California Regional Water Quality Control Board
Central Coast Region

Total Maximum Daily Load for Nitrate

for the

Los Berros Creek Subwatershed, San Luis Obispo County, California

Final Project Report

Prepared April 9, 2012
For the May 3, 2012 Water Board Meeting

Adopted by the
California Regional Water Quality Control Board
Central Coast Region
on May 3, 2012

and the
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on June 11, 2012

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List of Acronyms and Abbreviations

This report contains numerous acronyms and abbreviations. In general, staff wrote an acronym or abbreviation in parentheses following the first time a title or term was used. Staff wrote the acronym/abbreviation in place of that term from that point throughout this report. The following alphabetical list of acronyms/abbreviations used in this report is provided for the convenience of the reader:

Basin Plan	Water Quality Control Plan for the Central Coast Region
CCAMP	Central Coast Ambient Monitoring Program
CEQA	California Environmental Quality Act
CFR	Code of Federal Regulations
CWA	Clean Water Act
DFG (or CDFG)	Calif. Dept. of Fish and Game
DHS	California Department of Health Services
DO	Dissolved oxygen
DWR	California Department of Water Resources
FMMP	Farmland Mapping and Monitoring Program
GWAVA	Ground Water Vulnerability Assessment model
HSG	Hydrologic Soil Group
HUC	Hydrologic Unit Code
MMs	Management measures
MS4	Municipal Separate Storm Sewer System
NASS	National Agricultural Statistics Service
NCDC	National Climatic Data Center
NHD	National Hydrography Dataset
MOU	Memorandum of Understanding
NOAA	National Oceanic and Atmospheric Administration
NO3	Nitrate
NO3-N	Nitrate as Nitrogen
NPDES	National Pollutant Discharge Elimination System
NPS	Nonpoint Source
NRCS	Natural Resources Conservation Service
PRISM	Parameter-elevation Regressions on Independent Slopes Model
RCD	Resources Conservation District
SSURGO	Soil Survey Geographic Database
STORET	Storage and Retrieval dataset repository (USEPA)
SWRCB	State Water Resources Control Board (State Board)
TMDL	Total Maximum Daily Load
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
Water Board	California Central Coast Regional Water Quality Control Board

EXECUTIVE SUMMARY

Los Berros Creek is located in a largely-rural 28 square mile subwatershed in southern San Luis Obispo County and forms the southeastern tributary reaches of the Arroyo Grande Creek watershed. Los Berros Creek is listed on Central Coast Region's Clean Water Act Section 303(d) List due to impairment by nitrate. Consequently, designated drinking water supply (MUN) and ground water recharge (GWR) beneficial uses are not being supported. Creek water also are not meeting non-regulatory recommended guidelines for nitrate in agricultural supply water (AGR) for nitrogen-sensitive crop types, indicating that potential or future designated agricultural supply beneficial uses may be impaired.

Water Board staff also evaluated the potential for biosimulatory impairments, due to the presence of elevated nitrate in creek waters. Nutrients (such as nitrate), in combination with other physical and chemical factors, can potentially contribute to excessive growth of algae and aquatic plants. This excess algal biomass can then result in biostimulatory impairments by detrimentally affecting dissolved water column oxygen, pH, and aquatic habitat. However, available data indicates there is no evidence of biostimulatory impairments in Los Berros Creek, nor are there downstream downstream biostimulatory impacts to the receiving waters of Arroyo Grande Creek resulting from elevated nitrate levels in Los Berros Creek.

The following Nitrate Total Maximum Daily Load (TMDL) project report evaluates nitrate loading to Los Berros Creek, assesses the source contributions contributing to these loads, and develops load allocations and an implementation plan for the identified source categories. Reducing nitrate pollution and ultimately achieving the nitrate drinking water quality standard in Los Berros Creek will restore and be protective of the full range of MUN, GWR and AGR designated beneficial uses of creek water that are being impaired by excess nitrate.

Total Maximum Daily Load (TMDL)

This TMDL project report addresses nitrate in the Los Berros Creek subwatershed. 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. 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.

A TMDL study 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, Water Board staff is proposing to assign responsibility to someone, an agency, group, or individuals, to reduce their contribution in order to meet water quality standards.

Water Quality Objective and Numeric Target for Nitrate

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 most stringent relevant water quality objective for nitrate (and therefore the one that is protective of the full range of all nitrate-impaired beneficial uses of Los Berros Creek) is the numeric Basin Plan objective for nitrate in municipal and domestic water supply. This regulatory standard is 10 milligrams per liter of nitrate as nitrogen. The numeric targets for these TMDLs are equal to the Basin Plan numeric water quality objective for nitrate in municipal and domestic water supply = 10 mg/L nitrate as nitrogen.

Impaired Waterbody

The spatial extent of impaired waterbody reaches identified in this TMDL includes all reaches and tributaries of Los Berros Creek. This includes the 28-square mile subwatershed draining to Los Berros Creek. It is important to note that the only monitoring data currently available is from the lowermost reach of Los Berros Creek. Indirect and anecdotal evidence suggest the upper reaches of the subwatershed (e.g., Los Berros canyon) may not be impacted by elevated water column nitrate. However, State policy is to conservatively and presumptively presume that the impairment could extend all the way upstream to the upper reaches of the subwatershed unless and until additional data or information is available to reasonably rule out upstream impairments.

Allocations

A TMDL is by definition a "total" daily pollutant load; therefore all probable contributing controllable and natural sources of nitrate loading to surface water should be considered. Discharges of nitrate from irrigated agriculture, urban lands, grazing lands, and natural sources are contributing loads of nitrate to receiving waters. These source categories are assigned allocations for nitrate to achieve the TMDL. Staff has concluded irrigated agriculture to be the overwhelming majority of controllable water column nitrate loads in the TMDL project area and this source category is not currently meeting its proposed load allocation. Non-controllable, natural sources of nitrate are not subject to regulatory action and staff estimates these sources contribute approximately 52% of the existing annual nitrate loads observed in the water column. The table below identifies the allocations assigned to implementing parties for the affected waterbodies.

LOAD ALLOCATIONS			
Waterbody	**WBID**	**Implementing Party (Source)**	**Receiving Water Nitrate (mg/L)**
Los Berros Creek and its tributaries	CAR3103102319990304143314	Owners/operators of irrigated cropland (Cropland- fertilizer application)	Allocation-1
Los Berros Creek and its tributaries	CAR3103102319990304143314	Owners/operators of land used for/containing domestic animals/livestock (Grazing lands - livestock waste)	Allocation-1
Los Berros Creek and its tributaries	CAR3103102319990304143314	No implementing party (All land use categories: natural sources, ambient-unimpacted groundwater contributions, atmospheric deposition)	Allocation-1
WASTE LOAD ALLOCATIONS			
Waterbody	**WBID**	**Implementing Party Responsible for Allocation (Source) NPDES/WDR number**	**Receiving Water Nitrate (mg/L)**
Los Berros Creek and its tributaries	CAR3103102319990304143314	City of Arroyo Grande Storm Water General Permit NPDES No. CAS000004 County of San Luis Obispo Storm Water General Permit NPDES No. CAS000004	Allocation-1
Allocation-1: Maximum nitrate concentration shall not exceed 10 mg/L as nitrogen.			

TMDL Implementation

Load allocations for owners/operators of irrigated lands will be implemented by complying with the conditions and requirements of the current *Conditional Waiver of Waste Discharge Requirements For Discharges from Irrigated Lands* (Agricultural Order) and any renewals or revisions thereof. Owners and operators are required to comply with the requirements of the Agricultural Order as described in Section 7 of Attachment 2 (TMDL project report). The goals of implementing these load allocations can be summarized as follows:

1) Control discharges of nitrate to impaired waterbodies and groundwater[1]; and
2) Implement management practices capable of achieving load allocations identified in this TMDL.

Based on available information, urban sources (i.e., municipal MS4 entities in the TMDL project) area are in compliance with their nitrate waste load allocations for Los Berros Creek and are not causing or contributing to impairment. Therefore, at this time waste load allocations are not proposed to be incorporated as enforceable effluent limitations and associated monitoring requirements into the applicable NPDES MS4 stormwater permits. To protect and maintain water quality, and to continue complying with nitrate waste load allocations, these MS4 entities shall continue to implement their Water Board-approved Storm Water Management Plans.

Based on available information, owners/operators of grazing operations and domestic animals on grazing lands in the TMDL project are in compliance with their load allocation and are not causing or contributing to impairment. As such, new regulatory mechanisms, reporting requirements, and formal regulatory oversight are deemed unnecessary for this source category, and are not being proposed. To maintain and protect existing water quality, owners and operators of grazing operations should continue or begin to self-monitor, self-assess and make management decisions consistent with technical guidance from existing rangeland water quality management plans; for example, the California Rangeland Water Quality Management Plan, the Central Coast Cattlemen's Grazing Lands Nonpoint Source Approach, or in conjunction with other resources appropriate to private grazing lands.

TMDL Timeline

Water Board staff proposes a 12-year timeframe to achieve the TMDL. The timeframe for TMDL completion is based primarily on the expectation that nearly all landowners and operators of irrigated agricultural activities will have completed Farm Water Quality Plans and be implementing management practices within 5 years. Water quality benefits resulting from implementing nutrient-control management measures (e.g., grass swales and riparian buffers, etc.) may take a few years to be realized. Water Board staff believes 12 years is a reasonable timeframe to implement management measures and reduce nitrate levels consistent with the allocations and the numeric target. This time frame was also identified because:

1) Nitrate polluted shallow groundwater appears to be a major source of nitrate exceedances in Los Berros Creek; and
2) Available data indicates there are not present any legacy pollutant loads (loads related to land use practices from many years or decades ago) present in shallow groundwater[2] that could impact creek water quality, and which would take many years or decades to dissipate or attenuate;

[1] Shallow, recently recharged groundwater is identified in this TMDL as a substantial source contributor of nitrate loads to creek waters of the TMDL project area.

[2] Deep groundwater and deeper aquifers likely have longer residence times for nitrate; however deep groundwater-bearing strata are unlikely to be a contributor to baseflow and nitrate loads to the creek. The nitrate loads to the creek likely originate from shallow or perched, recently-recharged groundwater sources.

3) Available data indicate that baseflow mean contact time (e.g., the residence time of groundwater baseflow in the subsurface before it is expressed as stream flow) is relatively short (on the order of week, months, or less than one year);
4) *Consequently, improved irrigation and nutrient management practices could express themselves as improvements to shallow or perched groundwater quality, and surface water quality relatively rapidly;*
5) The 12 year time frame is consistent with the Water Board's vision for the central coast region of healthy functioning watersheds, and clean groundwater by the year 2025.

1 INTRODUCTION

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 California 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. 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 which takes into account any lack of knowledge concerning the relationship between effluent limitations and water quality.

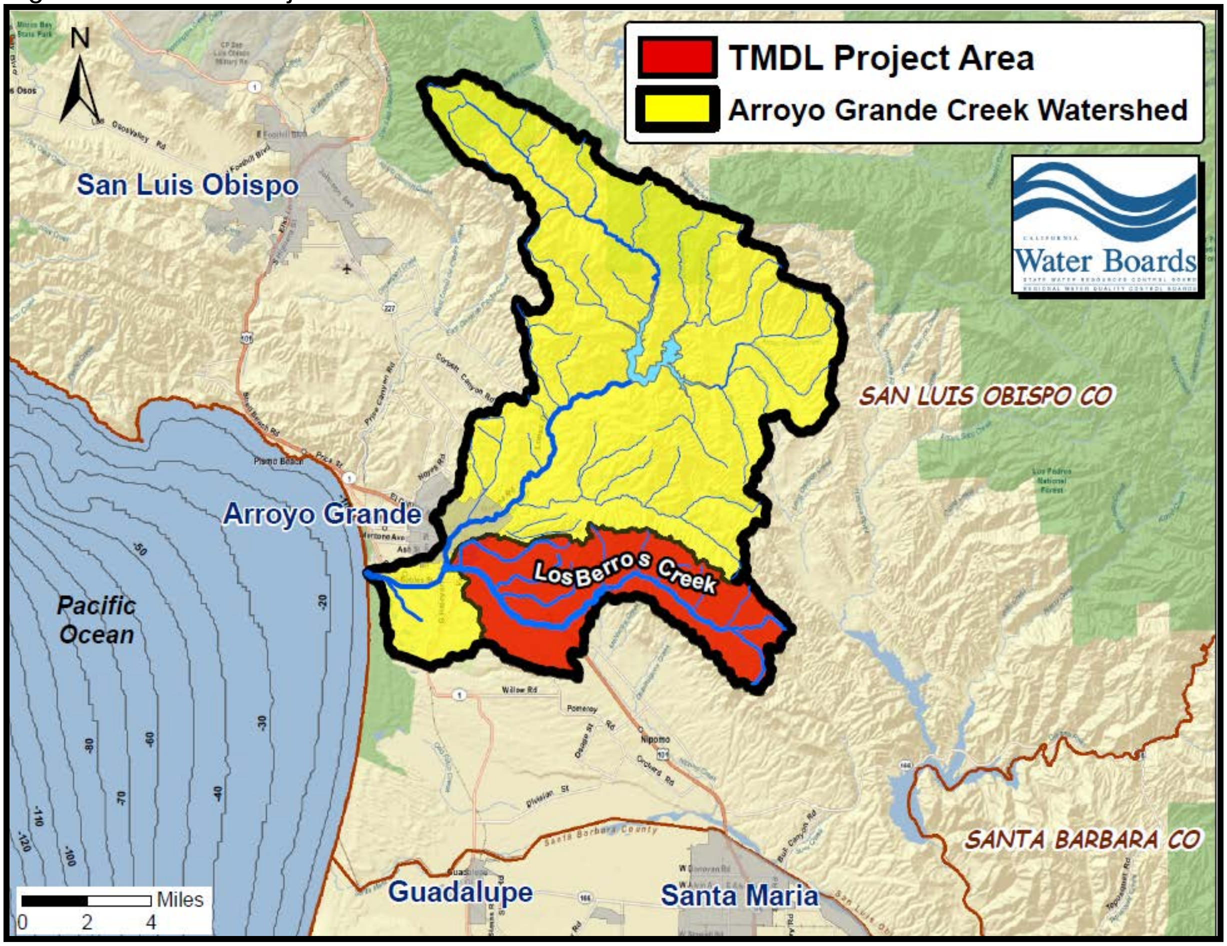
The State complies with this requirement by periodically assessing the conditions of the rivers, lakes and bays and identifying them as "impaired" if they do not meet water quality standards. These waters, and the pollutant or condition causing the impairment, are placed on the 303(d) List of Impaired Waters. In addition to creating this list of waterbodies not meeting water quality standards, the Clean Water Act mandates each state to develop TMDLs for each waterbody listed. The Central Coast Regional Water Quality Control Board is the agency responsible for protecting water quality consistent with the Basin Plan, including developing TMDLs for waterbodies identified as not meeting water quality objectives.

1.2 Project Area

The geographic scope of this TMDL encompasses approximately 28 square miles of the Los Berros Creek subwatershed (Hydrologic Unit Code 180600060104) in southern San Luis Obispo County and forms the southeastern tributary reaches of Arroyo Grande Creek. The TMDL project area[3] includes the subwatershed area contributing flow to the Los Berros Creek, downstream to Los Berros Creek's confluence with the Arroyo Grande Creek. Figure 1-1 illustrates the location of the TMDL project area.

[3] The terms "project area" and "Los Berros Creek subwatershed" are synonymous in the context of this report, and the terms are therefore used interchangeably.

Figure 1-1. TMDL Project Area – Los Berros Creek subwatershed.



1.3 Nitrate Pollution and its Environmental Impacts

The pollutant addressed in this TMDL is nitrate. Nitrate pollution of both surface waters in Los Berros Creek and of the underlying groundwater resource is occurring and constitutes a risk to public health and to safe drinking water. When flow is present, Los Berros Creek routinely exceeds the water quality objective for nitrate in drinking water, therefore, the designated drinking water supply (MUN) and groundwater recharge (GWR) beneficial uses[4] of the creek are not being supported. The Water Quality Control Plan for the Central Coast Region (Basin Plan) explicitly requires that the GWR beneficial use of surface waters be maintained to protect the water quality of the underlying groundwater resources[5].

Nitrate pollution of drinking water supplies is a critical problem throughout the Central Coast Region. National studies indicate that fertilizer from agricultural operations is the largest primary source of nitrate pollution in drinking water wells and that substantial loading of nitrate continues as a result of agricultural fertilizer practices (Carle, et a., 2006). Private, domestic wells are often more vulnerable to higher levels of nitrate because they draw water from shallower, recently recharged groundwater aquifers. While the actual number of polluted wells and people affected

[4] "Beneficial uses" is a regulatory term which refers to the legally-protected current, potential, or future designated uses of the waterbody. The Water Board is required by law to protect all designated beneficial uses.
[5] See Basin Plan, Chapter 2 Beneficial Use Definitions, page II-19

are unknown; protecting public health and ensuring safe drinking water are among the highest priorities for the Water Board.

Regarding nitrate-related health concerns, it is well-established that infants below six months who are fed formula made with water containing nitrate in excess of the U.S. Environmental Protection Agency's safe drinking water standard (i.e., 10 milligrams of nitrate-N per liter) are at risk of becoming seriously ill and, if untreated, may die. Symptoms include shortness of breath and blue baby syndrome, also known as methemoglobinemia.[6] The well-established linkage between nitrate and methemoglobenemia alone should be compelling reason enough to warrant TMDL development. High nitrate levels may also affect the oxygen-carrying ability of the blood of pregnant women[7]. There is some evidence to suggest that exposure to nitrate in drinking water is associated with adverse reproductive outcomes such as intrauterine growth retardations and various birth defects such as anencephaly; however, the evidence is inconsistent (Manassaram et al., 2006). Additionally, public health concerns have been raised about the linkage between nitrate and cancer. Some peer-reviewed epidemiological studies have suggested elevated nitrate in drinking water may be associated with elevated cancer risk (for example, Ward et al. 2010); however currently there is no strong and systematic evidence linking higher risk of cancer in humans to elevated nitrate in drinking water. Further research is recommended by researchers to confirm or refute the linkage between nitrates in drinking water supply and cancer.

The U.S. Environmental Protection Agency recently reported that nitrogen pollution, and the associated degradation of drinking and environmental water quality, has the potential to become one of the costliest and most challenging environmental problems the nation faces[8]. Over half of the nation's streams, including Los Berros Creek, have medium to high levels of nitrogen. Nitrate drinking water standard violations have doubled nationwide in eight years, and staff has demonstrated that drinking water supplies in some areas of the central coast region have been detrimentally impacted by nitrate.

2 PHYSICAL SETTING & WATERSHED DESCRIPTION

2.1 Project Area & Watershed Delineation

The geographic scope of this TMDL encompasses approximately 28 square miles of the Los Berros Creek subwatershed in southern San Luis Obispo County. The Los Berros Creek subwatershed constitutes the southeastern tributary reaches of the geographically larger Arroyo Grande Creek watershed.

The subwatershed is an east-west trending drainage with headwater reaches at Temettate Ridge to the east, and ultimately draining into Arroyo Grande Creek to the west. Estimated mean annual discharge from the Los Berros Creek subwatershed is approximately 1,900 acre-feet/year (source: San Luis Obispo County, Division of Public Works, stream gage #5, Water Years 1992-2001).

Agriculture, including cropland and grazing lands, is the current dominant land use in the watershed. According to recent San Luis Obispo County crop maps, vineyard, orchard, and

[6] U.S. Environmental Protection Agency: http://water.epa.gov/drink/contaminants/basicinformation/nitrate.cfm
[7] California Department of Public Health www.cdph.ca.gov/certlic/drinkingwater/Pages/Nitrate.aspx
[8] U.S. Environmental Protection Agency: Memorandum from Acting Assisstant Administrator Nancy K. Stoner. March 16, 2011. Subject: "Working in Partnership with States to Address Phosphorus and Nitrogen Pollution through Use of a Framework for State Nutrient Reductions".

vegetable crops are cultivated in the subwatershed. The few urban areas within the subwatershed include residential areas in the lowermost reaches of the subwatershed. Upper reaches of the subwatershed are characterized by oak woodland and grasslands (source: National Land Cover Dataset, 2001).

ESRI™ ArcMap® 9.2 was used to create watershed layers for the project area. The drainage boundary of the Project Area was delineated on the basis of the Watershed Boundary Dataset[9], which contain digital hydrologic unit boundary layers organized on the basis of Hydrologic Unit Codes (HUCs). The Los Berros Creek subwatershed (HUC 12 - 180600060104) - is nested within the larger Arroyo Grande Creek watershed (HUC 10 - 1806000601), as previously illustrated in Figure 1-1.

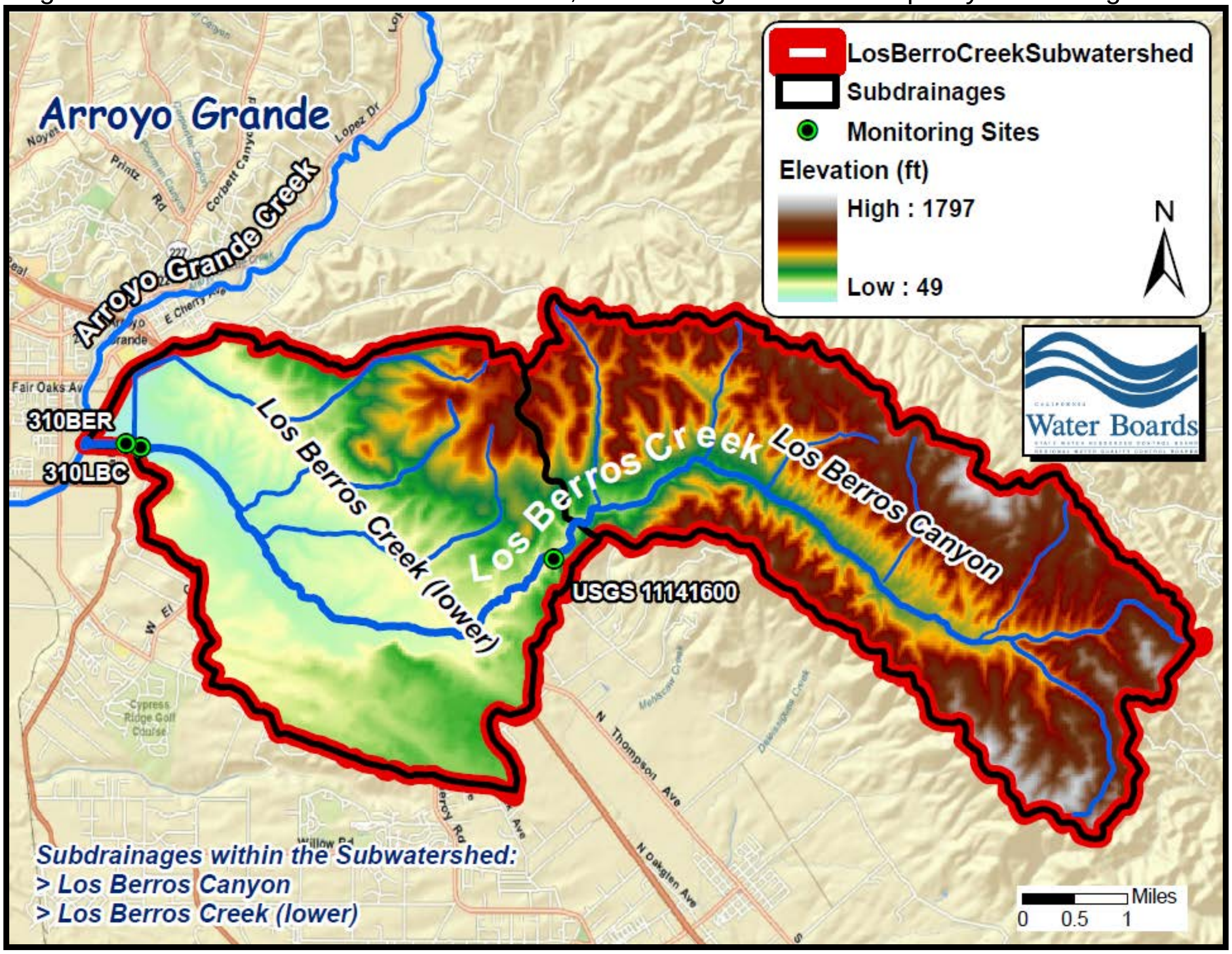
Individual drainage catchments nested within the Los Berros Creek subwatershed were delineated by clipping CalWater22 planning watershed (PWS) shape files to HUC 180600060104. Based on CalWater22 delineations, there are two distinct subdrainages/catchments nested within the Los Berros Creek subwatershed: 1) Lower Los Berros Creek (Calwater22 ID 3310.310203); and 2) Los Berros Canyon (Calwater22 ID 3310.310202). An illustration of the regional watershed hierarchy is presented in Table 2-1. Figure 2-1 illustrates the Los Berros Creek subwatershed, and the subdrainage catchments (Los Berros Canyon and Lower Los Berros Creek) nested within the subwatershed.

Table 2-1. Watershed hierarchy.

Name	Hydrologic Scale	Data Source
Arroyo Grande Creek	Watershed	WBD 10-digit Hydrologic Unit Code
Los Berros Creek	Subwatershed (tributary to Arroyo Grande Creek)	WBD 12-digit Hydrologic Unit Code
Los Berros Creek (lower)	Subdrainage / catchment	Calwater22 PWS unit
Los Berros Canyon	Subdrainage / catchment	Calwater22 PWS unit

[9] The Watershed Boundary Dataset (WBD) is developed by federal agencies and national associations. WBD contains watershed boundaries that define the areal extent of surface water drainage to a downstream outlet. WBD watershed boundaries are determined soley upon science-based principles, not favoring any administrative boundaries.

Figure 2-1. Los Berros Creek subwatershed, subdrainages and water quality monitoring sites.



2.2 Land Use and Land Cover

Land use and land cover in the project area can be evaluated from digital data provided by the California Department of Conservation Farmland Mapping and Monitoring Program (FMMP)[10]. The FMMP maps are updated every two years with the use of aerial photographs, a computer mapping system, public review, and field reconnaissance. For this data analysis report, the 2008 FMMP mapping data for San Luis Obispo County was used.

