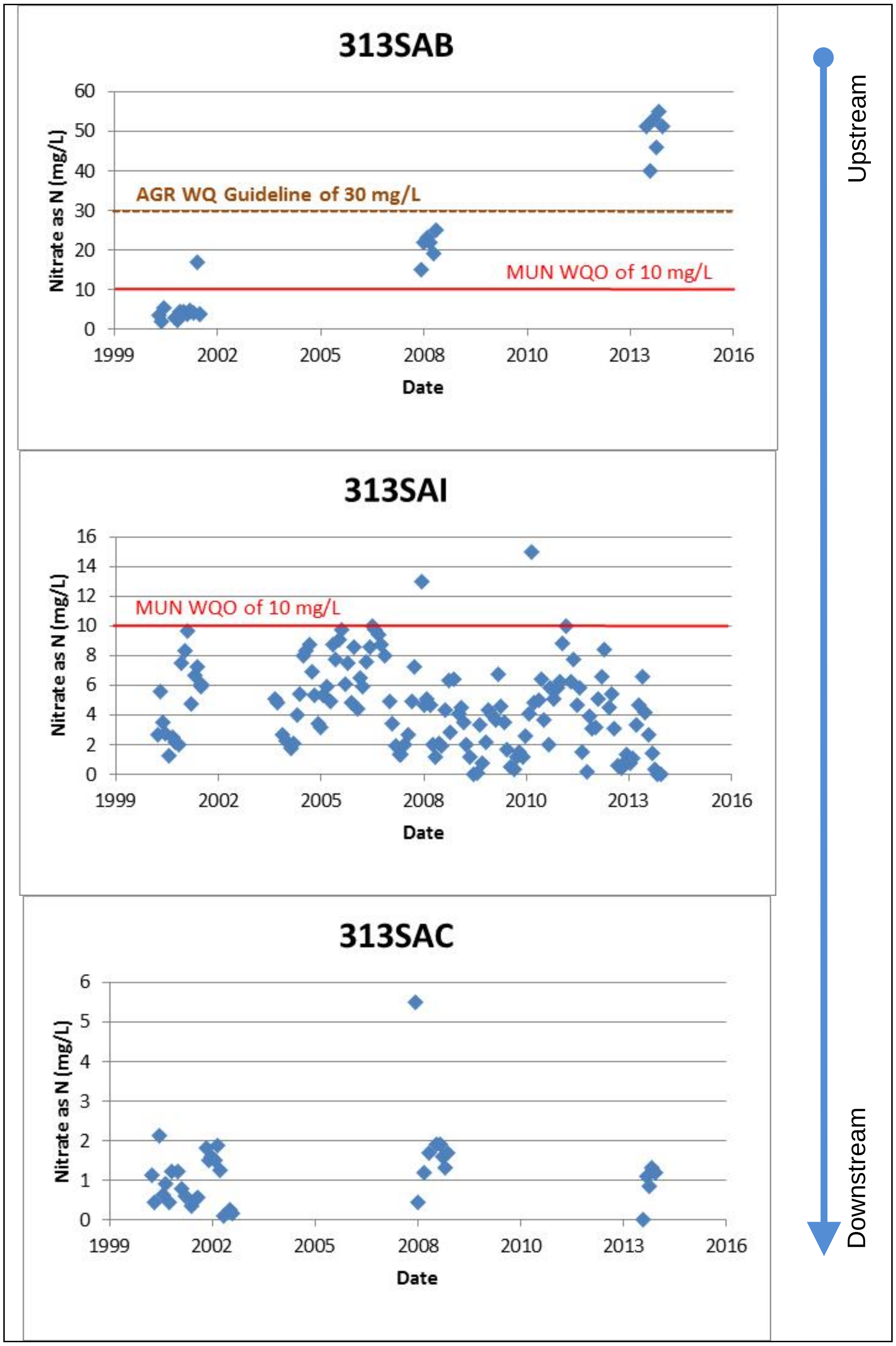


Figure 4-8. Scatter plot of nitrate as nitrogen concentrations (mg/L).
Note that the vertical axis is different for each site.

As shown in the figures above, the MUN beneficial use water quality objective (10 mg/L nitrate as nitrogen) is rarely exceeded at monitoring station 313SAI and never exceeded at site 313SAC. Since 2013, nitrate as nitrogen concentrations at site 313SAB are nearly 5 times greater than the water quality objective for the MUN beneficial use and concentrations frequently exceed guidelines for the AGR beneficial use (30 mg/L nitrate as nitrogen). San Antonio Creek is not included on the 2008-2010 303(d) List due to nitrate impairment. However, based on water quality data that has been obtained since the 2008-2010 303(d) Listing cycle (2006), staff has concluded that San Antonio Creek is impaired due to excessive nitrate levels. As a result, this TMDL will address nitrate impairment.

4.4 Joint nitrate/nitrite as nitrogen

OEHHA developed a PHG of 10 mg/L for joint nitrate/nitrite as nitrogen in drinking water (OEHHA, 1997). The calculation of this PHG is based on the protection of infants from the occurrence of methemoglobinemia, the principal toxic effect observed in humans exposed to nitrate or nitrite.

Table 4-5. Summary of CCAMP monitoring results for joint nitrate/nitrite as nitrogen (mg/L).

	Station	Dates	Count	Count > 10	% > 10	Median	Mean	Max	Min
Flow Direction ↓	313SAB	2/12/01-3/17/02 1/31/08-6/16/08 1/22/14-6/25/14	25	13	52	15.05	19.41	55.1	1.88
	313SAE	3/06/01	1	0	0	2.32	2.32	2.32	2.32
	313SAI	1/18/01-3/17/02 3/04/04-4/12/11	135	5	3.7	4.77	4.9	15.1	0.11
	313SAC	1/18/01-3/18/03 1/31/08-12/09/08 2/27/14-3/6/14	33	0	0	1.23	1.23	5.62	0.12

Monitoring station 313SAB, the most upstream site in the watershed, exceeded the OEHHA PHG of 10 mg/L joint nitrate/nitrogen as nitrate on thirteen (13) occasions. Both mean and median values for site 313SAB exceed the PHG. Station 313SAI exceeded the OEHHA PHG five (5) times.

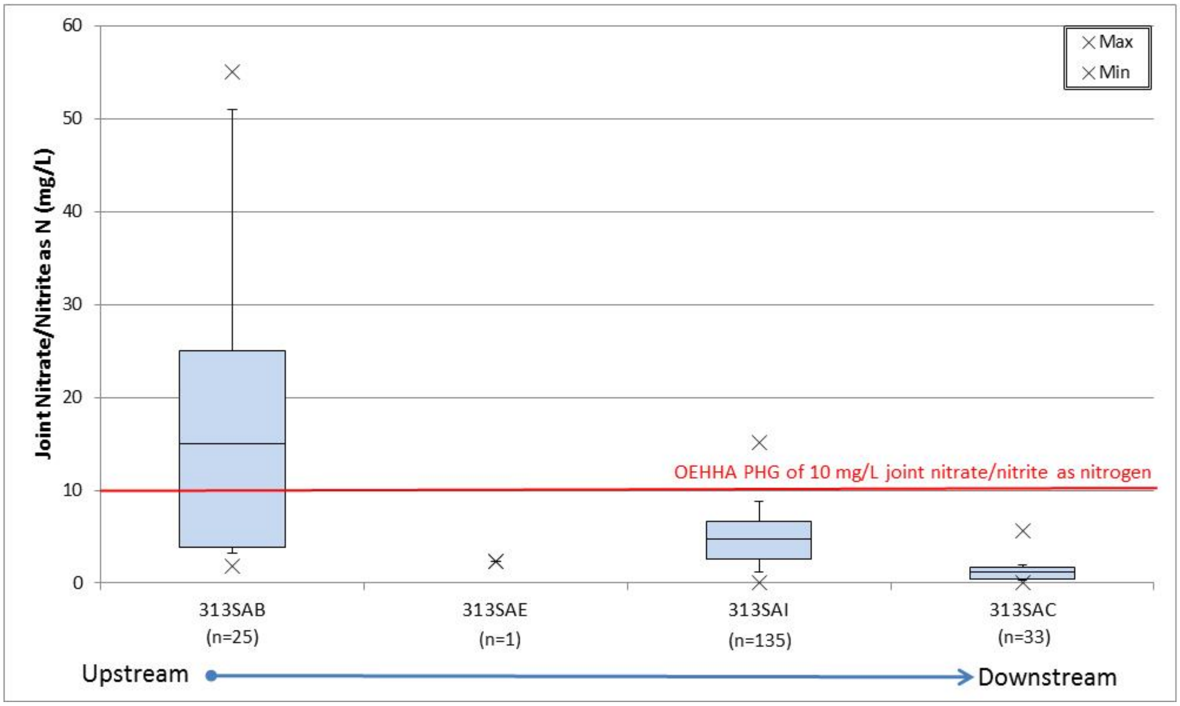


Figure 4-9. Box plots of joint nitrate/nitrite as nitrogen (mg/L) concentrations.

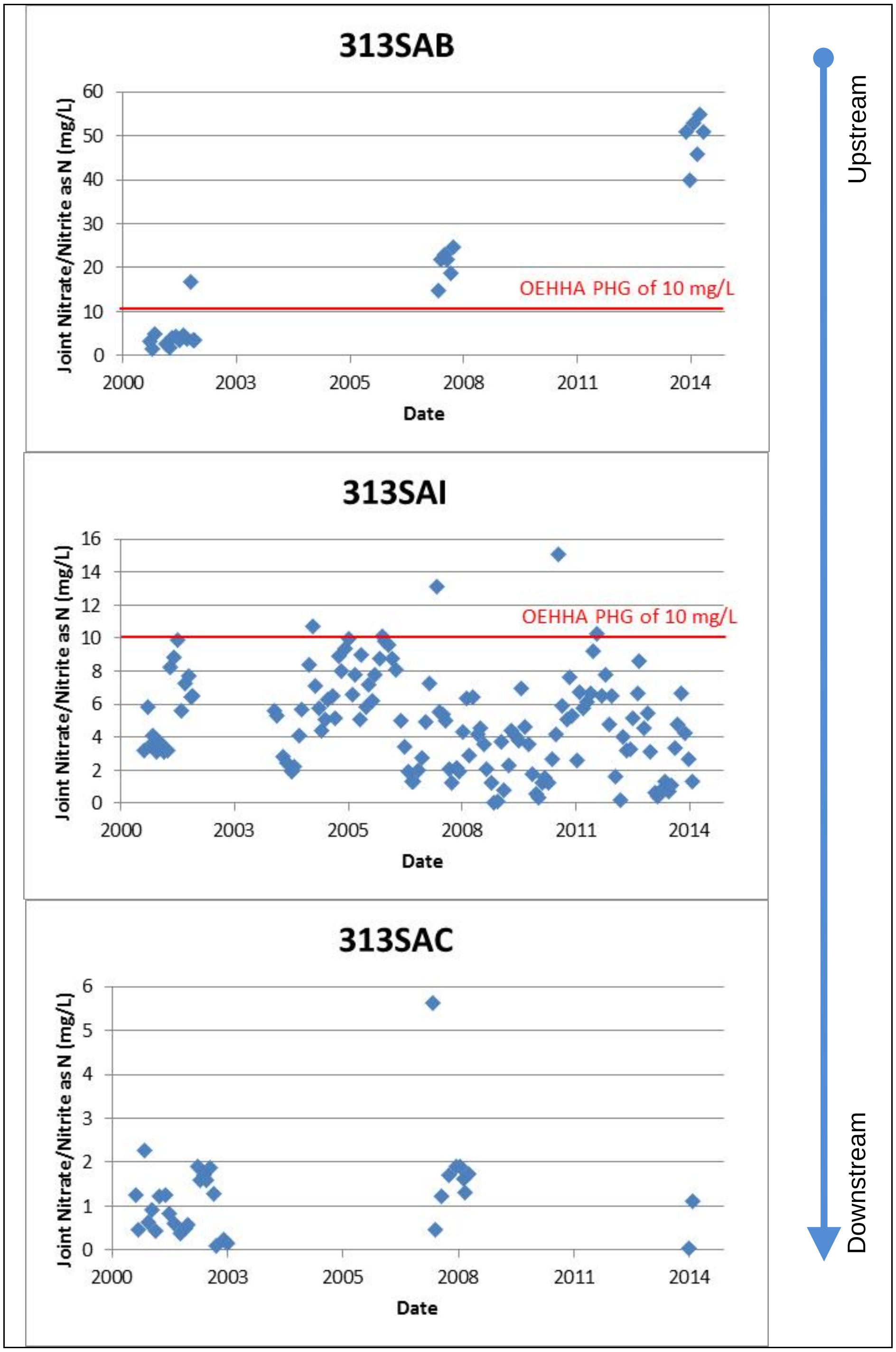


Figure 4-10. Scatter plot of joint nitrate/nitrite as nitrogen concentrations.
Note that the vertical axis is different for each site.

Figure 4-10 shows that site joint nitrate/nitrite concentrations at site 313SAB have more than doubled between the period of 2008 and 2014. Concentrations in 2008 are twice the OEHHA PHG and nearly five times the OEHHA PHG in 2014. Based on this information staff has concluded that a significant source of nitrogen compounds are entering the water body upstream of monitoring station 313SAB. Because nitrite as nitrogen concentrations are relatively low (see Figure 4-6), staff has concluded that nitrate is the primary component responsible for exceedance of this joint nitrogen compound objective.

4.5 Dissolved oxygen (mg/L)

The Basin Plan Cold Water Habitat (COLD) Objective states the following: The dissolved oxygen concentration shall not be reduced below 7.0 mg/l at any time.

The Basin Plan Warm Water Habitat (WARM) Objective states the following: The dissolved oxygen concentration shall not be reduced below 5.0 mg/l at any time.

In addition, the Basin Plan General Objective, Chapter 3, Section II.A.2 General Objectives for all Inland Surface Waters, Enclosed Bays and Estuaries states the following: For waters not mentioned by a specific beneficial use, dissolved oxygen concentration shall not be reduced below 5.0 mg/l at any time.

Peer-reviewed research in California's central coast region (Worcester et al., 2010) has established an upper limit of 13 mg/L for dissolved oxygen to screen for excessive dissolved oxygen saturation indicative of biostimulatory conditions. For monitoring sites within the central coast region that support designated aquatic habitat beneficial uses and do not show signs of biostimulation, dissolved oxygen virtually never exceeded 13 mg/L at any time[21]). Note that the 13 mg/L dissolved oxygen saturation target is not a regulatory standard, but can be used as a TMDL nutrient-response indicator target to assess primary biological response to nutrient pollution.

Staff used the above objectives and screening levels to assess dissolved oxygen water quality conditions.

Table 4-6. Summary of CCAMP monitoring results for dissolved oxygen (mg/L).

	Station	Dates	Count	Count < 5 Warm	% < 5 Warm	Count < 7 Cold	% <7 Cold	Count >13	% >13	Median	Mean	Max	Min
Flow Direction ↓	313SAB	2/12/01-3/17/02 1/31/08-6/16/08 1/22/14-6/25/14	26	0	0.0	0.0	0.0	2	7.7	10.7	10.7	13.2	8.5
	313SAE	3/6/01	1	0	0.0	0.0	0.0	0	0	10.4	10.4	10.4	10.4
	313SAI	1/18/01-3/17/02 3/4/04-6/25/14	138	13	9.4	53.0	38.4	3	2.17	8.0	8.0	14.6	2.6
	313SAC	1/18/01-3/18/03 1/31/08-12/9/08 2/27/14-6/25/14	36	12	33.3	22.0	61.1	0	0	5.8	6.2	9.8	2.6

[21] Of 2,399 samples at these reference sites, only about 1% of the samples ever exceeded 13 mg/L DO.

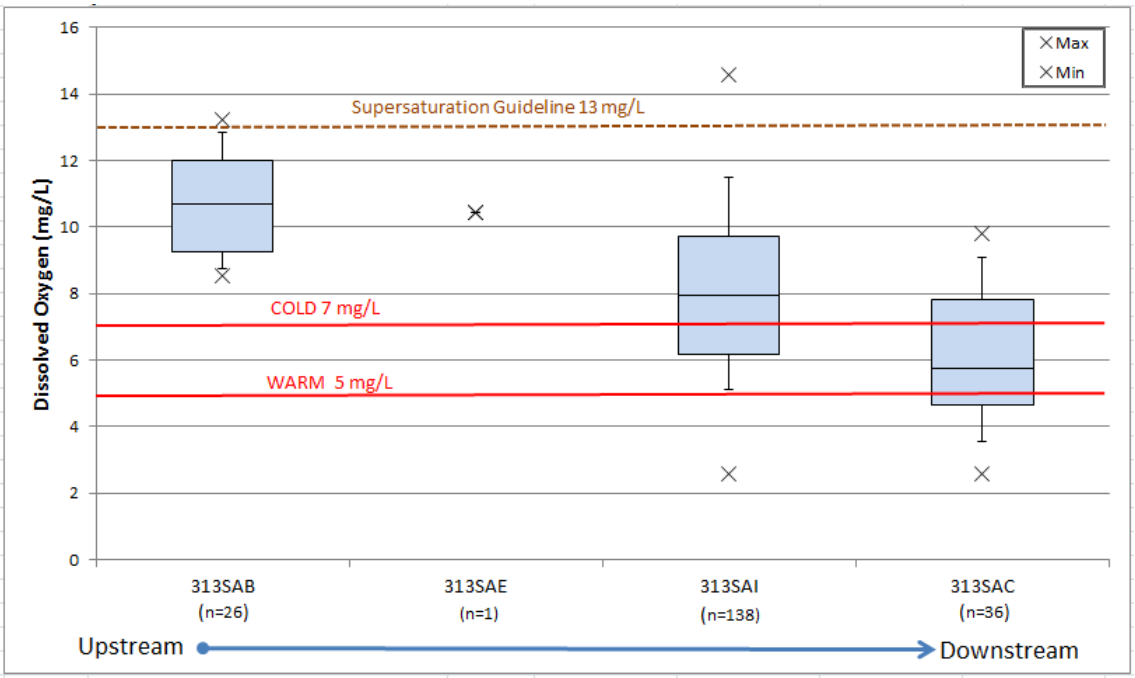


Figure 4-11. Boxplots of dissolved oxygen concentrations (mg/L).

Low dissolved oxygen concentrations that do not meet (are below) both the WARM beneficial use water quality objective of 5 mg/L and the COLD beneficial use objective of 7 mg/L are primarily observed in the lower portion of the San Antonio Creek watershed. Low dissolved oxygen conditions are most pronounced at lowermost station in the watershed, monitoring site 313SAC, whereby the median concentration of 5.8 mg/L does not meet the COLD beneficial use water quality objective. Also at monitoring site 313SAC, dissolved oxygen concentrations do not meet objectives supporting the COLD water beneficial use 61% of the time and the WARM beneficial use 33% of the time. It should be noted however that the dissolved oxygen supersaturation level of 13 mg/L, indicative of biostimulatory conditions, has not been observed at site 313SAC.

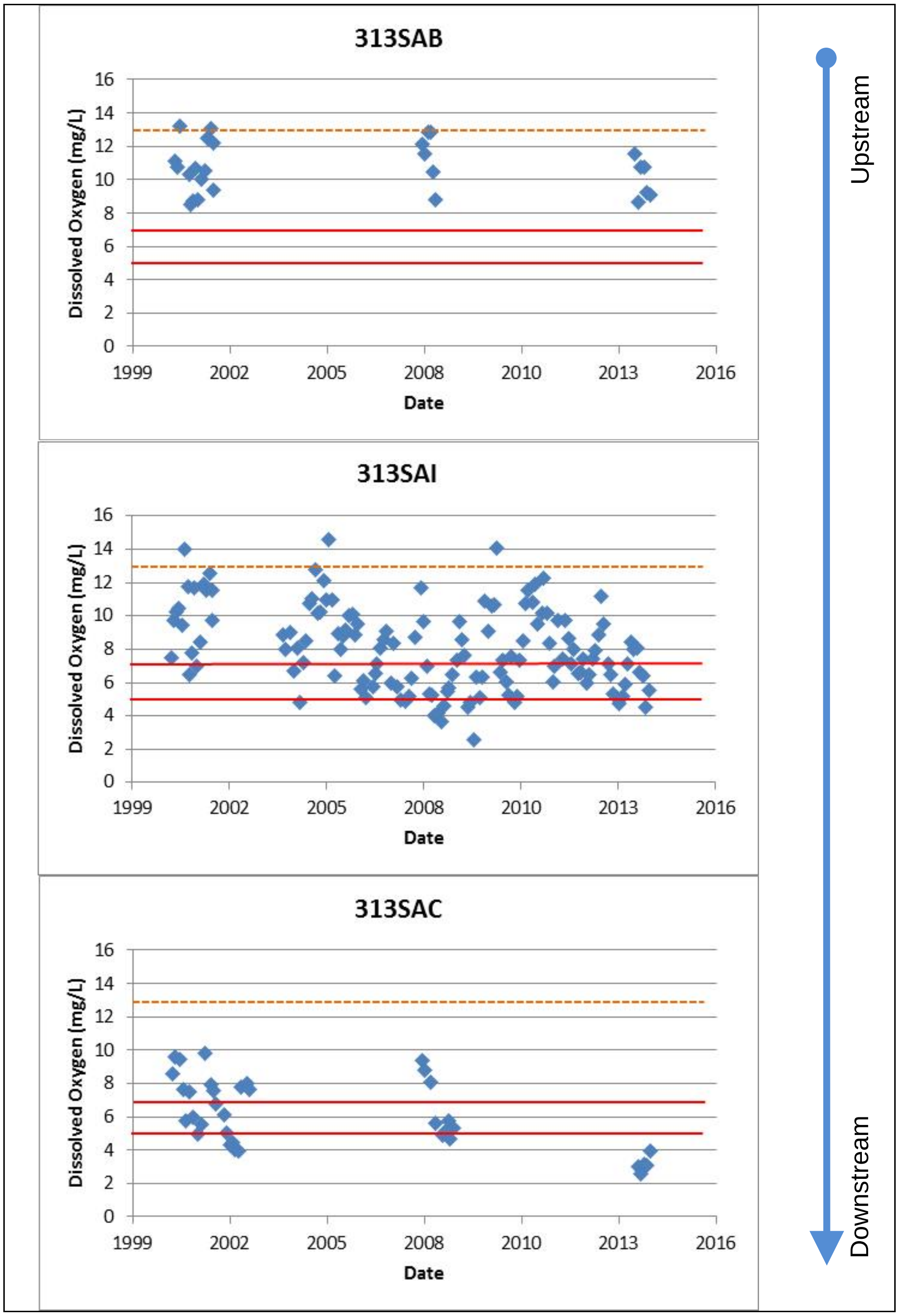


Figure 4-12. Scatter plot of dissolved oxygen concentrations (mg/L).
Note: Upper and lower red horizontal lines represent dissolved oxygen water quality objectives for COLD (7 mg/L) and WARM (5 mg/L) beneficial uses respectively. Dashed brown horizontal line represents screening level guideline for oxygen supersaturation (13mg/L), above which may be indicative of potential biostimulatory conditions.

4.6 Dissolved oxygen (% saturation)

The Basin Plan General Objective, Chapter 3, Section II.A.2 General Objectives for all Inland Surface Waters, Enclosed Bays and Estuaries states the following: Median values for dissolved oxygen should not fall below 85% saturation as a result of controllable conditions.

Table 4-7. Summary of CCAMP monitoring results for dissolved oxygen saturation (%).

	Station	Dates	Count	Count < 85	% < 85	Median	Mean	Max	Min
Flow Direction	313SAB	2/12/2001-3/17/02 1/31/08-6/16/08 1/14/14-6/25/14	26	4	15.4	98.3	97.4	117.5	80.5
	313SAE	3/6/2001-	1	0	0.0	100.5	100.5	100.5	100.5
	313SAI	1/18/2001-3/17/02 3/4/04-6/25/14	138	87	63.0	75.7	80.5	179.3	27.5
	313SAC	1/18/2001-3/18/03 1/31/08-12/9/08 2/27/14-6/25/14	36	33	91.7	58.6	60.0	93.5	25.7

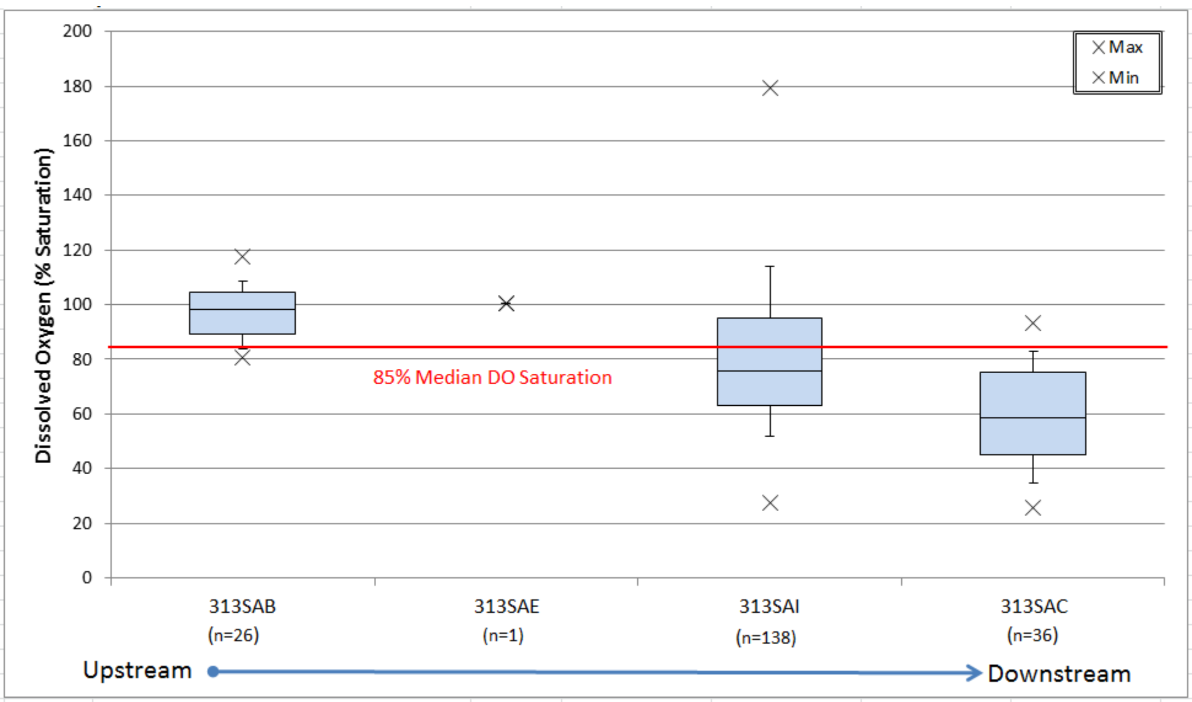


Figure 4-13. Boxplots of dissolved oxygen saturation (%).

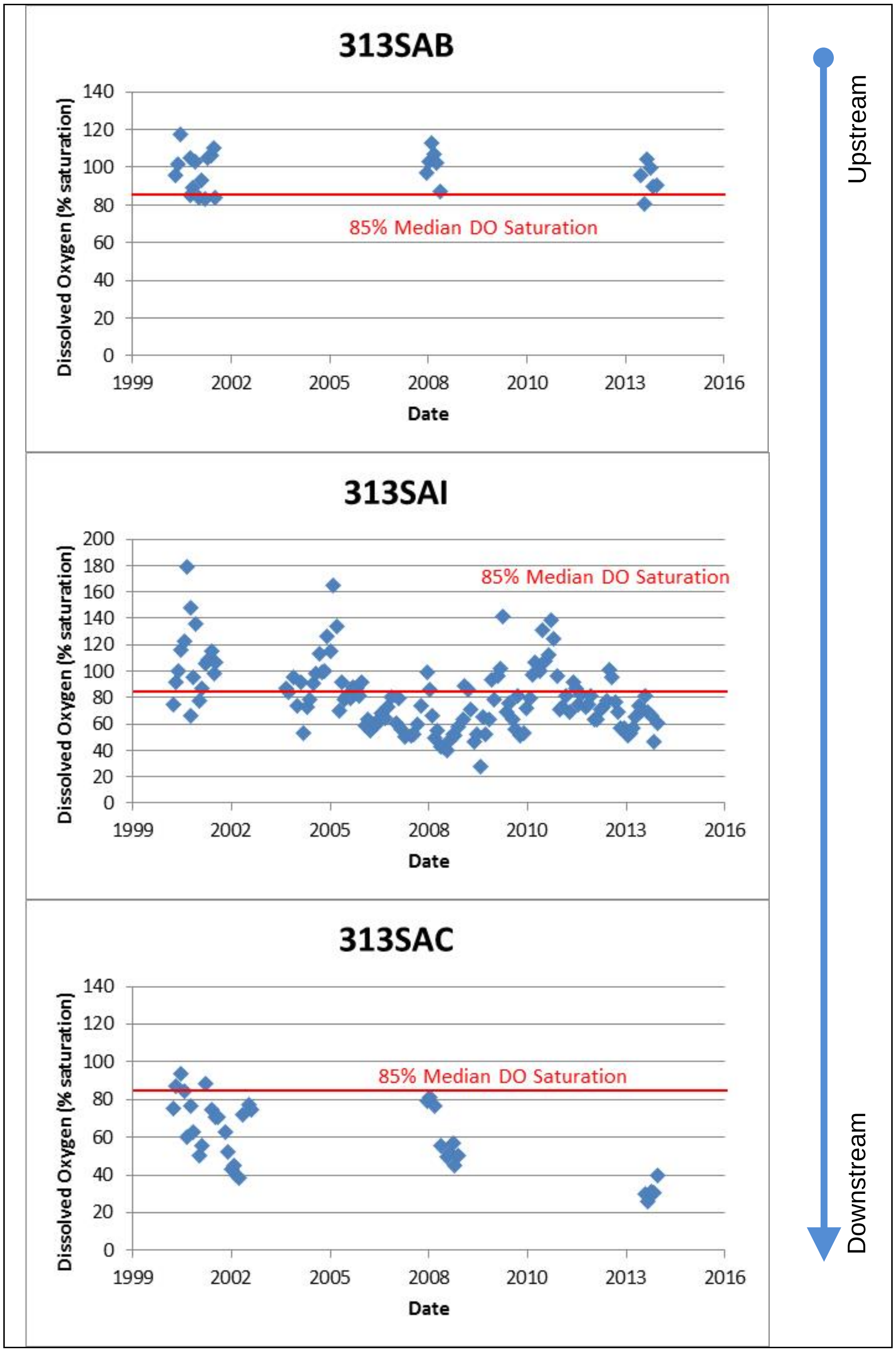


Figure 4-14. Scatter plot of dissolved oxygen saturation (%).

Low dissolved oxygen saturation conditions (85% median value) do not meet (are below) the General Objective for all Inland Surface Waters, Enclosed Bays, and Estuaries, primarily in the lower portion of the San Antonio Creek watershed. The median dissolved oxygen saturation objective is not met at station 313SAC, whereby the average median concentration is 60%.

4.7 Diel dissolved oxygen (mg/L) CCAMP Site 313SAI

Excessive algal growth in waterbodies is often characterized by wide swings in dissolved oxygen concentrations, typically dropping below concentrations set to protect for aquatic life at night, and often rising above the CCAMP upper screening limit of 13 mg/L (CCAMP, 2010). Low oxygen conditions can result in fish kills and harm to other aquatic life. Some species, such as trout, are particularly sensitive to low oxygen conditions, which is why more rigorous standards are necessary to support cold water fish habitat.

CCAMP collected diel (24-hour) data at site 313SAI to determine if oxygen levels drop during the highest risk time of day, which is pre-dawn. The diel data is important because monitoring staff conducts routine monthly grab sampling between 9 a.m. and 4 p.m., when oxygen levels are typically highest. Therefore, results of CCAMP monthly grab samples generally represent higher daytime oxygen values, as opposed to the lower (high risk) oxygen values that occur before dawn.

Note that the COLD beneficial use water quality objective for dissolved oxygen is 7 mg/L; which applies to this portion of San Antonio Creek near site 313SAI.

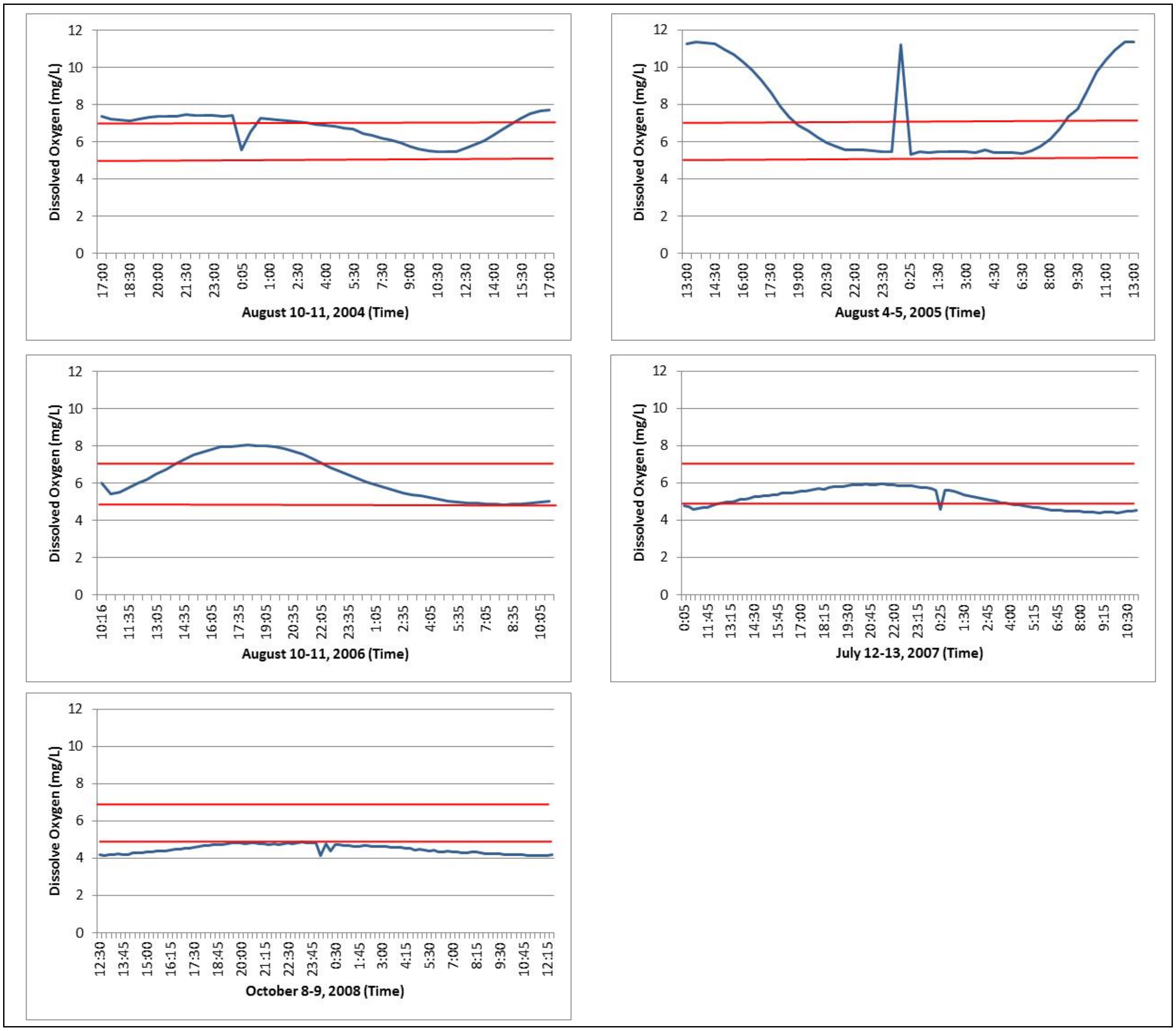


Figure 4-15. CCAMP diel dissolved oxygen concentrations (mg/L) for site 313SAI (2004-2008).
Note: Upper and lower red horizontal lines represent dissolved oxygen water quality objectives for COLD (7 mg/L) and WARM (5 mg/L) beneficial uses respectively.

The diel dissolved oxygen graphs shown in Figure 4-15 indicate that oxygen levels are at times below the water quality objective for the COLD beneficial use (not less than 7 mg/L) during the five monitoring events. A swing in dissolved oxygen concentrations is apparent during the 2005 monitoring event, possibly indicating an increase in algae respiratory rates associated with biostimulatory conditions. However, it should be noted that the dissolved oxygen supersaturation level of 13 mg/L, indicative of biostimulatory conditions, has not been observed at site 313SAI.

4.8 Chlorophyll *a*

Chlorophyll *a* is an algal biomass indicator however the Basin Plan does not include numeric water quality objectives or criteria for chlorophyll *a*. Staff considered a range of published numeric criteria. The State of Oregon uses an average chlorophyll *a* concentration of greater than 15 micrograms per liter (µg/L) as a criterion for nuisance phytoplankton growth in lakes and rivers[22]. The state of North Carolina has set a maximum acceptable chlorophyll *a* standard of 15 µg/L for cold water (lakes, reservoir, and other waters subject to growths of macroscopic or microscopic vegetation designated as trout waters), and 40 µg/L for warm water (lakes, reservoir, and other waters subject to growths of macroscopic or microscopic vegetation not designated as trout waters)[23]. A chlorophyll *a* concentration of 8 µg/L is recommended as a threshold of eutrophy for plankton in EPA's Nutrient Criteria Technical Guidance Manual for Rivers and Streams (USEPA, 2000a). Central Coast Water Board staff currently uses 40 µg/L as stand-alone evidence to support chlorophyll *a* listing recommendations for the 303(d) Impaired Water Bodies List.

Table 4-8. Summary of CCAMP monitoring results for chlorophyll *a* (µg/L) concentrations.

	Station	Dates	Count	Count > 40	% > 40	Median	Mean	Max	Min
Flow Direction ↓	313SAB	2/12/2001-3/17/02 1/31/08-6/16/08 1/22/14-5/22/14	23	0	0	3.8	6.2	29.6	0.7
	313SAE	3/6/2001-	1	0	0	1	1.0	1	1
	313SAI	1/18/2001-3/17/02 3/4/04-5/22/14	132	5	3.8	6.4	9.7	59.6	0.01
	313SAC	1/18/2001-3/18/03 1/31/08-12/9/08 2/27/14-2/22/14	35	0	0	2.2	4.4	33.9	0.01

Chlorophyll *a* concentrations exceeded the 40 µg/L criteria on only 5 occasions (n=191) at site 313SAI. Median concentrations for all sites are below the most stringent threshold of 8 µg/L that is recommended in EPA nutrient guidance. Also, from 2011 to 2014, chlorophyll *a* levels rarely exceeded 10 µg/L indicating that excessive algal biomass as a result of biostimulatory conditions does not occur within the watershed.

[22] Oregon Administrative Rules (OAR). 2000. Nuisance Phytoplankton Growth. Water Quality Program Rules, 340-041-0150.
[23] North Carolina Administrative Code 15A NCAC 02B .0211(3)(a).

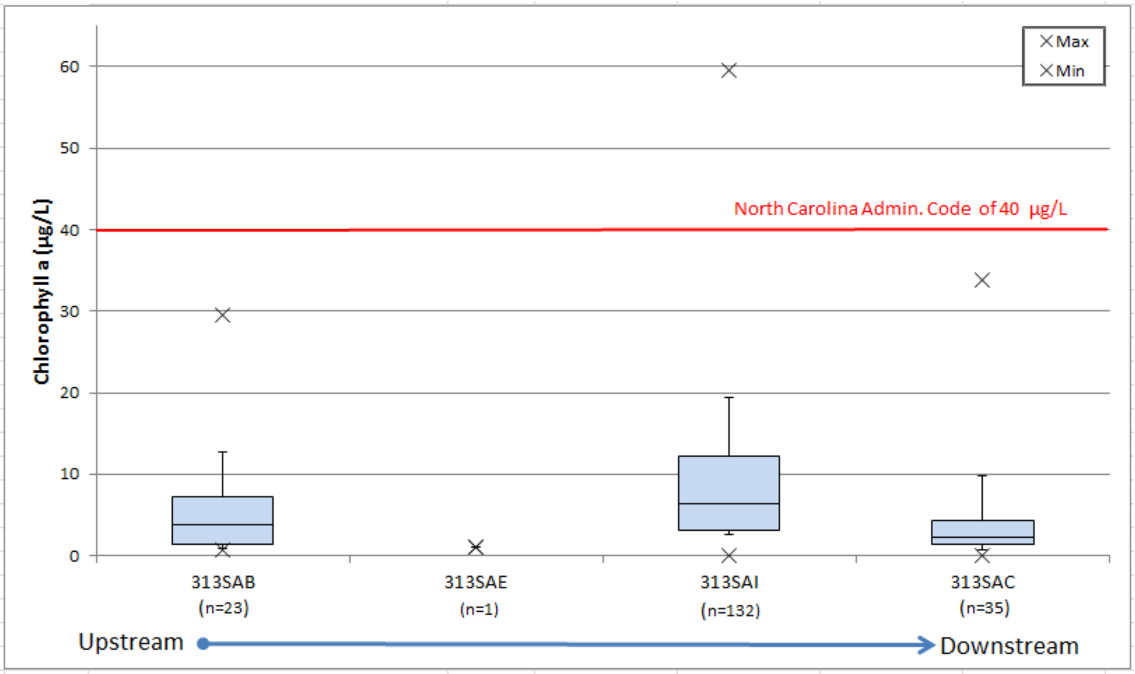


Figure 4-16. Boxplots of chlorophyll *a* (µg/L) concentrations.

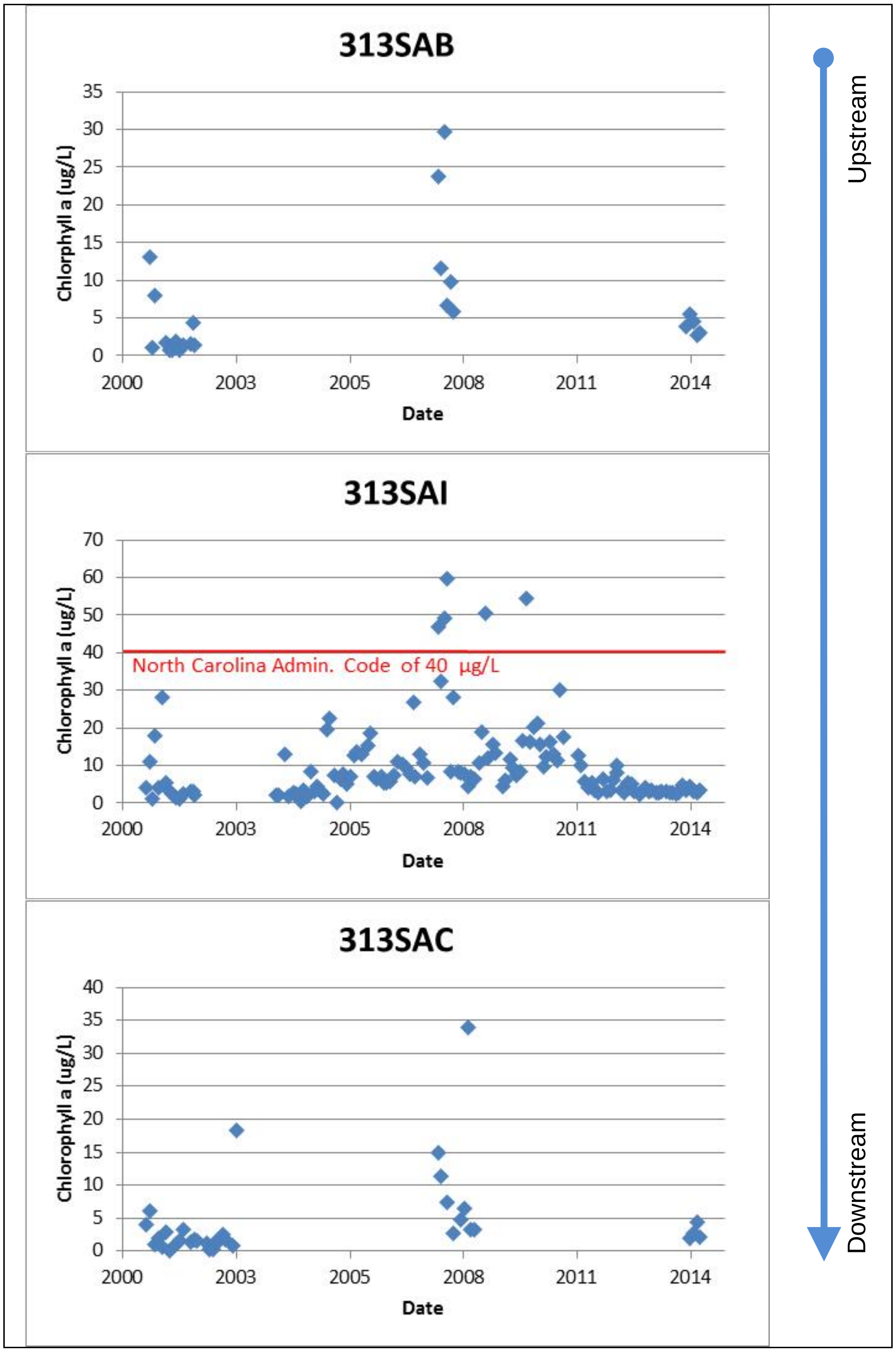


Figure 4-17. Scatter plot of chlorophyll *a* concentrations (µg/L).

4.9 Floating algae

CCAMP records a visual estimate of floating algae (% coverage) which may be used as an indicator of algal biomass. One or more observations of 50% cover or grater may be used as supporting evidence of potential nutrient over-enrichment and biostimulation (Worcester, et. al., 2010). Floating algae was only observed on 16 occasions (n=128) with a maximum percent coverage of 33% observed for station 313SAI.

Table 4-9. Summary of CCAMP monitoring results for floating algae (% coverage).

Flow Direction	Station	Dates	Count	Count floating algae observed	Mean algae % coverage	Max algae % coverage
↓	313SAB	2/12/2001-3/11/02 1/31/08-6/16/08	17	6	4.7	20
	313SAE	N/A	N/A	N/A	N/A	N/A
	313SAI	1/18/2001-3/11/02 3/4/04-8/23/12	101	10	1.2	33
	313SAC	1/31/08-12/9/08	10	0	0	0

For site 313SAC (the most downstream site), floating algae has not been observed because duckweed encompasses the entire water surface year-round (CCAMP staff M. Hamilton 2015, pers. comm.), thus preventing the growth of nuisance algae that may consume oxygen and harm aquatic life. Duckweed is a native aquatic plant that grows within low flow waterbodies such as wetlands, lakes, and ponds. Duckweed is often considered beneficial to aquatic habitats because it provides food and shelter for fish and other animals, while also providing shade that promotes cooler water temperature. Figure 4-18 is a photo of CCAMP site 313SAC, note extensive riparian vegetation and presence of duckweed.

Figure 4-18. Photo of CCAMP site 313SAC (November 20, 2002).

4.10 Summary of water quality data analysis

Exceedance of the water quality objective for un-ionized ammonia (0.025 mg/l as nitrogen) only occurs at monitoring station 313SAI with most exceedances occurring prior to 2006. Between 2007 and 2011, 2 out of 51 samples exceeded the un-ionized ammonia water quality objective; however, this exceedance rate does not meet the minimum number of exceedances needed to place a water segment on the 303(d) List for toxicants (see Table 3-3). As a result staff will propose de-listing San Antonio Creek for un-ionized ammonia in accordance with the Listing Policy.

The OEHHA nitrite PHG (1 mg/L nitrite as nitrogen) was exceeded only at monitoring station 313SAI prior to 2011 and since that time there have been no exceedances. As a result staff will propose de-listing San Antonio Creek for nitrite as nitrogen in accordance with the Listing Policy. All other monitoring stations are well below the OEHHA goal for nitrite.

The water quality objective for municipal and domestic drinking water supply (MUN) beneficial use (10 mg/L nitrate as nitrogen) is rarely exceeded at monitoring station 313SAI and never exceeded at site 313SAC. Note that San Antonio Creek is not included on the 2008-2010 303(d) List due to nitrate impairment. However, since the 2008-2010 303(d) Listing cycle, nitrate as nitrogen concentrations at the uppermost monitoring site 313SAB are nearly 5 times greater than the water quality objective for the MUN beneficial use and concentrations frequently exceed guidelines for the AGR beneficial use (30 mg/L nitrate as nitrogen). As a result, staff has concluded that an upper portion of San Antonio Creek (above site 313SAB) is impaired due to excessive nitrate levels and therefore this TMDL will address nitrate impairment.

Low dissolved oxygen concentrations exist in the lower portion of the San Antonio Creek watershed, primarily at the lowermost monitoring site (313SAC). However, staff has concluded that low dissolved oxygen conditions are most likely due to natural conditions rather than biostimulatory conditions associated with nutrient over-enrichment. Staff made this conclusion is based on the following:

- Nitrate concentrations are relatively low for the lowermost monitoring stations. The median nitrate as nitrogen concentrations for site 313SAC is 1.2 mg/L and the median for site 313SAI is 4.5 mg/L (see Section 4.3).
- The dissolved oxygen supersaturation level of 13 mg/L, indicative of biostimulatory conditions, has never been observed at site 313SAC (see Section 4.5).
- Based on 24-hour diel monitoring, the dissolved oxygen supersaturation level of 13 mg/L has not been observed at site 313SAI which is the next monitoring site upstream of site 313SAC (see Section 4.7). Note that this is the only monitoring site where diel monitoring has been conducted.
- Concentrations of chlorophyll *a*, an algal biomass indicator, are extremely low at site 313SAC where the median concentration is 2.2 µg/L. Chlorophyll *a* concentrations for site 313SAI are marginally higher at 6.4 µg/L. Note that median concentrations for all sites are below the most stringent threshold of 8 µg/L that is recommended in EPA nutrient guidance (see Section 4.8).
- Floating algae, an indicator or nuisance algal growth, has not been observed above 33% surface water coverage. Note that one or more observations of 50% cover or grater may be used as supporting evidence of potential nutrient over-enrichment and biostimulation (Worcester, et. al., 2010).

San Antonio Creek will remain on the 2008-2010 303(d) List of impaired waters due to low dissolved oxygen and staff will evaluate this impairment in a future TMDL or water quality standards action.

5 NUMERIC TARGETS

This section describes the numeric targets used to develop the TMDL. Numeric targets are water quality targets developed to ascertain when and where water quality objectives are achieved, and hence, when beneficial uses are protected. For this TMDL, the numeric targets are equal to the existing water quality objective.

5.1 Water Column Numeric Targets

Staff selected water column numeric target values for nitrate as a direct measure of water quality conditions for the protection of municipal and domestic supply (MUN) beneficial use. The Basin Plan numeric water quality objective for nitrate (as nitrogen) is 10 mg/L; therefore the nitrate target is set at the Basin Plan water quality objective as follows:

- *Receiving water column nitrate must not exceed 10 mg/L-N.*

6 SOURCE ANALYSIS

6.1 Introduction: Source Assessment Using STEPL Model

Excessive levels of nitrogen may reach surface waters as a result of human activities (USEPA, 1999). For this TMDL project report, staff derived nutrient source loading estimates using the US Environmental Protection Agency's STEPL (Spreadsheet Tool for Estimating Pollutant Load) model. The STEPL model provides a calculation of nutrient loads from different land uses and source categories and provides a Visual Basic (VB) interface to create a customized, spreadsheet-based output in Microsoft (MS) Excel.

STEPL calculates watershed surface runoff of nutrient loads that are based on various land uses and watershed characteristics. The STEPL model has been used previously in USEPA-approved TMDLs to estimate source loading[24] as well as several other Central Coast Water Board-approved nutrient TMDLs.

The annual nutrient loading estimate in STEPL is calculated based on the runoff volume and the pollutant concentrations in the runoff water as influenced by factors such as land use distribution, precipitation data, soil characteristics, groundwater inputs, and management practices. Additional details on the model can be found at: http://it.tetratech-ffx.com/steplweb/.

To estimate nitrate loads, STEPL requires area estimates for the following four land use classifications; urban, cropland, pastureland, and forest. Staff used FMMP aggregated the NLDC land use/land cover classification to derive land use acreage required for STEPL as shown in Table 2-1.

[24] For example, see USEPA, 2010: Decision Document for Approval of White Oak Creek Watershed (Ohio) TMDL Report. February 25, 2010; and Indiana Dept. of Environmental Management, 2008. South Fork Wildcat Creek Watershed Pathogen, Sediment, and Nutrient TMDL.

STEPL input parameters used in this nitrate source assessment are shown in Figure 6-1 and Appendix B. The spreadsheet nitrate loading results are presented in Table 6-9 . It should be emphasized that nutrient load estimates calculated by STEPL are merely estimates and subject to uncertainties; actual loading at the local stream-reach scale can vary substantially due to numerous factors over various temporal and spatial scales.

Table 6-1. STEPL input data.