Figure 2-2 illustrates land use and land cover in the TMDL project area. Table 2-2 tabulates the distribution of land use in the project area. Figure 2-3 presents land use and landcover within the two subdrainages of the subwatershed; lower Los Berros Creek and Los Berros Canyon.

[10] FMMP data is available for download from: http://www.consrv.ca.gov/DLRP/fmmp/index.htm

Figure 2-2. Los Berros Creek subwatershed: land use – land cover.

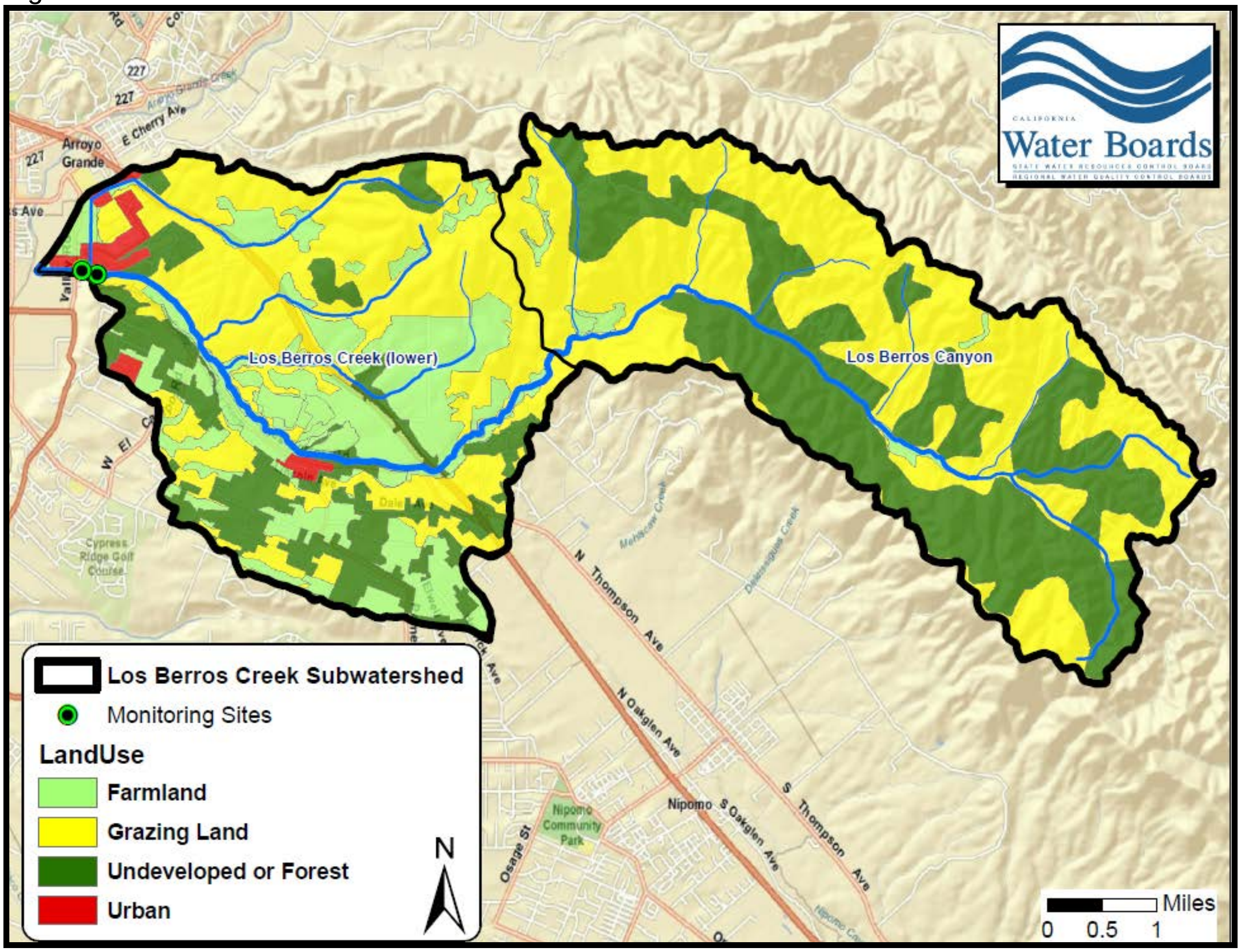


Table 2-2. Tabulation of land use/land cover in the Los Berros Creek subwatershed

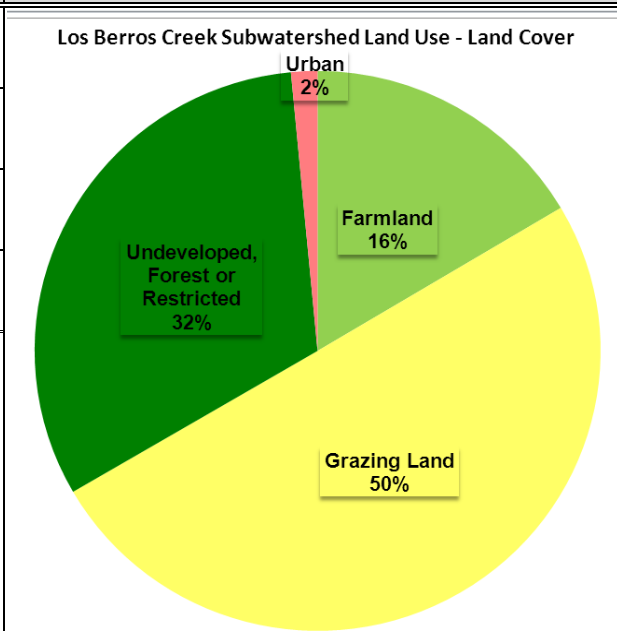
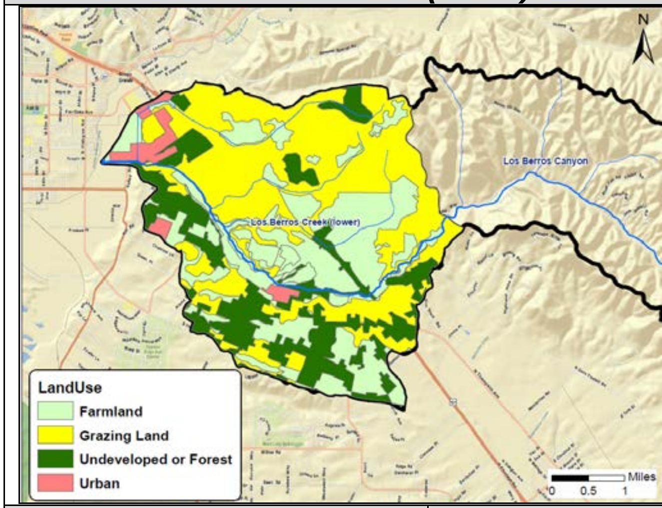
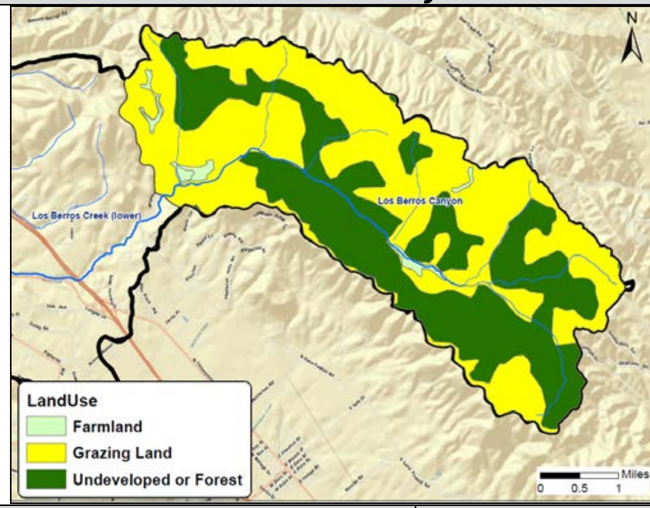
Land Cover	Acres	Land Cover Pie Chart
Urban	274	
Farmland	2,997	
Grazing Land	9,127	
Undeveloped, Forest, or Restricted	5,805	
Total	18,203	

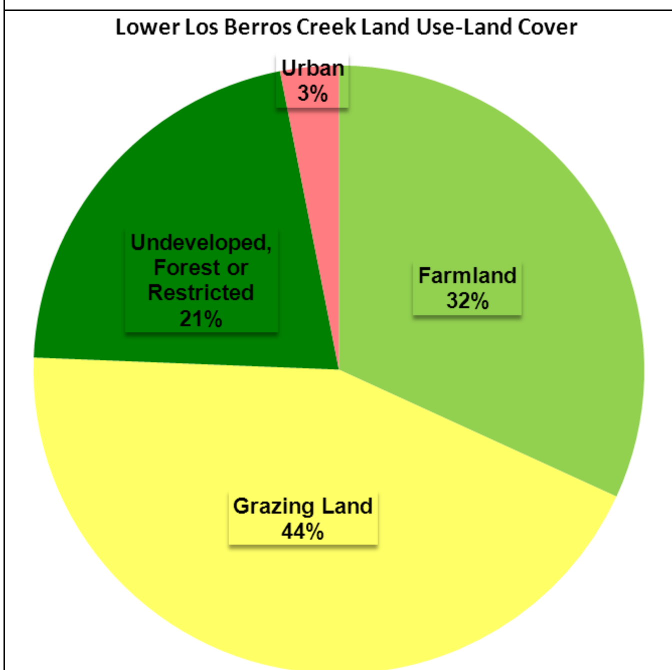
Figure 2-3. Land use-land cover in the project area subdrainages: Lower Los Berros Creek and Los Berros Canyon.

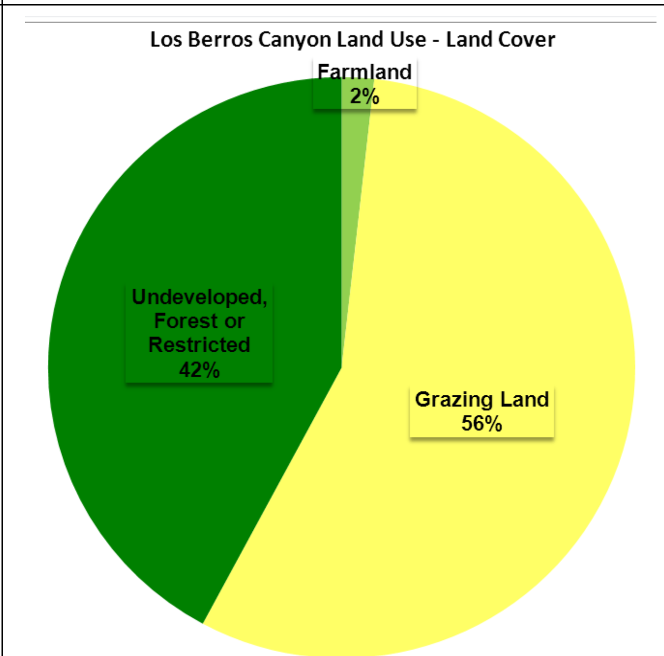
Lower Reach of Subwatershed: ***Los Berros Creek (lower)***	**Upper Reach of Subwatershed:** ***Los Berros Canyon***





Los Berros Creek (Lower) Land Cover	**Acres**	**Los Berros Canyon Land Cover**	**Acres**
Urban	274	Urban	0
Farmland	2,822	Farmland	165
Grazing Land	3,879	Grazing Land	5,200
Forest, Undeveloped, or Restricted	1,885	Forest, Undeveloped, or Restricted	3,910
Total	8,860	**Total**	9,275

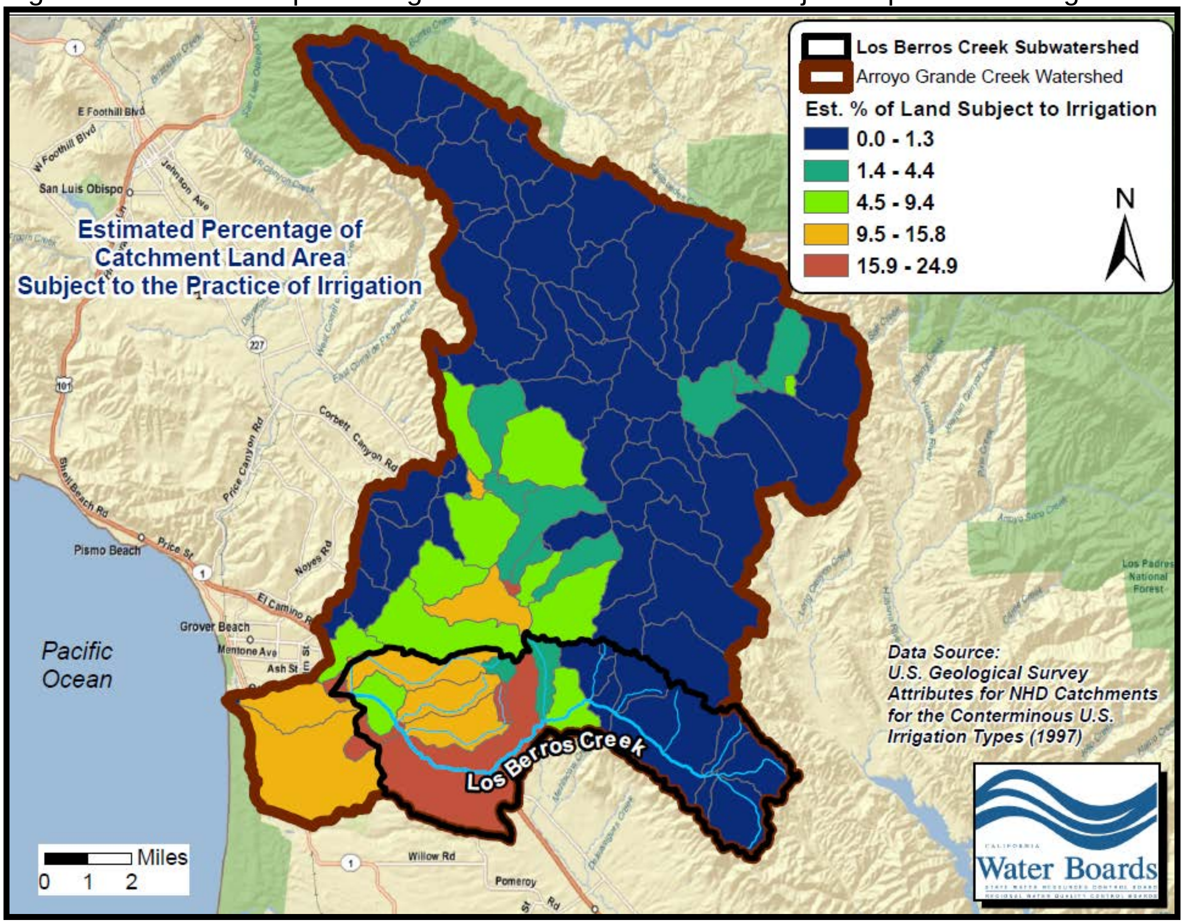




Additionally, an estimate of the spatial variation in intensity of agricultural irrigation practices can be approximated using NHDplus catchment attributes published by the U.S. Geological

Survey[11]. These estimates are for the year 1997, but are presumed to represent a plausible gross approximation of the areal extent of current watershed irrigated land. Figure 2-4 illustrates the intensity (defined here as percentage of land area subject to irrigation practices) of irrigation in the Arroyo Grande watershed; note that the lower Los Berros Creek area is estimated to have the highest intensity of irrigation in the watershed.

Figure 2-4. Estimated percentage of catchment land area subject to practice of irrigation.



2.3 Hydrology

Assessing the hydrology of a watershed is an important step in evaluating the magnitude and nature of nutrient transport and loading in waterbodies. The entire drainage area contributing to flow in the TMDL Project Area (i.e., the Los Berros Creek subwatershed) encompasses 28 square miles.

California central coast streams tend to have flashy hydrologic conditions with short durations of high flows following precipitation events, followed by long, extended periods of low or no flows. As such, low flow, baseflow conditions, or dry conditions characterize the Los Berros Creek between rainy periods and throughout the dry season (May through October).

[11] This dataset is entitled "Attributes for NHDplus Cachments in the Conterminous Unites States: Artifiial Drainage Irrigation Types (1997) and represents the estimated area of irrigation types for the year 1997 compiled for every catchment of NHDplus for the United States. The source datasets were derived from tabular National Resource Inventory (NRI) datasets created by the Natural Resource Conservation Service (NRCS, U.S. Dept. of Agriculture). Onlike linkage: http://water.usgs.gov/GIS/metadata/usgswrd/XML/nhd_adrain.xml#stdorder#stdorder

A synthetic flow record for Los Berros Creek at monitoring site 310LBC was developed with instantaneous flow records provided by the Cooperative Monitoring Program in conjunction with daily flow records from nearby USGS gage 11137900 at Huasna Creek as a suitable reference flow gage, as described in Appendix A: Synthetic Flow Record. Figure 2-5 illustrates the flow duration curve for Los Berros Creek at monitoring site 310LBC. Flow duration curves are graphical representations of the flow regime of a stream at a given site. The horizontal axis is essentially a flow frequency distribution, depicting the percentage of times a certain flow is exceeded on a daily basis. As such, highest flows are represented on the extreme left side of the horizontal axis, lowest flows (or dry conditions) recorded are represented the extreme right side of the axis. The median flow occurs at a flow exceedance frequency of 50 percent. The shape of the flow duration curve for Los Berros Creek is typical for an intermittent stream, with observable flows occurring 50% or less of the time over the entire period of record.

Figure 2-5. Flow Duration Curve, Los Berros Creek at 310LBC.

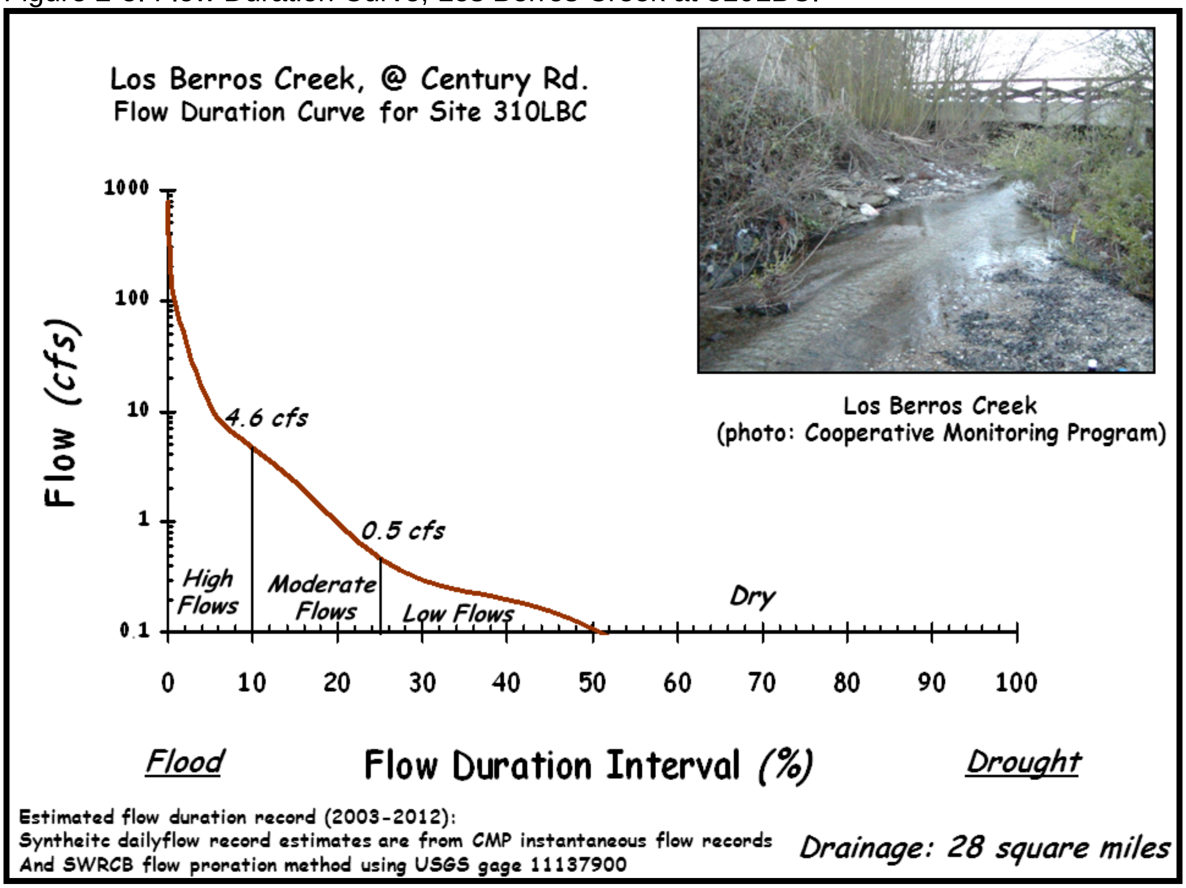
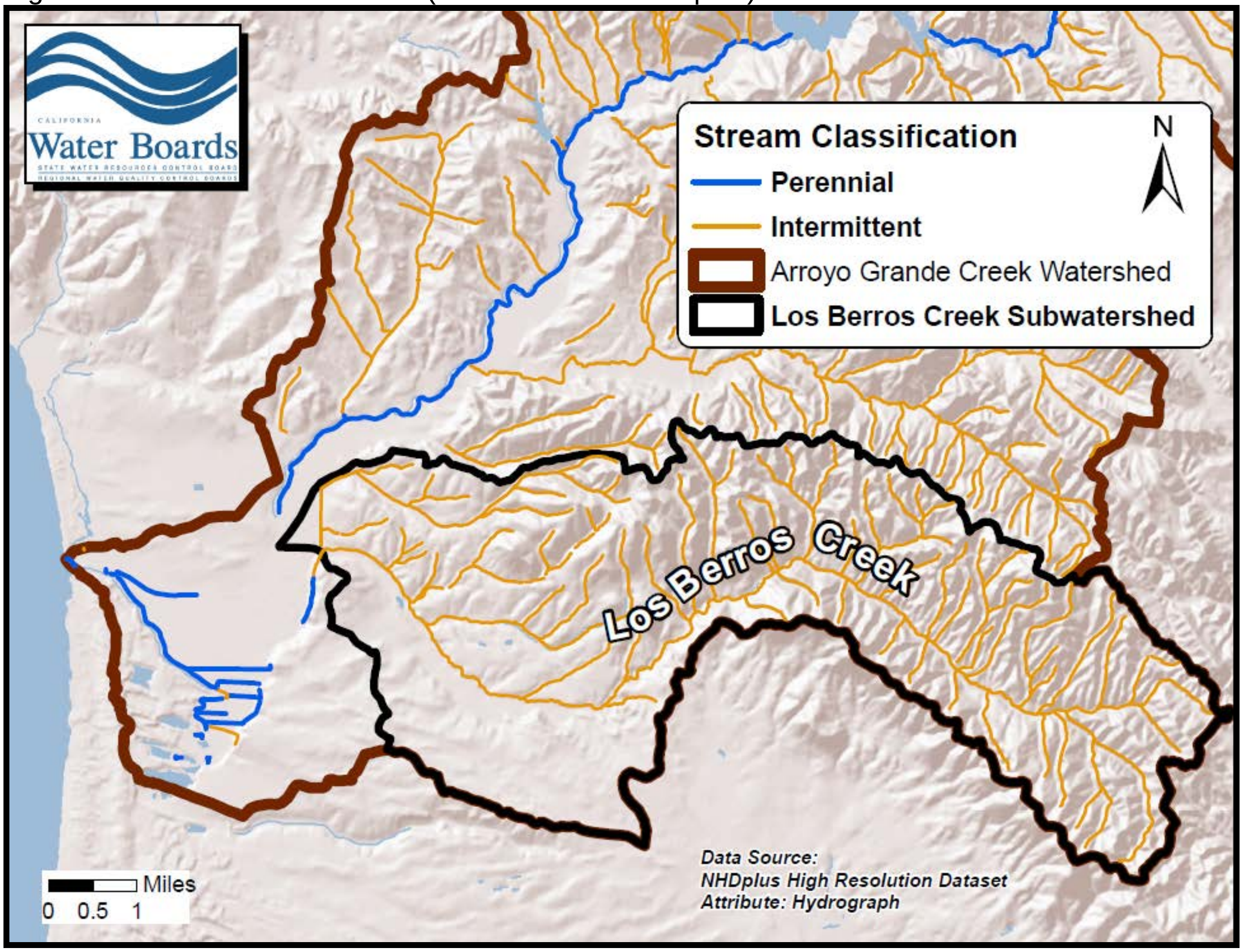


Figure 2-6 illustrates the hydrologic stream channel classifications in the project area. The source of these hydrologic classification attributes is from the USGS's high resolution National Hydrography Dataset (NHD). The Los Berros Creek mainstem is defined by the USGS as an intermittent stream from its headwaters to the downstream outlet of the subwatershed. The Los Berros Creek is a losing stream along all or portions of its stream bed, and stream flow recharges the underlying aquifer through the alluvium along the creek (Todd Engineers, 2007) The lowermost reach of Los Berros Creek, below Century Road, was diverted from its original course below the Nipomo Mesa and channelized to join the Arroyo Grande Creek at the upstream point of a flood control channel (CCSE, 2009). Although channelized, this lowermost reach still has vegetation along its banks. Based on historical flow data Los Berros Creek contributed to about 16.9 percent of the flow in the lower Arroyo Grande Creek. The majority of the flow contribution occurred between January and April. During the dry season, Los Berros Creek contributes three to four percent of the flow in Arroyo Grande Creek (Stetson Engineers Inc. et al., 2004).