Input Category	Input Data	Sources of Data
Mean Annual Rainfall	18.68 inches/year	Santa Maria WSO Airport as provided in STEPL
Mean Rain Days/Year	42.3 days/year	Santa Maria WSO Airport as provided in STEPL
Weather Station (for rain correction factors)	0.865 Mean Annual Rainfall- 0.418 Mean Rain Days/Yr.	Santa Maria WSO Airport as provided in STEPL
Land Cover	FMMP (see Table 2-1)	Farmland Mapping and Monitoring Program (FMMP, 2010) land use/ land cover as represented in Table 2-1.
Urban Land Use Distributions (impervious surfaces categories)	STEPL default values	STEPL
Agricultural Animals	See STEPL spreadsheet Appendix B	Estimates of quantities of agricultural animals by individual subwatersheds from information developed and reported by Tetra Tech, Inc. for use in STEPL version 4.0 See: http://mingle.tetratech-ffx.com/steplweb2/steplweb.html.
Septic system discharge and failure rate data	254 Systems 2.43 persons/system 2% failure rate	Estimated 254 systems based on Tetra Tech, Inc. for use in STEPL version 4.0. See: http://mingle.tetratech-ffx.com/steplweb2/steplweb.html with 2.43 persons/system (National Average contained in STEPL). Failure rate of 2% (Typical range between 1 and 5%/year. De Walle, 1981 as cited in USEPA Preventing Septic system Failure)
Hydrologic Soil Group (HSG)	HSG "D"	HSG based on SSURGO soil data for TMDL project area
Soil N concentrations (%)	N = 0.10%	• N (%) – estimated national median value from information in GWLF User's Manual, v. 2.0 (Cornell University, 1992 - http://www.avgwlf.psu.edu/Downloads/GWLFManual.pdf).
NRCS reference runoff curve numbers	STEPL default values	NRCS default curve numbers provided in STEPL
Nutrient concentration in runoff (mg/L)	1.5 – 2.5 mg/L (urban) 2.1 mg/L (cropland) 0.25 mg/L (pastureland) 0.2 mg/L (forest)	• Urban lands –Used STEPL default values that contain a range of N runoff concentrations based on specific urban land use type (e.g., commercial, industrial, residential. Transportation, etc.). • Cropland (vineyards) - N Concentration of 2.1 mg/L derived from Larsen, et. al. (2006). Maximum stream concentration from three San Luis Obispo vineyards. http://www.fs.fed.us/psw/publications/documents/psw_gtr217/psw_gtr217_81.pdf. • Pastureland (grazing lands) mean N runoff concentration. from California Rangeland Watershed Laboratory rangeland presentation for stream water quality (average of the concentrations given for moderate grazing intensity and no grazing land use categories). • Forest N concentration: used STEPL default values.
Nutrient concentration in shallow groundwater (mg/L).	2.2 mg/L (ag and urban) 1.44 mg/L (pastureland) 0.11 mg/L (forest)	• NO3-N (ag and urban) – mean value for project area using USGS GWAVA model dataset . http://water.usgs.gov/GIS/metadata/usgswrd/XML/gwava-s_out.xml • NO3-N (grazing Lands and forest) - N default values from STEPL

Staff ran the STEPL model for the San Antonio Creek watershed and the results are discussed in the section below.

6.1.1 Urban Runoff

The Water Board is the permitting authority for NPDES stormwater permits in the Central Coast region. Urban runoff can be a contributor of nutrients to waterbodies. Within residential areas, potential controllable nutrient sources can include lawn care fertilizers, trash, and pet waste (Tetratech, 2004). Many of these pollutants enter surface waters via runoff without undergoing treatment. Impervious cover characterizes urban areas and refers to roads, parking lots, driveways, asphalt, and any surface cover that precludes the infiltration of water into the soil. Pollutants deposited on impervious surface have the potential of being entrained by discharges of water from storm flows, wash water, or excess lawn irrigation, etc. and routed to storm sewers, and potentially being discharged to surface water bodies.

NPDES-permitted stormwater dischargers in the project area include the City of Los Alamos which is covered by the County of Santa Barbara (NPDES General Permit CAS000004), and a small residential portion of Vandenberg Air Force Base (NPDES General Permit CAS000004). These municipalities are small municipal separate storm sewer system (MS4s) requiring coverage under the National Pollutant Discharge Elimination System (NPDES) General Permit for Storm Water Discharges from Small Municipal Separate Storm Sewer Systems. There is no need to limit point source discharges from these facilities, as their nitrate discharges are insignificant; any de minimis discharges from these facilities are far below the applicable numeric water quality objectives and the numeric targets set for the TMDL (which are also equivalent to the TMDLs). To ensure that these point sources remain insignificant sources, the Regional Board will ensure in future permitting actions that nitrate discharges are evaluated, and that applicable permits incorporate limitations as needed to ensure the discharge is substantially below the applicable numeric WQO and TMDL limits.

There are numerous studies, both nationwide and from the central coast region, that characterize nitrate-nitrogen concentrations in urban runoff (see Figure 6-1). These data (n = 438) illustrate that nitrate concentrations in urban runoff virtually never exceed the 10 mg/L nitrate as nitrogen water quality objective protective of the MUN beneficial use. In fact, the central coast-specific urban runoff data (Santa Cruz and Monterey County) shown in Figure 6-1 infrequently exceed nitrate-N concentrations of 2 mg/L. Based on the preceding information, staff concludes that discharges of nitrate-nitrogen from urban lands to San Antonio Creek are negligible and do not cause or contribute to impairment from nitrate-nitrogen.

States are required to establish TMDLs at levels necessary to attain and retain numeric and narrative water quality standards.[25] As will be discussed in the following section, discharges from agricultural lands are the single source causing impairment of water quality standards for protection of the MUN beneficial use. Therefore, wasteload allocations for urban stormwater are not needed to retain and maintain water quality standards addressed in this TMDL.

[25] 40CFR130.7(c)(1)

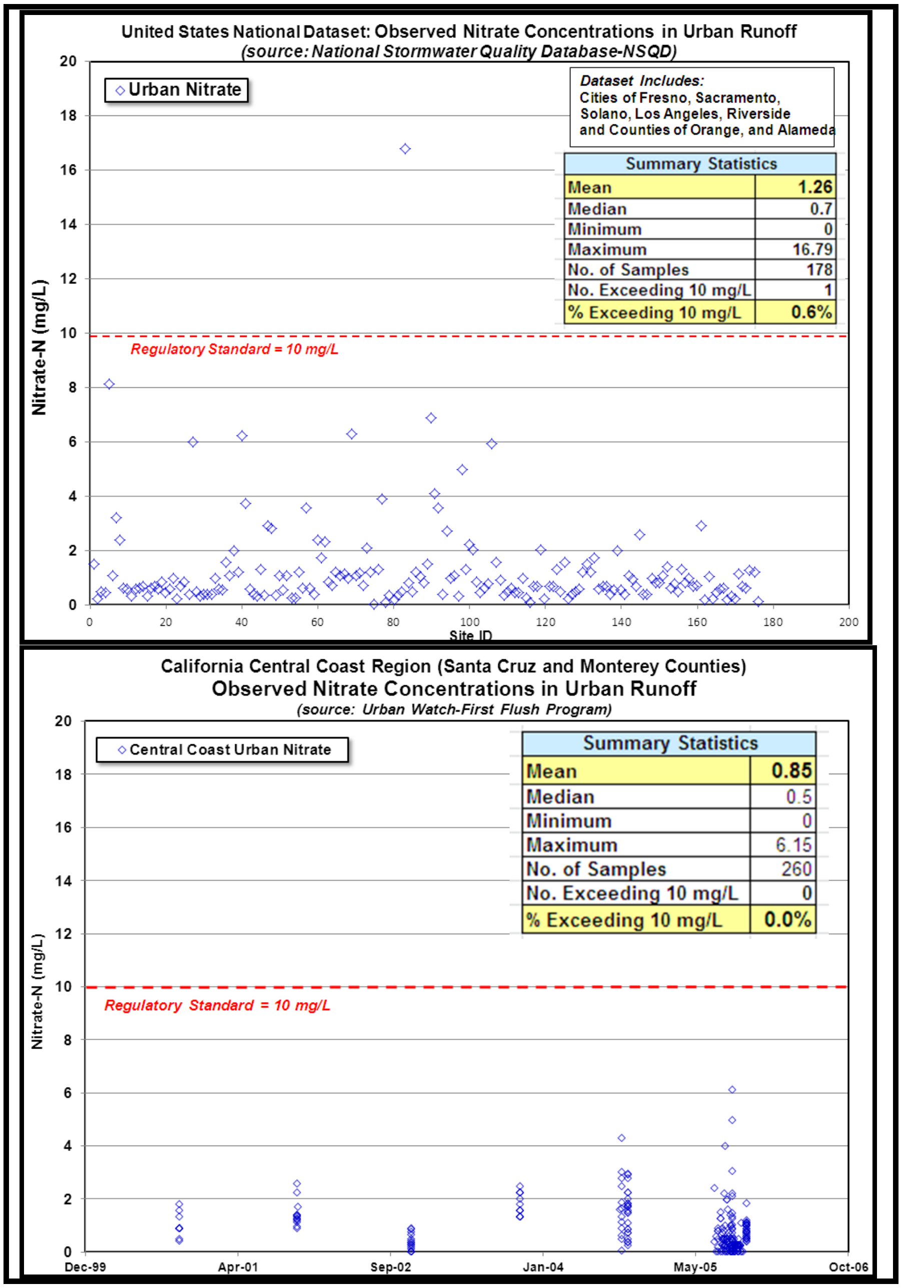


Figure 6-1. Nitrate concentration in urban runoff: national, California, and central coast regional data.

Using the parameter inputs identified in Table 6-1 the estimated annual nutrient load from urban runoff in the project area as calculated by STEPL is shown in Table 6-2.

Table 6-2. Urban Annual Nitrogen Load (lbs./year)

Source	San Antonio Creek Watershed
Urban	5,025

6.1.2 Agricultural Sources

Fertilizers or manure applied to cropland can constitute a significant source of nutrient loads to waterbodies. The primary concern with the application fertilizers on crops or forage areas is that the application can exceed the uptake capability of the crop. If this occurs, the excess nutrients become mobile and can be transported to either nearby surface waters, the groundwater table, or the atmosphere (Tetratech, 2004).

Figure 6-2 illustrates temporal trends of fertilizer sales in Santa Barbara County. It is important to recognize that fertilizer sales in a county does not necessarily mean those fertilizers were actually applied in that same county. Recorded sales in one county may actually be applied on crops in other, nearby counties. However, Krauter et al. (2002) reported fertilizer application estimates that were obtained from surveys, county farm advisors and crop specialists; these data indicated that in the Central Coast region, county fertilizer recorded sales correlated well with estimated in-county fertilizer applications (within 10 percent). Also, it is important to recognize that not all fertilizing material is sold to or applied to farm operations. The California Department of Food and Agriculture reports that for the annual period July 2007 to June 2008, non-farm entities purchased about 2.6% of fertilizing materials sold in Santa Barbara County[26].

[26] California Department of Food and Agriculture, Fertilizing Materials Tonnage Report, January – June 2008, pg. 10.

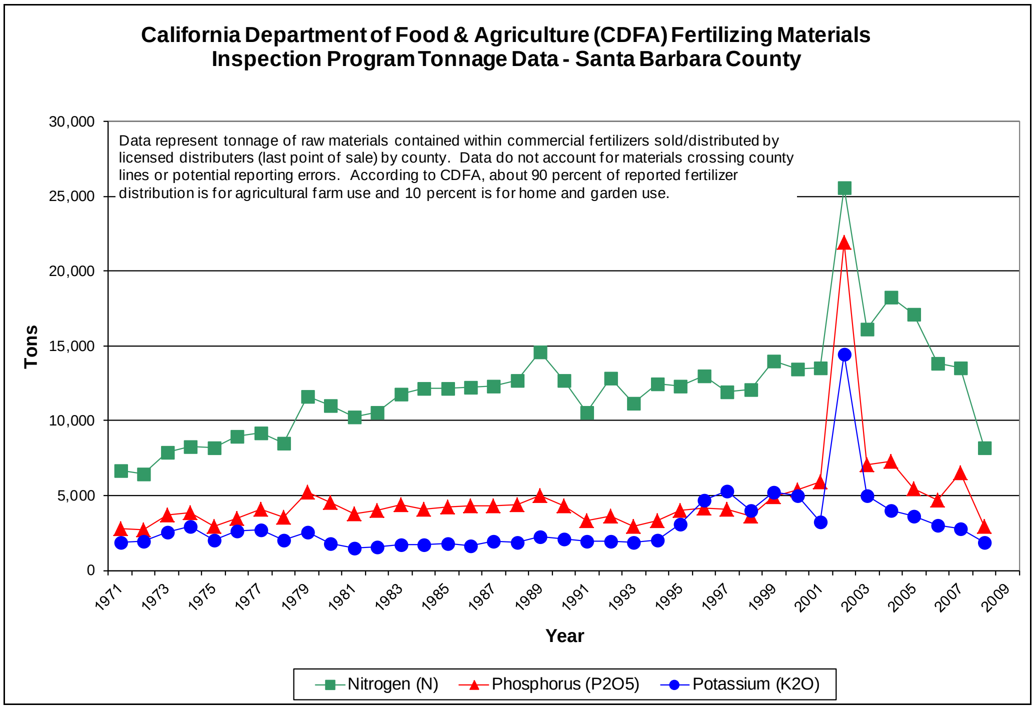


Figure 6-2. Fertilizer sales in Santa Barbara County.

California fertilizer application rates on specific crop types are available from the U.S. Department of Agriculture, National Agricultural Statistics Service (NASS), as shown in Table 6-3.

Table 6-3. California fertilizer application rates.

Crop	Application Rate per Crop Year in California (pounds per acre)			Source
	Nitrogen	Phosphate	Potash	
Tomatoes	243	133	174	2007 NASS report
Sweet Corn	226	127	77	2007 NASS report
Rice	124	46	34	2007 NASS report
Avocado	63	25	45	2009 NASS report
Lemon	67	39	59	2009 NASS report
Cotton	123	74	48	2008 NASS report
Barley	73	19	7	2004 NASS report
Oats[1]	64	35	50	2006 NASS report
Head Lettuce	200	118	47	2007 NASS report
Cauliflower	232	100	43	2007 NASS report
Broccoli	216	82	49	2007 NASS report
Celery	344	114	151	2007 NASS report
Asparagus	72	20	46	2007 NASS report
Spinach	150	60	49	2007 NASS report
Strawberries[2]	155	88	88	University of Delaware Ag, Nutrient Recommendations on Crops webpage

[1]insufficient reports to publish fertilizer data for P and potash; used national average from 2006 NASS report for P and K.
[2] median of ranges, calculated from table 1, table 4, and table 5 @ http://ag.udel.edu/other_websites/DSTP/Orchard.htm

Based on 2012 Santa Barbara County Assessor parcel data for the project area (see Appendix C), croplands are comprised primarily of vineyards (66%) and truck crops (34%).

The estimated annual nutrient load from cropland in the project area as calculated by STEPL is shown in Table 6-4.

Table 6-4. Cropland Annual Load (lbs./year)

Source	San Antonio Creek Watershed
Cropland	171,128

6.1.3 Pastureland

Livestock and other domestic animals that spend significant periods of time in or near surface waters can contribute significant loads of nitrogen and phosphorus because they use only a portion of the nutrients fed to them and the remaining nutrients are excreted (Tetratech, 2004). For example, in a normal finishing diet, a yearling cattle will retain only between 10 percent and 20 percent of the nitrogen and phosphorus it is fed. The rest of the nutrients are excreted as waste, and are thus available for runoff into nearby waterbodies or into the groundwater (Koelsch and Shapiro, 1997 as reported in Tetratech, 2004).

The estimated annual nutrient load from grazing lands in the project area as calculated by STEPL is shown in Table 6-5.

Table 6-5. Pastureland Annual Load (lbs./year)

Source	San Antonio Creek Watershed
Pastureland	130,849

6.1.4 Forest and Undeveloped Lands

The estimated annual nutrient load from forest in the project area as calculated by STEPL is shown in Table 6-6. Note that the load from these lands represent loading from natural sources of nitrate.

Table 6-6. Forest and Undeveloped Land Annual Load (lbs./year)

Source	San Antonio Creek Watershed
Forested Lands	4,649

6.1.5 Onsite Disposal Systems (OSDS)

The estimated annual nitrate load from OSDS (i.e., septic systems) to surface waters in the project area as calculated by STEPL is shown in Table 6-7. Staff used National Agricultural Imagery Program (NAIP, 2010) aerial imagery to identify approximately 254 OSDS within San Antonio Creek watershed. Based on this information, staff has concluded that OSDS discharges to surface waters within the project area are inconsequential. While the impacts of OSDS to underlying groundwater may be locally significant, researchers have concluded that at the basin-scale and regional-scale of agricultural valleys, OSDS impacts to groundwater are insignificant relative to agricultural fertilizer impacts (University of California-Davis, 2012).

The estimated annual nitrate load from OSDS in the project area as calculated by STEPL is shown in Table 6-7.

Table 6-7. OSDS (Septic) Annual Load (lbs./year)

Source	San Antonio Creek Watershed
OSDS (Septic)	158

6.1.6 Groundwater

Shallow groundwater provides the base flows to streams and can be a major source of surface water flows during the summer season. Therefore, dissolved nutrients in groundwater can be important nitrate source during dry periods. Ground water contamination from nitrate can occur from various sources, including septic systems, fertilizer application, animal waste, waste-lagoon sludge, and soil mineralization (USEPA, 1999).

The estimated annual nitrate load from groundwater in the project area as calculated by STEPL is shown in Table 6-8.

Table 6-8. Groundwater Annual Load (lbs./year)

Source	San Antonio Creek Watershed
Groundwater	28,681

6.2 Summary of Sources

It is worth reiterating that these are estimates for the TMDL project area. It is understood that there will be substantial variation due to temporal or local, site specific conditions. More information will be collected during TMDL implementation to assess controllable sources of nitrate. Table 6-9 and Figure 6-3 summarize estimated loads of nitrate.

Table 6-9. Summary of estimated nitrate load by source (lbs./yr.).

Sources	Nitrate Load (lb/yr)
Urban	5,025
Cropland	171,128
Pastureland	130,849
Forest and Undeveloped	4,649
OSDS (Septic)	158
Groundwater	28,681
Total	340,489

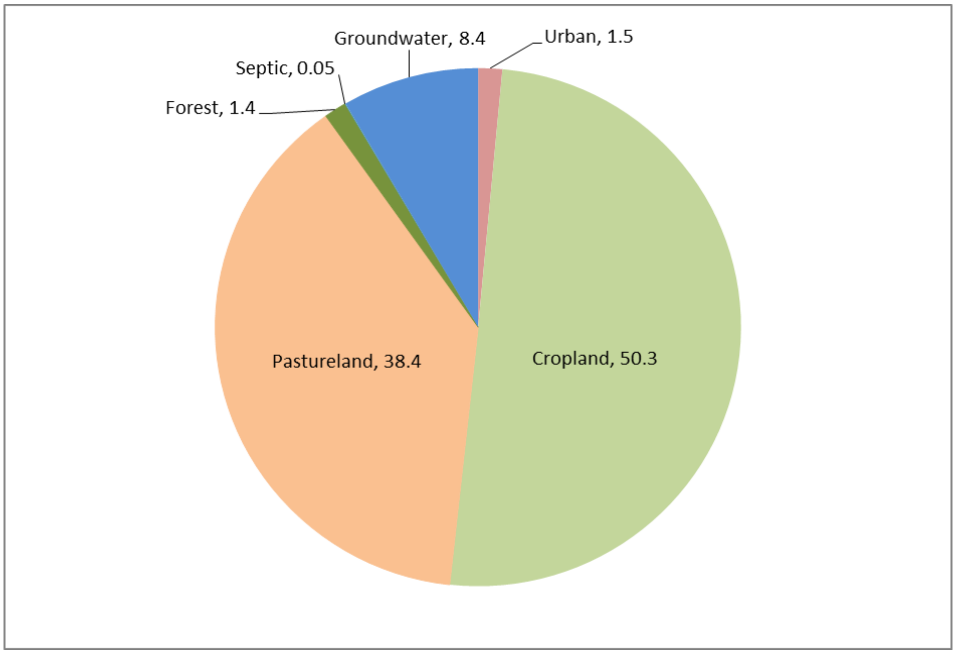


Figure 6-3. Summary of estimated nitrate loads (%).

6.3 Conclusions from Source Analysis

As shown in Figure 6-3 over half of the estimated nitrate loading in the watershed is from croplands while about 40 percent of the estimated loading is from pasturelands (grazing). To derive source nitrate loading rates per acre staff used land use areas (see Table 2-1) and STEPL load estimates (see Table 6-9). As shown in Table 6-10, the loading rate per acre is highest for croplands, followed by urban lands and pastureland. Staff concludes that discharges of nitrate from agricultural lands (croplands) are the sole source of nitrate causing impairment. In the absence of discharges from agricultural lands, there would not be impairment due to nitrate. This conclusion is based on fertilizer application rates for crops as discussed in Section 6.1.2. Although pastureland comprises nearly 40 percent of estimated loading, pastureland provides a relatively low nitrate loading rate per acre and most pastureland is located in upland areas at greater distance from San Antonio Creek when compared to croplands that are located adjacent to San Antonio Creek along the valley floor.

Table 6-10. Estimated annual nitrate loading rate by source (lbs./acre).

Sources	Annual N Load (lbs./acre)
Urban	4.0
Cropland	11.5
Pastureland	2.0
Forest and Undeveloped	0.3

6.4 Estimates of Existing Loading

Staff estimated existing mean annual loads using a simple averaging method where the load is calculated as the average concentration of samples multiplied by the mean flow. The calculation is as follows:

Nitrate Load (lbs./year) = Discharge (cfs) * 5.394 (conversion factor)* Nutrient Concentration (mg/L) * 365

Staff used CCAMP water quality monitoring data and the USGS mean discharge data to calculate mean concentrations and derive the estimated loads. The mean annual loading capacity and percent reduction goals are based on the water quality objective of 10 mg/L nitrate as nitrogen. Table 6-11 presents a tabulation of estimated mean annual nitrate-N loads, loading capacity under TMDL conditions, and percent reduction goals for project area waterbodies. Note that percent reduction goals are for informational purposes only and should not be viewed as the TMDL.

Table 6-11. Estimated mean annual nitrate-N loads, loading capacities, and percent reduction goals.

Water body	Estimated Mean Annual Flow (cfs) [A]	Mean Annual Conc. (mg/L)	Est. Existing Mean Annual Load (lbs.)	Mean Annual Loading Capacity (lbs.)	% Reduction Goal [B]	NO3-N Numeric Target Used for Loading Capacity (mg/L)
San Antonio Creek above Barka Slough [C]	0.1	18.7	3,682	1,969	46%	(10)
San Antonio Creek below Barka Slough [D]	6	4.5	53,158	118,129		(10)

[A] USGS average daily flow based on streamflow characteristics dataset (Wolock, 2003) containing data up through November 2001. See Figure 2.5.
[B] Percent reduction goals are for informational purposes only and should not be viewed as the TMDL
[C] Mean annual concentration from CCAMP sites 313SAE and 313SAB.
[D] Mean annual concentration from CCAMP sites 313SAI.

7 LOADING CAPACITY AND ALLOCATIONS

7.1 Introduction

TMDLs are “[t]he sum of the individual waste load allocations for point sources and load allocations for nonpoint sources and natural background. TMDLs can be expressed in terms of either mass per time, toxicity, or other appropriate measure” in accordance with Code of Federal Regulations, Title 40, §130.2[i].

Staff proposes the establishment of concentration-based TMDLs in accordance with this provision of the Clean Water Act.

7.2 Loading Capacity (TMDL)

The TMDLs are set equal to the loading capacity. The loading capacity for San Antonio Creek is the amount of nitrate that can be assimilated without exceeding the water quality objectives. The allowable nitrate water column concentration that will achieve the water quality objectives for the municipal and domestic supply (MUN) beneficial use is equal to the numeric target.

The loading capacity, or Total Maximum Daily Load, for nitrate is a receiving water column concentration-based Total Maximum Daily Load and is applicable to each day of all seasons as indicated in Table 7-1.

Table 7-1. Concentration-based TMDL for nitrate

Impaired Waterbody Assigned TMDL	TMDL Nitrate as Nitrogen in receiving waters
San Antonio Creek (including all tributaries)	10 mg/L

7.3 Linkage Analysis

The goal of the linkage analysis is to establish a link between pollutant loads and desired water quality. This, in turn, ensures that the loading capacity specified in the TMDLs will result in attaining the desired water quality. For these TMDLs, this link is established because the load allocations are equal to the numeric targets, which are the same as the TMDLs. Therefore, reductions in nitrate loading will result in achieving the water quality standards.

7.4 Load Allocations

Table 7-2 shows load allocations assigned to responsible parties. The allocations are equal to the TMDL as receiving water allocations.

Table 7-2. TMDL allocations.

LOAD ALLOCATIONS	
Responsible Party Assigned Allocation (Source)	**Receiving Water Allocation**
Owners/operators of irrigated agricultural lands in the San Antonio Creek Watershed (Discharges from irrigated lands)	10 mg/L Nitrate as Nitrogen
Natural Sources	10 mg/L Nitrate as Nitrogen

7.5 Margin of Safety

This TMDL incorporates an implicit margin of safety. The water column nitrate numeric target is derived from promulgated USEPA MCLs and OEHHA PHGs protocols. Therefore the loading capacity has the same conservative assumptions used in these procedures.

7.6 Critical Conditions, Seasonal Variation

A critical condition is the combination of environmental factors resulting in the water quality standard being achieved by a narrow margin, i.e., that a slight change in one of the environmental factors could result in exceedance of the water quality standard. Such a phenomenon could be significant if the TMDL were expressed in terms of load, and the allowed load was determined on achieving the water quality standard by a narrow margin. However, this TMDL is expressed as a concentration, which is equal to the desired water quality condition. Consequently, there are no critical conditions and the TMDL is applicable during all seasons.

To evaluate seasonal conditions, staff aggregated all nitrate and joint nitrate/nitrite water quality monitoring data by dry season (May-Oct) and wet season (Nov-Apr) then calculated seasonal statistics as shown Figure 7-1 and Table 7-3. Seasonal statistical concentrations are higher during the wet season. Load allocations do not account for seasonal variation since the allocations are based on the water quality objective for nitrate, which is a concentration and applicable during all seasons. However, implementing parties might focus management efforts within the wet season.

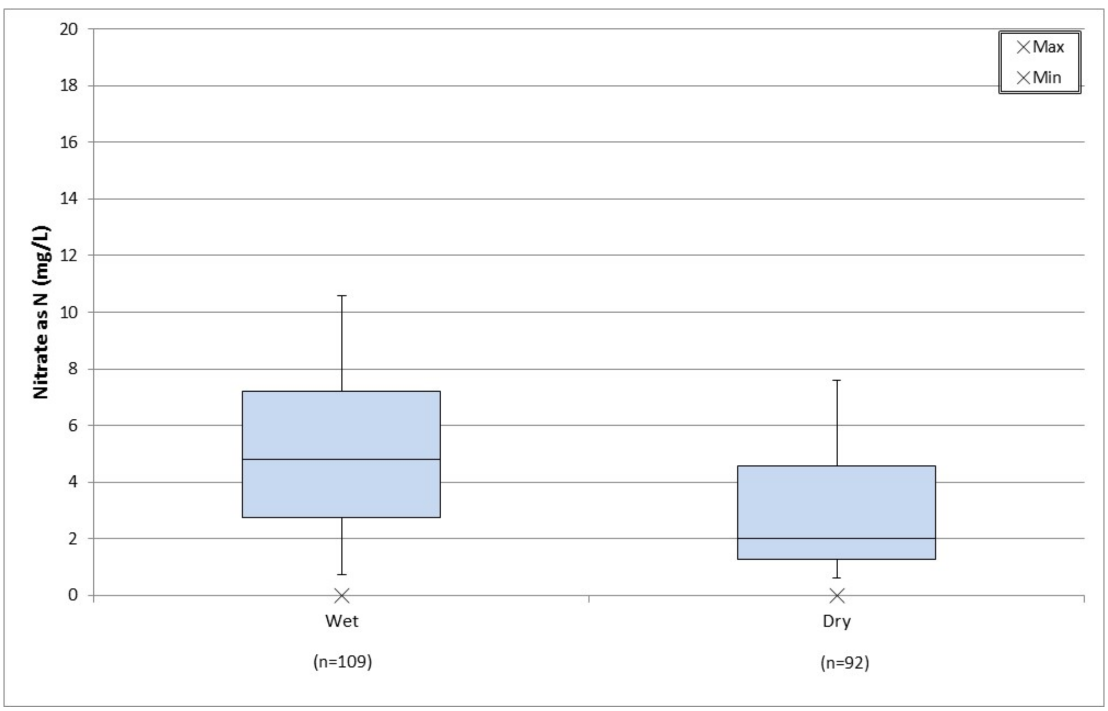


Figure 7-1. Wet season (Nov-Apr) and dry season (May-Oct) plots.
Not shown: Wet and dry maximum values of 53 mg/L and 55 mg/L, respectively.

Table 7-3. Seasonal statistics.

Season	Mean	Max	90th percentile	75th percentile	Median	25th percentile	10th percentile	Min
Wet	6.95	53.00	10.60	7.20	4.79	2.74	0.74	0.004
Dry	4.36	55.00	7.59	4.58	2.01	1.27	0.60	0.01

8 IMPLEMENTATION AND MONITORING

8.1 Introduction

This TMDL is being implemented by the Conditional Waiver of Waste Discharge Requirements for Discharges from Irrigated Lands (Agricultural Order); this includes the order currently in effect and renewals or modifications thereof. Water Board staff will conduct a review of implementation activities when monitoring and reporting data is submitted as required by the Agricultural Order. Water Board staff will pursue modification of Agricultural Order conditions or other regulatory means (e.g. waste discharge requirements), as necessary, to address remaining impairments during the TMDL implementation phase.

Note that the current Agricultural Order requires dischargers to comply with applicable TMDLs. If the Agricultural Order did not provide the necessary requirements to implement this TMDL, staff would propose modifications of the Agricultural Order in order to achieve this TMDL. Staff has concluded that the current Agricultural Order provides the requirements necessary to implement this TMDL. Therefore, no new requirements are proposed as part of this TMDL.

The Agricultural Order states that compliance is determined by: a) management practice implementation and effectiveness, b) treatment or control measures, c) individual discharge monitoring results, d) receiving water monitoring results, and e) related reporting. The Agricultural Order also requires that dischargers comply by implementing and improving management practices and complying with other conditions, including monitoring and reporting requirements, which is consistent with the Nonpoint Source Pollution Control Program (NPS Policy, 2004). Finally, the Agricultural Order states that dischargers shall implement management practices, as necessary, to improve and protect water quality and to achieve compliance with applicable water quality objectives. Therefore, compliance with this TMDL is demonstrated through compliance with the Agricultural Order, which provides several avenues for demonstrating compliance, including management practices that improve water quality that lead to ultimate achievement of water quality objectives.

The Agricultural Order should prioritize implementation and monitoring efforts in stream reaches or areas where:

1) Water quality data and land use data indicate the largest magnitude of nutrient loading and/or impairments;
2) Reductions in nutrient loading, reductions in-stream nutrient concentrations, and/or implementation of improved nutrient management practices that will have the greatest benefit to human health in receiving waters;
3) Crops that are grown that require high fertilizer inputs;
4) Other information such as proximity to water body; soils/runoff potential; irrigation and drainage

practices, or relevant information provided by stakeholders, resource professionals, and/or researchers indicate a higher risk of nitrate impacts to receiving waters.

As stated earlier, staff has identified and eliminated a high nitrate discharge into San Antonio Creek which most likely lead to the nitrate impairment. However, based on information developed for this project report, staff recommends that the following areas should receive higher priority mitigation efforts:

- San Antonio Creek upstream from Barka Slough, including Barka Slough and all unnamed tributaries.

8.2 Implementation Requirements for Dischargers from Irrigated Agricultural Lands

Owners and operators of irrigated agricultural land must comply with the Conditional Waiver of Waste Discharge Requirements for Irrigated Lands (Order R3-2012-0011; the "Agricultural Order") and the Monitoring and Reporting Programs in accordance with Orders R3-2012-0011-01, R3-2012-0011-02, and R3-2012-0011-03, or their renewals or replacements, to meet load allocations and achieve the TMDLs. The requirements in these orders, and their renewals or replacements in the future, will implement the TMDLs and rectify the impairments addressed in the TMDLs.

Current requirements in the Agricultural Order that will achieve the load allocations include:

A. Implement, and update as necessary, management practices to reduce nutrient loading.
B. Maintain existing, naturally occurring riparian vegetative cover in aquatic habitat areas.
C. Develop/update and implement Farm Plans.
D. Properly destroy abandoned groundwater wells.
E. Develop and initiate implementation of an Irrigation and Nutrient Management Plan (INMP) or alternative certified by a Professional Soil Scientist, Professional Agronomist, or Crop Advisor certified by the American Society of Agronomy, or similarly qualified professional.

The current Agricultural Order provides the requirements necessary to implement this TMDL. Therefore, no new requirements are proposed as part of this TMDL.

Central Coast Water Board staff will conduct a review of implementation activities as monitoring and reporting data are submitted as required by the Agricultural Order, or when other monitoring data and/or reporting data are submitted outside the requirements of the Agricultural Order. Central Coast Water Board staff will pursue modification of Agricultural Order conditions, or other regulatory means, if necessary, to address remaining impairments resulting from nitrate during the TMDL implementation phase.

8.2.1 Monitoring and Reporting Requirements

Owners and operators of irrigated agricultural lands must perform monitoring and reporting in accordance with Monitoring and Reporting Program Orders R3-2012-0011-01, R3-2012-0011-02, and R3-2012-0011-03, as applicable to the operation.

Recommended receiving water monitoring sites are:

- San Antonio Creek sites 313SAB, 313SAI, and 313SAC

8.2.2 Determination of Compliance with Load Allocations

Demonstration of compliance with the load allocations is consistent with compliance with the Agricultural Order. Load allocations will be achieved through a combination of implementation of management practices and strategies to reduce nitrogen compound loading and water quality monitoring. Flexibility to allow owners and operators of irrigated lands to demonstrate compliance with load allocations is a consideration; additionally, staff is aware that not all implementing parties are necessarily contributing to or causing surface water impairment.

To allow for flexibility, Water Board staff will assess compliance with load allocations using one or a combination of the following:

A. Attaining the load allocations in the receiving water;
B. Demonstrating quantifiable receiving water mass load reductions;
C. Implementing management practices that are capable of achieving load allocations identified in this TMDL;
D. Providing sufficient evidence to demonstrate that they are and will continue to be in compliance with the load allocations; such evidence could include documentation submitted by the owner/operator to the Executive Officer that the owner/operator is not causing waste to be discharged to impaired waterbodies resulting or contributing to violations of the load allocations.

8.3 Timeline and Milestones

The discharge of nitrate at toxic levels is a serious water quality problem. As such, implementation should occur at an accelerated pace to achieve the allocations and TMDL in the shortest time-frame feasible.

The target date to achieve the allocations, numeric targets, and TMDLs in the impaired waterbody is November 2020. Staff concludes that the TMDL is achievable by this date because the most likely source of nitrate impairment has been identified and eliminated, it provides enough time for other potential irrigated agricultural sources to control their discharges of nitrate, and CCAMP data will be available in 2020 to verify that no other sources are contributing to nitrate impairment.

Water Board staff will reevaluate impairments caused by nitrate when monitoring data is submitted and during renewals of the Agricultural Order. Water Board staff will propose modifications of the Agricultural Order or other regulatory mechanisms, if necessary, to address remaining impairments.

8.4 Cost Estimate

Existing regulatory requirements are sufficient to attain water quality standards for nitrate in the project area. The Regional Board is not approving any new activity, but merely finding that ongoing activities and regulatory requirements are sufficient. Therefore, this TMDL is not a “project” that requires compliance with the California Environmental Quality Act (California Public Resources Code § 21000 et seq.) and the Central Coast Water Board is not directly undertaking an activity, funding an activity or issuing a permit or other entitlement for use by this action (Public Resources Code § 21065; 14 Cal. Code of Regs. §15378).

8.5 Existing Implementation Efforts

Irrigated agricultural operators in the San Antonio Creek watershed are enrolled in the Agricultural Order and, as a result, these growers have met requirements aimed at addressing impaired waters. Staff commends the effort of agricultural operators in the San Antonio Creek watershed who have implemented nutrient and irrigation management practices to reduce nutrient loading to surface water and to groundwaters. In addition, staff is appreciative of the help and support provided by landowners who assisted in identifying and eliminating the high nitrate discharge located above monitoring station 313SAB.

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Appendix A – Water Quality Data

Table A-1. Un-ionized ammonia as nitrogen

SiteTag	SampleDate	Un-ionized ammonia as nitrogen (mg/L)
313SAB	2/12/2001	0.005551359
313SAB	3/6/2001	0.001857136
313SAB	4/3/2001	0.000245498
313SAB	7/10/2001	0.000772786
313SAB	8/8/2001	0.000873049
313SAB	9/6/2001	0.000475078
313SAB	10/3/2001	0.001772897
313SAB	11/7/2001	0.001064982
313SAB	12/10/2001	0.00020468
313SAB	1/7/2002	0.0001
313SAB	2/11/2002	0.000554331
313SAB	3/11/2002	0.000433255
313SAB	3/17/2002	0.00177201
313SAB	1/31/2008	0.000282586
313SAB	2/25/2008	0.0001
313SAB	3/24/2008	0.000588595
313SAB	4/21/2008	0.0001
313SAB	5/21/2008	0.0001
313SAB	6/16/2008	0.0001
313SAC	1/18/2001	0.002993437
313SAC	2/12/2001	0.001239417
313SAC	4/3/2001	0.000350469
313SAC	5/9/2001	0.001467038
313SAC	6/6/2001	0.00072001
313SAC	7/10/2001	0.00064972
313SAC	8/8/2001	0.000117927
313SAC	10/3/2001	0.000183003
313SAC	11/7/2001	0.000411491
313SAC	12/10/2001	0.000479445
313SAC	2/11/2002	0.000674022
313SAC	3/17/2002	0.000352766
313SAC	4/11/2002	0.000667506
313SAC	7/2/2002	8.76034E-05
313SAC	7/30/2002	0.000192899
313SAC	8/26/2002	0.000157773
313SAC	9/23/2002	0.000164079
313SAC	10/21/2002	9.5512E-05
313SAC	11/20/2002	0.000146403
313SAC	12/18/2002	0.000274496
313SAC	2/18/2003	0.000707331
313SAC	3/18/2003	0.000299248
313SAC	1/31/2008	0.000182589
313SAC	2/25/2008	0.0001
313SAC	4/21/2008	0.000740358
313SAC	6/16/2008	0.000206326
313SAC	8/18/2008	0.00042235

Appendix A – Water Quality Data

SiteTag	SampleDate	Un-ionized ammonia as nitrogen (mg/L)
313SAC	9/22/2008	0.000134919
313SAC	10/21/2008	0.000169613
313SAC	11/11/2008	0.000277252
313SAC	12/9/2008	0.000498716
313SAE	3/6/2001	0.000702241
313SAI	1/18/2001	0.170231032
313SAI	2/12/2001	0.001918381
313SAI	3/6/2001	0.004056091
313SAI	4/3/2001	0.078360227
313SAI	5/9/2001	0.564367257
313SAI	6/6/2001	0.320938857
313SAI	7/10/2001	0.325048291
313SAI	8/8/2001	0.247092478
313SAI	9/6/2001	0.019884784
313SAI	10/3/2001	0.015719644
313SAI	11/7/2001	0.008742912
313SAI	12/10/2001	0.085612853
313SAI	1/7/2002	0.012727454
313SAI	2/11/2002	0.012123343
313SAI	3/11/2002	0.004978169
313SAI	3/17/2002	0.004971849
313SAI	3/4/2004	0.06383382
313SAI	3/31/2004	0.014248495
313SAI	5/20/2004	0.01252323
313SAI	6/23/2004	0.009652566
313SAI	8/5/2004	0.004963947
313SAI	8/30/2004	0.007279247
313SAI	10/4/2004	0.002938735
313SAI	11/1/2004	0.00296935
313SAI	12/7/2004	0.001526167
313SAI	1/4/2005	0.008725354
313SAI	2/3/2005	0.044240355
313SAI	3/2/2005	0.02991859
313SAI	3/29/2005	0.042998921
313SAI	4/27/2005	0.178481845
313SAI	5/25/2005	0.12319202
313SAI	6/22/2005	0.021857131
313SAI	7/27/2005	0.035532118
313SAI	8/24/2005	0.010575588
313SAI	9/22/2005	0.004868984
313SAI	10/19/2005	0.004051296
313SAI	11/16/2005	0.003934219
313SAI	12/14/2005	0.006481855
313SAI	1/18/2006	0.021833498
313SAI	2/16/2006	0.00407321
313SAI	3/22/2006	0.002504743
313SAI	4/11/2006	0.037922575

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SiteTag	SampleDate	Un-ionized ammonia as nitrogen (mg/L)
313SAI	5/16/2006	0.036862173
313SAI	6/13/2006	0.001832053
313SAI	7/11/2006	0.001955441
313SAI	8/10/2006	0.001725958
313SAI	9/14/2006	0.001620407
313SAI	10/12/2006	0.001058858
313SAI	11/2/2006	0.00176988
313SAI	12/6/2006	0.002674402
313SAI	1/4/2007	0.001466915
313SAI	2/7/2007	0.001045671
313SAI	3/26/2007	0.001892166
313SAI	4/19/2007	0.001720599
313SAI	5/22/2007	0.001300499
313SAI	6/28/2007	0.001132132
313SAI	7/12/2007	0.001125175
313SAI	8/23/2007	0.000694441
313SAI	9/20/2007	0.000868169
313SAI	10/24/2007	0.000647098
313SAI	11/28/2007	0.000529868
313SAI	1/31/2008	0.011283711
313SAI	2/25/2008	0.014694379
313SAI	3/24/2008	0.002940604
313SAI	4/21/2008	0.002865129
313SAI	5/21/2008	0.003383516
313SAI	6/16/2008	0.002071904
313SAI	7/21/2008	0.001736114
313SAI	8/18/2008	0.002261894
313SAI	9/22/2008	0.001073569
313SAI	10/21/2008	0.000863012
313SAI	11/11/2008	0.000992481
313SAI	12/9/2008	0.000439417
313SAI	1/29/2009	0.001231355
313SAI	2/19/2009	0.001309068
313SAI	3/19/2009	0.000953985
313SAI	4/16/2009	0.001625655
313SAI	5/21/2009	0.001098602
313SAI	6/18/2009	0.002896463
313SAI	7/23/2009	0.003353413
313SAI	8/19/2009	0.005550389
313SAI	9/17/2009	0.001559483
313SAI	10/21/2009	0.000522968
313SAI	11/16/2009	0.00087994
313SAI	12/15/2009	0.000647687
313SAI	1/19/2010	0.00102522
313SAI	2/16/2010	0.004215422
313SAI	3/17/2010	0.000855199
313SAI	4/19/2010	0.001652013

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SiteTag	SampleDate	Un-ionized ammonia as nitrogen (mg/L)
313SAI	5/18/2010	0.003799379
313SAI	6/23/2010	0.006558976
313SAI	7/19/2010	0.004529184
313SAI	8/11/2010	0.002675822
313SAI	9/9/2010	0.002482571
313SAI	10/12/2010	0.001948281
313SAI	11/8/2010	0.001563294
313SAI	12/14/2010	0.001260366
313SAI	1/4/2011	0.021941887
313SAI	2/2/2011	0.053591251
313SAI	3/22/2011	0.005390969
313SAI	4/12/2011	0.293946488

Appendix A – Water Quality Data

Table A-2. Nitrate as nitrogen

SiteTag	SampleDate	Nitrate as nitrogen (mg/L)
313SAB	2/12/2001	3.4831445
313SAB	3/6/2001	1.86067332
313SAB	4/3/2001	5.2134808
313SAB	7/10/2001	2.9662908
313SAB	8/8/2001	2.08539232
313SAB	9/6/2001	4.2921329
313SAB	10/3/2001	4.4719081
313SAB	11/7/2001	3.8
313SAB	12/10/2001	4.85
313SAB	1/7/2002	4.18
313SAB	2/11/2002	17
313SAB	3/11/2002	3.86
313SAB	3/17/2002	3.87
313SAB	1/31/2008	15
313SAB	2/25/2008	22
313SAB	3/24/2008	23
313SAB	4/21/2008	22
313SAB	5/21/2008	19
313SAB	6/16/2008	25
313SAB	1/22/2014	51
313SAB	2/27/2014	40
313SAB	3/26/2014	53
313SAB	4/23/2014	46
313SAB	5/22/2014	55
313SAB	6/25/2014	51
313SAC	1/18/2001	1.123595
313SAC	2/12/2001	0.449438
313SAC	4/3/2001	2.1348305
313SAC	5/9/2001	0.6292132
313SAC	6/6/2001	0.898876
313SAC	7/10/2001	0.4269661
313SAC	8/8/2001	1.2134826
313SAC	10/3/2001	1.22921293
313SAC	11/7/2001	0.78
313SAC	12/10/2001	0.58
313SAC	2/11/2002	0.36
313SAC	3/17/2002	0.49
313SAC	4/11/2002	0.56
313SAC	7/2/2002	1.8

SiteTag	SampleDate	Nitrate as nitrogen (mg/L)
313SAC	7/30/2002	1.5
313SAC	8/26/2002	1.6
313SAC	9/23/2002	1.5
313SAC	10/21/2002	1.86
313SAC	11/20/2002	1.26
313SAC	12/18/2002	0.097
313SAC	2/18/2003	0.24
313SAC	3/18/2003	0.15
313SAC	1/31/2008	5.5
313SAC	2/25/2008	0.44
313SAC	4/21/2008	1.2
313SAC	6/16/2008	1.7
313SAC	8/18/2008	1.9
313SAC	9/22/2008	1.9
313SAC	10/21/2008	1.6
313SAC	11/11/2008	1.3
313SAC	12/9/2008	1.7
313SAC	2/27/2014	0.00425
313SAC	3/26/2014	1.1
313SAC	4/23/2014	0.85
313SAC	5/22/2014	1.3
313SAC	6/25/2014	1.2
313SAE	3/6/2001	2.2921338
313SAI	1/18/2001	2.6741561
313SAI	2/12/2001	5.5730312
313SAI	3/6/2001	3.4606726
313SAI	4/3/2001	2.7415718
313SAI	5/9/2001	1.2808983
313SAI	6/6/2001	2.5168528
313SAI	7/10/2001	2.13033612
313SAI	8/8/2001	2.01797662
313SAI	9/6/2001	7.5280865
313SAI	10/3/2001	8.3595468
313SAI	11/7/2001	9.68
313SAI	12/10/2001	4.77
313SAI	1/7/2002	6.69
313SAI	2/11/2002	7.2
313SAI	3/11/2002	5.95
313SAI	3/17/2002	6.09
313SAI	3/4/2004	5.11

SiteTag	SampleDate	Nitrate as nitrogen (mg/L)
313SAI	3/31/2004	4.79
313SAI	5/20/2004	2.64
313SAI	6/23/2004	2.27
313SAI	8/5/2004	1.79
313SAI	8/30/2004	2.09
313SAI	10/4/2004	4
313SAI	11/1/2004	5.42
313SAI	12/7/2004	7.98
313SAI	1/4/2005	8.33
313SAI	2/3/2005	8.72
313SAI	3/2/2005	6.9
313SAI	3/29/2005	5.3
313SAI	4/27/2005	3.4
313SAI	5/25/2005	3.2
313SAI	6/22/2005	5.3
313SAI	7/27/2005	5.9
313SAI	8/24/2005	4.9
313SAI	9/22/2005	8.7
313SAI	10/19/2005	7.7
313SAI	11/16/2005	9.1
313SAI	12/14/2005	9.7
313SAI	1/18/2006	6.1
313SAI	2/16/2006	7.5
313SAI	3/22/2006	4.8
313SAI	4/11/2006	8.6
313SAI	5/16/2006	4.4
313SAI	6/13/2006	6.5
313SAI	7/11/2006	5.9
313SAI	8/10/2006	7.6
313SAI	9/14/2006	8.6
313SAI	10/12/2006	10
313SAI	11/2/2006	9.7
313SAI	12/6/2006	9.4
313SAI	1/4/2007	8.7
313SAI	2/7/2007	8
313SAI	3/26/2007	4.9
313SAI	4/19/2007	3.4
313SAI	5/22/2007	1.9
313SAI	6/28/2007	1.3
313SAI	7/12/2007	1.3

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SiteTag	SampleDate	Nitrate as nitrogen (mg/L)
313SAI	8/23/2007	2
313SAI	9/20/2007	2.7
313SAI	10/24/2007	4.9
313SAI	11/28/2007	7.2
313SAI	1/31/2008	13
313SAI	2/25/2008	4.7
313SAI	3/24/2008	5.1
313SAI	4/21/2008	4.7
313SAI	5/21/2008	2
313SAI	6/16/2008	1.2
313SAI	7/21/2008	2.1
313SAI	8/18/2008	1.9
313SAI	9/22/2008	4.3
313SAI	10/21/2008	6.3
313SAI	11/11/2008	2.8
313SAI	12/9/2008	6.4
313SAI	1/29/2009	4.1
313SAI	2/19/2009	4.5
313SAI	3/19/2009	3.5
313SAI	4/16/2009	2
313SAI	5/21/2009	1.2
313SAI	6/18/2009	0.026
313SAI	7/23/2009	0.052
313SAI	8/19/2009	3.3
313SAI	9/17/2009	0.74
313SAI	10/21/2009	2.2
313SAI	11/16/2009	4.3
313SAI	12/15/2009	4
313SAI	1/19/2010	3.7
313SAI	2/16/2010	6.7
313SAI	3/17/2010	4.6
313SAI	4/19/2010	3.5
313SAI	5/18/2010	1.7
313SAI	6/23/2010	0.54
313SAI	7/19/2010	0.31
313SAI	8/11/2010	1.2
313SAI	9/9/2010	1.5
313SAI	10/12/2010	1.2
313SAI	11/8/2010	2.6
313SAI	12/14/2010	4.1

Appendix A – Water Quality Data

SiteTag	SampleDate	Nitrate as nitrogen (mg/L)
313SAI	1/4/2011	15
313SAI	2/2/2011	4.8
313SAI	3/22/2011	5
313SAI	4/12/2011	6.4
313SAI	5/9/2011	3.7
313SAI	6/21/2011	2
313SAI	7/12/2011	5.8
313SAI	8/9/2011	5.1
313SAI	9/13/2011	5.8
313SAI	10/12/2011	6.2
313SAI	11/1/2011	8.8
313SAI	12/8/2011	10
313SAI	1/25/2012	6.2
313SAI	2/21/2012	7.7
313SAI	3/27/2012	4.7
313SAI	4/17/2012	5.8
313SAI	5/16/2012	1.5
313SAI	6/28/2012	0.14
313SAI	7/24/2012	3.9
313SAI	8/23/2012	3.1
313SAI	9/25/2012	3.2
313SAI	10/23/2012	5.1
313SAI	11/27/2012	6.6
313SAI	12/17/2012	8.4
313SAI	1/28/2013	4.5
313SAI	2/25/2013	5.4
313SAI	3/19/2013	3.1
313SAI	5/1/2013	0.6
313SAI	5/28/2013	0.39
313SAI	6/19/2013	0.68
313SAI	7/25/2013	1.3
313SAI	8/28/2013	0.72
313SAI	9/25/2013	1.1
313SAI	10/24/2013	3.3
313SAI	11/14/2013	4.7
313SAI	12/19/2013	6.6
313SAI	1/22/2014	4.2
313SAI	2/27/2014	2.7
313SAI	3/26/2014	1.4
313SAI	4/23/2014	0.34

Appendix A – Water Quality Data

SiteTag	SampleDate	Nitrate as nitrogen (mg/L)
313SAI	5/22/2014	0.0125
313SAI	6/25/2014	0.0125

Appendix A – Water Quality Data

Table A-3. Nitrite as nitrogen

Site ID	Sample Date	Nitrite as nitrogen (mg/L)
313SAB	02/12/2001	0.05
313SAB	03/06/2001	0.02
313SAB	04/03/2001	0.07
313SAB	07/10/2001	0.005
313SAB	08/08/2001	0.005
313SAB	09/06/2001	0.005
313SAB	10/03/2001	0.010
313SAB	11/07/2001	0.005
313SAB	12/10/2001	0.02
313SAB	01/07/2002	0.02
313SAB	02/11/2002	0.12
313SAB	03/11/2002	0.05
313SAB	03/17/2002	0.03
313SAB	1/31/2008	0.048
313SAB	2/25/2008	0.065
313SAB	3/24/2008	0.29
313SAB	4/21/2008	0.046
313SAB	5/21/2008	0.044
313SAB	6/16/2008	0.032
313SAB	1/22/2014	0.02
313SAB	2/27/2014	0.037
313SAB	3/26/2014	0.07
313SAB	4/23/2014	0.042
313SAB	5/22/2014	0.1
313SAB	6/25/2014	0.052
313SAC	01/18/2001	0.12
313SAC	02/12/2001	0.02
313SAC	04/03/2001	0.13
313SAC	04/03/2001	0.13
313SAC	05/09/2001	0.005
313SAC	06/06/2001	0.005
313SAC	06/06/2001	0.005
313SAC	07/10/2001	0.02
313SAC	07/10/2001	0.02
313SAC	08/08/2001	0.02
313SAC	08/08/2001	0.02
313SAC	10/03/2001	0.02
313SAC	10/03/2001	0.02
313SAC	11/07/2001	0.05
313SAC	11/07/2001	0.05
313SAC	12/10/2001	0.02
313SAC	12/10/2001	0.02
313SAC	02/11/2002	0.005
313SAC	02/11/2002	0.005