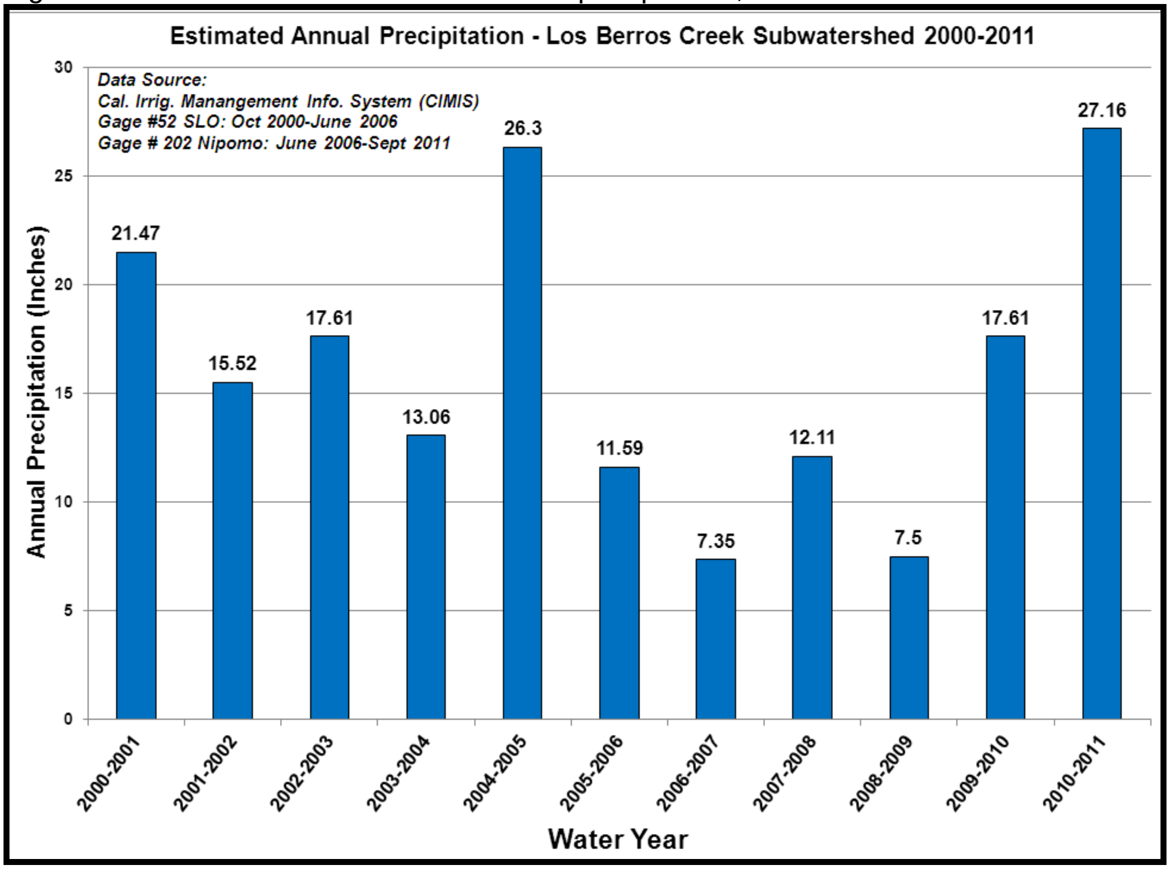
Figure 2-6. Stream classification (source: USGS-NHDplus).



2.4 Climate and Precipitation

Figure 2-7 represents annual precipitation in the project area from rain gage data for Water Year 2000-2001 to Water Year 2010-2011. Precipitation data can be used, in conjunction with other physical metrics, to estimate flow for ungaged streams. For example the California State Water Resources Control Board (SWRCB) uses a precipitation-based proration method to estimate flow at ungaged streams (SWRCB, 2002). Having a good estimate of precipitation is also a necessary input parameter of the USEPA STEPL source analysis spreadsheet tool staff used for source assessment (see Section 5).

Figure 2-7. Time series of estimated annual precipitation, Los Berros Creek subwatershed.

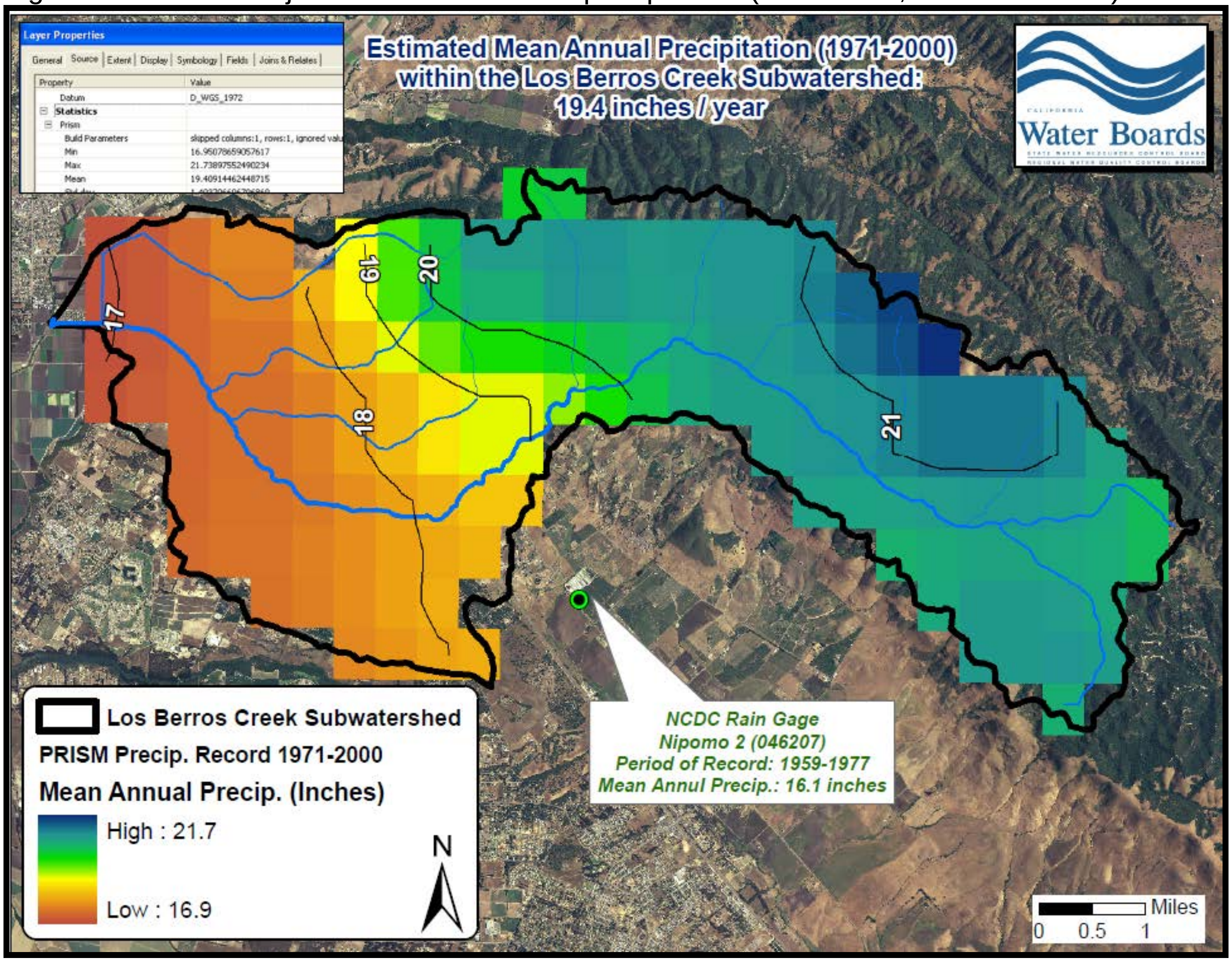


It is important to recognize that rainfall gauging stations have limited spatial distribution, and that gauging stations tend to be located in lower elevations where people live. Consequently, these locations can bias estimates of regional rainfall towards climatic conditions at lower elevations. The topography of the California central coast region, however, can result in significant orographic enhancement of rainfall (i.e., enhancement of rainfall due to topographic relief and mountainous terrain).

Therefore, mean annual precipitation estimates for the project area may be assessed using the Parameter-elevation Regressions on Independent Slopes Model (PRISM)[12]. PRISM is a climate mapping system that accounts for orographic climatic effects and is widely used in watershed studies and TMDL projects to make projections of precipitation into rural or mountainous areas where rain gage data is often absent, or sparse. PRISM is also the U.S. Department of Agriculture's official climatological dataset and PRSIM is used by the U.S. National Weather Service to spatially interpolate rainfall frequency estimates. An isohyetal map for estimated mean annual precipitation in the project area is presented in Figure 2-8.

[12] The PRISM dataset was developed by researchers at Oregon State University, and uses point measurements of precipitation, temperature, and other climatic factors to produce continuous, digital grid estimates of climatic parameters. The dataset incorporates a digital elevation model, and expert knowledge of climatic variation, including rain shadows, coastal effects, and orographic effects. Online linkage: http://www.prism.oregonstate.edu/

Figure 2-8. TMDL Project area mean annual precipitation (1971-2000, source: PRISM).



Based on the statistical summary as calculated by ArcMap® 9.2 for the digitally clipped PRISM grid, average precipitation in the subwatershed can be summarized as follows:

Average precipitation in the Los Berros Creek subwatershed, accounting for orographic effects:
19.4 inches per year (period of record 1971-2000)

2.5 Groundwater

Groundwater (as baseflow) can be a source of nutrient loads to surface waters (USEPA, 1999). In addition, although TMDLs do not directly address groundwater quality problems, many surface waters are in fact designated for groundwater recharge beneficial use in the Basin Plan. Excessive nutrient concentrations in surface waters can potentially contribute to elevated nitrate concentrations in groundwater. Available groundwater data for the TMDL project area indicates degradation of groundwater by nitrate.

Regarding possible nitrate loading to surface waters via baseflow, it is important to consider the nature and scope of hydrologic communication between the creek and the water table. Also, to the extent the GWR (groundwater recharge) beneficial use of surface water is being impacted, the vertical separation between groundwater and surface water and the extent to which hydrologic communication exists needs to be considered. Figure 2-9 illustrates groundwater elevation and groundwater flow direction in aquifers underlying the Los Berros Creek subwatershed during the spring of 2000. The vertical separation between the creek bed and the water table is approximately less than ten feet; locally the water table may be in direct communication with the creek bed. Note that Water Year 1999-2000 was near-average for precipitation (18.6 inches at Pismo Beach precipitation gage 046943), suggesting that on average there is little vertical separation between the Los Berros creek bed and the water table. Further, groundwater levels reported by USGS[13] at a well near Los Berros Creek at Century Road indicate that during wet weather cycles the water table stayed at or near the elevation of the creek bed indicating direct hydrologic communication between the creek bed and the water table (see Figure 2-9. Groundwater elevation and groundwater flow map, Spring 2000.

Further, visual observation indicates sustained flow in the creek, well into the dry season, after abnormally wet winters. Therefore, Los Berros Creek evidently can and does receive sustained groundwater baseflow during abnormally wet water years. Well data confirm these visual observations; Figure 2-10 illustrates that locally, the water table is at or near the creek bed elevation during abnormally wet weather years. During dry weather cycles, the water table is deeper and most or all water in the creek infiltrates and recharges the underlying groundwater resource. It should be noted that localized zones of saturation (perched zones) can exist vertically above the main water table, and may potentially contribute to groundwater seepage into creeks, sometimes perhaps masking the process of deep infiltration. Laterally discontinuous perched zones occur in older dune sands in and around the TMDL project area (Department of Water Resource, 2002). The extent to which these perched zones may contribute locally to groundwater seepage into Los Berros creek is currently unknown.

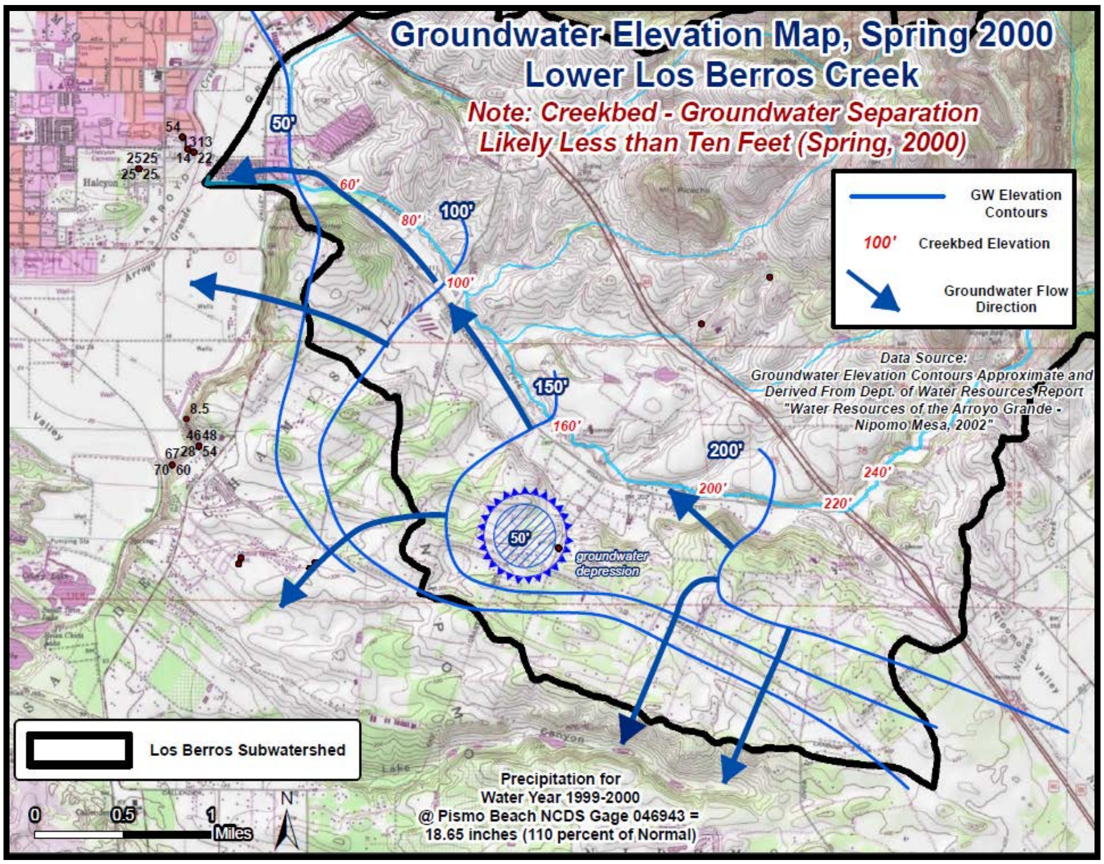


Figure 2-9. Groundwater elevation and groundwater flow map, Spring 2000.

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[13] Groundwater levels are available from the U.S. Geological Survey National Water Information System. Online linkage at http://nwis.waterdata.usgs.gov/ca/nwis/gwlevels

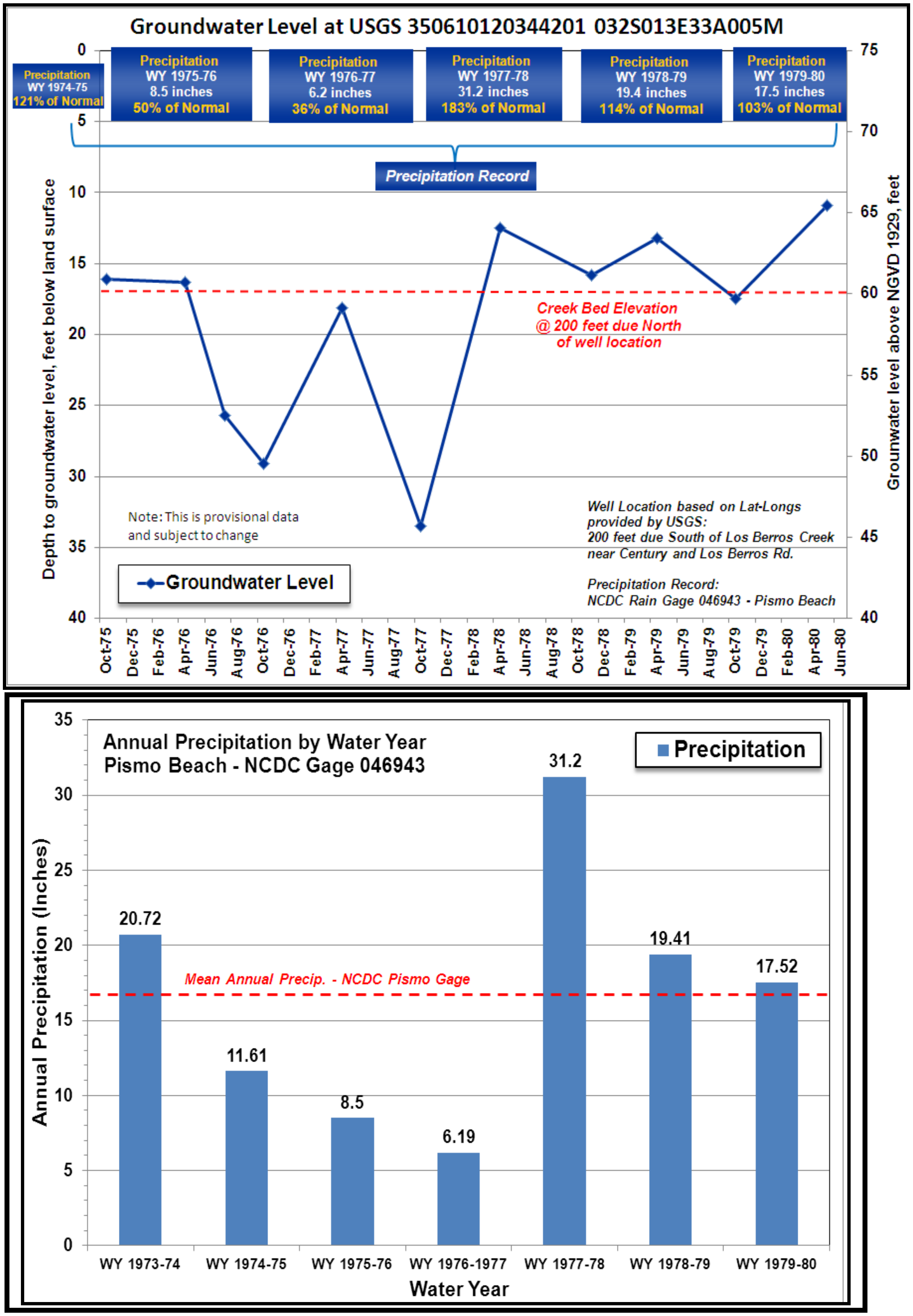
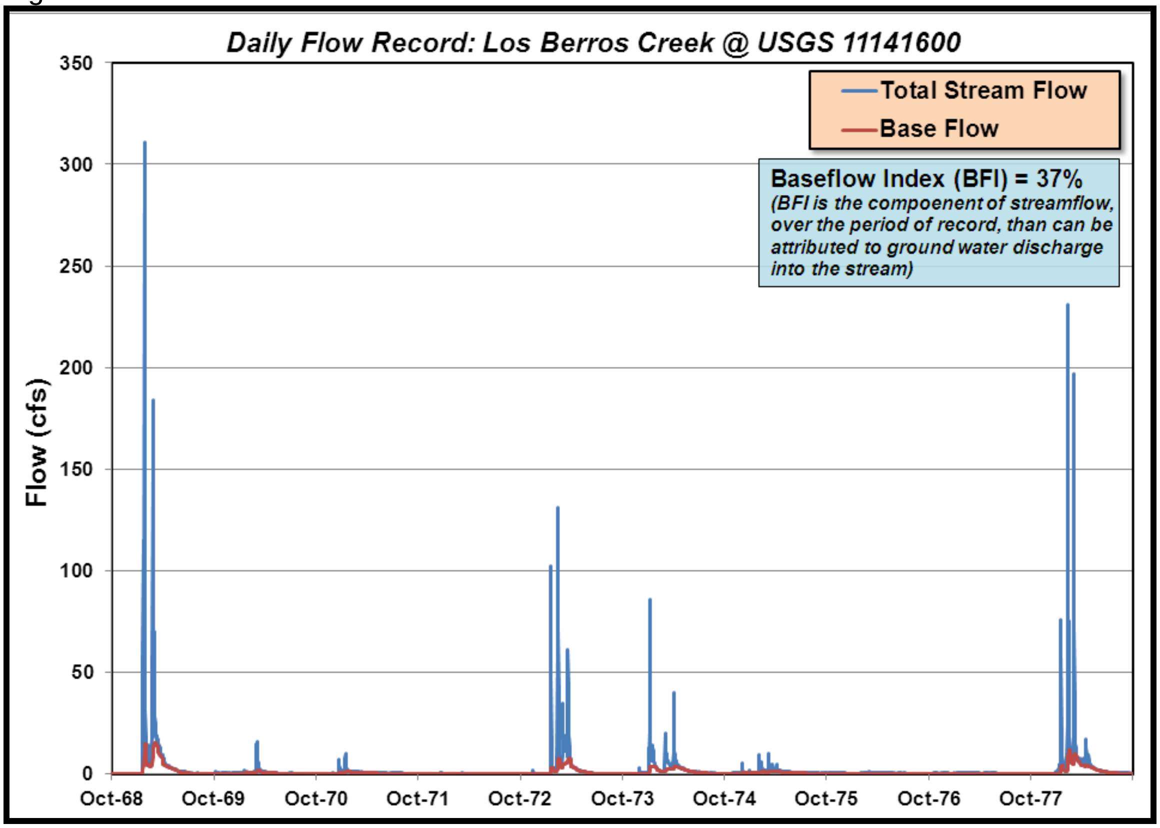


Figure 2-10. Groundwater level, approximate creek bed elevation and precipitation record @ Los Berros Rd. and Century.

Further, flow separation analysis[14] (Figure 2-11) on historical USGS gage 11141600 indicates a baseflow index[15] of 37% (see Figure 2-1 for location of USGS gage). While this USGS gage is located well upstream of the current water quality monitoring sites, and is not necessarily representative of the monitoring sites, it does illustrate that, locally, baseflow can be a significant hydrologic process in this subwatershed.

Figure 2-11. Baseflow index for Los Berros Creek at USGS 11141600.



It should be noted that groundwater resources in the lower Los Berros Creek subdrainage largely exist in unconsolidated alluvial and dune deposits, while groundwater resources in the Los Berros Canyon subdrainage in the upper reaches of the subwatershed occur in fractured shale and bedrock. The groundwater hydraulics of alluvium and fractured bedrock are substantially different from each other.

The following summary observations can be made from the aforementioned data:

- Regional groundwater flow in the Los Berros Creek subwatershed is to the west and southwest;
- Locally, groundwater flows subparallel to Los Berros Creek, and contributes baseflow to the creek;
- Vertical separation between the creek bed and the water table is relatively small during normal to dry conditions: likely only a few feet to perhaps a few tens of feet based on available well data and groundwater elevation maps;

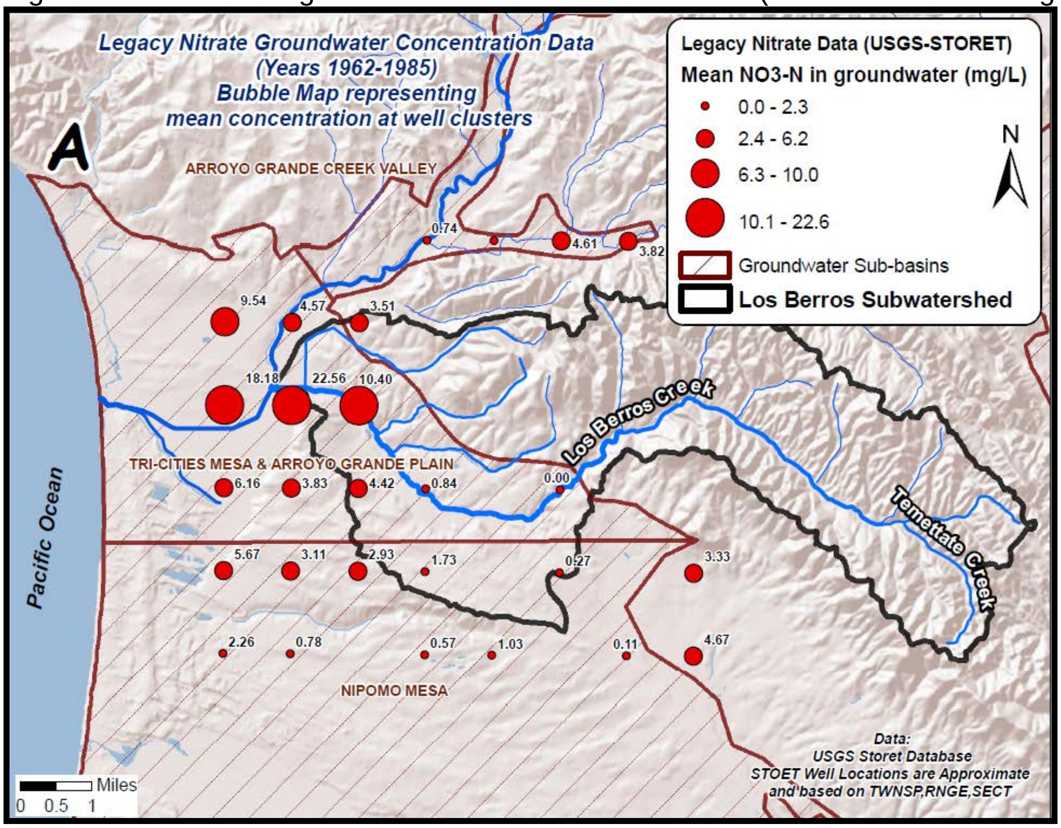
[14] Flow separation was accomplished using the Web-based Hydrograph Analysis Tool (W.H.A.T.) developed by the Purdue University engineering department.

[15] Baseflow is the component of stream flow over the period of record that is attributable to groundwater discharge into the stream.

- During wet weather cycles, some reaches of the creek bed are evidently in direct hydrologic communication with the water table, and sustained groundwater seepage and baseflow in the creek is likely.

An additional reason for developing groundwater data for this TMDL project is that many nutrient loading models (e.g., STEPL, see Section 5.1) require data input for groundwater nitrate concentrations to allow for baseflow load estimates to surface waters. Groundwater data for aquifers underlying the Los Berros Creek subwatershed are available from several sources: measured concentrations of nitrate are available from the State's Groundwater Ambient Monitoring and Assessment Program (GAMA); older vintage groundwater data is available via the USEPA STORET database; and modeled predicted nitrate concentrations are available from the U.S. Geological Survey's Groundwater Vulnerability Assessment (GWAVA) spatial model[16]. Illustrations of these datasets are presented in Figure 2-12 and Figure 2-13. These data indicate that groundwater beneath the lower Los Berros Creek subdrainage, and in groundwater hydraulically downgradient from Los Berros Creek frequently has nitrate concentrations in excess of the drinking water standard (10/mg/L-N).