Site ID	Sample Date	Nitrite as nitrogen (mg/L)
313SAC	03/17/2002	0.005
313SAC	04/11/2002	0.005
313SAC	07/02/2002	0.050
313SAC	07/30/2002	0.050
313SAC	08/26/2002	0.050
313SAC	09/23/2002	0.050
313SAC	10/21/2002	0.020
313SAC	11/20/2002	0.005
313SAC	12/18/2002	0.005
313SAC	02/18/2003	0.005
313SAC	03/18/2003	0.005
313SAC	1/31/2008	0.12
313SAC	2/25/2008	0.01
313SAC	4/21/2008	0.01
313SAC	6/16/2008	0.015
313SAC	8/18/2008	0.01
313SAC	9/22/2008	0.01
313SAC	10/21/2008	0.017
313SAC	11/11/2008	0.013
313SAC	12/9/2008	0.018
313SAC	2/27/2014	0.018
313SAC	3/26/2014	0.014
313SAC	4/23/2014	0.012
313SAC	5/22/2014	0.015
313SAC	6/25/2014	0.01
313SAE	03/06/2001	0.03
313SAI	01/18/2001	0.54
313SAI	02/12/2001	0.25
313SAI	03/06/2001	0.04
313SAI	04/03/2001	1.32
313SAI	05/09/2001	1.83
313SAI	06/06/2001	1.11
313SAI	07/10/2001	1.02
313SAI	08/08/2001	1.20
313SAI	09/06/2001	0.72
313SAI	10/03/2001	0.45
313SAI	11/07/2001	0.23
313SAI	12/10/2001	0.84
313SAI	01/07/2002	0.56
313SAI	02/11/2002	0.52
313SAI	03/11/2002	0.47
313SAI	03/17/2002	0.41
313SAI	03/04/2004	0.50
313SAI	03/31/2004	0.51

Appendix A – Water Quality Data

Site ID	Sample Date	Nitrite as nitrogen (mg/L)
313SAI	05/20/2004	0.14
313SAI	06/23/2004	0.18
313SAI	08/05/2004	0.14
313SAI	08/30/2004	0.13
313SAI	10/04/2004	0.11
313SAI	11/01/2004	0.22
313SAI	01/04/2005	0.08
313SAI	02/03/2005	2.00
313SAI	03/02/2005	0.19
313SAI	03/29/2005	0.47
313SAI	04/27/2005	0.96
313SAI	05/25/2005	1.90
313SAI	06/22/2005	1.00
313SAI	07/27/2005	0.57
313SAI	08/24/2005	0.27
313SAI	09/22/2005	0.23
313SAI	10/19/2005	0.32
313SAI	11/16/2005	0.25
313SAI	12/14/2005	0.25
313SAI	01/18/2006	0.50
313SAI	02/16/2006	0.29
313SAI	03/22/2006	0.27
313SAI	04/11/2006	0.41
313SAI	05/16/2006	1.40
313SAI	06/13/2006	0.65
313SAI	07/11/2006	0.33
313SAI	08/10/2006	0.17
313SAI	09/14/2006	0.14
313SAI	10/12/2006	0.12
313SAI	11/02/2006	0.10
313SAI	12/06/2006	0.19
313SAI	1/4/2007	0.083
313SAI	2/7/2007	0.058
313SAI	3/26/2007	0.084
313SAI	4/19/2007	0.049
313SAI	5/22/2007	0.036
313SAI	6/28/2007	0.03
313SAI	7/12/2007	0.044
313SAI	8/23/2007	0.022
313SAI	9/20/2007	0.035
313SAI	10/24/2007	0.024
313SAI	11/28/2007	0.037
313SAI	1/31/2008	0.11
313SAI	2/25/2008	0.82

Appendix A – Water Quality Data

Site ID	Sample Date	Nitrite as nitrogen (mg/L)
313SAI	3/24/2008	0.26
313SAI	4/21/2008	0.29
313SAI	5/21/2008	0.093
313SAI	6/16/2008	0.062
313SAI	7/21/2008	0.06
313SAI	8/18/2008	0.036
313SAI	9/22/2008	0.04
313SAI	10/21/2008	0.07
313SAI	11/11/2008	0.1
313SAI	12/9/2008	0.054
313SAI	1/29/2009	0.056
313SAI	2/19/2009	0.064
313SAI	3/19/2009	0.043
313SAI	4/16/2009	0.028
313SAI	5/21/2009	0.018
313SAI	6/18/2009	0.017
313SAI	7/23/2009	0.017
313SAI	8/19/2009	0.4
313SAI	9/17/2009	0.032
313SAI	10/21/2009	0.049
313SAI	11/16/2009	0.06
313SAI	12/15/2009	0.076
313SAI	1/19/2010	0.085
313SAI	2/16/2010	0.24
313SAI	3/17/2010	0.054
313SAI	4/19/2010	0.073
313SAI	5/18/2010	0.059
313SAI	6/23/2010	0.017
313SAI	7/19/2010	0.026
313SAI	8/11/2010	0.035
313SAI	9/9/2010	0.067
313SAI	10/12/2010	0.041
313SAI	11/8/2010	0.04
313SAI	12/14/2010	0.063
313SAI	1/4/2011	0.1
313SAI	2/2/2011	1.1
313SAI	3/22/2011	0.055
313SAI	4/12/2011	1.2
313SAI	5/9/2011	1.6
313SAI	6/21/2011	0.56

Appendix A – Water Quality Data

Site ID	Sample Date	Nitrite as nitrogen (mg/L)
313SAI	7/12/2011	0.91
313SAI	8/9/2011	0.64
313SAI	9/13/2011	0.35
313SAI	10/12/2011	0.48
313SAI	11/1/2011	0.44
313SAI	12/8/2011	0.28
313SAI	1/25/2012	0.31
313SAI	2/21/2012	0.1
313SAI	3/27/2012	0.07
313SAI	4/17/2012	0.72
313SAI	5/16/2012	0.13
313SAI	6/28/2012	0.01
313SAI	7/24/2012	0.11
313SAI	8/23/2012	0.087
313SAI	9/25/2012	0.00
313SAI	10/23/2012	0.02
313SAI	11/27/2012	0.00
313SAI	12/17/2012	0.10
313SAI	1/28/2013	0.066
313SAI	2/25/2013	0.048
313SAI	3/19/2013	0.055
313SAI	5/1/2013	0.019
313SAI	5/28/2013	0.018
313SAI	6/19/2013	0.026
313SAI	7/25/2013	0.015
313SAI	8/28/2013	0.021
313SAI	9/25/2013	0.018
313SAI	10/24/2013	0.041
313SAI	11/14/2013	0.037
313SAI	12/19/2013	0.077
313SAI	1/22/2014	0.047
313SAI	2/27/2014	0.03
313SAI	3/26/2014	0.02
313SAI	4/23/2014	0.01
313SAI	5/22/2014	0.014
313SAI	6/25/2014	0.0048

Table A-4. Joint nitrate/nitrite as nitrogen

Site ID	Sample Date	Joint nitrate/nitrite as nitrogen (mg/L)
313SAB	2/12/2001	3.5341445
313SAB	3/6/2001	1.88047332
313SAB	4/3/2001	5.2794808
313SAB	7/10/2001	2.9761908
313SAB	8/8/2001	2.09529232
313SAB	9/6/2001	4.3020329
313SAB	10/3/2001	4.4914081
313SAB	11/7/2001	3.81
313SAB	12/10/2001	4.87
313SAB	1/7/2002	4.2
313SAB	2/11/2002	17.12
313SAB	3/11/2002	3.905
313SAB	3/17/2002	3.898
313SAB	1/31/2008	15.048
313SAB	2/25/2008	22.065
313SAB	3/24/2008	23.29
313SAB	4/21/2008	22.046
313SAB	5/21/2008	19.044
313SAB	6/16/2008	25.032
313SAB	1/22/2014	51.02
313SAB	2/27/2014	40.037
313SAB	3/26/2014	53.07
313SAB	4/23/2014	46.042
313SAB	5/22/2014	55.100
313SAB	6/25/2014	51.052
313SAC	1/18/2001	1.243595
313SAC	2/12/2001	0.469238
313SAC	4/3/2001	2.2638305
313SAC	5/9/2001	0.6391132
313SAC	6/6/2001	0.912076
313SAC	7/10/2001	0.4467661
313SAC	8/8/2001	1.2332826
313SAC	10/3/2001	1.24901293
313SAC	11/7/2001	0.83
313SAC	12/10/2001	0.6
313SAC	2/11/2002	0.37
313SAC	3/17/2002	0.5
313SAC	4/11/2002	0.573
313SAC	7/2/2002	1.9
313SAC	7/30/2002	1.6
313SAC	8/26/2002	1.7
313SAC	9/23/2002	1.6
313SAC	10/21/2002	1.88
313SAC	11/20/2002	1.273
313SAC	12/18/2002	0.107
313SAC	2/18/2003	0.25

Site ID	Sample Date	Joint nitrate/nitrite as nitrogen (mg/L)
313SAC	3/18/2003	0.16
313SAC	1/31/2008	5.62
313SAC	2/25/2008	0.45
313SAC	4/21/2008	1.21
313SAC	6/16/2008	1.715
313SAC	8/18/2008	1.91
313SAC	9/22/2008	1.91
313SAC	10/21/2008	1.617
313SAC	11/11/2008	1.313
313SAC	12/9/2008	1.718
313SAC	2/27/2014	0.11
313SAC	3/26/2014	1.114
313SAE	3/6/2001	2.3197338
313SAI	1/18/2001	3.2141561
313SAI	2/12/2001	5.8190312
313SAI	3/6/2001	3.4966726
313SAI	4/3/2001	4.0615718
313SAI	5/9/2001	3.1108983
313SAI	6/6/2001	3.6268528
313SAI	7/10/2001	3.15033612
313SAI	8/8/2001	3.21797662
313SAI	9/6/2001	8.2480865
313SAI	10/3/2001	8.8095468
313SAI	11/7/2001	9.91
313SAI	12/10/2001	5.61
313SAI	1/7/2002	7.25
313SAI	2/11/2002	7.72
313SAI	3/11/2002	6.42
313SAI	3/17/2002	6.5
313SAI	3/4/2004	5.61
313SAI	3/31/2004	5.3
313SAI	5/20/2004	2.78
313SAI	6/23/2004	2.45
313SAI	8/5/2004	1.93
313SAI	8/30/2004	2.22
313SAI	10/4/2004	4.11
313SAI	11/1/2004	5.64
313SAI	1/4/2005	8.413
313SAI	2/3/2005	10.72
313SAI	3/2/2005	7.09
313SAI	3/29/2005	5.77
313SAI	4/27/2005	4.36
313SAI	5/25/2005	5.1
313SAI	6/22/2005	6.3
313SAI	7/27/2005	6.47
313SAI	8/24/2005	5.17
313SAI	9/22/2005	8.93

Site ID	Sample Date	Joint nitrate/nitrite as nitrogen (mg/L)
313SAI	10/19/2005	8.02
313SAI	11/16/2005	9.35
313SAI	12/14/2005	9.95
313SAI	1/18/2006	6.6
313SAI	2/16/2006	7.79
313SAI	3/22/2006	5.08
313SAI	4/11/2006	9.01
313SAI	5/16/2006	5.8
313SAI	6/13/2006	7.15
313SAI	7/11/2006	6.22
313SAI	8/10/2006	7.77
313SAI	9/14/2006	8.74
313SAI	10/12/2006	10.12
313SAI	11/2/2006	9.8
313SAI	12/6/2006	9.59
313SAI	1/4/2007	8.783
313SAI	2/7/2007	8.058
313SAI	3/26/2007	4.984
313SAI	4/19/2007	3.449
313SAI	5/22/2007	1.936
313SAI	6/28/2007	1.33
313SAI	7/12/2007	1.344
313SAI	8/23/2007	2.022
313SAI	9/20/2007	2.735
313SAI	10/24/2007	4.924
313SAI	11/28/2007	7.237
313SAI	1/31/2008	13.11
313SAI	2/25/2008	5.52
313SAI	3/24/2008	5.36
313SAI	4/21/2008	4.99
313SAI	5/21/2008	2.093
313SAI	6/16/2008	1.262
313SAI	7/21/2008	2.16
313SAI	8/18/2008	1.936
313SAI	9/22/2008	4.34
313SAI	10/21/2008	6.37
313SAI	11/11/2008	2.9
313SAI	12/9/2008	6.454
313SAI	1/29/2009	4.156
313SAI	2/19/2009	4.564
313SAI	3/19/2009	3.543
313SAI	4/16/2009	2.028
313SAI	5/21/2009	1.218
313SAI	6/18/2009	0.11
313SAI	7/23/2009	0.11
313SAI	8/19/2009	3.7
313SAI	9/17/2009	0.772

Site ID	Sample Date	Joint nitrate/nitrite as nitrogen (mg/L)
313SAI	10/21/2009	2.249
313SAI	11/16/2009	4.36
313SAI	12/15/2009	4.076
313SAI	1/19/2010	3.785
313SAI	2/16/2010	6.94
313SAI	3/17/2010	4.654
313SAI	4/19/2010	3.573
313SAI	5/18/2010	1.759
313SAI	6/23/2010	0.557
313SAI	7/19/2010	0.336
313SAI	8/11/2010	1.235
313SAI	9/9/2010	1.567
313SAI	10/12/2010	1.241
313SAI	11/8/2010	2.64
313SAI	12/14/2010	4.163
313SAI	1/4/2011	15.1
313SAI	2/2/2011	5.9
313SAI	3/22/2011	5.055
313SAI	4/12/2011	7.6
313SAI	5/9/2011	5.3
313SAI	6/21/2011	2.56
313SAI	7/12/2011	6.71
313SAI	8/9/2011	5.74
313SAI	9/13/2011	6.15
313SAI	10/12/2011	6.68
313SAI	11/1/2011	9.24
313SAI	12/8/2011	10.28
313SAI	1/25/2012	6.51
313SAI	2/21/2012	7.8
313SAI	3/27/2012	4.77
313SAI	4/17/2012	6.52
313SAI	5/16/2012	1.63
313SAI	6/28/2012	0.15
313SAI	7/24/2012	4.01
313SAI	8/23/2012	3.187
313SAI	9/25/2012	3.296
313SAI	10/23/2012	5.148
313SAI	11/27/2012	6.626
313SAI	12/17/2012	8.59
313SAI	1/28/2013	4.566
313SAI	2/25/2013	5.448
313SAI	3/19/2013	3.145
313SAI	5/1/2013	0.619
313SAI	5/28/2013	0.408
313SAI	6/19/2013	0.706
313SAI	7/25/2013	1.315
313SAI	8/28/2013	0.741

Site ID	Sample Date	Joint nitrate/nitrite as nitrogen (mg/L)
313SAI	9/25/2013	1.118
313SAI	10/24/2013	3.341
313SAI	11/14/2013	4.737
313SAI	12/19/2013	6.677
313SAI	1/22/2014	4.247
313SAI	2/27/2014	2.65
313SAI	3/26/2014	1.34

Table A-5. Dissolved oxygen (mg/L)

Site ID	Sample Date	Dissolved Oxygen (mg/L)
313SAB	2/12/2001	11.1
313SAB	3/6/2001	10.75
313SAB	4/3/2001	13.24
313SAB	7/10/2001	10.31
313SAB	7/18/2001	8.53
313SAB	8/8/2001	8.72
313SAB	9/6/2001	10.65
313SAB	10/3/2001	8.82
313SAB	11/7/2001	10
313SAB	12/10/2001	10.56
313SAB	1/7/2002	12.49
313SAB	2/11/2002	13.06
313SAB	3/11/2002	12.2
313SAB	3/17/2002	9.37
313SAB	1/31/2008	12.12
313SAB	2/25/2008	11.53
313SAB	3/24/2008	12.87
313SAB	4/21/2008	12.82
313SAB	5/21/2008	10.49
313SAB	6/16/2008	8.79
313SAB	1/22/2014	11.56
313SAB	2/27/2014	8.63
313SAB	3/26/2014	10.75
313SAB	4/23/2014	10.74
313SAB	5/22/2014	9.21
313SAB	6/25/2014	9.08
313SAC	1/18/2001	8.57
313SAC	2/12/2001	9.59
313SAC	4/3/2001	9.43
313SAC	5/9/2001	7.65
313SAC	6/6/2001	5.75
313SAC	7/10/2001	7.46
313SAC	8/8/2001	5.98
313SAC	10/3/2001	4.98
313SAC	11/7/2001	5.55
313SAC	12/10/2001	9.79
313SAC	2/11/2002	7.9
313SAC	3/17/2002	7.53
313SAC	4/11/2002	6.78
313SAC	7/2/2002	6.1
313SAC	7/30/2002	5.05
313SAC	8/26/2002	4.28
313SAC	9/23/2002	4.43
313SAC	10/21/2002	4

Site ID	Sample Date	Dissolved Oxygen (mg/L)
313SAC	11/20/2002	3.94
313SAC	12/18/2002	7.81
313SAC	2/18/2003	7.97
313SAC	3/18/2003	7.6
313SAC	1/31/2008	9.37
313SAC	2/25/2008	8.81
313SAC	4/21/2008	8.07
313SAC	6/16/2008	5.57
313SAC	8/18/2008	4.87
313SAC	9/22/2008	5.09
313SAC	10/21/2008	5.77
313SAC	11/11/2008	4.7
313SAC	12/9/2008	5.31
313SAC	2/27/2014	3.03
313SAC	3/26/2014	2.56
313SAC	4/23/2014	3.14
313SAC	5/22/2014	3.09
313SAC	6/25/2014	3.95
313SAE	3/6/2001	10.42
313SAI	1/18/2001	7.51
313SAI	2/12/2001	9.75
313SAI	3/6/2001	10.27
313SAI	4/3/2001	10.49
313SAI	5/9/2001	9.47
313SAI	6/6/2001	13.99
313SAI	7/10/2001	11.79
313SAI	7/18/2001	6.47
313SAI	8/8/2001	7.77
313SAI	9/6/2001	11.67
313SAI	10/3/2001	6.96
313SAI	11/7/2001	8.41
313SAI	12/10/2001	11.88
313SAI	1/7/2002	11.53
313SAI	2/11/2002	12.56
313SAI	3/11/2002	9.7
313SAI	3/17/2002	11.51
313SAI	3/4/2004	8.85
313SAI	3/31/2004	8.02
313SAI	5/20/2004	9.02
313SAI	6/23/2004	6.67
313SAI	8/5/2004	8.09
313SAI	8/30/2004	4.84
313SAI	10/4/2004	7.2
313SAI	11/1/2004	8.52
313SAI	12/7/2004	10.76
313SAI	1/4/2005	11.06

Site ID	Sample Date	Dissolved Oxygen (mg/L)
313SAI	2/3/2005	12.81
313SAI	3/2/2005	10.19
313SAI	3/29/2005	10.24
313SAI	4/27/2005	12.12
313SAI	5/25/2005	10.93
313SAI	6/22/2005	14.58
313SAI	7/27/2005	10.96
313SAI	8/24/2005	6.42
313SAI	9/22/2005	8.92
313SAI	10/19/2005	8
313SAI	11/16/2005	8.78
313SAI	12/14/2005	9.18
313SAI	1/18/2006	10.03
313SAI	2/16/2006	10.08
313SAI	3/22/2006	8.83
313SAI	4/11/2006	9.49
313SAI	5/16/2006	5.63
313SAI	6/13/2006	6.13
313SAI	7/11/2006	5.09
313SAI	9/14/2006	5.73
313SAI	10/12/2006	6.56
313SAI	11/2/2006	7.15
313SAI	12/6/2006	8.08
313SAI	1/4/2007	8.54
313SAI	2/7/2007	9.05
313SAI	3/26/2007	6
313SAI	4/19/2007	8.36
313SAI	5/22/2007	5.72
313SAI	6/28/2007	4.93
313SAI	8/23/2007	4.88
313SAI	9/20/2007	5.14
313SAI	10/24/2007	6.25
313SAI	11/28/2007	8.72
313SAI	1/31/2008	11.7
313SAI	2/25/2008	9.66
313SAI	3/24/2008	6.98
313SAI	4/21/2008	5.32
313SAI	5/21/2008	5.25
313SAI	6/16/2008	4.02
313SAI	7/21/2008	4.14
313SAI	8/18/2008	3.65
313SAI	9/22/2008	4.6
313SAI	10/21/2008	5.48
313SAI	11/11/2008	5.65
313SAI	12/9/2008	6.47
313SAI	1/29/2009	7.38

Site ID	Sample Date	Dissolved Oxygen (mg/L)
313SAI	2/19/2009	9.66
313SAI	3/19/2009	8.59
313SAI	4/16/2009	7.62
313SAI	5/21/2009	4.49
313SAI	6/18/2009	4.8
313SAI	7/23/2009	2.57
313SAI	8/19/2009	6.33
313SAI	9/17/2009	5.1
313SAI	10/21/2009	6.35
313SAI	11/16/2009	10.89
313SAI	12/15/2009	9.11
313SAI	1/19/2010	10.57
313SAI	2/16/2010	10.65
313SAI	3/17/2010	14.07
313SAI	4/19/2010	6.59
313SAI	5/18/2010	7.38
313SAI	6/23/2010	6.05
313SAI	7/19/2010	5.28
313SAI	8/11/2010	7.57
313SAI	9/9/2010	4.81
313SAI	10/12/2010	5.2
313SAI	11/8/2010	7.35
313SAI	12/14/2010	8.51
313SAI	1/4/2011	10.78
313SAI	2/2/2011	11.51
313SAI	3/22/2011	10.83
313SAI	4/12/2011	11.91
313SAI	5/9/2011	9.52
313SAI	6/21/2011	10.14
313SAI	7/12/2011	12.25
313SAI	8/9/2011	10.2
313SAI	9/13/2011	8.39
313SAI	10/12/2011	6.06
313SAI	11/1/2011	6.96
313SAI	12/8/2011	9.72
313SAI	1/25/2012	7.42
313SAI	2/21/2012	9.71
313SAI	3/27/2012	8.67
313SAI	4/17/2012	7.12
313SAI	5/16/2012	8
313SAI	6/28/2012	6.54
313SAI	7/24/2012	6.61
313SAI	8/23/2012	7.41
313SAI	9/25/2012	5.95
313SAI	10/23/2012	6.51
313SAI	11/27/2012	7.44

Site ID	Sample Date	Dissolved Oxygen (mg/L)
313SAI	12/17/2012	7.9
313SAI	1/28/2013	8.9
313SAI	2/25/2013	11.18
313SAI	3/19/2013	9.51
313SAI	5/1/2013	7.1
313SAI	5/28/2013	6.45
313SAI	6/19/2013	5.32
313SAI	7/25/2013	5.12
313SAI	8/28/2013	4.74
313SAI	9/25/2013	5.17
313SAI	10/24/2013	5.93
313SAI	11/14/2013	7.12
313SAI	12/19/2013	8.45
313SAI	1/22/2014	8
313SAI	2/27/2014	8.1
313SAI	3/26/2014	6.64
313SAI	4/23/2014	6.39
313SAI	5/22/2014	4.55
313SAI	6/25/2014	5.52

Table A-6. Dissolved oxygen (% saturation)

Site ID	Sample Date	Dissolved Oxygen (% saturation)
313SAB	2/12/2001	95.90
313SAB	3/6/2001	101.80
313SAB	4/3/2001	117.50
313SAB	7/10/2001	104.83
313SAB	7/18/2001	85.07
313SAB	8/8/2001	88.97
313SAB	9/6/2001	102.95
313SAB	10/3/2001	84.03
313SAB	11/7/2001	93.32
313SAB	12/10/2001	83.46
313SAB	1/7/2002	104.97
313SAB	2/11/2002	106.10
313SAB	3/11/2002	110.00
313SAB	3/17/2002	83.70
313SAB	1/31/2008	97.20
313SAB	2/25/2008	102.90
313SAB	3/24/2008	112.90
313SAB	4/21/2008	107.00
313SAB	5/21/2008	102.50
313SAB	6/16/2008	87.10
313SAB	1/22/2014	96.00
313SAB	2/27/2014	80.50
313SAB	3/26/2014	104.30
313SAB	4/23/2014	99.40
313SAB	5/22/2014	90.00
313SAB	6/25/2014	90.40
313SAC	1/18/2001	75.00
313SAC	2/12/2001	86.80
313SAC	4/3/2001	93.50
313SAC	5/9/2001	84.80
313SAC	6/6/2001	60.12
313SAC	7/10/2001	76.48
313SAC	8/8/2001	62.70
313SAC	10/3/2001	50.12
313SAC	11/7/2001	55.26
313SAC	12/10/2001	88.28
313SAC	2/11/2002	74.80
313SAC	3/17/2002	70.70
313SAC	4/11/2002	70.50
313SAC	7/2/2002	63.00
313SAC	7/30/2002	52.20
313SAC	8/26/2002	43.10
313SAC	9/23/2002	45.20
313SAC	10/21/2002	39.60

Site ID	Sample Date	Dissolved Oxygen (% saturation)
313SAC	11/20/2002	38.40
313SAC	12/18/2002	72.10
313SAC	2/18/2003	77.40
313SAC	3/18/2003	74.40
313SAC	1/31/2008	79.40
313SAC	2/25/2008	81.00
313SAC	4/21/2008	76.70
313SAC	6/16/2008	55.40
313SAC	8/18/2008	49.50
313SAC	9/22/2008	51.80
313SAC	10/21/2008	57.00
313SAC	11/11/2008	45.10
313SAC	12/9/2008	50.40
313SAC	2/27/2014	30.10
313SAC	3/26/2014	25.70
313SAC	4/23/2014	31.20
313SAC	5/22/2014	30.80
313SAC	6/25/2014	40.00
313SAE	3/6/2001	100.50
313SAI	1/18/2001	74.80
313SAI	2/12/2001	91.60
313SAI	3/6/2001	100.00
313SAI	4/3/2001	115.80
313SAI	5/9/2001	122.60
313SAI	6/6/2001	179.33
313SAI	7/10/2001	148.10
313SAI	7/18/2001	66.60
313SAI	8/8/2001	95.73
313SAI	9/6/2001	135.32
313SAI	10/3/2001	77.80
313SAI	11/7/2001	86.88
313SAI	12/10/2001	105.87
313SAI	1/7/2002	108.66
313SAI	2/11/2002	115.50
313SAI	3/11/2002	98.00
313SAI	3/17/2002	106.50
313SAI	3/4/2004	86.50
313SAI	3/31/2004	84.00
313SAI	5/20/2004	94.90
313SAI	6/23/2004	74.00
313SAI	8/5/2004	91.90
313SAI	8/30/2004	53.40
313SAI	10/4/2004	72.90
313SAI	11/1/2004	78.30
313SAI	12/7/2004	90.20
313SAI	1/4/2005	97.90

Site ID	Sample Date	Dissolved Oxygen (% saturation)
313SAI	2/3/2005	113.20
313SAI	3/2/2005	99.00
313SAI	3/29/2005	99.70
313SAI	4/27/2005	126.80
313SAI	5/25/2005	115.50
313SAI	6/22/2005	164.60
313SAI	7/27/2005	133.50
313SAI	8/24/2005	69.70
313SAI	9/22/2005	91.70
313SAI	10/19/2005	78.70
313SAI	11/16/2005	81.30
313SAI	12/14/2005	78.90
313SAI	1/18/2006	87.90
313SAI	2/16/2006	86.60
313SAI	3/22/2006	81.40
313SAI	4/11/2006	91.60
313SAI	5/16/2006	58.70
313SAI	6/13/2006	63.00
313SAI	7/11/2006	54.90
313SAI	9/14/2006	59.90
313SAI	10/12/2006	64.70
313SAI	11/2/2006	67.70
313SAI	12/6/2006	64.60
313SAI	1/4/2007	72.50
313SAI	2/7/2007	80.60
313SAI	3/26/2007	60.10
313SAI	4/19/2007	79.70
313SAI	5/22/2007	56.00
313SAI	6/28/2007	50.10
313SAI	8/23/2007	51.00
313SAI	9/20/2007	51.90
313SAI	10/24/2007	59.70
313SAI	11/28/2007	73.80
313SAI	1/31/2008	98.90
313SAI	2/25/2008	86.20
313SAI	3/24/2008	66.00
313SAI	4/21/2008	49.60
313SAI	5/21/2008	55.10
313SAI	6/16/2008	42.90
313SAI	7/21/2008	43.10
313SAI	8/18/2008	39.40
313SAI	9/22/2008	47.00
313SAI	10/21/2008	52.10
313SAI	11/11/2008	51.40
313SAI	12/9/2008	57.40
313SAI	1/29/2009	63.80

Site ID	Sample Date	Dissolved Oxygen (% saturation)
313SAI	2/19/2009	88.30
313SAI	3/19/2009	85.60
313SAI	4/16/2009	71.10
313SAI	5/21/2009	46.80
313SAI	6/18/2009	52.00
313SAI	7/23/2009	27.50
313SAI	8/19/2009	65.00
313SAI	9/17/2009	52.20
313SAI	10/21/2009	62.90
313SAI	11/16/2009	93.90
313SAI	12/15/2009	78.80
313SAI	1/19/2010	96.60
313SAI	2/16/2010	101.70
313SAI	3/17/2010	141.10
313SAI	4/19/2010	69.20
313SAI	5/18/2010	75.30
313SAI	6/23/2010	63.80
313SAI	7/19/2010	55.70
313SAI	8/11/2010	81.10
313SAI	9/9/2010	51.10
313SAI	10/12/2010	52.90
313SAI	11/8/2010	71.40
313SAI	12/14/2010	79.20
313SAI	1/4/2011	97.00
313SAI	2/2/2011	106.40
313SAI	3/22/2011	99.80
313SAI	4/12/2011	130.80
313SAI	5/9/2011	107.90
313SAI	6/21/2011	112.50
313SAI	7/12/2011	138.90
313SAI	8/9/2011	124.80
313SAI	9/13/2011	96.00
313SAI	10/12/2011	71.10
313SAI	11/1/2011	72.50
313SAI	12/8/2011	81.10
313SAI	1/25/2012	68.70
313SAI	2/21/2012	92.00
313SAI	3/27/2012	87.00
313SAI	4/17/2012	74.80
313SAI	5/16/2012	81.80
313SAI	6/28/2012	72.80
313SAI	7/24/2012	74.20
313SAI	8/23/2012	80.80
313SAI	9/25/2012	63.20
313SAI	10/23/2012	63.60
313SAI	11/27/2012	70.70

Site ID	Sample Date	Dissolved Oxygen (% saturation)
313SAI	12/17/2012	72.30
313SAI	1/28/2013	77.70
313SAI	2/25/2013	100.80
313SAI	3/19/2013	95.00
313SAI	5/1/2013	76.10
313SAI	5/28/2013	69.00
313SAI	6/19/2013	56.90
313SAI	7/25/2013	56.70
313SAI	8/28/2013	51.50
313SAI	9/25/2013	52.90
313SAI	10/24/2013	57.20
313SAI	11/14/2013	65.10
313SAI	12/19/2013	74.00
313SAI	1/22/2014	69.80
313SAI	2/27/2014	81.30
313SAI	3/26/2014	69.00
313SAI	4/23/2014	65.80
313SAI	5/22/2014	46.30
313SAI	6/25/2014	61.00

Table A-7. Chlorophyll *a*

Site ID	Sample Date	Chlorophyll a (µg/L)
313SAB	2/12/2001	13
313SAB	3/6/2001	1
313SAB	4/3/2001	8
313SAB	7/10/2001	1.7
313SAB	8/8/2001	0.8
313SAB	9/6/2001	0.7
313SAB	10/3/2001	1.9
313SAB	11/7/2001	0.7
313SAB	12/10/2001	1.4
313SAB	2/11/2002	1.5
313SAB	3/11/2002	4.3
313SAB	3/17/2002	1.4
313SAB	1/31/2008	23.7
313SAB	2/25/2008	11.5
313SAB	3/24/2008	29.6
313SAB	4/21/2008	6.6
313SAB	5/21/2008	9.7
313SAB	6/16/2008	5.8
313SAB	1/22/2014	3.8
313SAB	2/27/2014	5.52
313SAB	3/26/2014	4.52
313SAB	4/23/2014	2.75
313SAB	5/22/2014	2.99
313SAC	1/18/2001	4
313SAC	2/12/2001	6
313SAC	4/3/2001	1
313SAC	5/9/2001	2
313SAC	6/6/2001	0.6
313SAC	7/10/2001	2.9
313SAC	8/8/2001	0.01
313SAC	10/3/2001	1.1
313SAC	11/7/2001	1.6
313SAC	12/10/2001	3.2
313SAC	2/11/2002	1.3
313SAC	3/17/2002	1.7
313SAC	4/11/2002	1.6
313SAC	7/2/2002	1.2
313SAC	7/30/2002	0.3
313SAC	8/26/2002	0.2
313SAC	9/23/2002	1.4
313SAC	10/21/2002	1.6
313SAC	11/20/2002	2.5
313SAC	12/18/2002	1.8
313SAC	2/18/2003	0.9
313SAC	3/18/2003	18.4

Site ID	Sample Date	Chlorophyll a (µg/L)
313SAC	1/31/2008	14.9
313SAC	2/25/2008	11.4
313SAC	4/21/2008	7.4
313SAC	6/16/2008	2.64
313SAC	8/18/2008	4.77
313SAC	9/22/2008	6.54
313SAC	10/21/2008	33.9
313SAC	11/11/2008	3.2
313SAC	12/9/2008	3.24
313SAC	2/27/2014	1.96
313SAC	3/26/2014	2.75
313SAC	4/23/2014	4.44
313SAC	5/22/2014	2.21
313SAE	3/6/2001	1
313SAI	1/18/2001	4
313SAI	2/12/2001	11
313SAI	3/6/2001	1
313SAI	4/3/2001	18
313SAI	5/9/2001	4
313SAI	6/6/2001	28
313SAI	7/10/2001	5.4
313SAI	8/8/2001	3.1
313SAI	9/6/2001	2.3
313SAI	10/3/2001	1.5
313SAI	11/7/2001	1.1
313SAI	12/10/2001	2.3
313SAI	2/11/2002	3.2
313SAI	3/11/2002	3.1
313SAI	3/17/2002	2.1
313SAI	3/4/2004	2.2
313SAI	3/31/2004	2.1
313SAI	5/20/2004	13
313SAI	6/23/2004	1.8
313SAI	8/5/2004	2.9
313SAI	8/30/2004	2.6
313SAI	10/4/2004	0.6
313SAI	11/1/2004	3.4
313SAI	12/7/2004	1.8
313SAI	1/4/2005	8.5
313SAI	2/3/2005	3
313SAI	3/2/2005	4.5
313SAI	3/29/2005	3.1
313SAI	4/27/2005	2.3
313SAI	5/25/2005	19.4
313SAI	6/22/2005	22.4
313SAI	7/27/2005	7.5

Site ID	Sample Date	Chlorophyll a (µg/L)
313SAI	8/24/2005	0.01
313SAI	9/22/2005	6.5
313SAI	10/19/2005	7.6
313SAI	11/16/2005	5.1
313SAI	12/14/2005	6.9
313SAI	1/18/2006	12.7
313SAI	2/16/2006	13.7
313SAI	3/22/2006	12.9
313SAI	5/16/2006	15.2
313SAI	6/13/2006	18.5
313SAI	7/11/2006	6.9
313SAI	8/10/2006	6.5
313SAI	9/14/2006	6.9
313SAI	10/12/2006	5.4
313SAI	11/2/2006	5.5
313SAI	12/6/2006	5.7
313SAI	1/4/2007	7.5
313SAI	2/7/2007	11.1
313SAI	3/26/2007	10.2
313SAI	4/19/2007	9.5
313SAI	5/22/2007	7.6
313SAI	6/28/2007	26.7
313SAI	7/12/2007	6.9
313SAI	8/23/2007	12.8
313SAI	9/20/2007	10.8
313SAI	10/24/2007	6.8
313SAI	1/31/2008	47
313SAI	2/25/2008	32.4
313SAI	3/24/2008	49.1
313SAI	4/21/2008	59.6
313SAI	5/21/2008	8.5
313SAI	6/16/2008	27.95
313SAI	7/21/2008	8.27
313SAI	8/18/2008	7.96
313SAI	9/22/2008	7.62
313SAI	10/21/2008	4.37
313SAI	11/11/2008	7.08
313SAI	12/9/2008	6.24
313SAI	1/29/2009	10.81
313SAI	2/19/2009	18.8
313SAI	3/19/2009	50.4
313SAI	4/16/2009	12.11
313SAI	5/21/2009	15.6
313SAI	6/18/2009	13.38
313SAI	8/19/2009	4.48
313SAI	9/17/2009	5.99
313SAI	10/21/2009	11.7

Site ID	Sample Date	Chlorophyll a (µg/L)
313SAI	11/16/2009	9.44
313SAI	12/15/2009	7.47
313SAI	1/19/2010	8.33
313SAI	2/16/2010	16.58
313SAI	3/17/2010	54.54
313SAI	4/19/2010	16.38
313SAI	5/18/2010	20.21
313SAI	6/23/2010	21.17
313SAI	7/19/2010	15.51
313SAI	8/11/2010	9.77
313SAI	9/9/2010	12.4
313SAI	10/12/2010	16.2
313SAI	11/8/2010	12.8
313SAI	12/14/2010	11.34
313SAI	1/4/2011	29.96
313SAI	2/2/2011	17.54
313SAI	6/21/2011	12.7
313SAI	7/12/2011	10.16
313SAI	8/9/2011	5.68
313SAI	9/13/2011	3.95
313SAI	10/12/2011	5.36
313SAI	11/1/2011	3.55
313SAI	12/8/2011	2.79
313SAI	1/25/2012	6.34
313SAI	2/21/2012	3.21
313SAI	3/27/2012	3.49
313SAI	4/17/2012	6.11
313SAI	5/16/2012	7.9
313SAI	5/16/2012	10
313SAI	6/28/2012	3.45
313SAI	7/24/2012	2.76
313SAI	8/23/2012	5.26
313SAI	9/25/2012	5.14
313SAI	10/23/2012	3.08
313SAI	11/27/2012	2.57
313SAI	12/17/2012	2.5
313SAI	1/28/2013	4.03
313SAI	2/25/2013	3.09
313SAI	3/19/2013	3.43
313SAI	5/1/2013	2.85
313SAI	5/28/2013	2.69
313SAI	6/19/2013	2.97
313SAI	7/25/2013	3.18
313SAI	8/28/2013	2.72
313SAI	9/25/2013	2.62

Site ID	Sample Date	Chlorophyll a (µg/L)
313SAI	10/24/2013	2.59
313SAI	11/14/2013	2.8
313SAI	12/19/2013	4.86
313SAI	1/22/2014	3.35
313SAI	2/27/2014	4.32
313SAI	3/26/2014	3.03
313SAI	4/23/2014	2.84
313SAI	5/22/2014	3.42

Table A-8. Floating algae

Site ID	Sample Date	Floating Algae (% cover)
313SAB	12/10/2000	0
313SAB	2/12/2001	0
313SAB	4/3/2001	0
313SAB	8/8/2001	15
313SAB	9/6/2001	20
313SAB	10/3/2001	10
313SAB	11/7/2001	0
313SAB	12/10/2001	0
313SAB	1/7/2002	0
313SAB	2/11/2002	0
313SAB	3/11/2002	20
313SAB	1/31/2008	0
313SAB	2/25/2008	0
313SAB	3/24/2008	0
313SAB	4/21/2008	0
313SAB	5/21/2008	10
313SAB	6/16/2008	5
313SAC	6/6/2001	0
313SAC	1/31/2008	0
313SAC	2/25/2008	0
313SAC	4/21/2008	0
313SAC	6/16/2008	0
313SAC	8/18/2008	0
313SAC	9/22/2008	0
313SAC	10/21/2008	0
313SAC	11/11/2008	0
313SAC	12/9/2008	0
313SAI	1/18/2001	1
313SAI	4/3/2001	0
313SAI	5/9/2001	10
313SAI	8/8/2001	2
313SAI	9/6/2001	25
313SAI	3/11/2002	0
313SAI	3/4/2004	0
313SAI	3/31/2004	33
313SAI	8/30/2004	0
313SAI	10/4/2004	5
313SAI	11/1/2004	0
313SAI	12/7/2004	0

Site ID	Sample Date	Floating Algae (% cover)
313SAI	1/4/2005	0
313SAI	2/3/2005	0
313SAI	3/2/2005	0
313SAI	3/29/2005	0
313SAI	4/27/2005	0
313SAI	5/25/2005	30
313SAI	6/22/2005	5
313SAI	7/27/2005	10
313SAI	8/24/2005	0
313SAI	9/22/2005	0
313SAI	10/19/2005	0
313SAI	11/16/2005	0
313SAI	12/14/2005	0
313SAI	1/18/2006	0
313SAI	2/16/2006	0
313SAI	3/22/2006	0
313SAI	4/11/2006	0
313SAI	5/16/2006	0
313SAI	6/13/2006	2
313SAI	7/11/2006	0
313SAI	8/10/2006	0
313SAI	9/14/2006	0
313SAI	10/12/2006	0
313SAI	11/2/2006	0
313SAI	12/6/2006	0
313SAI	1/4/2007	0
313SAI	2/7/2007	0
313SAI	3/26/2007	0
313SAI	4/19/2007	0
313SAI	5/22/2007	0
313SAI	6/28/2007	0
313SAI	7/12/2007	0
313SAI	8/23/2007	0
313SAI	9/20/2007	0
313SAI	10/24/2007	0
313SAI	11/28/2007	0
313SAI	1/31/2008	0
313SAI	2/25/2008	0
313SAI	3/24/2008	0
313SAI	4/21/2008	0

Site ID	Sample Date	Floating Algae (% cover)
313SAI	5/21/2008	0
313SAI	6/16/2008	0
313SAI	7/21/2008	0
313SAI	8/18/2008	0
313SAI	9/22/2008	0
313SAI	10/21/2008	0
313SAI	11/11/2008	0
313SAI	12/9/2008	0
313SAI	1/29/2009	0
313SAI	2/19/2009	0
313SAI	3/19/2009	0
313SAI	4/16/2009	0
313SAI	5/21/2009	0
313SAI	6/18/2009	0
313SAI	7/23/2009	0
313SAI	8/19/2009	0
313SAI	9/17/2009	0
313SAI	10/21/2009	0
313SAI	11/16/2009	0
313SAI	12/15/2009	0
313SAI	1/19/2010	0
313SAI	2/16/2010	0
313SAI	3/17/2010	0
313SAI	4/19/2010	0
313SAI	5/18/2010	0
313SAI	7/19/2010	0
313SAI	9/9/2010	0
313SAI	10/12/2010	0
313SAI	11/8/2010	0
313SAI	12/14/2010	0
313SAI	1/4/2011	0
313SAI	2/2/2011	0
313SAI	3/22/2011	0
313SAI	4/12/2011	0
313SAI	5/9/2011	0
313SAI	6/21/2011	0
313SAI	7/12/2011	0
313SAI	8/9/2011	0
313SAI	10/12/2011	0
313SAI	11/1/2011	0

Site ID	Sample Date	Floating Algae (% cover)
313SAI	12/8/2011	0
313SAI	1/25/2012	0
313SAI	2/21/2012	0
313SAI	3/27/2012	0
313SAI	4/17/2012	0
313SAI	5/16/2012	0
313SAI	6/28/2012	0
313SAI	7/24/2012	0
313SAI	8/23/2012	0

STEPL Spreadsheets for San Antonio Creek Watershed

STEPL Input Sheet: Values in RED are required input. Change worksheets by clicking on tabs at the bottom. You entered 1 subwatershed(s).

This sheet is composed of eight input tables. The first four tables require users to change initial values. The next four tables (initially hidden) contain default values users may choose to change.
Step 1: Select the state and county where your watersheds are located. Select a nearby weather station. This will automatically specify values for rainfall parameters in Table 1 and USLE parameters in Table 4.
Step 2: (a) Enter land use areas in acres in Table 1; (b) enter total number of agricultural animals by type and number of months per year that manure is applied to croplands in Table 2;
(c) enter values for septic system parameters in Table 3; and (d) if desired, modify USLE parameters associated with the selected county in Table 4.
Step 3: You may stop here and proceed to the BMPs sheet. If you have more detailed information on your watersheds, click the Yes button in row 10 to display optional input tables.
Step 4: (a) Specify the representative Soil Hydrologic Group (SHG) and soil nutrient concentrations in Table 5; (b) modify the curve number table by landuse and SHG in Table 6;
(c) modify the nutrient concentrations (mg/L) in runoff in Table 7; and (d) specify the detailed land use distribution in the urban area in Table 8.
Step 5: Select BMPs in BMPs sheet. **Step 6**: View the estimates of loads and load reductions in Total Load and Graphs sheets.

Show optional input tables? Yes No ☑ Treat all the subwatersheds as parts of a single watershed ☑ Groundwater load calculation

State	County	Weather Station (for rain correction factors)
California	Santa Barbara	CA SANTA MARIA WSO ARPT

1. Input watershed land use area (ac) and precipitation (in)

Rain correction factors: 0.865 | 0.418

Watershed	Urban	Cropland	Pastureland	Forest	User Defined	Feedlots	Feedlot Percent Paved	Total	Annual Rainfall	Rain Days	Avg. Rain/Event
W1	1245	14845	66093	15468	0	0	0-24%	97651	18.68	42.3	0.914

2. Input agricultural animals

Watershed	Beef Cattle	Dairy Cattle	Swine (Hog)	Sheep	Horse	Chicken	Turkey	Duck	# of months manure applied
W1	953	192	16	156	344	60	5	1	0
Total	953	192	16	156	344	60	5	1	0

from http://mingle.tetratech-ffx.com/steplweb2/steplweb.html

3. Input septic system and illegal direct wastewater discharge data

Watershed	No. of Septic Systems	Population per Septic System	Septic Failure Rate, %	Wastewater Direct Discharge, # of People	Direct Discharge Reduction, %
W1	254	2.43	2	0	0

from http://mingle.tetratech-ffx.com/steplweb2/steplweb.html

4. Modify the Universal Soil Loss Equation (USLE) parameters

Watershed	Cropland					Pastureland					Forest				
	R	K	LS	C	P	R	K	LS	C	P	R	K	LS	C	P
W1	62.886	0.269	9.274	0.200	0.998	62.886	0.269	9.274	0.040	1.000	62.886	0.269	9.274	0.003	1.000

Optional Data Input:

5. Select average soil hydrologic group (SHG), SHG A = highest infiltration and SHG D = lowest infiltration

Watershed	SHG A	SHG B	SHG C	SHG D	SHG Selected	Soil N conc.%	Soil P conc.%	Soil BOD conc.%
W1	○	○	●	○	C	0.080	0.031	0.160

6. Reference runoff curve number (may be modified)

SHG	A	B	C	D
Urban	83	89	92	93
Cropland	67	78	85	89
Pastureland	49	69	79	84
Forest	39	60	73	79
User Defined	50	70	80	85

6a. Detailed urban reference runoff curve number (may be modified)

Urban\SHG	A	B	C	D
Commercial	89	92	94	95
Industrial	81	88	91	93
Institutional	81	88	91	93
Transportatic	98	98	98	98
Multi-Family	77	85	90	92
Single-Famil	57	72	81	86
Urban-Cultiv	67	78	85	89
Vacant-Devel	77	85	90	92
Open Space	49	69	79	84

7. Nutrient concentration in runoff (mg/l)

Land use	N	P	BOD
1. L-Croplan	2.1	0.64	4
1a. w/ manur	0	0	12.3
2. M-Croplan	2.1	0.64	6.1
2a. w/ manur	0	0	18.5
3. H-Croplan	2.1	0.64	9.2
3a. w/ manur	0	0	24.6
4. Pasturelar	0.25	0.27	13
5. Forest	0.2	0.1	0.5
6. User Defin	0	0	0

7a. Nutrient concentration in shallow groundwater (mg/l) (may be modified)

Landuse	N	P	BOD	
Urban	2.7	0.127	0	GWAVA mean N from GIS
Cropland	2.7	0.127	0	
Pastureland	0.14	0.063	0	
Forest	0.11	0.009	0	
Feedlot	6	0.07	0	
User-Defined	0	0	0	

8. Input or modify urban land use distribution

Watershed	Urban Area (ac.)	Commercial %	Industrial %	Institutional %	Transportation %	Multi-Family %	Single-Family %	Urban-Cultivated %	Vacant (developed)	Open Space %	Total % Area
W1	1245	15	10	10	10	10	30	5	5	5	100

9. Input irrigation area (ac) and irrigation amount (in)

Watershed	Total Cropland (ac)	Cropland: Acres Irrigated	Water Depth (in) per Irrigation - Before BMP	Water Depth (in) per Irrigation - After BMP	Irrigation Frequency (#/Year)
W1	14845	0	0	0	0

Input Ends Here.

Appendix B – STEPL Spreadsheets

Total Load This is the summary of annual nutrient and sediment load for each subwatershed. This sheet is initially protected.

1. Total load by subwatershed(s)

Watershed	N Load (no BMP)	P Load (no BMP)	BOD Load (no BMP)	Sediment Load (no BMP)	N Reduction	P Reduction	BOD Reduction	Sediment Reduction	N Load (with BMP)	P Load (with BMP)	BOD (with BMP)	Sediment Load (with BMP)	%N Reduction	%P Reduction	%BOD Reduction	%Sed Reduction
	lb/year	lb/year	lb/year	t/year	lb/year	lb/year	lb/year	t/year	lb/year	lb/year	lb/year	t/year	%	%	%	%
W1	340488.6	132259.1	1539082.7	75417.8	0.0	0.0	0.0	0.0	340488.6	132259.1	1539082.7	75417.8	0.0	0.0	0.0	0.0
Total	340488.6	132259.1	1539082.7	75417.8	0.0	0.0	0.0	0.0	340488.6	132259.1	1539082.7	75417.8	0.0	0.0	0.0	0.0

c. Nutrient and sediment load by land uses with BMP (lb/year)

Watershed	Urban				Cropland				Pastureland				Forest			
	N	P	BOD	Sediment	N	P	BOD	Sediment	N	P	BOD	Sediment	N	P	BOD	Sediment
W1	5024.9	777.7	19652.3	230665.8	171127.6	62603.9	337986.9	78944193.1	130848.7	63286.2	1170166.3	70424559.5	4648.5	2101.7	10632.4	1236129.9
Total	5024.9	777.7	19652.3	230665.8	171127.6	62603.9	337986.9	78944193.1	130848.7	63286.2	1170166.3	70424559.5	4648.5	2101.7	10632.4	1236129.9

d. Load from groundwater by land uses with BMP (lb/year)

Watershed	Urban				Cropland				Pastureland				Forest			
	N	P	BOD	Sediment	N	P	BOD	Sediment	N	P	BOD	Sediment	N	P	BOD	Sediment
W1	673.7	31.7	0.0		21995.8	1034.6	0.0		5077.8	2285.0	0.0		933.7	76.4	0.0	
Total	673.7	31.7	0.0	0.0	21995.8	1034.6	0.0	0.0	5077.8	2285.0	0.0	0.0	933.7	76.4	0.0	0.0

2. Total load by land uses (with BMP)

Sources	N Load (lb/yr)	P Load (lb/yr)	BOD Load (lb/yr)	Sediment Load (t/yr)
Urban	5,024.88	777.69	19,652.31	115.33
Cropland	171,127.58	62,603.88	337,986.89	39,472.10
Pastureland	130,848.67	63,286.16	1,170,166.32	35,212.28
Forest	4,648.50	2,101.75	10,632.35	618.06
Feedlots	0.00	0.00	0.00	0.00
User Defined	0.00	0.00	0.00	0.00
Septic	157.93	61.86	644.87	0.00
Gully	0.00	0.00	0.00	0.00
Streambank	0.00	0.00	0.00	0.00
Groundwater	28,681.03	3,427.73	0.00	0.00
Total	340,488.60	132,259.05	1,539,082.75	75,417.77

LOS ALAMOS, CALIFORNIA (045107)
Period of Record Monthly Climate Summary
Period of Record: 4/27/1894 to 7/31/2008

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max. Temperature (F)	64.3	64.5	68.3	71.1	76.2	77.6	81.4	82.9	82.0	77.8	70.1	65.5	73.5
Average Min. Temperature (F)	37.6	39.4	39.8	40.8	45.8	48.9	52.3	52.8	50.7	44.5	40.7	36.4	44.1
Average Total Precipitation (in.)	3.16	3.19	2.82	1.23	0.34	0.06	0.02	0.04	0.25	0.57	1.36	2.46	15.50
Average Total Snow Fall (in.)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Average Snow Depth (in.)	0	0	0	0	0	0	0	0	0	0	0	0	0

Percent of possible observations for period of record.
Max. Temp.: 11.2% Min. Temp.: 11.2% Precipitation: 96.8% Snowfall: 96.8% Snow Depth: 96.4% .