Figure 2-12. Historical groundwater nitrate concentrations (1960s to 1980s vintage data).



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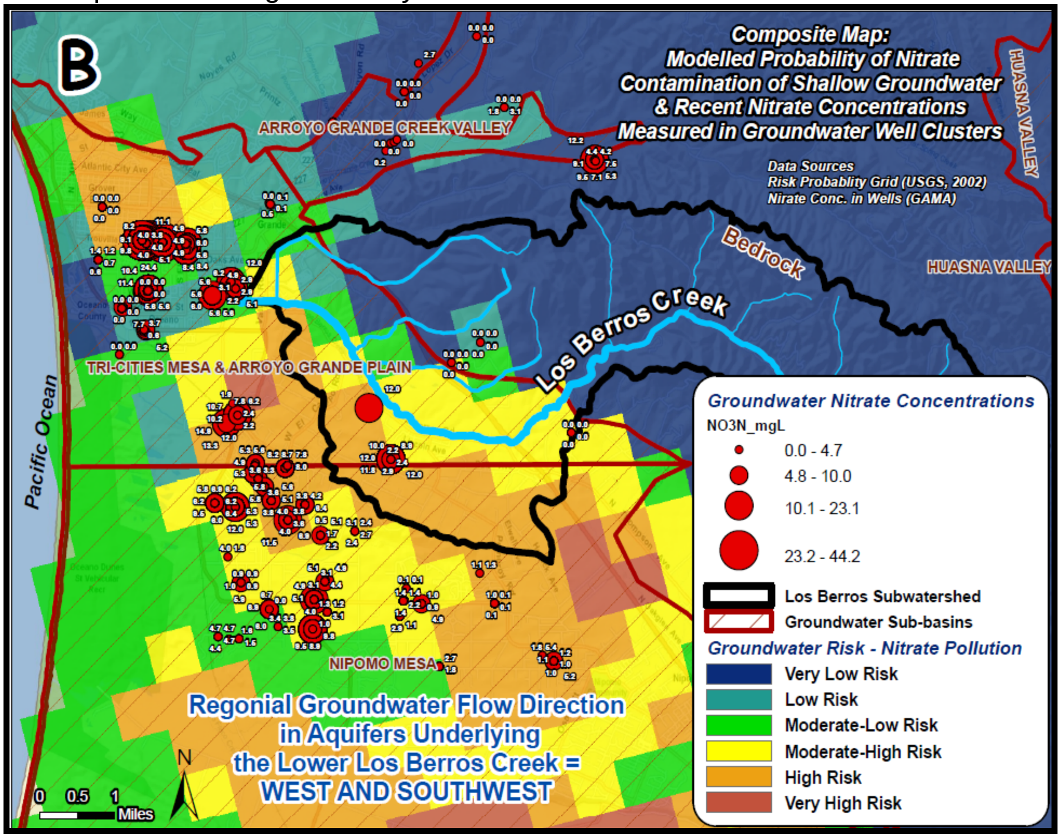
[16] The GWAVA dataset represents predicted nitrate concentration in shallow, recently recharged groundwater in the conterminous United States, and was generated by a national nonlinear regression model based on 14 input parameters.. Online linkage: http://water.usgs.gov/GIS/metadata/usgswrd/XML/gwava-s_out.xml

Figure 2-13. Recent groundwater nitrate concentrations (1990s to 2007) with spatially modeled nitrate pollution risk grid overlay.



Based on groundwater flow directions, hydrologic connectivity, and the potential for baseflow loads to the creek staff evaluated available groundwater data in close proximity to lower Los Berros Creek.

Figure 2-14 and Figure 2-15 present groundwater nitrate concentrations in close proximity to lower Los Berros Creek from two sources: 1) measured groundwater concentrations from the GAMA and Storet datasets; and 2) Spatially-modeled predicted nitrate concentrations in shallow, recently recharged groundwater developed by the U.S. Geological Survey's GWAVA model. Summary statistics shown in both figures indicate the predicted nitrate concentrations and the measured nitrate concentrations comport qualitatively reasonably well with each other. Each dataset has its own strengths and weaknesses: the measured well data represents tangible, measured observations but generally does not have good spatial resolution; includes data of older vintage that may not represent current conditions; wells may be perforated at substantially different depths, and therefore well data may have significant temporal and spatial bias. The modeled-predicted nitrate concentrations provide more consistent spatial and temporal resolution, and focuses on modeling the shallow, recently recharged groundwater horizon, but the predictions have limitations and uncertainties which are inherent in the GWAVA model on which it is based. A plausible estimation of average nitrate concentrations in shallow groundwater in the lower Los Berros Creek drainage may thus be approximated by the averaging the arithmetic means of the two datasets (well data and GWAVA estimates):

Average nitrate concentration observed in recent and current shallow groundwater underlying lower Los Berros Creek:

$[(9.95\ mg/L_{well\ data}) + (6.10\ mg/L_{modeled\ data})] / 2 =$ **8.02 mg/L Nitrate as N**

Nitrate-impacted groundwater has both a natural, ambient background load, and a load attributable to human activities. Consequently, an unimpacted, ambient background groundwater nitrate concentration for the subwatershed can be approximated from the subset of the hydraulically upgradient wells (see Table 2-3), as shown below:

Estimated average, ambient, natural background nitrate concentration that would be expected in unimpacted shallow groundwater underlying lower Los Berros Creek:
= **1.58 mg/L Nitrate as N.**

This estimated background groundwater concentration (1.58 mg/L) is plausible because it is consistent with ambient, natural nitrate concentrations in groundwater in the lower alluvial-agricultural reaches of the Arroyo Seco River watershed of Monterey County, as reported by Moran et at. (2011). These researchers found that ambient, precipitation-derived nitrate in observed wells adjacent to the Arroyo Seco River were always at concentrations less than 4 mg/L, with a mean for all the observed ambient groundwater samples calculated as 1.21 mg/L nitrate a N.

Figure 2-14. Nitrate concentrations in groundwater from wells within 2 kilometer buffer around lower Los Berros Creek (units = mg/L of nitrate as nitrogen).

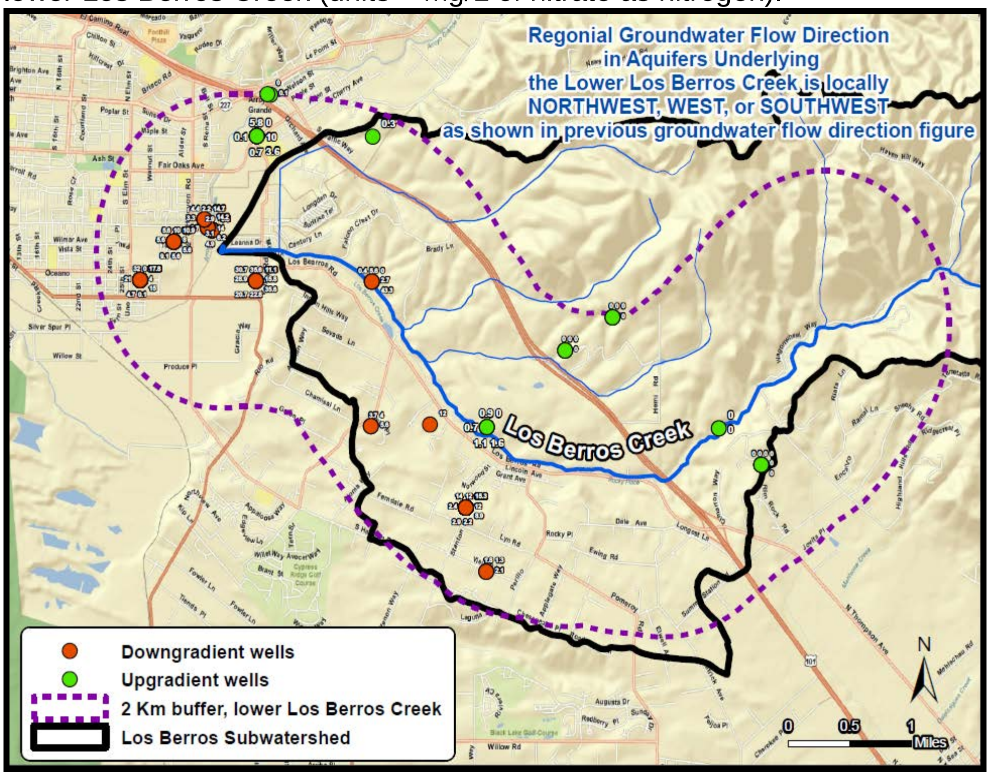


Table 2-3. Nitrate-N concentrations in groundwater - statistics for well locations shown (units = mg/L).

Hydraulically Downgradient Wells		*Hydraulically Upgradient Wells*		*All Wells in 2 Km Buffer*	
Mean	**12.30**	**Mean**	**1.58**	**Mean**	**9.95**
Median	11.10	Median	0.02	Median	7.22
Mode	5.55	Mode	0.02	Mode	0.02
Standard Deviation	9.53	Standard Deviation	3.03	Standard Deviation	9.62

Hydraulically Downgradient Wells		***Hydraulically Upgradient Wells***		***All Wells in 2 Km Buffer***	
Temporal Representation	Feb. 1960- July 2008	Temporal Representation	Mar. 1961- Feb. 2008	Temporal Representation	Feb. 1960- July 2008
Range	43.31	Range	11.78	Range	43.3
Minimum	**ND**	**Minimum**	**ND**	**Minimum**	**ND**
Maximum	**43.33**	**Maximum**	**11.78**	**Maximum**	**43.3**
No. of samples	125	No. of Samples	35	No. of samples	160

Figure 2-15. Spatially-modeled predicted shallow groundwater nitrate-N concentrations underlying the Arroyo Grande Creek watershed.

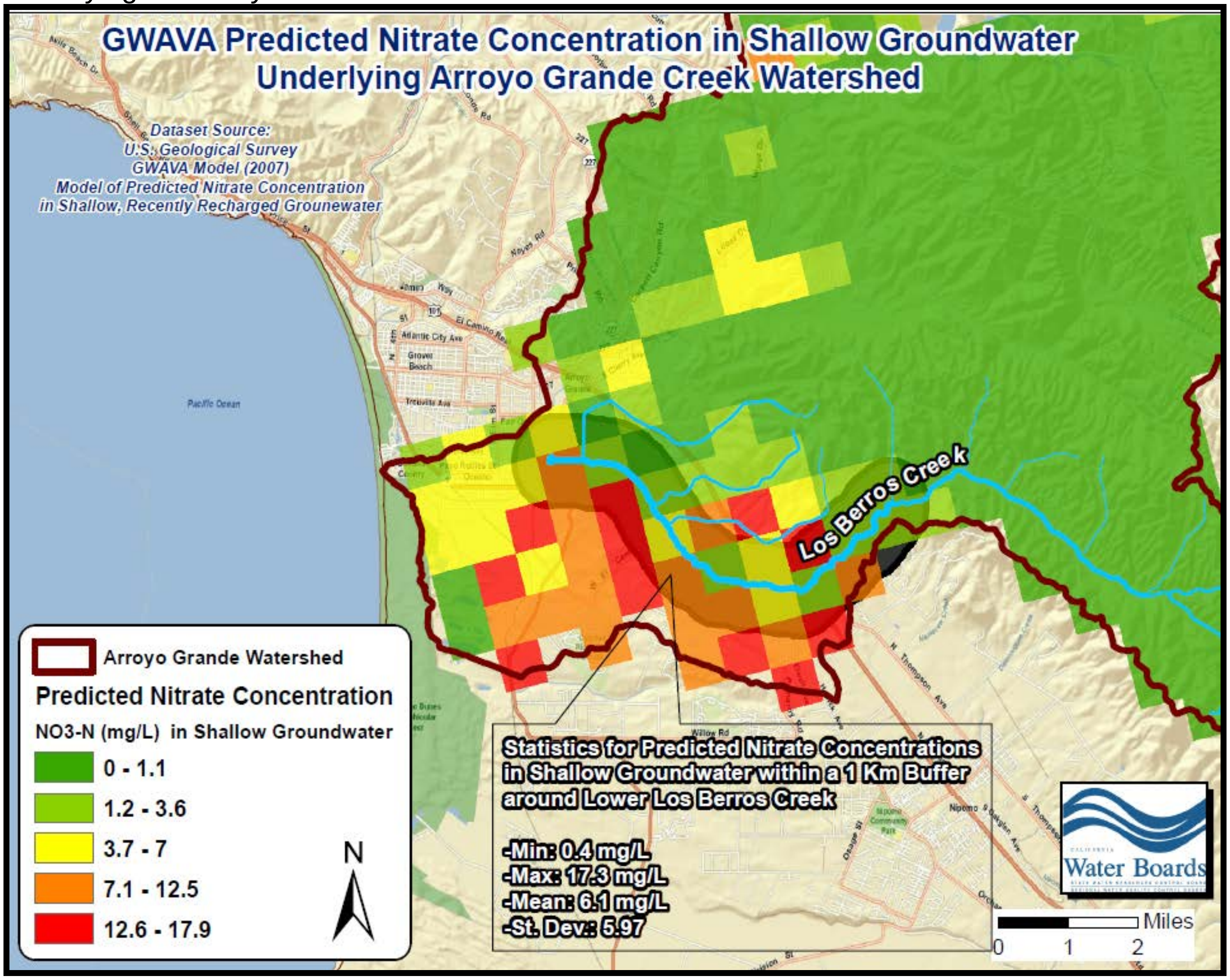


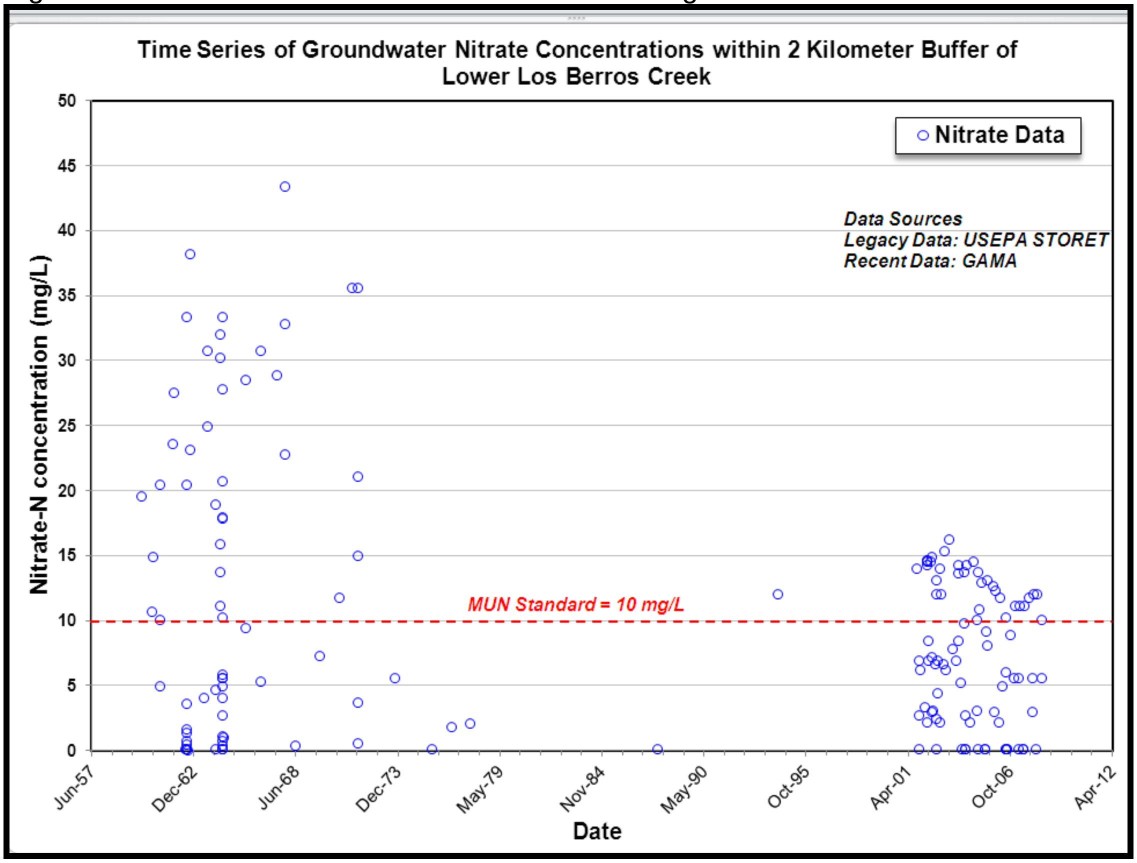
Figure 2-16 presents a time-series of nitrate concentrations in groundwater within a 2 kilometer buffer around lower Los Berros Creek. More recent vintage data generally appears to have lower nitrate concentrations on average. It is important to note that these data cannot be extrapolated to representing regional or basin-wide trends as they are intended to characterize groundwater quality in close proximity to Low Berros Creek. Two possible explanations for locally-decreasing nitrate concentrations are as follows:

- Spatial, temporal, and sampling trends may bias the trend observed in the data; for example wells may not be screened in the same aquifer zone, and high concentration wells may have been abandoned over time; and/or

- Changes in land use practices, and/or improved irrigation efficiency may have reduced nitrate loading, at least locally, to groundwater around Los Berros Creek. For example, anecdotal evidence suggests that some growers in the subwatershed have reportedly shifted to drip irrigation.

Reductions in nitrate loading to ground waters which are proximal to the creek could potentially result in improved creek water quality depending on the nature and scope of groundwater baseflow to the creek.

Figure 2-16. Time series of nitrate concentrations in groundwater.



Finally, it may be important to consider the possibility of existing legacy pollution of shallow groundwater, and the residence time in the subsurface before the groundwater is expressed as baseflow. Legacy pollution (associated with long-residence times in groundwater) may be unrelated to current land use practices, and could potentially be a result of land use practices that occurred many years ago. From an implementation perspective, it could be important to consider whether nitrate pollutant loads in shallow groundwater may express themselves as creek base flow relatively rapidly; or alternatively whether the subsurface residence time of baseflow is on the order of years to decades.

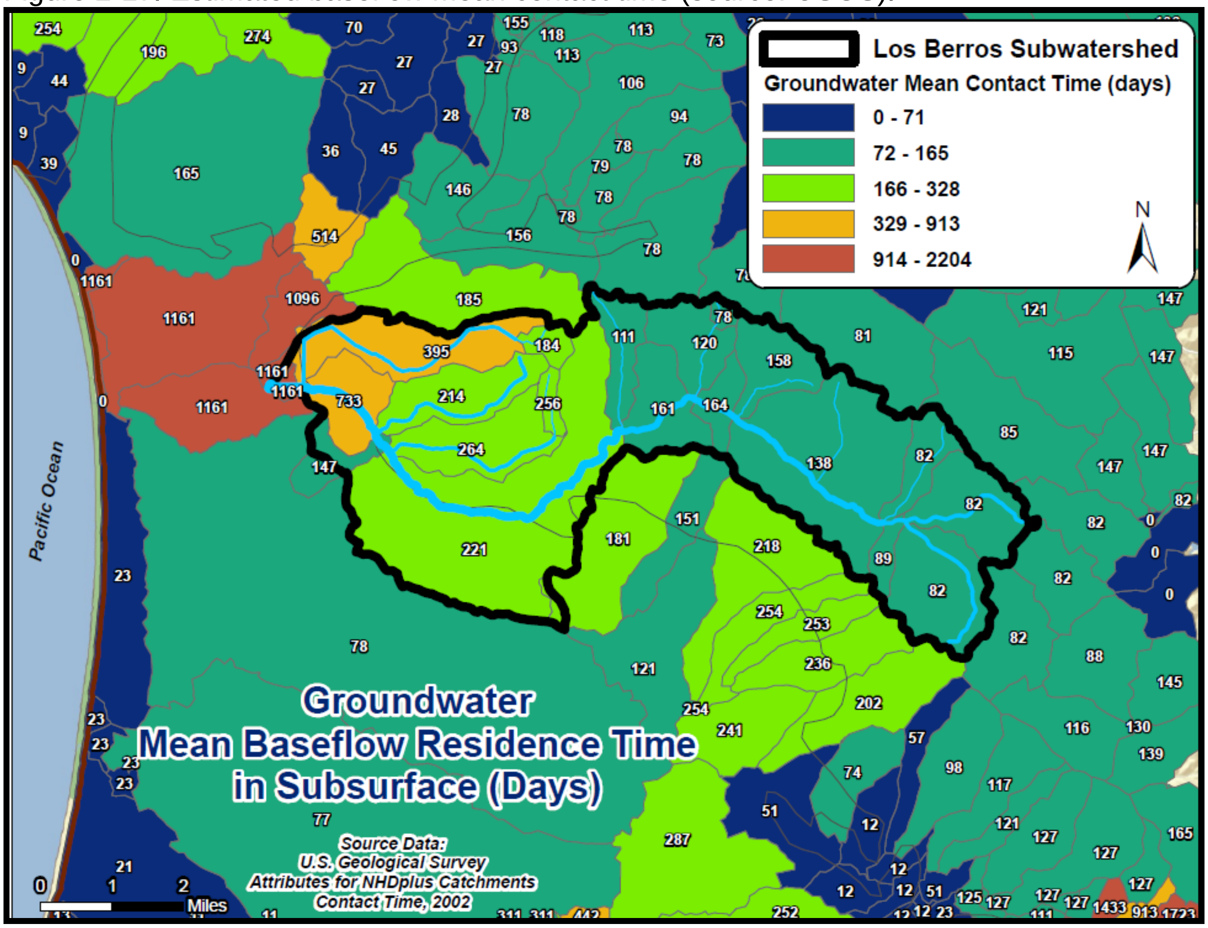
Consequently, staff evaluated groundwater residence time by reviewing available datasets for baseflow mean contact time available from the U.S. Geological Survey[17]. Figure 2-17 illustrates

[17] Data source: Attributes for NHDplus Catchments, Contact Time, 2002. This dataset was created by the U.S. Geological Survey and represents the average contact time, in units of days, compiled for every catchment of NHDplus for the conterminous United States. Contact time is the baseflow residence time in the subsurface. Online linkage: http://water.usgs.gov/GIS/metadata/usgswrd/XML/nhd_contact.xml#stdorder#stdorder

estimated mean groundwater contact time, measured in units of days, and represents average baseflow residence time in the subsurface in each NHDplus catchment.

The data suggest that mean baseflow contact times for catchments in the Los Berros Creek subwatershed are relatively short, generally ranging from several weeks, to a few months, to less than one year. In other words, shallow groundwater baseflow is estimated to move (i.e., flux) relatively rapidly through this hydrogeologic system. *This suggests that nitrate pollution of shallow groundwater, and also potential pollution to the creek resulting from baseflow, is not primarily a legacy pollution problem, but can reasonably be associated with recent or current land practices.*

Figure 2-17. Estimated baseflow mean contact time (source: USGS).



2.6 Geology

Geology may have a significant influence on natural, background concentrations of nutrients. Stein and Kyonga-Yoon (2007) report that catchment geology was the most influential environmental factor on variability in water quality from natural areas in undeveloped stream reaches located in Ventura, Los Angeles, and Orange counties, California. As such, in evaluating the effect of anthropogenic activities on nutrient loading, it is also relevant to consider the potential impact on water quality which might result from local geology and rock geochemistry.

The Los Berros Creek subwatershed lies with a northwest-trending geologic province of the southern central coast region of California, which has been described as an active fold and thrust belt (Nitchman, 1988, as reported in DWR, 2002). This geologic province constitutes a structural and tectonic transition between the Transverse Ranges in southern California and the Coast Ranges province to the north (DWR, 2002). The lower Los Berros Creek subdrainage is underlain largely by unconsolidated alluvium, dune sands, and sandstone. The upper reaches of the subwatershed, including Los Berros Canyon are comprised of geologically-older (Oligocene to Pliocene) consolidated sandstone, mudstone, and alkaline volcanic rock (see Figure 2-18).

Stein and Kyonga-Yoon (2007) concluded that catchments underlain by sedimentary rock had higher stream flow concentrations of metals, nutrients, and total suspended solids, as compared to areas underlain by igneous rock. The mean annual average of nutrient concentrations (wet weather plus dry weather samples), reported by Stein and Kyonga-Yoon (2007), indicates undeveloped stream reaches underlain by igneous rock had mean nutrient concentrations of: total nitrogen=1.12 mg/L, total phosphorus = 0.03 mg/L. In contrast, undeveloped stream reaches underlain by sedimentary rock in contrast had mean nutrient concentrations of: total nitrogen = 1.36 mg/L, total phosphorus = 0.06 mg/L.

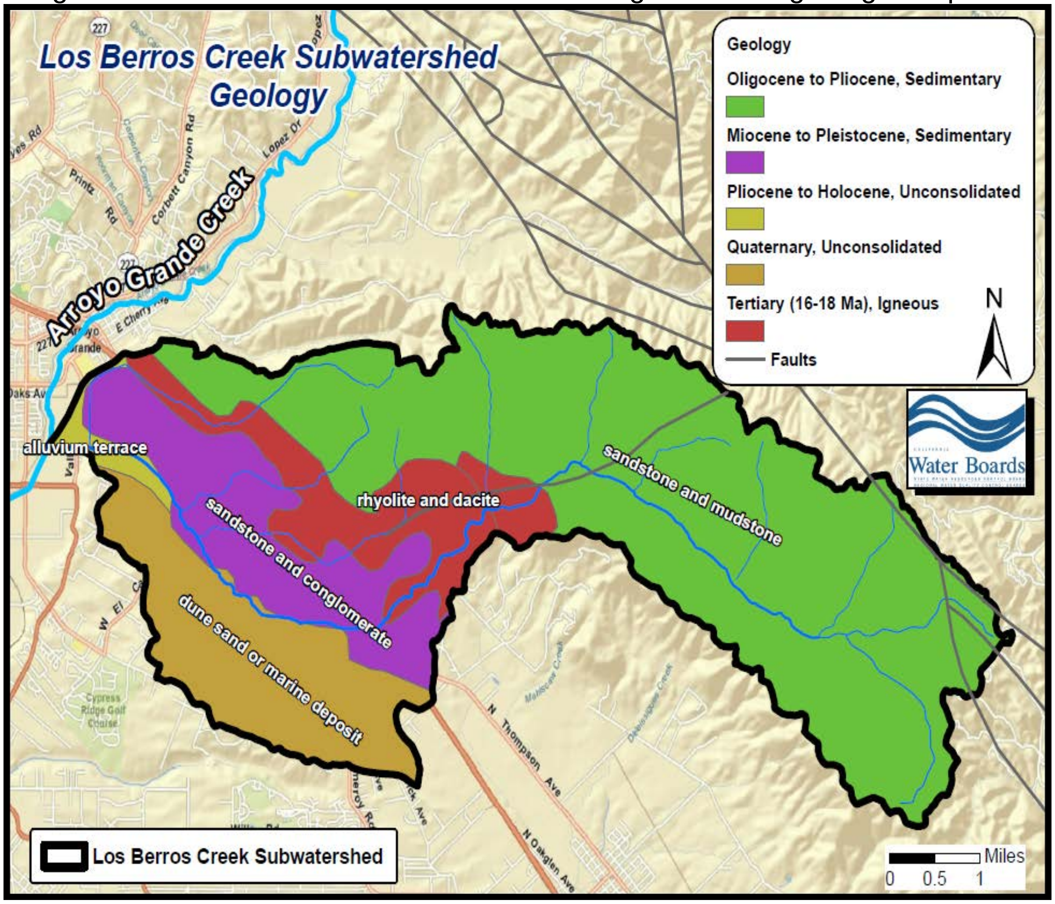
<u>Nitrogen Geochemistry</u>

It is important to note that while the aforementioned researchers indicated that catchment geology can influence “nutrient” concentrations, in fact igneous and metamorphic geology are likely to only influence phosphorus concentrations. Phosphorus is a relatively common minor element in all crystalline mineral assemblages, in contrast nitrogen is not a typical minor element found in crystalline material. Nitrogen-enriched minerals are rare, and are only found in nitrate minerals formed in highly-arid evaporative environments. The Los Berros Creek subwatershed does not contain nitrate-enriched evaporative sedimentary rocks.

With regard to non-mineralogical forms of nitrogen, organic nitrogen is more abundant in sedimentary rocks than in igneous or metamorphic rocks. Nitrogen in sedimentary rocks is typically associated with organic matter, which is commonly deposited with sedimentary strata, mostly shale or mudstone. Note in contrast, organic material is only an infrequent and trace component in most igneous or metamorphic rocks.

Lower Los Berros Creek is largely comprised of alluvium, dune sands, and coarse-grained sedimentary rocks and available data does not indicate the presence of significant amounts of organic-rich mudstones or shales (see Figure 2-18). Further, the ubiquitous mudstones in the upper subwatershed at Los Berros Canyon are evidently not organic-rich because limited amounts of groundwater and surface water data from the upper reaches indicate extremely low, ambient concentrations of nitrate. Consequently, there does not appear to be a significant geologic reservoir in the project area that could contribute to elevated nitrogen loads to surface waters.

Figure 2-18. Los Berros Creek subwatershed generalized geologic map.

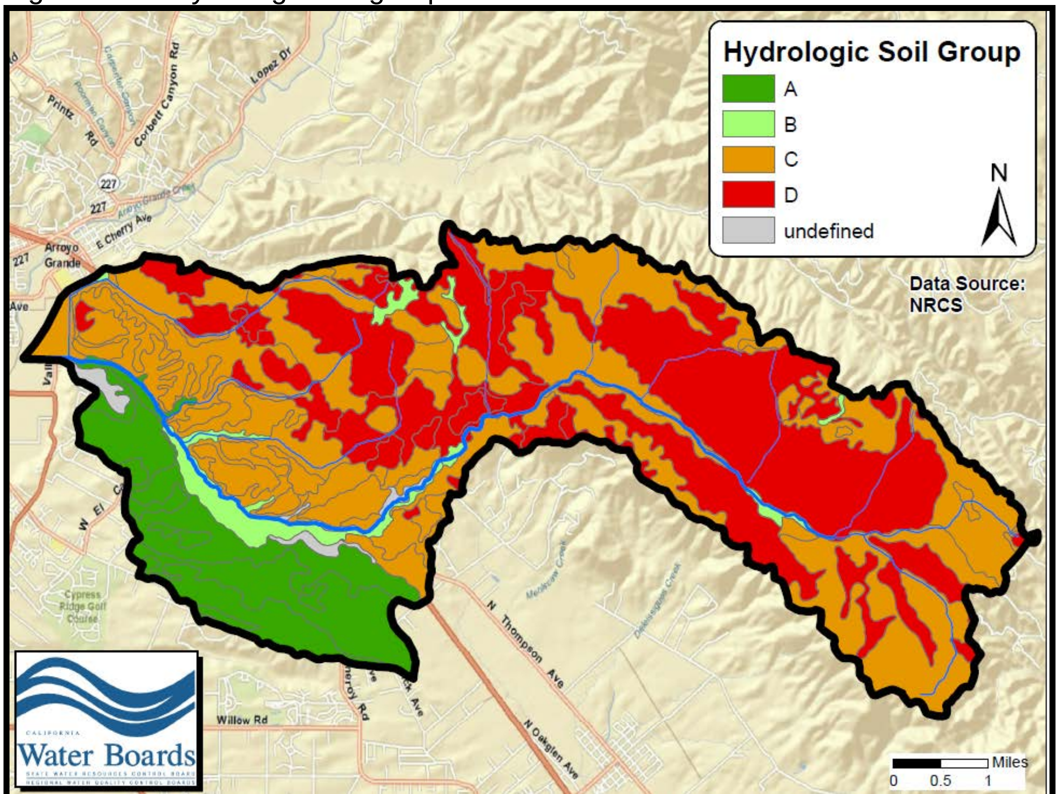


2.7 Soils and Stream Substrate

Soils have physical and hydrologic characteristics which may have a significant influence on the transport and fate of nutrients. Watershed researchers and TMDL projects often assess soil characteristics in conjunction with other physical watershed parameters to estimate the risk and magnitude of nutrient loading to waterbodies (Mitsova-Boneva and Wang, 2008; McMahon and Roessler, 2002). Generally, fine-textured soils with lower capacity for infiltration of precipitation/water are more prone to runoff, and are consequently typically associated with a higher risk of nutrient loads to surface waters.

Additionally, the STEPL source estimation spreadsheet tool used in this project report requires input for soil conditions. Accordingly, this section of the project report summarizes relevant soils information. The soil survey for Monterey County was compiled by the U.S. Department of Agriculture National Resources Conservation Service (NRCS) and is available online under the title of Soil Survey Geographic (SSURGO) Database. SSURGO has been updated with extensive soil attribute data, including Hydrologic Soil Groups. Hydrologic Soil Groups are a soil attribute associated with a mapped soil unit, which indicates the soil's infiltration rate and potential for runoff. Figure 2-19 illustrates the distribution of hydrologic soil groups in the Project Area along with a tabular description of the soil group's hydrologic properties.

Figure 2-19. Hydrologic soil groups in the Los Berros Creek subwatershed.



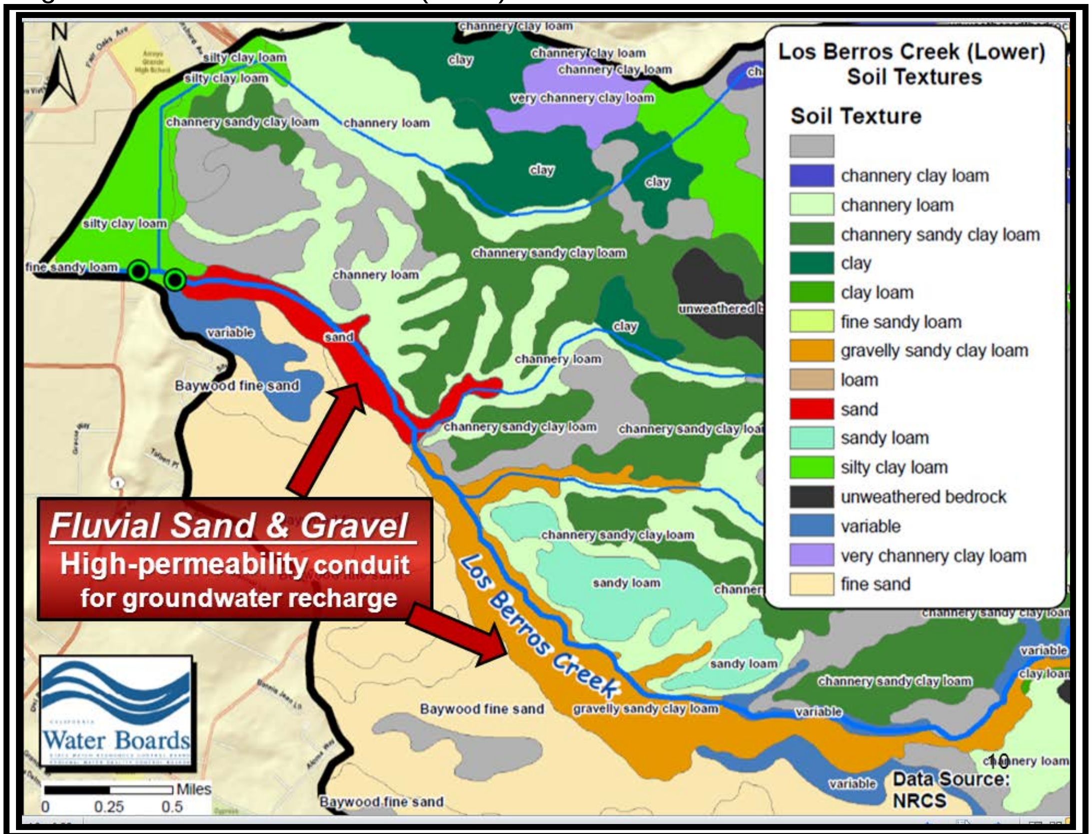
Hydrologic Soil Group Descriptions:	
A	**Well-drained sand and gravel; high permeability**
B	**Moderate to well-drained; fine to moderately course texture; moderate permeability**
C	**Poor to moderately well-drained; moderately fine to fine texture; slow permeability**
D	**Poorly drained; clay soils,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

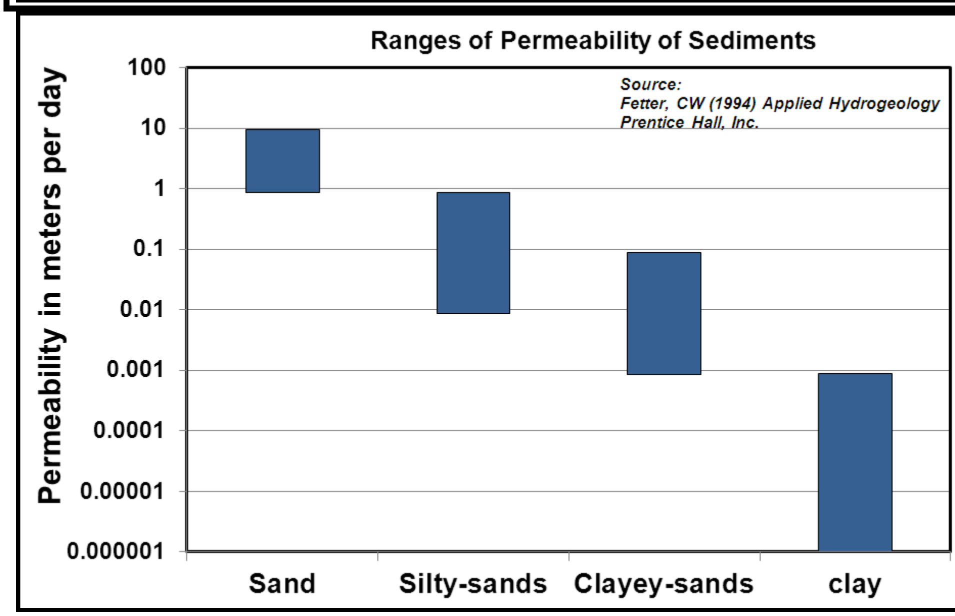
Information on creek substrate conditions are relevant to consider because Los Berros Creek is designated with a groundwater recharge beneficial use.

The Los Berros Creek is a losing stream along all or portions of its stream bed, and stream flow recharges the underlying aquifer through the alluvium along the creek (Todd Engineers, 2007). As shown in Figure 2-20, SSURGO soil attributes data indicate that the lower Los Berros Creek mainstem is comprised primarily of course-grained material such as sand and gravelly loam. Therefore, the creek bed represents a high-permeability, and efficient conduit for groundwater recharge. Permeability is a measure of a soil or rock's ability to transmit fluid. The observation that there is frequently very little vertical separation between the creek bed and the underlying groundwater resource (refer back to Section 2.5) indicates there is presumably relatively little opportunity for distance attenuation of nitrate, or other pollutants, that may be present in creek waters as they percolate to the water table. Figure 2-20 illustrates creek bed soil conditions and a graph comparing the permeability of various soil textures. Note that in sandy soils, water can be transmitted as rates as high as one to ten meters (3.3 feet to 33 feet) per day (see Figure 2-20).

Therefore, based on the aforementioned information, transmission of nitrate-impaired Los Berros creek surface waters recharging to the shallow subsurface saturated zone of groundwater could locally happen quite rapidly, with little opportunity for attenuation.

Figure 2-20. Los Berros Creek (lower) soil textures.



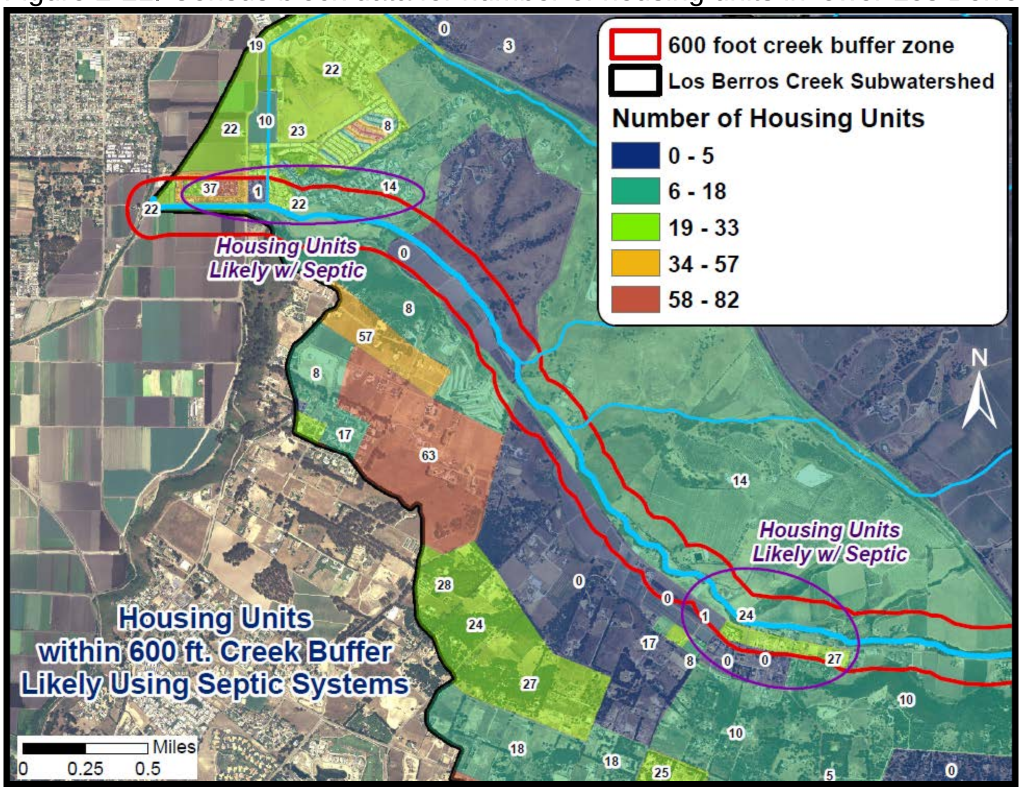


2.8 Census Data

The source analysis tool used in the TMDL (STEPL spreadsheet tool) requires inputs to estimate the nitrate loads from septic systems; therefore it is necessary to have watershed-specific demographic data on the number of housing units in the TMDL project area. The vast majority of the subwatershed consists of rural areas which are not sewered. State Water Resources Control Board recently estimated the number of existing septic systems found within

600 feet of 303(d) listed waterbodies (SWRCB, 2008). This estimate was based on the assumption that only homes and businesses within 600 feet of the impaired water bodies would have the potential to have an impact on surface waters. Therefore, staff clipped census block data for housing units to a 600 foot buffer around lower Los Berros Creek (see Figure 2-21). It is important to recognize that digitally clipping census blocks to a discrete buffer can overestimate septic systems within 600 feet of the creek, because census block boundaries do not geographically conform to the geometry of the buffer, and hence the attributes associated with an entire individual census block can "bleed" into the buffer zone. However, using the census data and best professional judgment, staff derived a plausible estimate of 100 housing units falling within the 600 foot buffer.

Figure 2-21. Census block data for number of housing units in lower Los Berros Creek.



2.9 Estimated Anthropogenic Nitrogen Inputs in the Watershed

Figure 2-22 illustrates a spatial representation of estimated total nitrogen inputs (kilograms per hectare, and total nitrogen-kilograms, year 2002) to the Arroyo Grande Creek watershed area from fertilizer and manure. Note that these data do not represent water column loads; they are estimated watershed-wide, land-based inputs of nitrogen from fertilizer and manure on a unit-area basis (kilograms per hectare). These data are based on National Hydrography Dataset attributes created by scientists at the U.S. Geological Survey (USGS).[18] It should be emphasized that these are modeled estimates produced by USGS scientists, but site-specific or real-time conditions pertaining to nutrient inputs can vary. The figure also illustrates the location of the Los Berros Creek subwatershed, nested within the larger Arroyo Grande Creek watershed.

[18] This spatial dataset was created and used by the U.S. Geological Survey (USGS) specifically to estimate nitrogen and phosphorus inputs from manure and fertilizer per watershed segment in the application of the national SPAtially Referenced Regression On Watershed attributes (SPARROW) model.

As indicated by the spatial distributions shown in the figure, the lower Los Berros Creek subdrainage has a substantially higher estimated intensity of nitrogen inputs from human activities (fertilizer and manure) relative to the Los Berros Canyon subdrainage. This is undoubtedly due to the presence of more intensive cultivated cropland operations in the lower Los Berros Creek subdrainage (refer back to Figure 2-3).

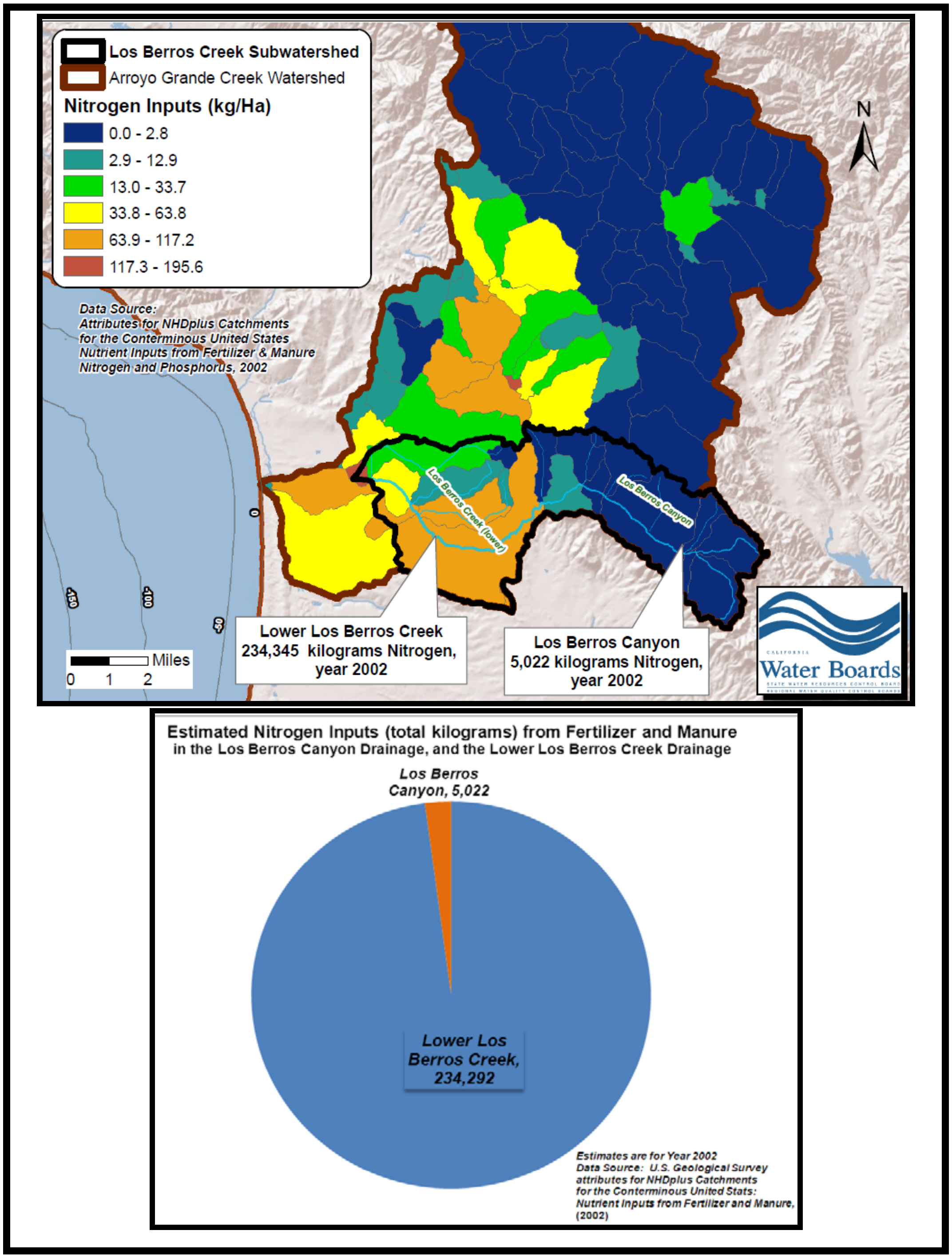


Figure 2-22. Estimated total nitrogen inputs (kg/ha- year 2002) from fertilizer and manure

3 PROBLEM IDENTIFICATION

3.1 Beneficial Uses

California's water quality standards designate beneficial uses for each waterbody (e.g., drinking water supply, aquatic life support, recreation, etc.) and the scientific criteria to support that use. The California Central Coast Water Board is required under both State Federal Law to protect and regulate beneficial uses of waters of the state. Beneficial uses are regarded as existing whether the water body is perennial or ephemeral, or the flow is intermittent or continuous. Table 3-1 presents the current beneficial use designations for the Los Berros Creek subwatershed.

Table 3-1. Basin Plan designated beneficial uses for Los Berros Creek

Waterbody Name	MUN	AGR	PROC	IND	GWR	REC1	REC2	WILD	COLD	WARM	MIGR	SPWN	BIOL	RARE	EST	FRESH	COMM	SHELL
Los Berros Creek	X	X			X	X	X	X	X		X			X			X	

MUN: Municipal and domestic water supply.
AGR: Agricultural supply.
PRO: Industrial process supply.
IND: Industrial service supply.
GWR: Ground water recharge.
REC1: Water contact recreation.
REC2: Non-Contact water recreation.
WILD: Wildlife habitat.
COLD: Cold fresh water habitat.
WARM: Warm fresh water habitat.
MIGR: Migration of aquatic organisms.
SPWN: Spawning, reproduction, and/or early development.
BIOL: Preservation of biological habitats of special significance.
RARE: Rare, threatened, or endangered species
EST: Estuarine habitat.
FRESH: Freshwater replenishment.
COMM: Commercial and sport fishing.
SHELL: Shellfish harvesting.

A brief narrative description of the designated beneficial uses of Los Berros Creek which are most likely to be potentially at risk of impairment by water column nitrate are presented below.

3.1.1 Municipal and Domestic Water Supply (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 under certain conditions (see Basin Plan, Chapter 2, Section II.)

The nitrate numeric water quality objective protective of the MUN beneficial use is legally established as 10 mg/L[19] nitrate as nitrogen (see Basin Plan, Table 3-2)

3.1.2 Ground Water Recharge (GWR)

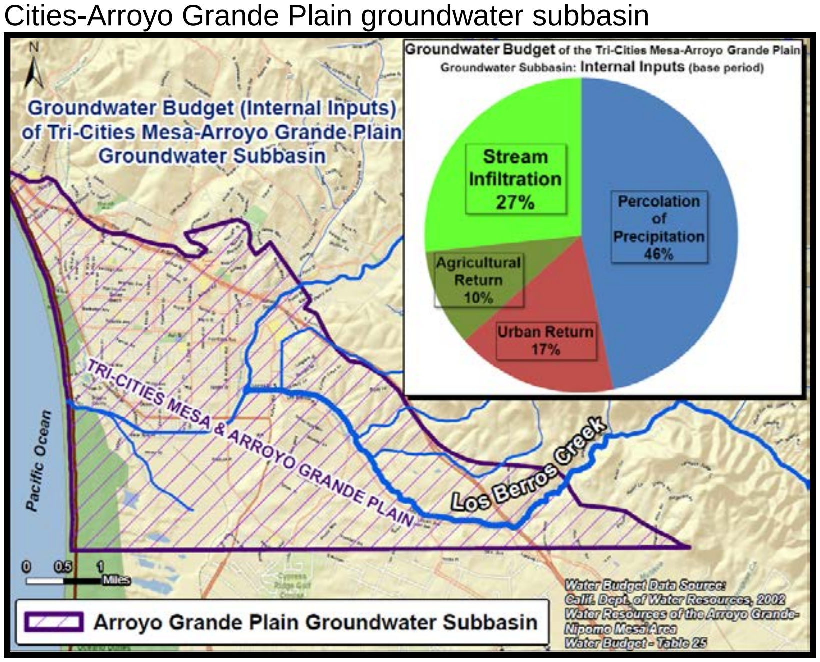
*Uses of water for natural or artificial recharge of ground water for purposes of future extraction, **maintenance of water quality**, or halting of saltwater intrusion into freshwater aquifers. Ground water recharge includes recharge of surface water underflow. (emphasis added)*
- (see Basin Plan, Chapter 2, Section II.)