USGS 11136100 SAN ANTONIO C NR CASMALIA CA

Santa Barbara County, California Hydrologic Unit Code 18060009 Latitude 34°46'56", Longitude 120°31'47" NAD27 Drainage area 135 square miles Gage datum 160.00 feet above NGVD29	**Output formats** HTML table of all data Tab-separated data Reselect output format

Water Year	00060, Discharge, cubic feet per second
1956	5.47
1957	2.34
1958	18.8
1959	2.88
1960	3.11
1961	2.55
1962	15.9
1963	3.58
1964	2.89
1965	2.85
1966	2.67
1967	2.88
1968	1.28
1969	19.8
1970	1.95
1971	1.16
1972	1.07
1973	7.76
1974	3.86
1975	3.16
1976	1.34
1977	1.00
1978	22.7
1979	3.04

Water Year	00060, Discharge, cubic feet per second
1980	9.36
1981	3.68
1982	1.69
1983	39.7
1984	1.39
1985	1.12
1986	2.19
1987	1.00
1988	1.03
1989	0.662
1990	0.467
1991	7.34
1992	6.79
1993	9.54
1995	20.8
1996	3.74
1997	3.22
1998	26.2
1999	2.23
2000	7.55
2001	12.2
2002	1.18
2003	1.31
** No Incomplete data have been used for statistical calculation	

USGS 11136050 SAN ANTONIO C AB BARKA SLOUGH CA

	Output formats
Santa Barbara County, California Hydrologic Unit Code 18060009 Latitude 34°46'02", Longitude 120°25'58" NAD27	HTML table of all data Tab-separated data Reselect output format

Water Year	00060, Discharge, cubic feet per second
1985	0.106

** No Incomplete data have been used for statistical calculation

USGS 11135800 SAN ANTONIO C A LOS ALAMOS CA

Santa Barbara County, California Hydrologic Unit Code 18060009 Latitude 34°44'36", Longitude 120°16'12" NAD27 Drainage area 34.9 square miles	**Output formats** HTML table of all data Tab-separated data Reselect output format

Water Year	00060, Discharge, cubic feet per second
1971	0.033
1972	0.033
1973	0.926
1974	0.270
1975	0.361
1976	0.061
1977	0.001
1978	7.90
1979	0.415
1980	2.16
1981	0.519
1982	0.034
1983	18.9
1984	0.152
1985	0.017
1986	0.152
1987	0.018
1988	0.027
1989	0.004
1990	0.045
1991	2.64
1992	3.15
1998	17.0
1999	0.147

2004	0.000
2006	0.528
2010	0.032
2011	2.31
2012	0.000
2013	0.000
** No Incomplete data have been used for statistical calculation	

Table C-1. USGS mean annual flow (cfs) summary.

Year	11136100 near Casmalia	11135800 near Los Alamos	11136050 above Barka Slough
1956	5.47		
1957	2.34		
1958	18.8		
1959	2.88		
1960	3.11		
1961	2.55		
1962	15.9		
1963	3.58		
1964	2.89		
1965	2.85		
1966	2.67		
1967	2.88		
1968	1.28		
1969	19.8		
1970	1.95		
1971	1.16	0.033	
1972	1.07	0.033	
1973	7.76	0.926	
1974	3.86	0.27	
1975	3.16	0.361	
1976	1.34	0.061	
1977	1	0.001	
1978	22.7	7.9	
1979	3.04	0.415	
1980	9.36	2.16	
1981	3.68	0.519	
1982	1.69	0.034	
1983	39.7	18.9	
1984	1.39	0.152	
1985	1.12	0.017	0.106
1986	2.19	0.152	
1987	1	0.018	
1988	1.03	0.027	
1989	0.662	0.004	
1990	0.467	0.045	
1991	7.34	2.64	
1992	6.79	3.15	
1993	9.54		

Year	11136100 near Casmalia	11135800 near Los Alamos	11136050 above Barka Slough
1995	20.8		
1996	3.74		
1997	3.22		
1998	26.2	17	
1999	2.23	0.147	
2000	7.55		
2001	12.2		
2002	1.18		
2003	1.31		
2004		0.001	
2005			
2006		0.528	
2007			
2008			
2009			
2010		0.032	
2011		2.31	
2012		0.001	
2013		0.001	
2014		0.001	

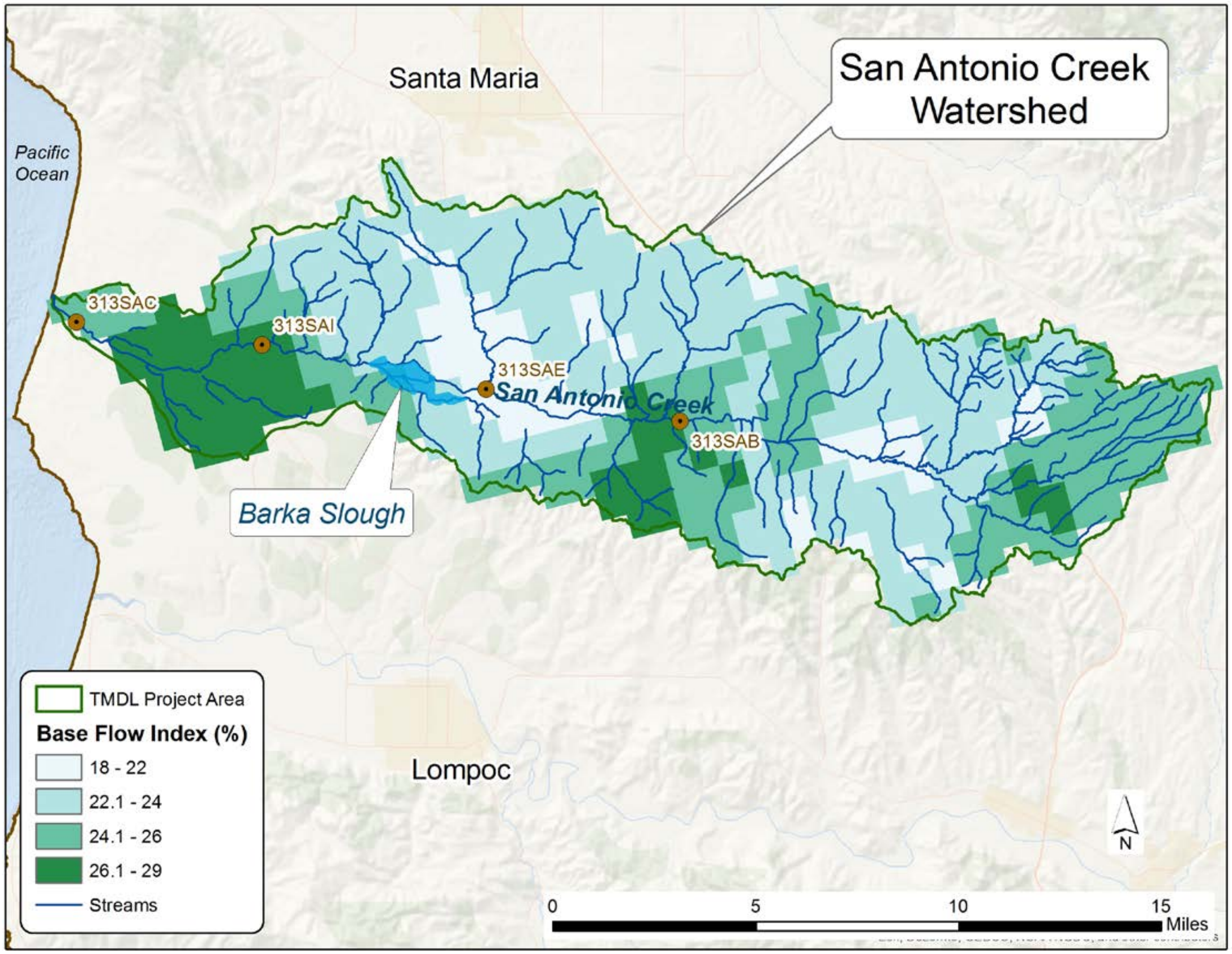

Figure C-1. Base-flow Index (%).

Base flow is the component of streamflow that can be attributed to ground-water discharge into streams. The BFI is the ratio of base flow to total flow, expressed as a percentage.

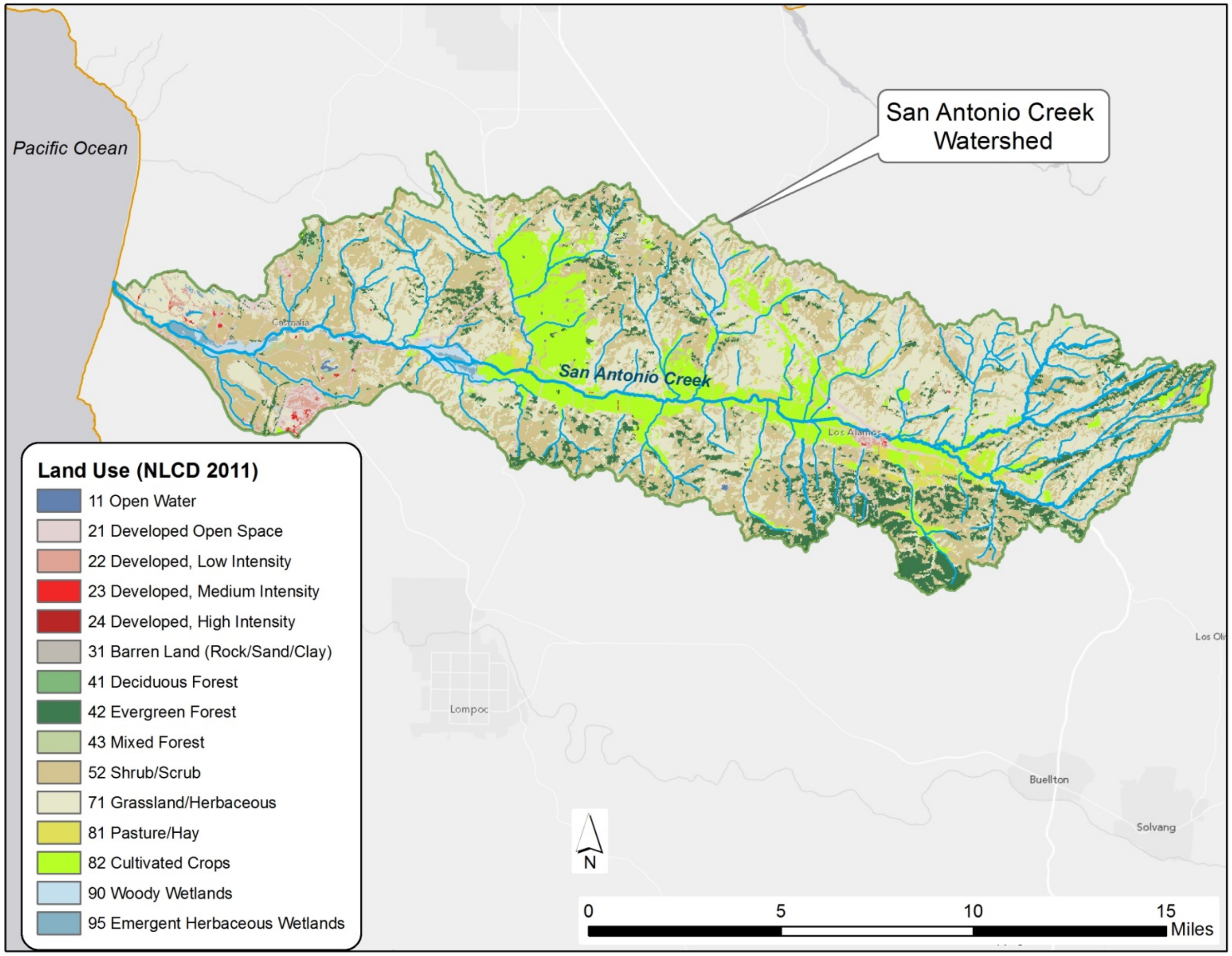

Figure C-2. NLCD land use

Table C- 2. NLCD land use areas

NLCD Code and Name	Area (acres)	Area (sq. miles)	% of Watershed
11 Open Water	97	0.15	0.10
21 Developed Open Space	5,812	9.08	5.95
22 Developed, Low Intensity	766	1.20	0.78
23 Developed, Medium Intensity	106	0.17	0.11
24 Developed, High Intensity	3	0.01	0.00
31 Barren Land (Rock/Sand/Clay)	74	0.12	0.08
41 Deciduous Forest	4	0.01	0.00
42 Evergreen Forest	8,363	13.07	8.56
43 Mixed Forest	3,940	6.16	4.03
52 Shrub/Scrub	29,182	45.60	29.88
71 Grassland/Herbaceous	34,198	53.43	35.02
81 Pasture/Hay	1,601	2.50	1.64
82 Cultivated Crops	11,544	18.04	11.82
90 Woody Wetlands	1,260	1.97	1.29
95 Emergent Herbaceous Wetlands	698	1.09	0.71
Watershed Totals	**97,648**	**153**	**100**

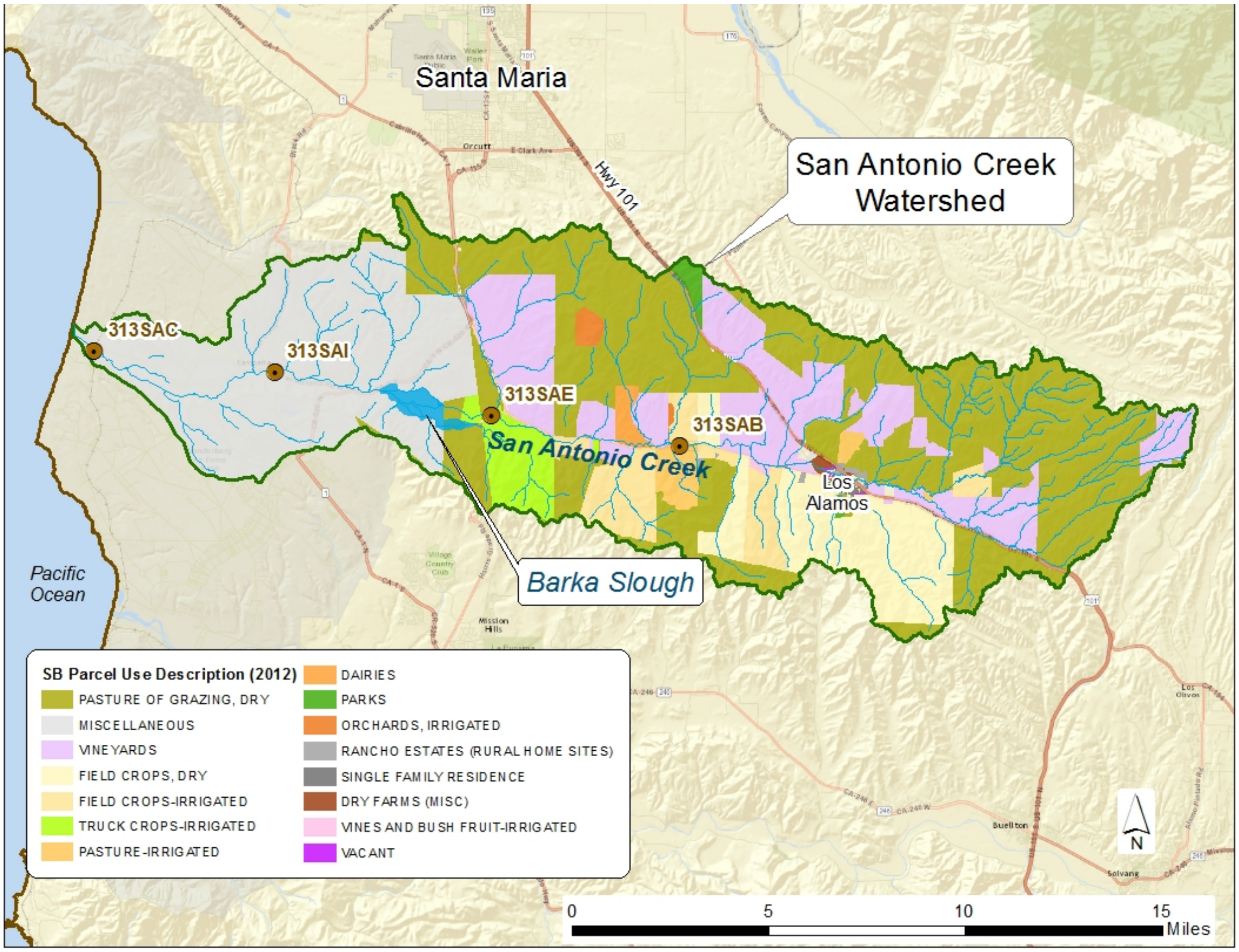

Figure C-3. Santa Barbara County parcel use descriptions (2012)

Table C-3. Santa Barbara County parcel use descriptions (2012)

Parcel Use Description	Parcel Count	Parcel Use Area (acres)	% of Watershed
PASTURE OF GRAZING, DRY	143	37,802	39.05
MISCELLANEOUS (Vandenberg AFB)	17	23,187	23.95
VINEYARDS	51	16,002	16.53
FIELD CROPS, DRY	12	8,489	8.77
FIELD CROPS-IRRIGATED	17	5,081	5.25
TRUCK CROPS-IRRIGATED	3	2,731	2.82
PASTURE-IRRIGATED	4	1,293	1.34
DAIRIES	1	554	0.57
PARKS	4	460	0.47
ORCHARDS, IRRIGATED	2	427	0.44
RANCHO ESTATES (RURAL HOME SITES)	35	225	0.23
SINGLE FAMILY RESIDENCE	407	113	0.12
DRY FARMS (MISC)	4	109	0.11
VINES AND BUSH FRUIT-IRRIGATED	1	77	0.08
VACANT	67	51	0.05
FLOWERS	2	48	0.05
WASTE	4	47	0.05
UTILITY,WATER COMPANY	5	18	0.02
COMMERCIAL (MISC)	31	15	0.02
MOBILE HOME PARKS	3	15	0.02
RIGHTS OF WAY,SEWER,LAND FILLS,ETC	2	13	0.01
SCHOOLS	2	12	0.01
RESIDENTIAL INCOME, 2-4 UNITS	23	9	0.01
WAREHOUSING	4	8	0.01
HOTELS	4	7	0.01
INSTITUTIONAL (MISC)	3	5	0.01
SERVICE STATIONS	5	5	0.00
RETAIL STORES, SINGLE STORY	8	2	0.00
RESTAURANTS,BARS	4	1	0.00
MOBILE HOMES	107	1	0.00
CHURCHES, RECTORY	3	1	0.00
INDUSTRIAL, MISC	3	1	0.00
CONDOS,COMMUNITY APT PROJS	20	1	0.00
APARTMENTS, 5 OR MORE UNITS	2	1	0.00
CLUBS, LODGE HALLS	1	0	0.00
AUTO SALES, REPAIR, STORAGE, CAR WASH, ETC	1	0	0.00
OFFICE BUILDINGS, SINGLE STORY	1	0	0.00
WATER RIGHTS,PUMPS	1	0	0.00
SUM	**1,007**	**96,810**	

SSURGO Soil Evaluation

Pesticide Leaching Potential

The ratings for Pesticide Loss Potential-Leaching are used for evaluating and determining the potential of the soil to transmit pesticides through the profile and the likelihood of the contamination of ground-water supplies. Evaluations consider movement of water through the soil and underlying fractured bedrock. Ratings are for soils in their natural condition and do not consider present land use. The properties that affect the pesticide loss potential include the soil's hydrologic group, depth to water table, saturated hydraulic conductivity at different depths, and the possibility of water movement in fractured bedrock.

The ratings are both verbal and numerical. Rating class terms indicate the extent to which the soils are limited by all of the soil features that affect the specified use. "Not limited" indicates that the soil has features that have low leaching potential. "Somewhat limited" indicates that the soil has features that are moderately rated for leaching potential. Some leaching can be expected. "Very limited" indicates that the soil has one or more features that are unfavorable and leaching potential is high.

Numerical ratings indicate the severity of individual limitations. The ratings are shown as decimal fractions ranging from 0.01 to 1.00. They indicate gradations between the point at which a soil feature has the greatest negative impact on the use (1.00) and the point at which the soil feature is not a limitation (0.00).

The map unit components listed for each map unit in the accompanying Summary by Map Unit table in Web Soil Survey or the Aggregation Report in Soil Data Viewer are determined by the aggregation method chosen. An aggregated rating class is shown for each map unit. The components listed for each map unit are only those that have the same rating class as that listed for the map unit. The percent composition of each component in a particular map unit is given so that the user will realize the percentage of each map unit that has the specified rating.

A map unit may have other components with different ratings. The ratings for all components, regardless of the map unit aggregated rating, can be viewed by generating the equivalent report from the Soil Reports tab in Web Soil Survey or from the Soil Data Mart site. Onsite investigation may be needed to validate these interpretations and to confirm the identity of the soil on a given site.

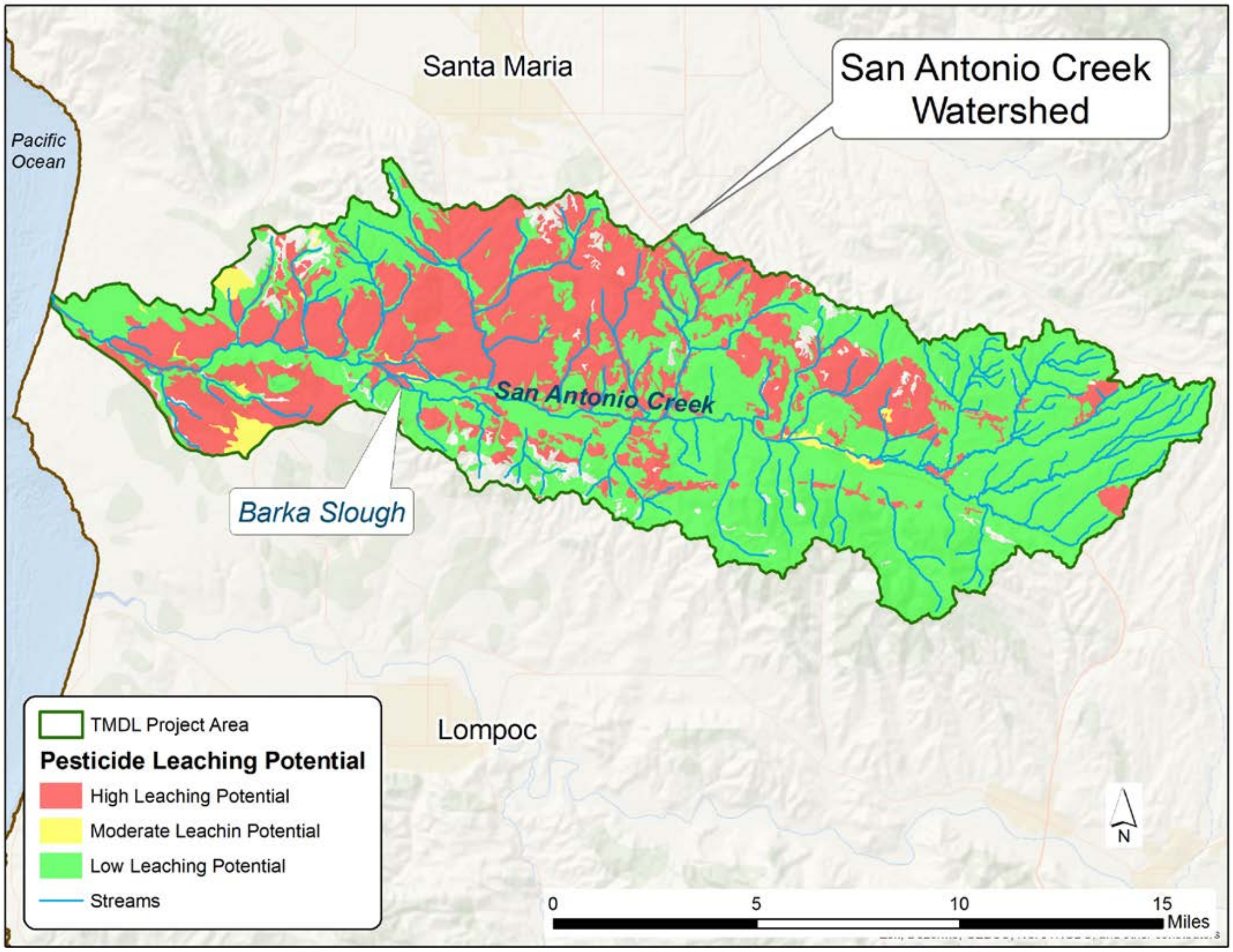

Figure C-4. SSURGO Pesticide Leaching Potential

Hydric Rating by Map Unit

This rating indicates the percentage of map units that meets the criteria for hydric soils. Map units are composed of one or more map unit components or soil types, each of which is rated as hydric soil or not hydric. Map units that are made up dominantly of hydric soils may have small areas of minor nonhydric components in the higher positions on the landform, and map units that are made up dominantly of nonhydric soils may have small areas of minor hydric components in the lower positions on the landform. Each map unit is rated based on its respective components and the percentage of each component within the map unit.

The thematic map is color coded based on the composition of hydric components. The five color classes are separated as 100 percent hydric components, 66 to 99 percent hydric components, 33 to 65 percent hydric components, 1 to 32 percent hydric components, and less than one percent hydric components.

In Web Soil Survey, the Summary by Map Unit table that is displayed below the map pane contains a column named 'Rating'. In this column the percentage of each map unit that is classified as hydric is displayed.

Hydric soils are defined by the National Technical Committee for Hydric Soils (NTCHS) as soils that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part (Federal Register, 1994). Under natural conditions, these soils are either saturated or inundated long enough during the growing season to support the growth and reproduction of hydrophytic vegetation.

The NTCHS definition identifies general soil properties that are associated with wetness. In order to determine whether a specific soil is a hydric soil or nonhydric soil, however, more specific information, such as information about the depth and duration of the water table, is needed. Thus, criteria that identify those estimated soil properties unique to hydric soils have been established (Federal Register, 2002). These criteria are used to identify map unit components that normally are associated with wetlands. The criteria used are selected estimated soil properties that are described in "Soil Taxonomy" (Soil Survey Staff, 1999) and "Keys to Soil Taxonomy" (Soil Survey Staff, 2006) and in the "Soil Survey Manual" (Soil Survey Division Staff, 1993).

If soils are wet enough for a long enough period of time to be considered hydric, they should exhibit certain properties that can be easily observed in the field. These visible properties are indicators of hydric soils. The indicators used to make onsite determinations of hydric soils are specified in "Field Indicators of Hydric Soils in the United States" (Hurt and Vasilas, 2006).

References:

Federal Register. July 13, 1994. Changes in hydric soils of the United States.

Federal Register. September 18, 2002. Hydric soils of the United States.

Hurt, G.W., and L.M. Vasilas, editors. Version 6.0, 2006. Field indicators of hydric soils in the United States.

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Soil Survey Staff. 1999. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. 2nd edition. Natural Resources Conservation Service. U.S. Department of Agriculture Handbook 436.

Soil Survey Staff. 2006. Keys to soil taxonomy. 10th edition. U.S. Department of Agriculture, Natural Resources Conservation Service.