[19] This value is equivalent to, and may be expressed as, 45 mg/L nitrate as NO3.

The groundwater recharge (GWR) beneficial use is recognition of the fundamental nature of the hydrologic cycle, and that surface waters and ground water are not closed systems that act independently from each other. Most surface waters and ground waters of the central coast region are both designated with the MUN beneficial use. The MUN nitrate water quality objective (10 mg/L) therefore applies to *both* the creek water, and to the underlying groundwater. This numeric water quality objective and the MUN designation of underlying groundwater is relevant to the extent that portions of the Los Berros Creek recharge the underlying groundwater resource. The Basin Plan GWR beneficial use explicitly states that the designated groundwater recharge use of surface waters are to be protected to maintain groundwater quality. Note that surface waters and ground waters 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 beneficial use of the underlying ground water resource. Indeed, protection of the GWR beneficial use of surface waters has been recognized in approved California TMDLs[20]. The Basin Plan does not specifically identify numeric water quality objectives to implement the GWR beneficial use, 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).

In terms of assessing potential impacts to the GWR beneficial use, it is important to consider the magnitude or importance of stream infiltration to the groundwater resource. Todd Engineers (2007) reported that inflow to the groundwater subbasin underlying the Arroyo Grande coastal plain includes inflows originating from the alluvium along Los Berros Creek. Further, the California Department of Resources (2002) estimated that stream infiltration accounted for a substantial amount of the water budget internal inputs[21] to the Tri-Cities-Arroyo Grande Plain groundwater subbasin which underlies the Los Berros and Arroyo Grande creeks (see Figure 3-1). Collectively, available information indicates that groundwater recharge of Los Berros Creek is an important hydrologic process pertaining to the supply and maintenance of local groundwater drinking supply resources.

Figure 3-1. Map with pie chart inset: total stream infiltration contribution to water budget of Tri-Cities-Arroyo Grande Plain groundwater subbasin



[20] for example, see RWQCB-Los Angeles Region, Calluguas Creek Nitrogen Compounds TMDL, 2002. Resolution No. 02-017, and approved by the State of California Office of Adminstrative Law, OAL File No. 03-0519-02 SR.

[21] External inputs include inflows from adjacent groundwater subbasins.

3.1.3 Agricultural Supply (AGR)

Uses of water for farming, horticulture, or ranching including, but not limited to, irrigation, stock watering, or support of vegetation for range grazing (see Basin Plan, Chapter 2, Section II.).

In accordance with the Basin Plan, interpretation of the amount of nitrate which adversely effects of the agricultural supply beneficial of waters of the State use 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[22]. 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 nitrates in irrigation water can potentially create problems for nitrogen sensitive crops (e.g., grapes, avocado, citrus) 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. For example, according to Ayers and Westcot (1985)[23] 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. In many grain crops, excess nitrogen may promote excessive vegetative growth producing weak stalks that cannot support the grain weight. 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 especially when the concentration exceeds 10 mg/L nitrate as N[24]. Should this be ignored, the resulting excess input of nitrogen could cause problems such as excessive vegetative growth and contamination of groundwater[25].

Further, the Basin Plan provides water quality objectives for nitrate which are protective of the AGR beneficial uses for livestock watering. Accordingly, the safe threshold of nitrate-N for purposes of livestock watering is 100 mg/L[26].

Also noteworthy is that the AGR beneficial use not only applies to the surface waters of Los Berros Creek, but also to the underlying groundwater resource. Therefore, the groundwater recharge (GWR) beneficial use of the creek provides the nexus between protection of designated AGR beneficial uses of both the creek waters and the underlying groundwater resource (refer back to Section 3.1.2).

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[22] The Univesity 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

[23] R.S. Ayers (Soil and Water Specialist, Univ. of Calif.-Davis) and D.W. Westcot (Senior Land and Water Resources Specialist – Calif. Central Valley Regional Water Quality Control Board) published in UN-FAO Irrigation and Drainage Paper 29 Rev.1

[24] 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, USDA/NRCS area resource conservationist; and J.G. Davis, Extension soils specialist and professor, soil and crop sciences

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

[26] 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).

3.1.4 Aquatic Habitat (COLD, MIGR)

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.

The Basin Plan water quality objective protective of COLD and MIGR and which is most relevant to nitrate (i.e., nutrient) pollution[27] is the biosimulatory substances objective. 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 COLD dissolved oxygen shall not be depressed below 7 mg/L.

3.2 Water Quality Objectives

The Central Coast Region's Water Quality Control Plan (Basin Plan) contains specific water quality objectives that apply to nitrate and nutrient-related parameters. These water quality objectives are established to protect beneficial uses and are compiled in Table 3-2.

[27] 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 nitrate and nutrient-related parameters (biostimulation).

Constituent Parameter	Source of Water Quality Objective	Numeric Target	Primary Use Protected
Nitrate as N	Basin Plan numeric objective	10 mg/L	MUN, GWR (Municipal/Domestic Supply; Groundwater Recharge[28])
Nitrate as N	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*
Nitrate (NO3_N) plus Nitrite (NO2_N)	Basin Plan numeric criteria (Table 3-4 in Basin Plan)	100 mg/L National Academy of Sciences-National Academy of Engineers guidelines	AGR (Agricultural Supply - livestock watering)
Nitrite (NO2_N)	Basin Plan numeric criteria (Table 3-4 in Basin Plan)	10 mg/L National Academy of Sciences-National Academy of Engineers guidelines	AGR (Agricultural Supply - livestock watering)
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: *"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." (Basin Plan,Chapter 3)*	None – narrative objective	General Objective for all Inland Surface Waters, Enclosed Bays, and Estuaries *(biostimulatory substances objective)* -- (e.g., WARM, COLD, REC, WILD, EST)

[28] The groundwater recharge beneficial use is defined in the basin plan as "*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)*. Therefore, the GWR beneficial uses of surface waters must be protected so as to maintain the water quality of the underlying groundwater resource where neccessary. Groundwater underlying the Los Berros Creek watershed is designated for municipal and domestic drinking water supply and is therefore required to meet the drinking water standard of 10 mg/L nitrate as N, just as the surface water of the creek is. The State of California has developed several TMDLs which explicitly cite protection of the GWR beneficial use of the surface waterbody as a compelling reason for TMDL development (See Calleguas Creek Nitrogen Compounds TMDL, and Santa Clara River Nitrogen Compounds TMDL). Consequently, GWR is a beneficial use a TMDL must protect.

3.3 California CWA Section 303(d) Listing Policy

The Central Coast Water Board assesses water quality monitoring data for surface waters every two years to determine if they contain pollutants at levels that exceed protective 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), water body and pollutants that exceed protective water quality standards are placed on the State's 303(d) List of impaired waters. The 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 (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 nitrate[29] is considered a toxicant, low dissolved oxygen, chlorophyll a and pH, are conventional pollutants. Thus, impairments by nitrate and unionized ammonia are assessed on the basis of Table 3-3; dissolved oxygen and chlorophyll (which may be expressions of potential nutrient-related biostimulation problems) 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

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

Sample Size	Number of Exceedances needed to assert impairment
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	

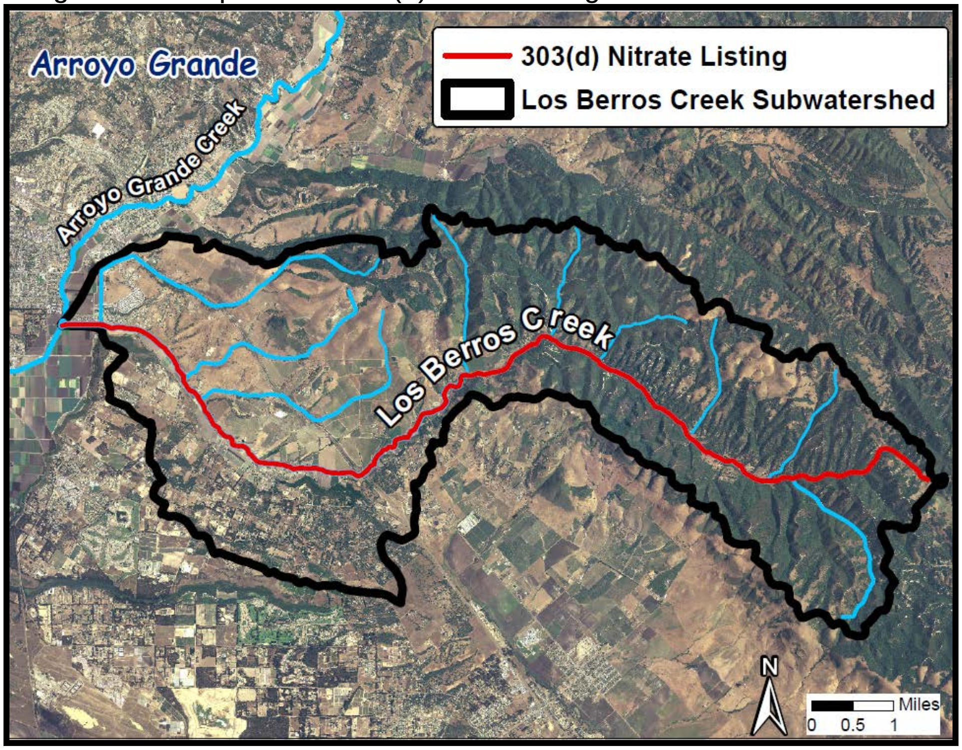
3.4 CWA Section 303(d) Listings

The final 2010 Update to the 303(d) List and 303(d)/305(b) Integrated Report for the Central Coast contains 303(d) listings for Los Berros Creek, and are presented in Table 3-5. This TMDL is addressing the 303(d) nitrate listing; other listings for Los Berros Creek will be addressed through a separate TMDL process or a water quality standards action. Figure 3-2 presents the nitrate 2010 303(d) listing in map view. It should be noted that water quality monitoring data is frequently spatially limited in extent, and limited to creek locations with public access. The only monitoring data currently available is from the lowermost reach of Los Berros Creek. However, the State policy is to conservatively and presumptively presume that the impairment could extend all the way upstream to the upper reaches of the watershed (e.g., Los Berros Canyon), unless and until additional data or information is available to rule out upstream impairments.

Table 3-5. 303(d) listings for Los Berros Creek

HU*	WATER BODY NAME	WBID Number	POLLUTANT NAME	LIST STATUS
310	Los Berros Creek	CAR3103102319990304143314	Nitrate	TMDL Required
310	Los Berros Creek	CAR3103102319990304143314	Chloride	TMDL Required
310	Los Berros Creek	CAR3103102319990304143314	Sodium	TMDL Required

Figure 3-2. Map view of 303(d) nitrate listing for Los Berros creek.



3.5 Water Quality Data Analysis

3.5.1 Water Quality Data Sources and Monitoring Sites

The surface water quality data used for this Project included water quality data from the Central Coast Ambient Monitoring Program[30] (CCAMP), and the Cooperative Monitoring Program (CMP)[31]. One older vintage surface water quality sample is available from the U.S. Geological Survey at the location of historical stream gage 11141600 in the upper reaches of the subwatershed. Groundwater quality data used in this project report are from the State's Groundwater Ambient Monitoring and Assessment Program[32] (GAMA), and legacy data used is from the U.S. Environmental Protection Agency's STORET[33] database. GAMA is California's comprehensive groundwater quality monitoring program. These data sources are tabulated below.

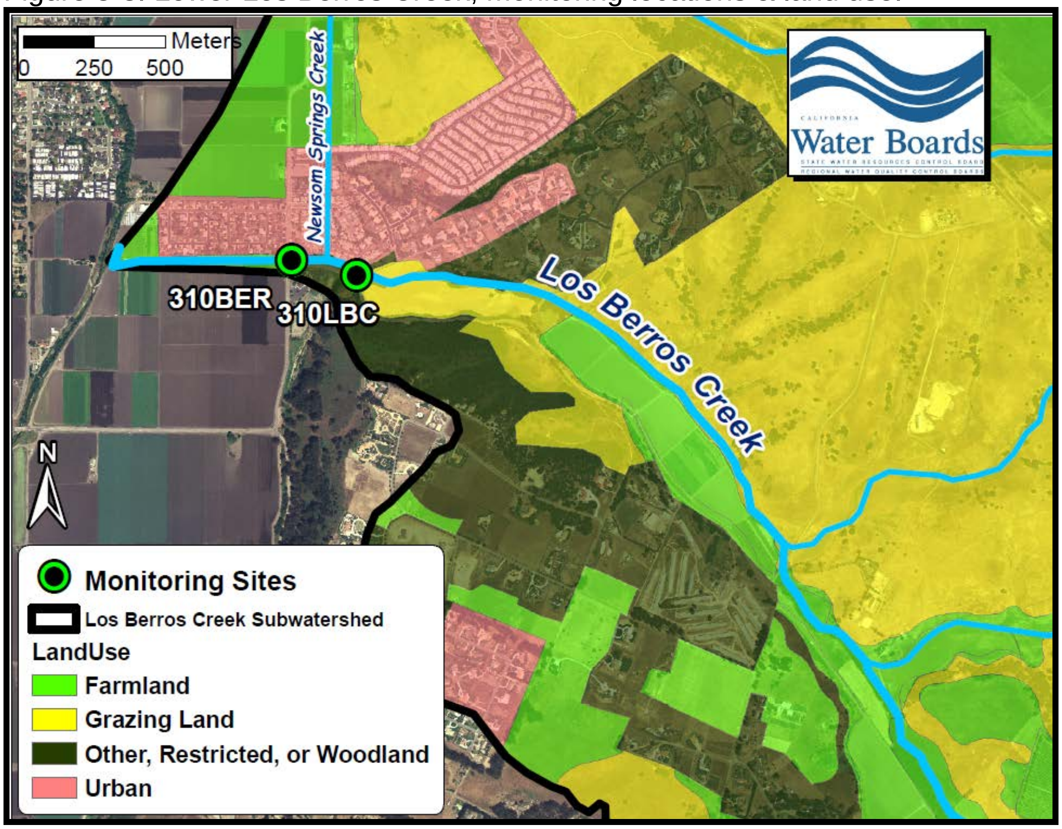
1 Central Coast Ambient Monitoring Program (CCAMP). CCAMP is the Central Coast Water Board's regional scaled water quality monitoring and assessment program.
2 Cooperative Monitoring Program (Central Coast Water Quality Preservation, Inc.)
3 U.S. Geological Survey (one surface water sample)
4 GAMA (groundwater data)
5 USEPA-STORET (groundwater data)

The locations of surface water monitoring locations were previously presented in Figure 3-3. Site 310LBC is location at Century Road; site 310BER is located about half a kilometer downstream of

[30] CCAMP is the Central Coast Water Board's regionally-scaled water quality monitoring program. The Water Board's CCAMP data is collected by the Board's in-house staff consisting of trained field scientists and technicians.
[31] CMP is managed by Central Coast Water Quality Preservation, Inc. on behalf of irrigated agriculture throughout the Central Coast region.
[32] GAMA is California's comprehensive groundwater quality monitoring program, with data collected and compiled from several agencies.
[33] http://www.epa.gov/storet/

310LBC at Valley Road and is downstream of the confluence of a tributary drainage feature identified as Newsom Springs Creek[34]. Newsome Springs Creek is reported by the City of Arroyo Grande (2008) as capturing storm water runoff from undeveloped, residential, and agricultural lands directly to the north of lower Los Berros Creek. Appendix B: Water Quality Data contains a tabulation of monitoring site data for the TMDL project area.

Figure 3-3. Lower Los Berros Creek, monitoring locations & land use.



3.5.2 Water Quality Spatial and Temporal Trends

Figure 3-4 illustrates a spatial representation of the average concentrations of nitrate (as N) at monitoring sites located at various stream reaches throughout the Arroyo Grande Creek watershed area. Lower Los Berros Creek, at site 310LBC, on average has the highest levels of surface water column nitrate observed in the Arroyo Grande-area.

[34] The City of Arroyo Grande identifies this drainage feature as "Newsome Springs Creek), in the City of Arroyo Grande Storm Water Master Management June 2008.

Figure 3-4. Bubble map of mean nitrate concentrations in creeks of the Arroyo Grande watershed.

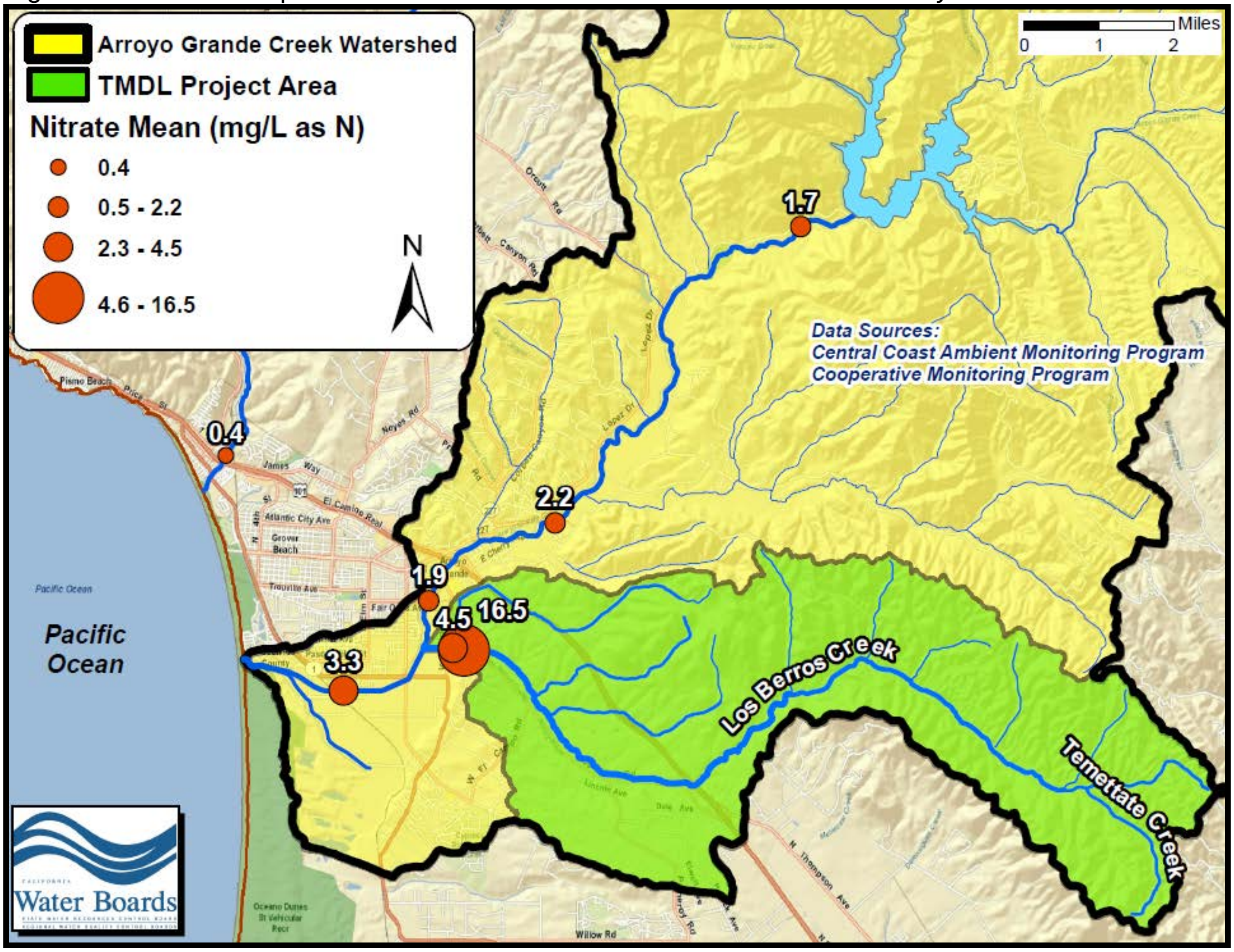
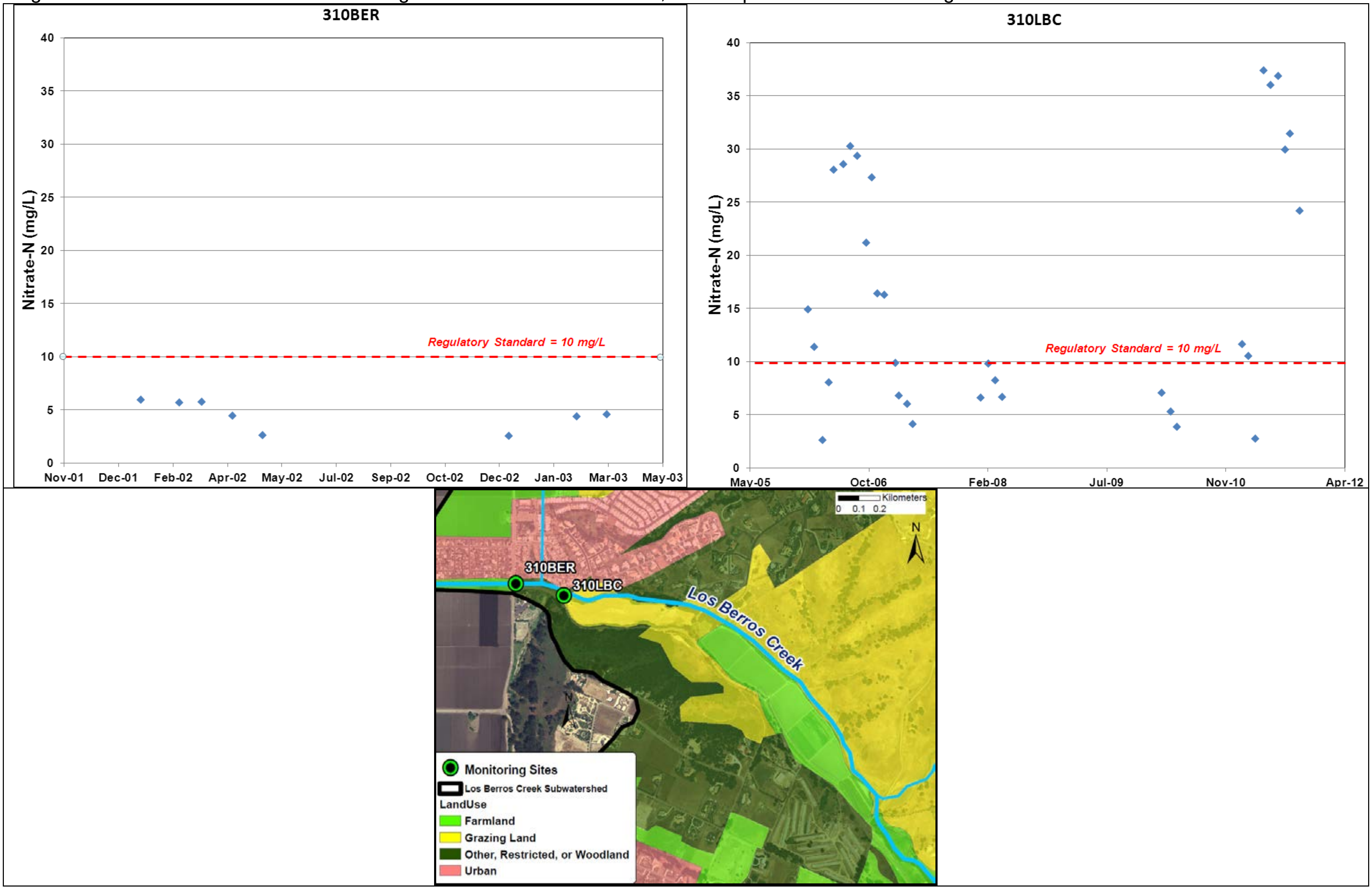


Figure 3-5 presents time series of nitrate concentrations at monitoring sites 310BER and 310LBC. As can be seen from the map inset in the figure, site 310BER captures upstream rural and agricultural drainage as well as residential-urban drainage from developed areas on the north side of Los Berros Creek. Site 310 LBC located at Century Road is far enough upstream to exclude any substantial urban drainage, and primarily captures drainage coming from upstream rural and agricultural lands. Note that for the period of record for site 310LBC, frequent exceedances of the regulatory standard are observed.

Figure 3-5. Nitrate time-series at monitoring sites 310BER and 310LBC, with map location of monitoring sites.



3.5.3 Water Quality Seasonal Trends

Seasonal trends in nitrate water quality data are presented Figure 3-6. The water quality monitoring data show a strong pattern of seasonality, with substantially higher nitrate concentrations, on average, in the dry season as summarized in Table 3-6.

Figure 3-6. Nitrate concentrations seasonal trends

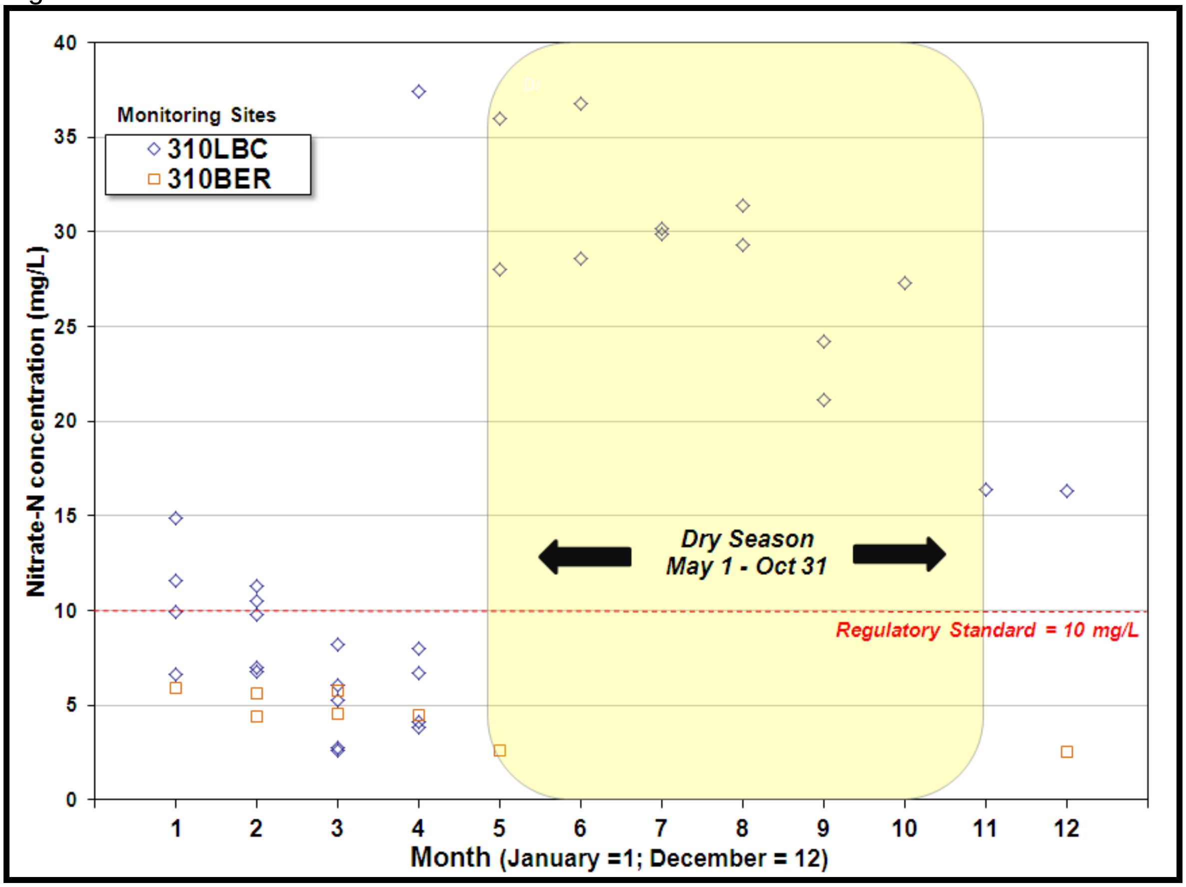


Table 3-6. Summary statistics for seasonal nitrate variation (units = mg/L).

	Dry Season	Wet Season
Months	May-Oct	Nov-Apr
Mean	**27.1**	**8.5**
Median	28.9	6.6
Minimum	2.6	2.5
Maximum	36.8	37.4
No. of Samples	12	28
No. of Samples Exceeding 10 mg/L	11	7
% of Samples Exceeding 10 mg/L	**92%**	**25%**

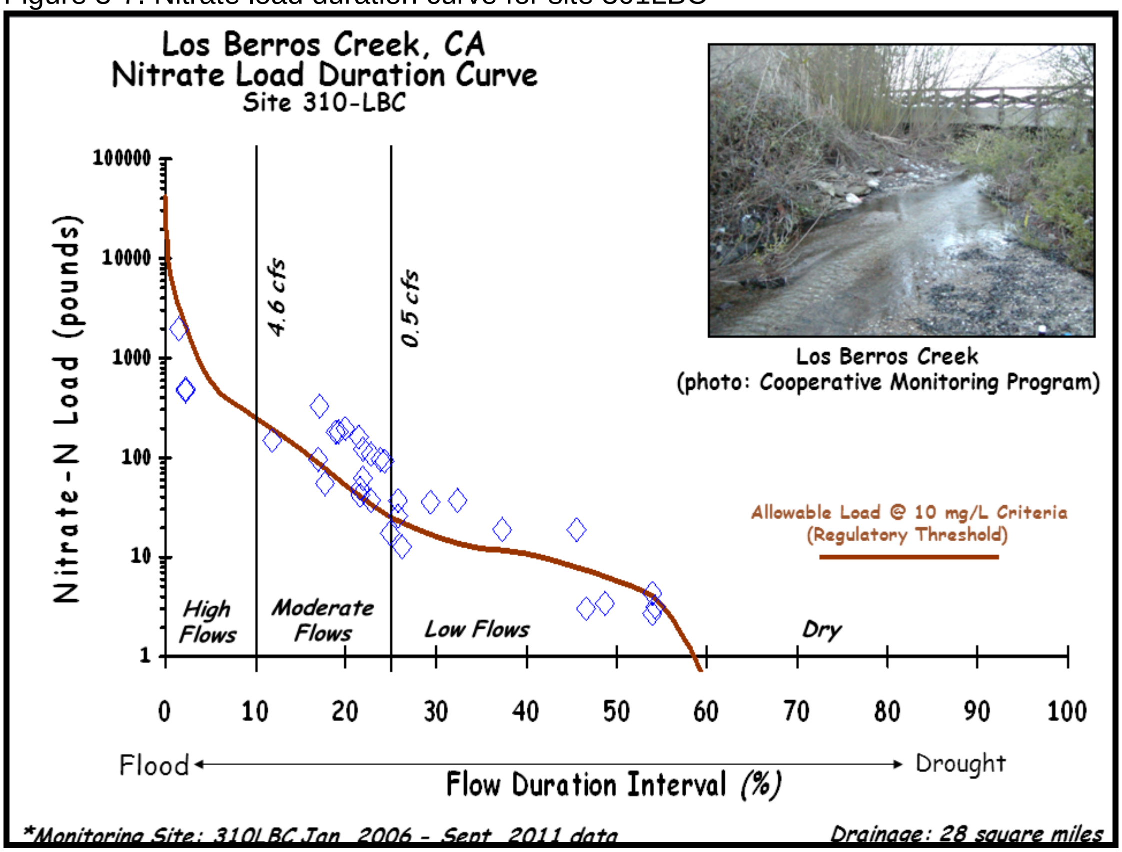
3.5.4 Water Quality Flow-based Trends

Analyses of seasonal trends are not always appropriate as a surrogate for flow-based trends because of the California central coast's Mediterranean climate and flashy flow conditions. While precipitation-driven high flow conditions are typically limited to the wet season months, the flashy, event-driven nature of regional hydrologic flow patterns, as well as persistent drought conditions, also means that there can be substantial and sustained periods of low flow and base flow conditions in the wet season. As such, it is relevant to assess possible flow-based patterns of nitrate-loading to Los Berros Creek.

Flow-based pollutant loading variation can be assessed using load duration curves. Load duration curves provide a graphical context for looking at monitoring data and can also potentially be used to focus and inform implementation decisions (Stiles and Cleland, 2003). A load duration curve is the allowable loading capacity of a pollutant, as a function of flow. A flow duration curve (refer back to Figure 2-5) is transformed into a load duration curve by multiplying the flow by the water quality objective and a conversion factor. The water quality objective that staff selected to calculate the load duration curve was the drinking water Basin Plan criterion for nitrate (10 mg/L). The load duration curve is thus calculated by multiplying the flow at the given flow exceedance percentile, by the nitrate numeric criteria and appropriate unit conversion factors. The methodology for constructing load duration curves for this project report is presented in Appendix C: Load Duration Analysis. A load duration curve for Los Berros Creek at site 310LBC is presented in Figure 3-7. This load duration curve indicates that excursions above the water quality criteria are relatively frequent across the low and moderate flow regimes. In contrast, there are no excursions above the water quality criteria in the high flow regime. This generally suggests that runoff events and precipitation events are not major drivers to nitrate water quality criteria exceedances.

The load duration analysis suggests that low to moderate flow conditions associated with groundwater baseflow and/or direct discharges from agricultural or residential return flows appear to be generally more consequential than storm water runoff.

Figure 3-7. Nitrate load duration curve for site 301LBC



3.5.5 Water Quality data from Upstream Reaches & Los Berros Canyon

There is very limited water quality data capturing conditions from the upper reaches of the subwatershed. The USGS collected one surface water nitrate sample in the 1977 at stream gage 11141600 which is too old to represent current conditions. However, in addition there is a substantial amount of recent groundwater quality available from GAMA in the proximity of Los Berros Creek near Upper Los Berros Road and North Dana Foothill Road[35]. Note that the lower Los Berros Creek subdrainage exhibits nitrate pollution of both creek waters and underlying groundwater. In contrast, the limited amount of surface water and groundwater quality representing the upper reaches of the TMDL project area (Los Berros Canyon subdrainage) indicate extremely low concentrations of nitrate (see Table 3-7). These concentrations are so low (below detection limits to well under 1 mg/L) that they would be entirely consistent with an ambient, relatively unimpacted background condition. For example, the U.S. Environmental Protection Agency concluded that 0.52 mg/L of water column nitrogen broadly and regionally approximates an undisturbed, natural background condition in surface waters of California's central coast region (USEPA, 2000). Additionally, these reaches of the subwatershed are sparsely populated areas, mostly comprised of grazing lands, undeveloped lands, and some pockets of rural residential. There is very little cultivated cropland or irrigated agriculture in these upper reaches of the subwatershed.

Table 3-7. Water quality data representing nitrate concentrations at outlet of the Los Berros Canyon subdrainage.

Surface Water Sample (units = mg/L nitrate as N)					
No. of Samples	Temporal Representation	Minimum	Mean	Median	Maximum
1 (site = USGS gage 11141600)	Aug. 1977	-	-	-	0.01
Groundwater Samples (units = mg/L nitrate as N)					
No. of Samples	Temporal Representation	Minimum	Mean	Median	Maximum
28 (sites = vicinity of Dana Foothill & Upper Los Berros roads)	Dec. 2001-March 2011	N.D	0.07	N.D	0.66

N.D. = no detection (concentration below detection limits)

With regard to the lower Los Berros Creek subdrainage and the reaches upstream of monitoring site 310LBC, anecdotal water quality data available to staff appear to indicate evidence of elevated nitrate water column concentrations extending at least as far upstream as Phelan Ranch Way (located at Creek Mile 2.4; or about 1.8 creek miles upstream of monitoring site 310LBC). It is important to note however, that this anecdotal evidence is not definitive.

Collectively, the available water quality data, land use data, and information available to staff provide indirect and anecdotal evidence that nitrate pollution and impairments are likely limited to the lower Los Berros Creek subdrainage and do not appear to be present in the upper reaches of the TMDL project area (e.g., reaches of Los Berros Creek in the Los Berros Canyon subdrainage). However, definitive conclusions cannot be drawn from these indirect, anecdotal, and older-vintage data sources.

[35] Due to confidentiality agreements inherent in the GAMA database, staff are not able to provide exact locations for these wells.

3.5.6 Summary Water Quality Statistics

Table 3-6 presents a statistical summary of the nitrate water quality data for nitrate at monitoring sites in the TMDL project area, including the number and frequency of exceedances of the municipal and domestic water supply numeric water quality objective (10 mg/L). The data indicate that the highest concentrations, and routine exceedances of the drinking water quality objective occur at the Los Berros Creek at Century Rd. (site 310LBC) location.

Table 3-8. TMDL project area summary statistics for nitrate as N (units = mg/L).

Waterbody	Monitoring Site	No. of Samples	Temporal Representation		Min	Median	Mean	Max	No. Exceeding 10 mg/L[A]	% Exceeding 10 mg/L
Los Berros Creek	**All sites**	40	1/15/2002	9/29/2011	2,56	9.0	14.11	37.4	**18**	**45%**
	310LBC	32	1/26/2006	9/29/2011	2.62	11.45	16.52	37.4	**18**	**56%**
	310BER	8	1/15/2002	3/19/2003	2.56	4.52	4.49	5.93	**0**	**0%**

[A] *Municipal and domestic water supply numeric water quality objective*

3.6 Assessment of Potential for Biostimulatory Impairments

Waterbodies that have high nutrient, or high nitrate concentrations may be at risk of biostimulatory impairments. Biostimulation is the excessive growth of algae and aquatic plants which may result from elevated nutrients and can cause degradation of aquatic habitat; for example high algal biomass may result in low dissolved oxygen in the water column. Staff used a range of numeric water quality objectives and peer-reviewed biostimulatory numeric screening criteria specific to the Central Coast region (Worcester et al., 2010)[36] to assess TMDL project area waterbodies which are exhibiting a range of indicators of biostimulation. These ranges of indicators collectively constitute a weight-of-evidence approach which demonstrates if and where biostimulatory conditions are impairing beneficial uses.

It is worth noting that elevated nutrients, in and of themselves, do not necessarily indicate biostimulation-eutrophication and impairment of beneficial uses. Nutrients act in combination with other physical or chemical factors to result in a biostimulatory impairment. Research has demonstrated the shortcomings of using ambient nutrient concentrations within a waterbody alone to predict eutrophication, particularly in streams (TetraTech, 2006). A linkage between elevated nutrients and actual impairment of beneficial uses must be demonstrated (e.g. dissolved oxygen and/or pH imbalances and other water quality-aquatic habitat indicators). Note that the USEPA Science Advisory Board (2010) and Worcester et al. (2010) report that numeric water quality targets protective against biostimulation may need to be supported with a weight of evidence approach, rather than stand-alone statistical methods. The weight of evidence approach could use other evidence of eutrophication; for example, presence and abundance of floating algal mats, water column chlorophyll a concentrations, evidence of oxygen depression and/or supersaturation, and pH over 9.5.

As such, staff used a wide range of Basin Plan numeric water quality objectives and peer-reviewed screening numeric criteria specific to the central coast region (Worcester et al., 2010) to assess the spatial distribution of biostimulatory effects and impairments in order to adequately determine if biostimulatory problems are being expressed in Los Berros Creek. Consistent with USEPA guidance, staff asserted biostimulatory impairment only if a waterbody exhibits a range of biostimulatory water quality indicators. Table 3-9 summarizes the range of biostimulatory indicators needed to assert biostimulatory impairment. The range of indicators in

[36] Worcester, K., D. Paradies, and M. Adams. 2010. Interpreting Narrative Objectives for Biostimulatory Substances for California Central Coast Waters. California Surface Water Ambient Monitoring Technical Report, July 2010.

this table constitute multiple lines of evidence, in a weight-of-evidence approach, to assess the presence of biostimulatory impairments.

It is also important to recognize that excess nutrients in inland streams which drain alluvial or headwater reaches will ultimately end up in a downstream receiving body of water where the nutrient concentrations and total load may degrade the water resource. The USEPA Scientific Advisory Board has stressed the importance of recognizing downstream impacts associated with excessive nutrients with respect to developing numeric nutrient concentration criteria for inland streams (USEPA, 2010, Worcester et al., 2010); further downstream impacts must be protected in accordance with federal water quality standards regulations[37]. Numeric targets developed for inland surface streams should generally be applied to also minimize downstream impacts of nutrients in receiving waterbodies, which are exhibiting signs of eutrophication. In other words, tributaries themselves may not exhibit routine or severe signs of biostimulation and eutrophication, but because they are feeding into a waterbody that is showing signs of eutrophication, the downstream effects of the tributaries should be considered. However, based on available data, the downstream receiving water body for Los Berros Creek (i.e., Arroyo Grande Creek) is not CWA 303(d)-listed as impaired for nitrate, nutrient, chlorophyll a, or dissolved oxygen problems.

Therefore, there is no current evidence that nutrient loads from Los Berros Creek are having an impact on a downstream biostimulation problem.

Table 3-9. Range of Indicators Needed to Assert Biostimulatory Impairment Problems.

	Biostimulation Indicators
1)	At least one line of evidence of dissolved oxygen problems – i.e., dissolved oxygen depletion and/or supersaturation (based on basin plan water quality objectives, and peer-reviewed numeric screening values) and/or wide diel swings in DO/pH;
2)	At least one line of evidence indicating elevated algal biomass exceeding central coast reference conditions (peer-reviewed numeric screening criteria values for the central coast region, i.e., Worcester et al, 2010);
3)	Evidence of elevated water column nutrients concentrations exceeding central coast reference conditions (e.g., Worcester et al., 2010); and
4)	At least one additional line of evidence including photo documentation of excessive algal growth; pH exceeding 9.5 units; and/or evidence of downstream nutrient impacts to a waterbody that does show multiple indicators of biostimulation problems.

Table 3-10 presents the numeric criteria and screening values used to assess the potential indicators of biostimulation as listed in Table 3-9). Figure 3-8 presents data summaries for chlorophyll *a*, dissolved oxygen, pH, and observed algal cover in Los Berros Creek. Table 3-11 presents the biostimulatory assessment matrix for Los Berros Creek.

Based on these data and assessments, Los Berros Creek is currently not exhibiting evidence of biostimulatory problems, nor is the creek contributing to a downstream biostimulation problem.

Accordingly, at this time staff is not proposing numeric water column targets for biostimulation in Los Berros Creek due to the absence of any water column impairments that can credibly be associated with biostimulation. The Water Board will consider the need for nutrient water column targets protective against biostimulation in Los Berros Creek, should future data and monitoring indicate such numeric targets are warranted.

[37] 40 C.F.R. 131.10(b)

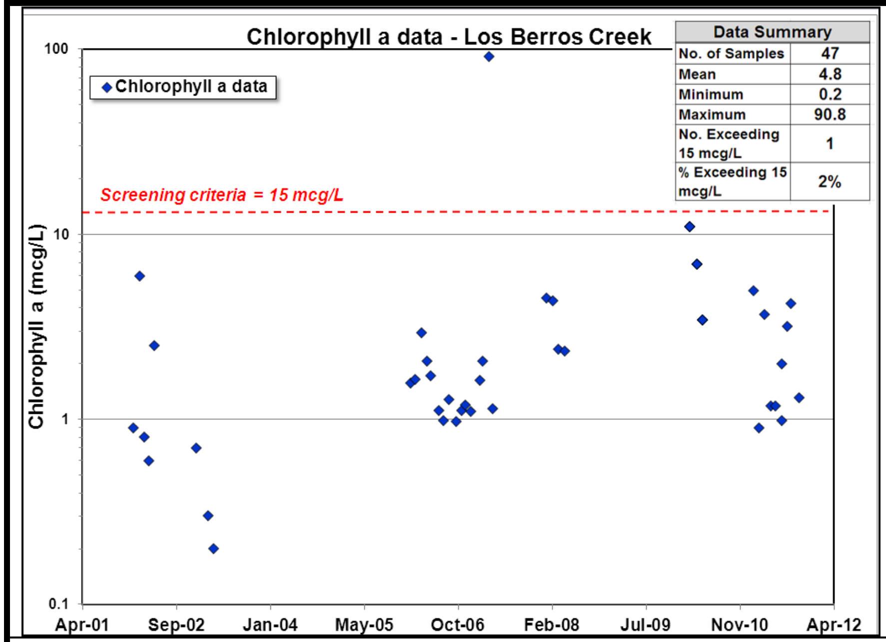
Table 3-10. WQOs and Screening Criteria Used as Indicators of Biostimulation.

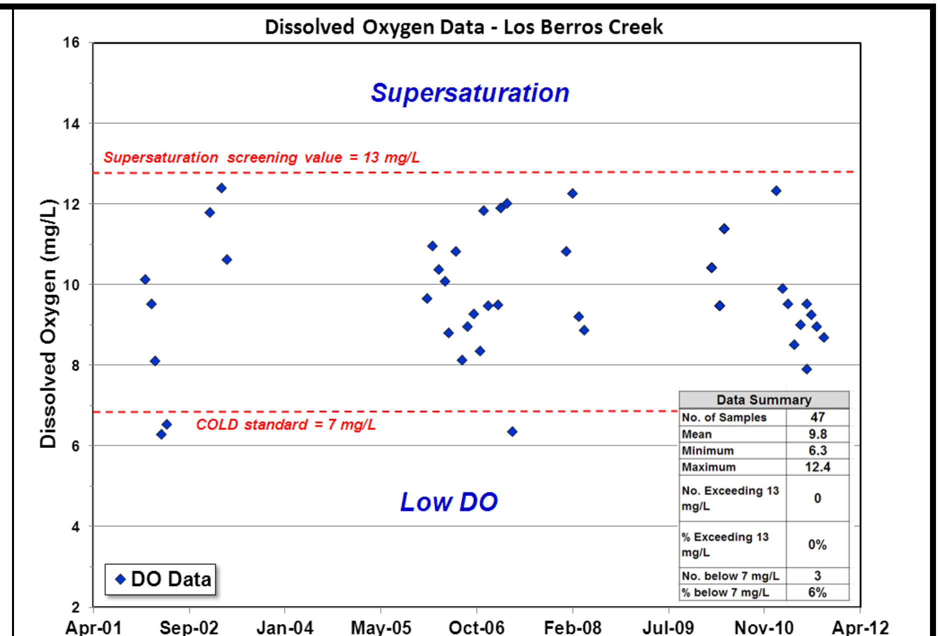
Water Quality Objectives (Regulatory Standards)		
Constituent Parameter	**Source of Water Quality Objective**	**Numeric Water Quality Objective**
Dissolved Oxygen	General Inland Surface Waters numeric objective	Dissolved Oxygen shall not be depressed below 5.0 mg/L Median values should not fall below 85% saturation.
	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**)
Biostimulatory Substances	Basin Plan General Objected for all Inland Surface Waters, Enclosed Bays, and Estuaries	Basin Plan narrative objective: *"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." (Basin Plan, Chapter 3)*
Additional Indicators Supporting Evidence for Biostimulation and Nutrient over-enrichment **(Many of these are NOT Regulatory Standards, and should not be used as stand-alone guidelines; but they can provide additional weight of evidence)**		
Constituent – Parameter	**Source of Screening Criteria**	**Screening Criteria/Method**
Wide diel swings in DO - pH	Wide diel swings widely reported in scientific literature as indicating potential biostimulation	Observational – compare diel swings to reference sites (reference sites show diel DO variation of less than 1 mg/L).
Early morning DO crashes (pre-dawn sampling program)	Early morning DO crashes widely reported in scientific literature as indicating potential biostimulation	Early morning DO crashes, depressed below Basin Plan numeric objectives, based on data from pre-dawn sampling program.
Low dissolved oxygen and/or oxygen super saturation	Basin Plan Objectives and California Surface Water Ambient Monitoring Program Technical Report[A]	1) Below Basin Plan Objectives: 7.0 mg/L (COLD, SPWN), or 5.0 mg/L (general objective); or below Basin Plan saturation objective of median 85% saturation; – and/or – 2) Exceeding 13 mg/L = evidence of supersaturated conditions and potential nutrient over-enrichment and biostimulation. Low DO or supersaturated DO conditions indicating potential biostimulatory impairments were asserted if exceedances of numeric screening values exceeding sample size and frequencies identified in Table 3.2 of the SWRCB Listing Policy (2004)[D]
Chlorophyll *a*	California Surface Water Ambient Monitoring Program Technical Report[A]	Exceeding 15 mcg/L = supporting evidence of potential nutrient over-enrichment and biostimulation (15 mcg = screening criteria reference condition for Central Coast Region).
Evidence of nitrogen enrichment relative to Central Coast reference conditions	California Surface Water Ambient Monitoring Program Technical Report[A]	NO3-N exceeding 1/mg/L = evidence of nutrient enrichment
Evidence of photosynthesis-driven elevated pH	California NNE Approach (Tetratech, 2006) [B]	pH exceeding 9.5 units, represents exceedance of the BURC II/III risk category boundary for COLD beneficial uses.
Percent Floating Algal Cover	California Surface Water Ambient Monitoring Program Technical Report[A]	One or more observances of 50% cover or greater = supporting evidence of potential nutrient over-enrichment and biostimulation.
Photo evidence of nuisance algae	-	Photo documentation of nuisance algae and aquatic plant growth, etc.

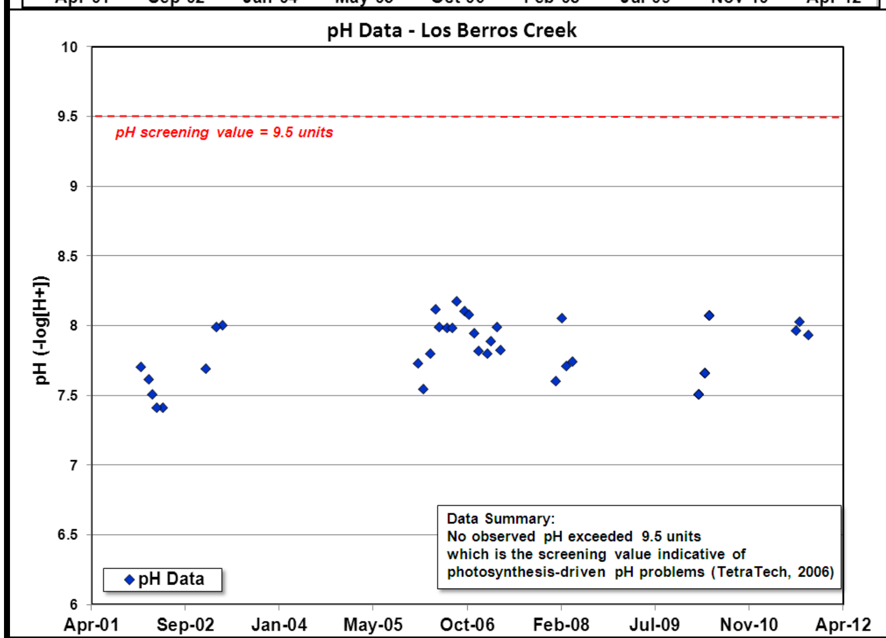
Downstream Impacts	USEPA Scientific Advisory Board (2010) stressed the importance of recognizing downstream impacts[C]	Observational: assess whether stream reach showing elevated nutrient concentrations (> 1 mg/L NO3-N; see nutrient enrichment screening criteria above) has downstream outlet discharging directly into waterbody which shows evidence of biostimulation problems (as indicated by screening values-weight of evidence in this Table).

[A] Worcester, K., D. M. Paradies, and M. Adams. 2010. Interpreting Narrative Objectives for Biostimulatory Substances for California Central Coast Waters. Surface Water Ambient Monitoring Program (SWAMP) Technical Report, July 2010.
[B] Technical Approach to Develop Nutrient Numeric Endpoints for California. TetraTech. 2006. Prepared for U.S EPA Region IX (Contract No. 69-C-02-108-To-111)
[C] U.S. EPA Science Advisory Board Review of “Empirical Approaches for Nutrient Criteria Derivation”. U.S Environmental Protection Agency. April 27, 2010.
[D] State Water Resources Control Board (SWRCB). 2004. Water Quality Control Policy for Developing California’s Clean Water Act Section 303(d) List.

Figure 3-8. Biostimulation indicators – data time series and data summaries.







Visual Observations - Algal Cover, Los Berros Creek

Data Summary	
No. of Observations	55
Mean	12%
Minimum	0%
Maximum	98%
No. of Observations of > 50% cover	4
% of Observations of > 50% cover	7%

Table 3-11. Biostimulatory assessment matrix for Los Berros Creek.