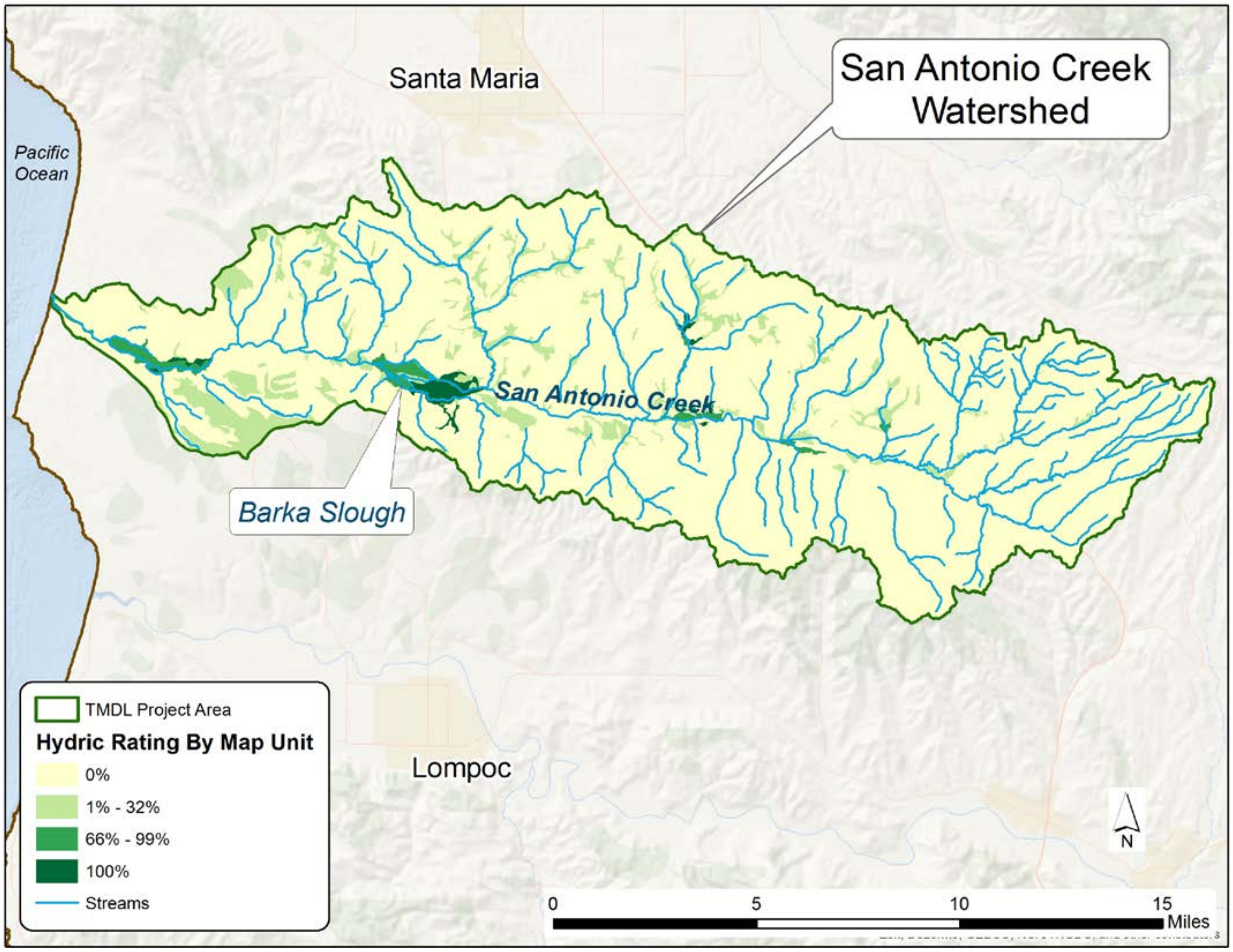

Figure C-5. SSURGO Hydric Rating

Surface Texture
This displays the representative texture class and modifier of the surface horizon.

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is 15 percent or more, an appropriate modifier is added, for example, "gravelly."

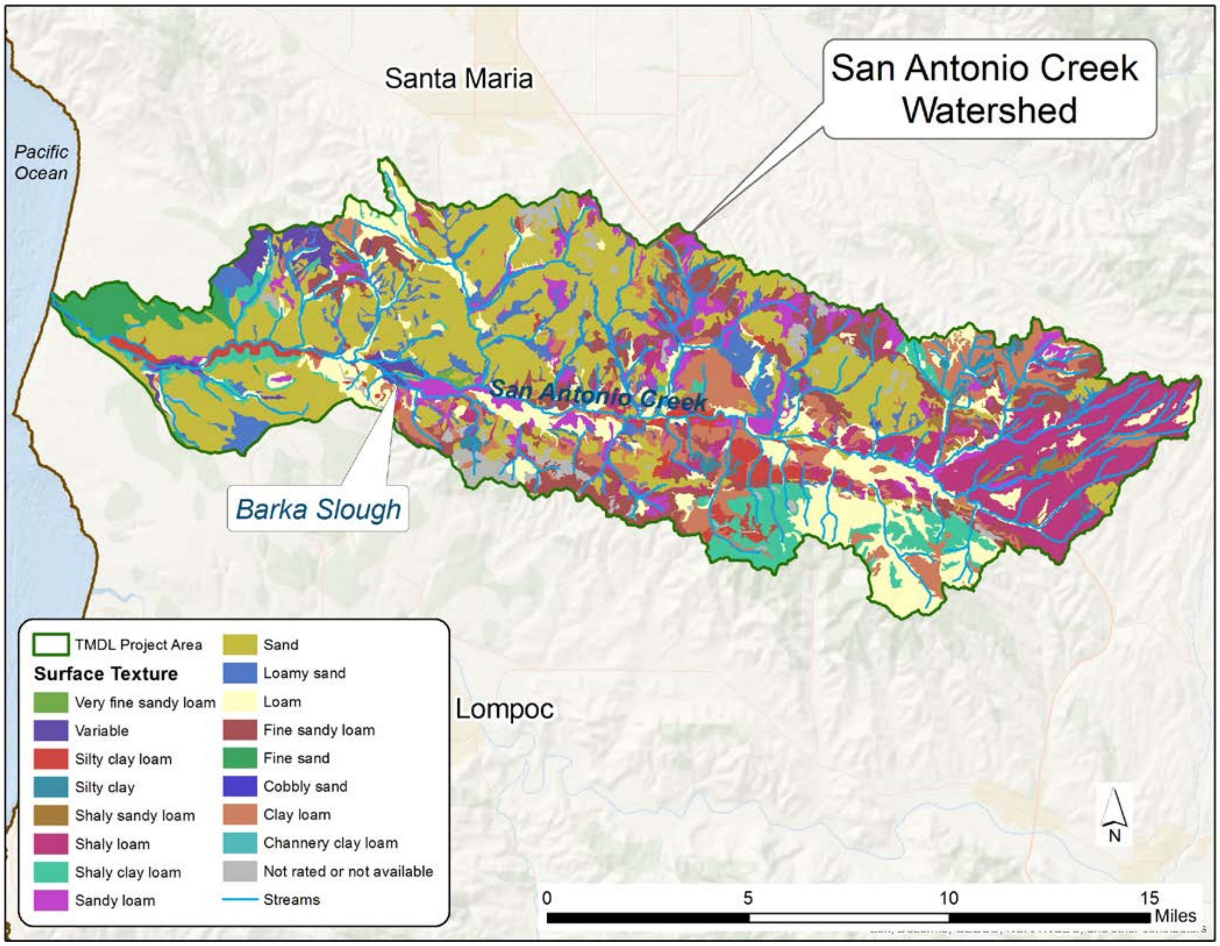

Figure C-6. SSURGO Surface Texture

Drainage Class

"Drainage class (natural)" refers to the frequency and duration of wet periods under conditions similar to those under which the soil formed. Alterations of the water regime by human activities, either through drainage or irrigation, are not a consideration unless they have significantly changed the morphology of the soil. Seven classes of natural soil drainage are recognized-excessively drained, somewhat excessively drained, well drained, moderately well drained, somewhat poorly drained, poorly drained, and very poorly drained. These classes are defined in the "Soil Survey Manual."

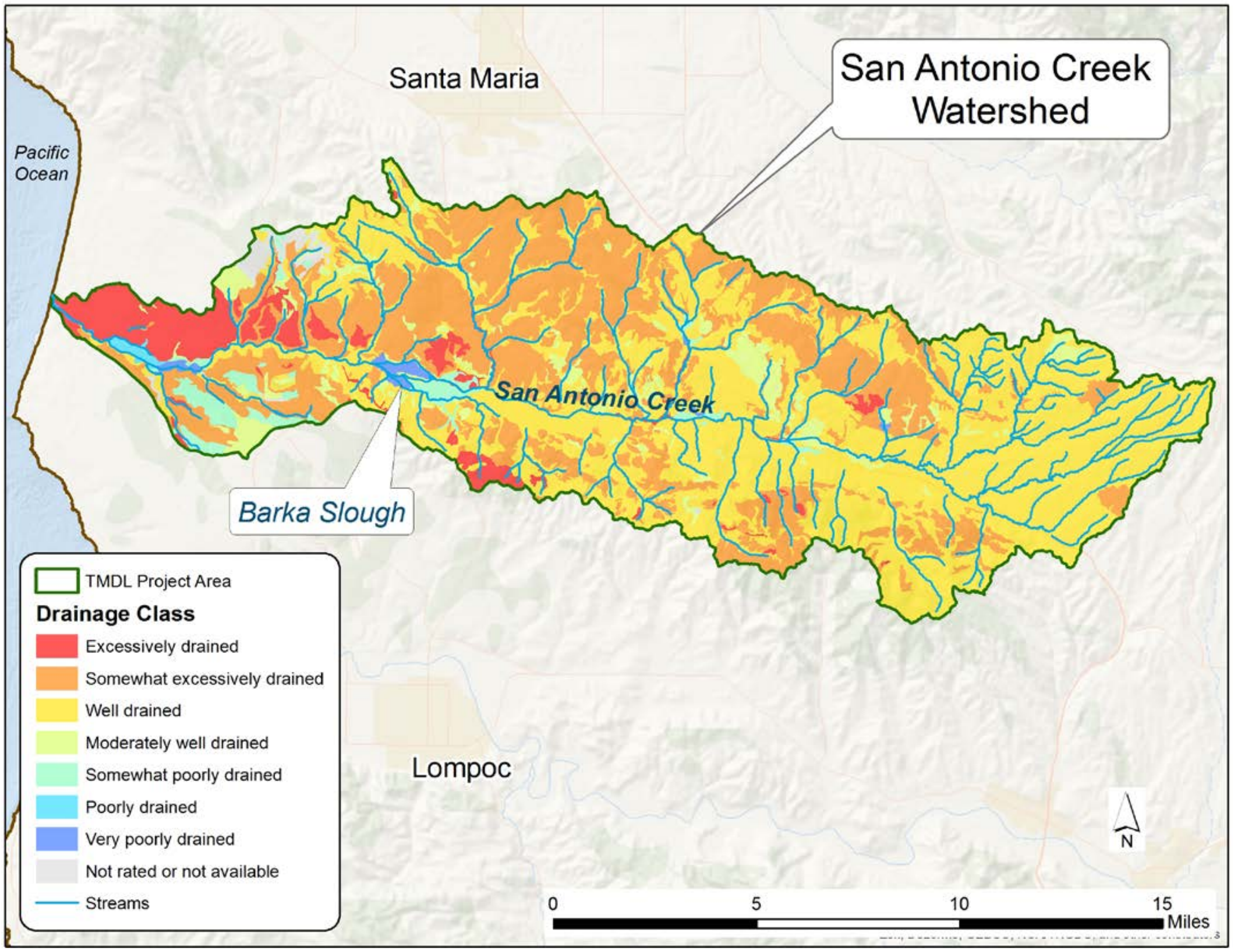

Figure C-7. SSURGO Drainage Class

Parent Material Name

Parent material name is a term for the general physical, chemical, and mineralogical composition of the unconsolidated material, mineral or organic, in which the soil forms. Mode of deposition and/or weathering may be implied by the name.

The soil surveyor uses parent material to develop a model used for soil mapping. Soil scientists and specialists in other disciplines use parent material to help interpret soil boundaries and project performance of the material below the soil. Many soil properties relate to parent material. Among these properties are proportions of sand, silt, and clay; chemical content; bulk density; structure; and the kinds and amounts of rock fragments. These properties affect interpretations and may be criteria used to separate soil series. Soil properties and landscape information may imply the kind of parent material.

For each soil in the database, one or more parent materials may be identified. One is marked as the representative or most commonly occurring. The representative parent material name is presented here.

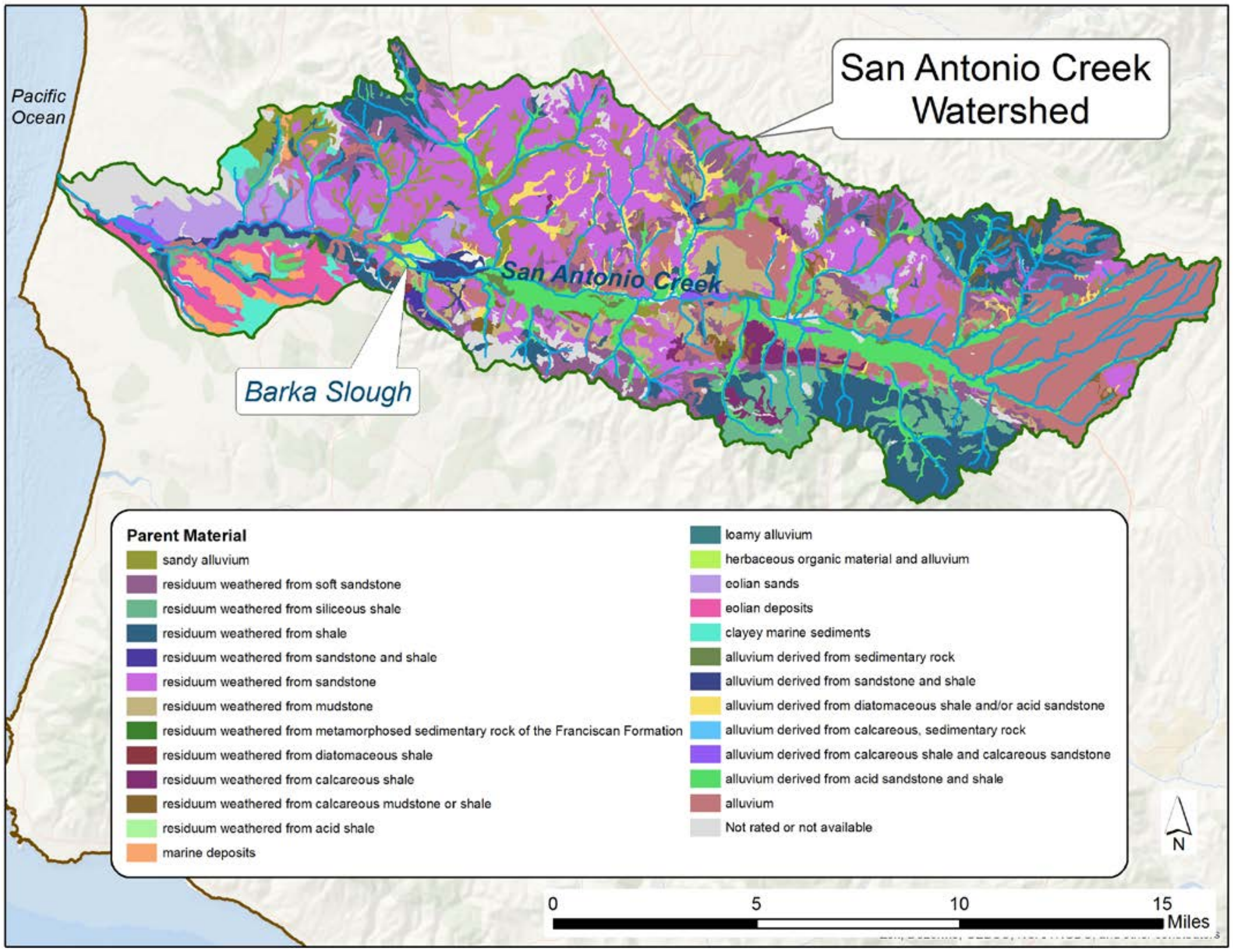

Figure C-8. SSURGO Parent Material

Hydrologic Soil Group

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

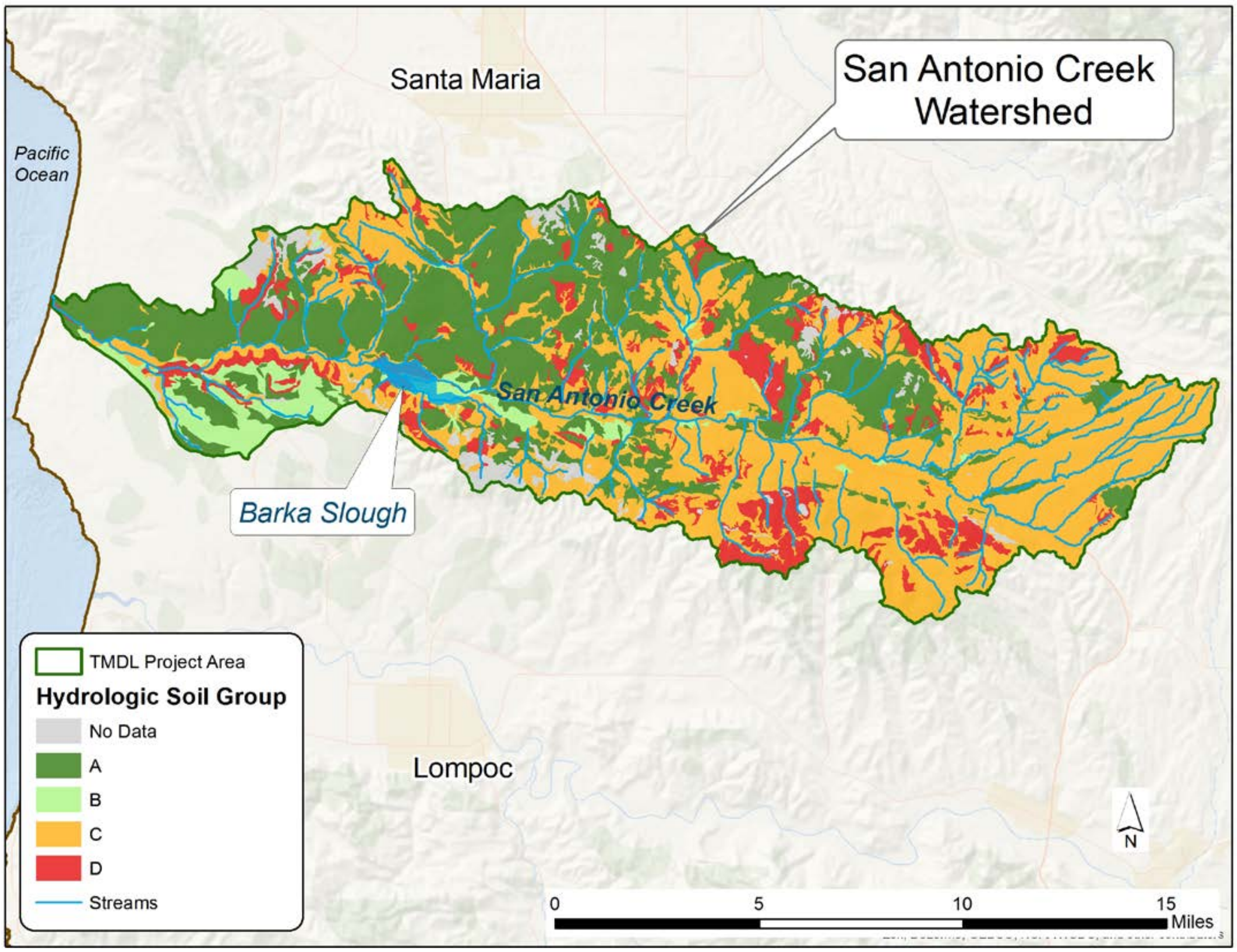

Figure C-9. SSURGO Hydrologic Soil Group

Table C-4. Hydrologic soil group descriptions

Hydrologic Soil Group Descriptions:	
A	Well-drained sand and gravel; high permeability
B	Moderate to well-drained; fine to moderately course texture; moderate permeability
C	Poor to moderately well-drained; moderately fine to fine texture; slow permeability
D	Poorly drained; clay soils, or shallow soils over nearly impervious layers(s)

Depth to Any Soil Restrictive Layer
A "restrictive layer" is a nearly continuous layer that has one or more physical, chemical, or thermal properties that significantly impede the movement of water and air through the soil or that restrict roots or otherwise provide an unfavorable root environment. Examples are bedrock, cemented layers, dense layers, and frozen layers.

This theme presents the depth to any type of restrictive layer that is described for each map unit. If more than one type of restrictive layer is described for an individual soil type, the depth to the shallowest one is presented. If no restrictive layer is described in a map unit, it is represented by the "> 200" depth class.

This attribute is actually recorded as three separate values in the database. A low value and a high value indicate the range of this attribute for the soil component. A "representative" value indicates the expected value of this attribute for the component. For this soil property, only the representative value is used.

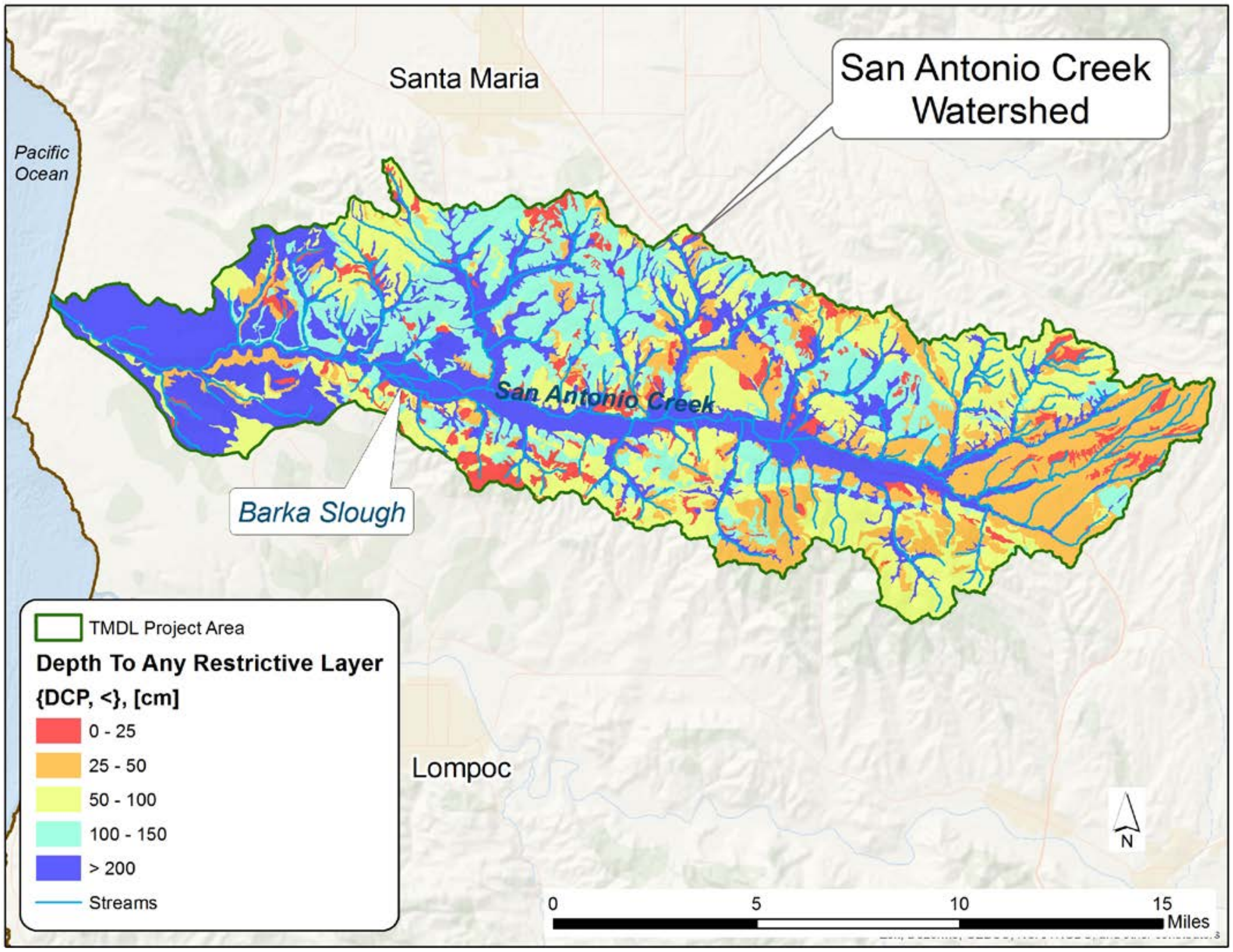

Figure C-10. SSURGO Depth to Any Restrictive Layer

Depth to Water Table

"Water table" refers to a saturated zone in the soil. It occurs during specified months. Estimates of the upper limit are based mainly on observations of the water table at selected sites and on evidence of a saturated zone, namely grayish colors (redoximorphic features) in the soil. A saturated zone that lasts for less than a month is not considered a water table.

This attribute is actually recorded as three separate values in the database. A low value and a high value indicate the range of this attribute for the soil component. A "representative" value indicates the expected value of this attribute for the component. For this soil property, only the representative value is used.

Threespine stickleback, unarmored. Captured from San Antonio Creek (Vandenberg Air Force Base) in 2008. Photo by Carl Page, ARS Consulting.

Figure C-11. Threespine stickleback, unarmored.
From: U.C. Davis, Division of Agriculture and Natural Resources, California Fish Website. http://calfish.ucdavis.edu/species/?uid=101&ds=241. Accessed May 11, 2015.

Figure C-12. Tidewater goby.

The tidewater goby appears to spend all life stages in lagoons, estuaries, and salt marshes where brackish water conditions occur. Adult tidewater gobies may enter marine environments when flushed out of their preferred estuarine habitats by seasonal breaching of the sandbars following storm events, but may not survive for long periods in the marine environment. Pelagic juvenile gobies may be flushed from natal estuaries and lagoons in those locations where daily interchange of water occurs with the marine environment. However, these may be natural mechanisms of dispersal between suitable habitats on a local basis, where conditions are favorable to retain a sufficiently robust breeding population in the natal site. Gobies are unlikely to persist where daily tidal fluctuations cause substantial portions of the breeding population to be flushed from natal sites on a regular basis, or where tidal fluctuations cause breeding substrates to be dewatered. Although usually associated with lagoons and estuaries, the tidewater goby has been documented in slack freshwater habitats as far as 5 miles upstream from San Antonio lagoon in Santa Barbara County.

(From: http://www.fws.gov/arcata/es/fish/goby/goby.html)

http://www.amphibians.org/wp-content/uploads/2013/07/California-Red-legged-Frog-Recovery-Plan.pdf

Northern Transverse Ranges and Tehachapi Mountains. On the Santa Maria River, California red-legged frogs occur up- and downstream of Twitchell Reservoir (Natural Diversity Database 2001). To the south, the lower drainage basin of San Antonio Creek, the adjacent San Antonio Terrace, and San Antonio Lagoon are considered to be among the most productive areas for red-legged frogs in Santa Barbara County (Christopher 1996). Most of this area occurs on Vandenberg Air Force Base. In this area, California red-legged frogs are found in dune swale ponds; this habitat type has remained essentially undisturbed, and the conditions seem to be less suitable for introduced fishes, crayfish, and bullfrogs because they dry completely in drought years.

Photo Credit: Mark Jennings

Figure C-13. California red-legged frog.
From USFWS, Pacific Region News Release (March 6, 2001)
http://www.fws.gov/pacific/news/2001/2001-43.htm