Stream Reach	**DO Problems**		**Nutrient Enrichment**	**Elevated Algal Biomass**		**Other indicators of Biostimulatory problems**			**Biostimulatory Impairment in Stream Reach?**
	Wide Diel DO Swings	**Low DO and/or DO supersaturation**	**NO3-N exceeding reference conditions**	**Chlorophyll a exceeding reference conditions**	**Excess floating algal cover (≥50% cover)**	**Downstream nutrient impacts to receiving waterbody**	**pH Evidence of photosynthesis-driven elevated pH (>9.5 units)**	**Photo documentation of excessive algal biomass**	
Lower Los Berros Creek (sites 301LBC and 310BER)	**No data**	**No**	**Yes**	**No**	**Yes** *there were a small number of observations of > 50% algal cover*	**No** *there are no nutrient, nitrate, DO, pH, or chlorophyll a impairments currently in Arroyo Grande Creek*	**No**	**No**	**No** based on dissolved oxygen, chlrorophyll-*a*, and pH problems not being expressed; and no evidence of downstream nutrient biostimulatory impacts

3.7 Summary of Impairment Addressed in this TMDL

The standards and water quality objectives that are being used to assess water quality conditions are contained in the Basin Plan for nitrate was previously presented in Table 3-2. Summary statistics of water quality parameters and exceedance frequencies as compared to numeric water quality objectives were previously presented in Section 3.5.5. Consequently, these exceedance frequencies are compared to the guidelines in the California Listing Policy (refer back Section 3.3) to determine impairment status. The current status of specific designated beneficial uses which could be impacted by nitrate pollution are summarized in Table 3-12 based on the full suite of water quality data from both 310BER and 310LBC. Table 3-13 presents staff's conclusions regarding the waterbody/pollutant combination addressed in this TMDL project. The impairment addressed is based on the drinking water quality objective for nitrate, which is the most stringent applicable numeric objective and will thus be protective of all designated beneficial uses.

While indirect evidence indicates that the upper subwatershed reaches of the Los Berros Canyon subdrainage may not be impaired by nitrate, at this time staff proposes to include all reaches of Los Berros Creek and its tributaries in this TMDL. Water Board policy is to conservatively and presumptively presume that an identified impairment could reach all upstream reaches and tributaries, pending acquisition of further information or data to rule out upstream impairments. More information about the spatial extent and nature of waterbody impairments can be collected during TMDL implementation. The U.S. Environmental Protection Agency's TMDL guidance[38] explicitly states that TMDLs and implementation of water quality-based controls should not be delayed because of lack of information and uncertainties about pollution problems, particularly with respect to nonpoint sources.

Table 3-12. Summary of current status of designated beneficial uses that could potentially be impacted by nitrate pollution.

Designated Beneficial Use	**Nitrate Water Quality Objective, or recommended level**	**Number of Samples Exceeding numeric objective or recommended level**	**Percent of Samples Exceeding objective or recommended level**	**Beneficial Use Impaired?[A]**
MUN, GWR (drinking water supply)	10 mg/L	18 of 40	45%	Yes
AGR, GWR (irrigation water supply)	30 mg/L *(for sensitive crops)*	5 of 40	13%	Potentially[B]
AGR (livestock watering)	100 mg/L	0 of 40	0%	No

[A] Based on exceedance frequencies in California 303(d) Listing Policy - see Table 3-3

[B] The University of California Agricultural Extension Service guideline values are flexible, and may not necessarily be appropriate due to local or special conditions of crop, soil, and method of irrigation.

Table 3-13. Tabular summary of waterbody/pollutant combination addressed in this TMDL.

		Pollutant: Nitrate		**303(d) Listing Information**	
Water Body Name	**Waterbody Identification (WBID)**	Impaired in accordance with Calif. Listing Policy?	Impaired Reach	Currently Listed on 303(d) List?	303(d) Listing **Addressed in this TMDL?**
Los Berros Creek	CAR3103102319990304143314	**Yes**	All Reaches	Yes (Nitrate)	**Yes**

[38] USEPA, 1991. Guidance for Water Quality-Based Decisions: The TMDL Process. Office of Water, EPA 440/4-91-001 (see Chapter 1 – Policies and Principles)

3.8 Problem Statement

Discharges of nitrate are occurring at levels in Los Berros Creek which are impairing beneficial uses. The municipal and domestic drinking water supply and groundwater recharge (MUN, GWR) beneficial uses of the creek are currently not being supported. In addition, potential or future beneficial uses of the agricultural irrigation water supply (AGR) beneficial use for nitrogen-sensitive crops are potentially not being supported (refer back to Basin Plan water quality objectives in Table 3-2, and Section 3.1.3). Elevated nitrate can create problems not only for drinking water supplies but can also cause potential problems for nitrogen sensitive crops (grapes, avocado, citrus[39]) by detrimentally impacting crop yield or quality. Nitrogen in the irrigation water acts the same as fertilizer nitrogen and excesses can cause problems just as fertilizer excesses cause problems. Reducing nitrate pollution and ultimately achieving the nitrate drinking water quality standard in Los Berros Creek will restore and be protective of the full range of MUN, GWR and AGR designated beneficial uses of the creek.

4 NUMERIC TARGETS

4.1 Target for Nitrate

The purpose of this target is to meet the water quality objective for nitrates in municipal and domestic drinking water sources (MUN: Municipal/Domestic Supply; GWR: Groundwater Recharge). The Basin Plan numeric water quality objective for nitrate (as nitrogen) is 10 mg/L NO3 as N, therefore the nitrate target is set at the Basin Plan water quality objective as follows:

- *10 mg/L nitrate as nitrogen to ensure that these surface waters are protected as drinking water sources and to assure compliance with the numeric water quality objective at all times.*

5 SOURCE ANALYSIS

5.1 Introduction: Source Assessment Using STEPL

Nitrogen reaches surface waters at an elevated rate as a result of human activities (USEPA, 1999). In this TMDL project report nitrogen source loading estimates were accomplished using the US Environmental Protection Agency's STEPL model. STEPL (Spreadsheet Tool for Estimating Pollutant Load) allows the calculation of nutrient loads from different land uses and source categories. STEPL provides a Visual Basic (VB) interface to create a customized, spreadsheet-based model in Microsoft (MS) Excel. STEPL calculates watershed surface runoff; nutrient loads, including nitrogen based on various land uses and watershed characteristics. STEPL has been used previously in USEPA-approved TMDLs to estimate source loading[40]. 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 the land use

[39] Source: Natural Resources Conservation Service, U.S. Department of Agriculture. "Irrigation Water Quality" http://www.nm.nrcs.usda.gov/technical/fotg/section-1/irrigation-guide/irrigation-water-quality.pdf and Ayers and Scott (1994). Water Quality for Agriculture. In: United Nations Food and Agriculture Program. http://www.fao.org/DOCREP/003/T0234E/T0234E06.htm

[40] 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.

distribution, precipitation data, soil characteristics, groundwater inputs, and management practices. Additional details on the model can be found at: http://it.tetratech-ffx.com/stepl/.

For source assessment purposes, staff used STEPL to estimate nitrogen annual loads for the lower Los Berros Creek subdrainage. Available data indicate that the overwhelming majority of controllable nitrogen loads occur in lower Los Berros Creek, and indirect evidence suggests that nitrate is not impairing water quality in the upper reaches in the Los Berros Canyon subdrainage. STEPL input parameters used in this TMDL project are outlined in Table 5-1. STEPL spreadsheet results are presented in Appendix D: STEPL Spreadsheets.

Table 5-1. STEPL input data.

Input Category	Input Data	Sources of Data
Mean Annual Rainfall	19.4 inches/year	PRISM dataset See Report Section 2.4
Mean Rain Days/Year	45 days/year	Arroyo Grande weather data www.weatherreports.com/United_States/CA/Arroyo_Grande/averages.html?n=4
Weather Station (for rain correction factors)	-	Santa Maria WSO Airport as provided in STEPL
Land Cover	See STEPL spreadsheets	Farmland Mapping and Monitoring Program - land use for lower Los Berros Creek subdrainage, see Figure 2-3
Urban Land Use Distributions (impervious surfaces categories)	STEPL default values	STEPL
Septic system discharge and failure rate data	See STEPL spreadsheets	Septic System (OSDS) failure rate = 1% as reported in Lower Salinas Watershed Fecal Coliform TMDL, Central Coast Water Board, 2010
Hydrologic Soil Group (HSG)	HSG "A"	See hydrologic sols group map for lower Los Berros Creek – Report Section 2.7
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)	4.55 mg/L (urban-San Diego) 13.8 mg/L (cropland) 1.26 mg/L (grazing land) 2.76 mg/L (undeveloped and rural residential)	• N Concentration data for farmland from Southern California Coastal Water Research Project, Technical Report 335 (Nov. 2000), Appendix C. • N mean concentration for rangeland/pasture from USDA MANAGE database http://www.ars.usda.gov/Research/docs.htm?docid=11079 • N Concentration data for undeveloped-rural residential from Southern California Coastal Water Research Project, Technical Report 335 (Nov. 2000), Appendix C – land category = "open". • N Urban runoff concentrations from Shaver et al., 2007
Nutrient concentration in shallow groundwater (mg/L)	NO3-N = 8.02 (cropland & urban) NO3-N = 1.58 (grazing land and undeveloped)	• NO3-N (Ag and Urban): mean groundwater concentrations In lower Los Berros Creek subdrainage as estimated in Report Section 2.5 • NO3-N (Grazing land and undeveloped land): concentration in groundwater from hydraulically upgradient well data (see • Table 2-3)

5.2 Urban Runoff

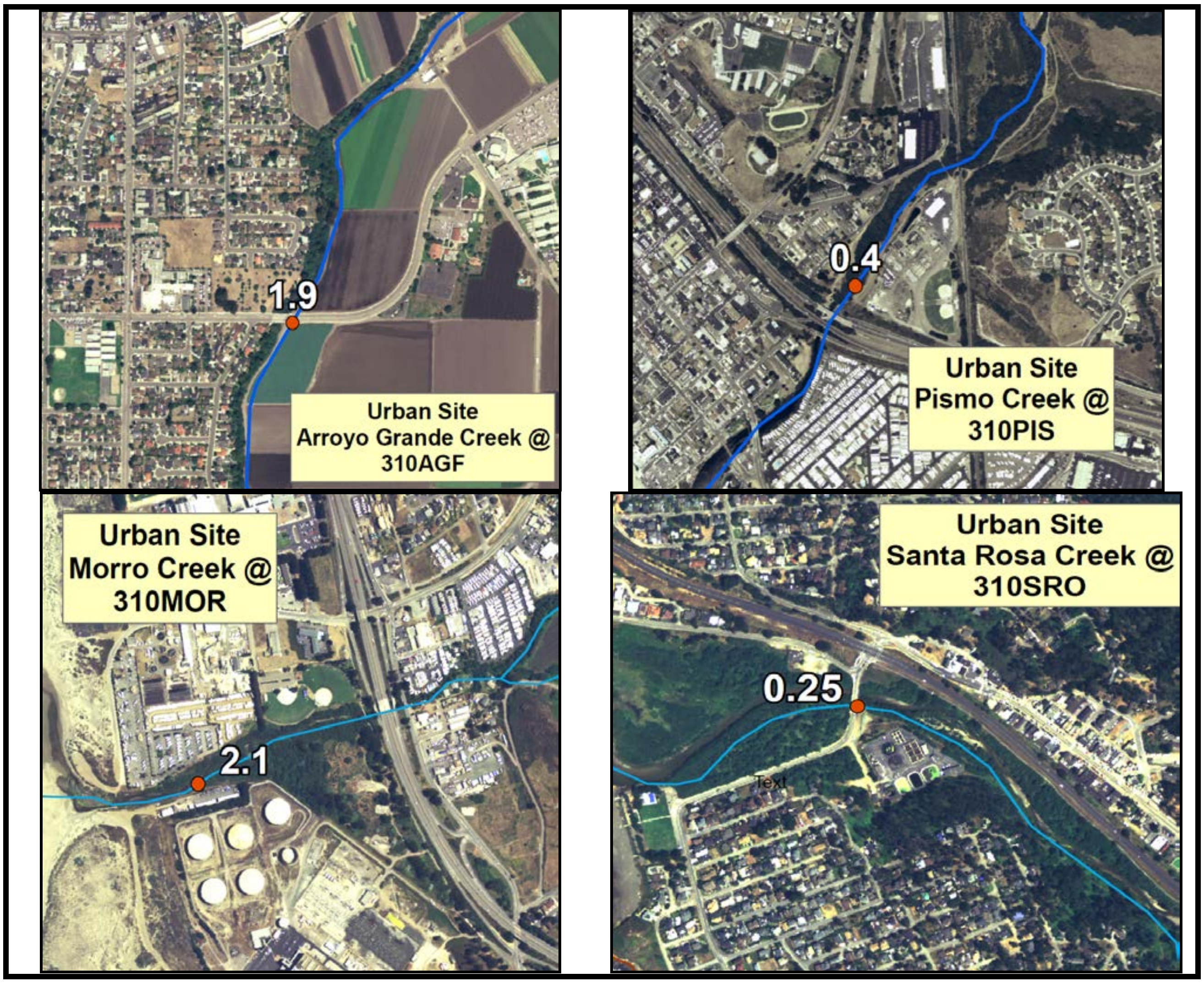
USEPA policy explicitly specifies NPDES-regulated urban stormwater discharges are point source discharges and, therefore, must be addressed by the WLA component of a TMDL.[41] The Water Board is the permitting authority for NPDES stormwater permits in the Central Coast region. Urban runoff can be a contributor of nutrients to waterbodies. Within residential areas,

[41] See 40CFR 130.2(g) & (h) and USEPA Office of Water Memorandum (Nov. 2002) *"Establishing Total Maximum Daily Load (TMDL) Wasteload Allocations (WLAs) for Storm Water Sources and NPDES Permit Requirements Based on Those WLAs"*

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.

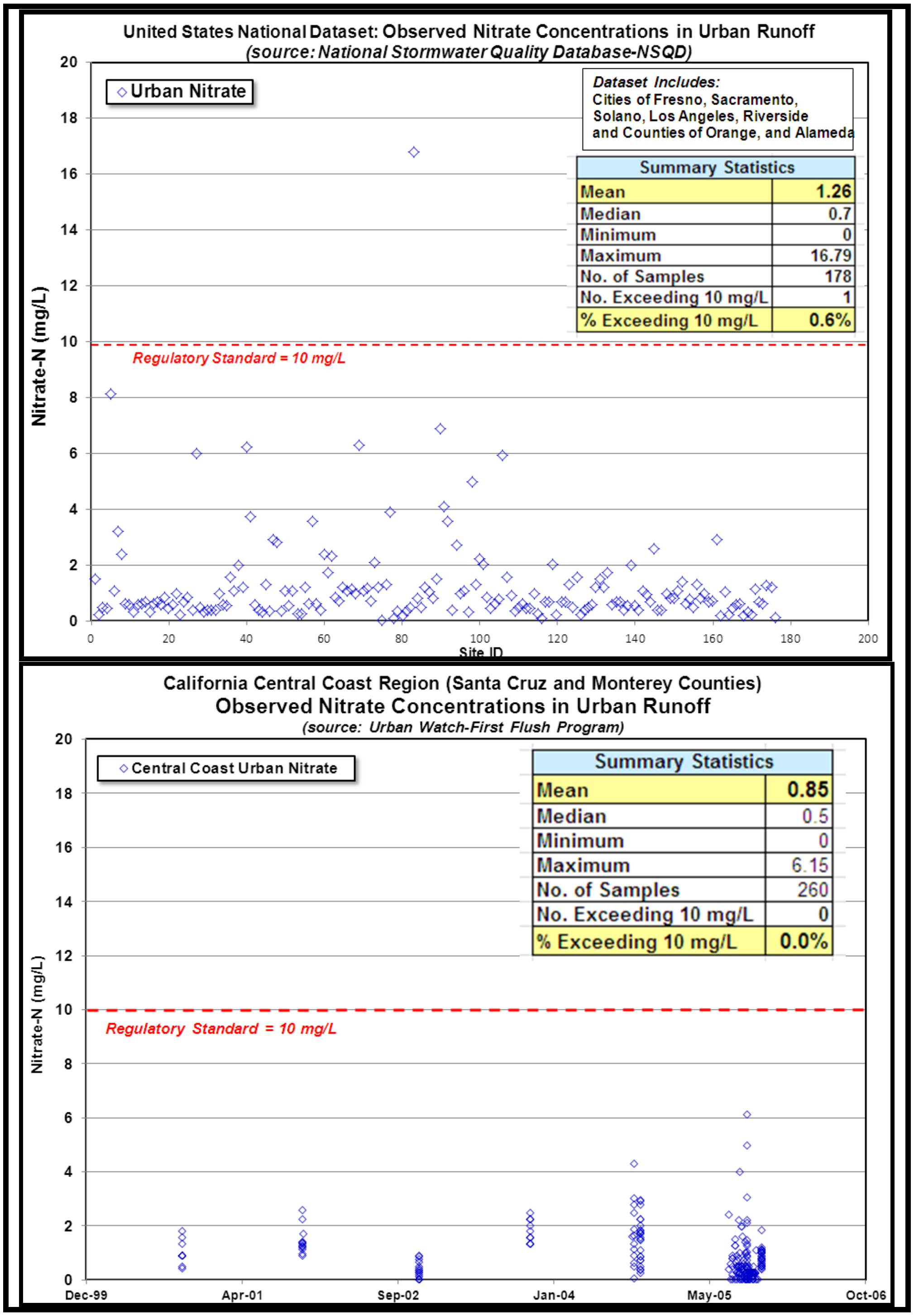
As previously illustrated in Figure 3-3, monitoring site 310BER receives a contribution of urban runoff from residential parcels located within the City of Arroyo Grande's MS4 permit boundary. However, as indicated in Figure 3-5, this site never exceeded the numeric water quality objective for nitrate. In particular, wet season monitoring which would be most likely to capture a strong urban runoff-influenced signature were all in compliance with the water quality standard. Further, nitrate water quality monitoring data from creeks strongly influenced by urban runoff (and absent any NPDES permitted point source discharges) within hydrologic unit 310, typically have relatively low mean nitrate concentrations that are well beneath drinking water standards for nitrate (see Figure 5-1).

Figure 5-1. Mean nitrate concentrations (mg/L – shown in white numerals) at sites in hydrologic unit 310 which are strongly influenced by urban land use and runoff, and with no NPDES point sources.



Furthermore, there is a large plethora of nationwide and central coast regional data characterizing nitrate concentrations in urban runoff (see Figure 5-2). These data (438 total samples) illustrate that nitrate concentrations in urban runoff virtually never exceed the 10 mg/L MUN regulatory standard[42].

Figure 5-2. Nitrate concentration in urban runoff: national, California, and central coast regional data.



42 Elevated nitrogen levels in urban runoff can, however, locally contribute to biostimulatory impairments of receiving waters where eutrophication has been identified as a water quality problem.

Collectively, available information suggests that urban runoff concentrations in the Los Berros Creek subwatershed are in compliance with the drinking water quality objective for nitrate, are meeting proposed waste load allocations, and is not causing a condition of impairment of the MUN water quality standard. .

The estimated annual nutrient load from urban runoff in the project area as calculated by STEPL is shown in Table 5-2.

Table 5-2. Urban Annual Load (lbs./year)

Source	N Load (lb./yr)
Urban	1,103

5.3 Cropland

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, April 29, 2004).

California fertilizer application rates on specific crop types are available from the U.S. Department of Agriculture, National Agricultural Statistics Service, as shown in Table 5-3 and Figure 5-3. Based on San Luis Obispo County Agricultural Commissioner crop maps, cultivated cropland in the Los Berros Creek subwatershed is largely comprised of vegetable crops, orchard, and vineyard.

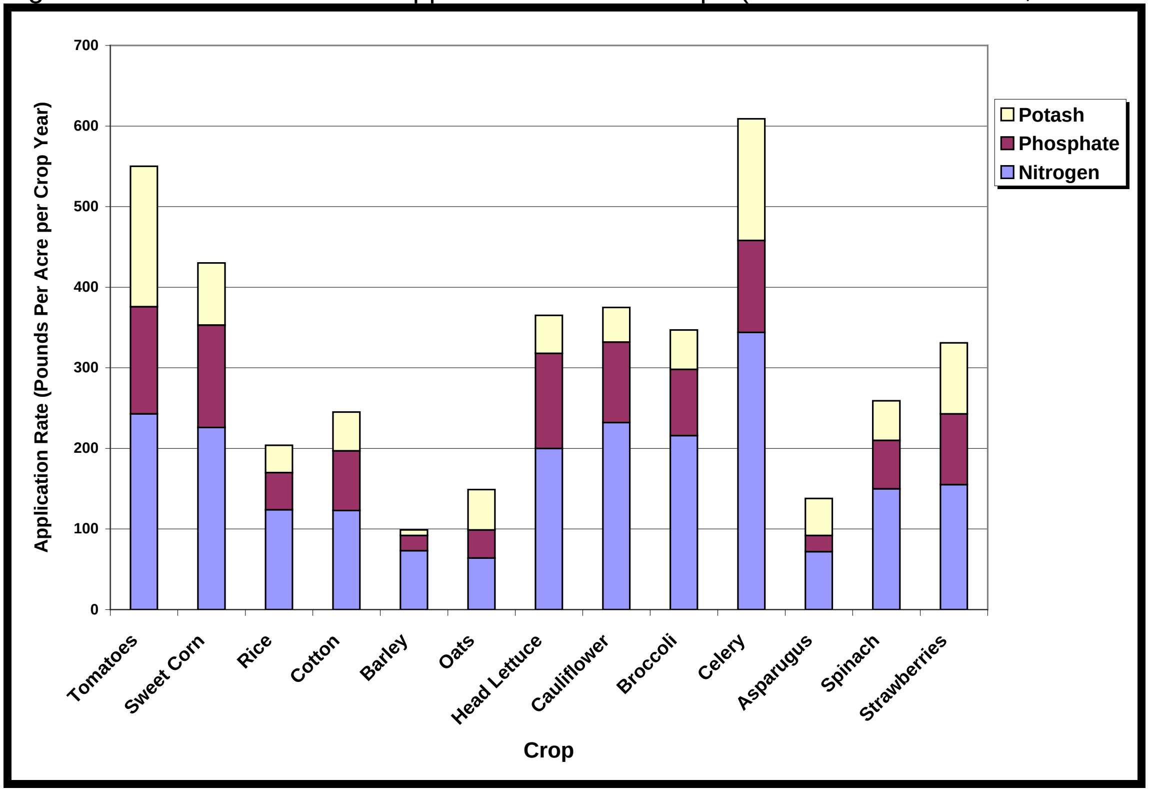
Table 5-3. California fertilizer application rates.

Crop	Application Rate per Crop Year (pounds per acre) in California			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
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

Figure 5-3. California fertilizer application rates on crops (source: USDA-NASS, 2004-2008).



The estimated annual nutrient load from cropland in the lower Los Berros Creek subdrainage as calculated by STEPL is shown in Table 5-4.

Table 5-4. Cropland annual load (lbs./year).

Source	N Load (lb./yr)
Cropland	74,294

5.4 Grazing Lands

Livestock and other domestic animals that spend significant periods of time in or near surface waters can potentially contribute 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). The estimated annual nutrient load from grazing lands in the lower Los Berros Creek subdrainage as calculated by STEPL is shown in Table 5-5. Based on available information, livestock and domestic animal operations associated with the grazing lands source category are in compliance with the drinking water quality objective for nitrate, are meeting proposed load allocations, and is not causing a condition of impairment of the MUN water quality standard (refer to Section 3.5.5).

Table 5-5. Grazing lands annual load (lbs./year).

Source	N Load (lb./yr)
Grazing Lands	14,712

5.5 Undeveloped or Rural Residential

The estimated annual nutrient load from forest in the lower Los Berros Creek subdrainage as calculated by STEPL is shown in Table 5-6.

Table 5-6. Forest annual load (lbs./year).

Source	N Load (lb./yr)
Undeveloped	1,786

5.6 Septic Systems

The estimated annual nutrient load to surface waters from septic systems in the lower Los Berros Creek subdrainage as calculated by STEPL is shown in Table 5-7.

Table 5-7. OSDS annual load (lbs./year).

Source	N Load (lb./yr)
Septic systems	31

5.7 Groundwater

Shallow groundwater provides the base flows to streams and can be an major source of surface water flows during the summer season. Therefore, dissolved nitrate in groundwater can be important nitrate sources during dry periods. Ground water contamination from nutrients can occur from various sources, including septic systems, fertilizer application, animal waste, waste-lagoon sludge, and soil mineralization (USEPA, 1999). In addition, groundwater has a natural, ambient background load of nitrogen and phosphorus. The estimated annual nitrogen load from groundwater to surface waters in the project area as calculated by STEPL is shown in Table 5-8. Figure 5-4 illustrates the total ground water load (56,088 pounds) attributable to the various land use categories. The overwhelming majority of the ground water load is attributable to the cropland category.

Table 5-8. Groundwater annual load (lbs./year).

Source	N Load (lb./yr) *Total Groundwater load attributable to human activities*	N Load (lb./yr) *Total Natural, ambient groundwater background load*
Groundwater	44,998	11,040

Figure 5-4. Attribution of ground water nitrate loads to land use categories.

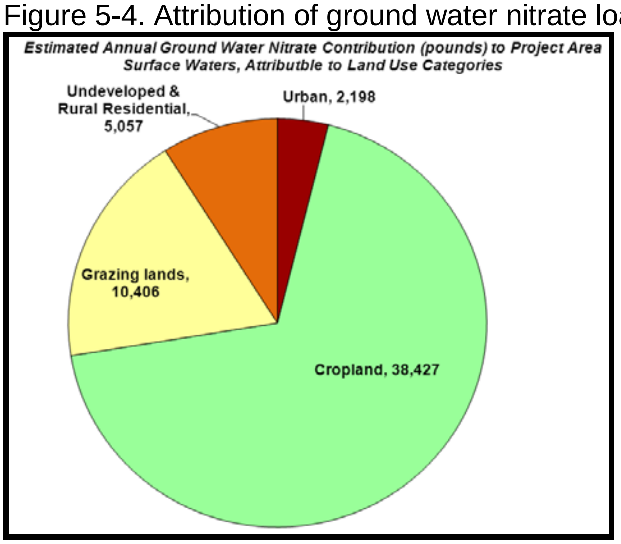
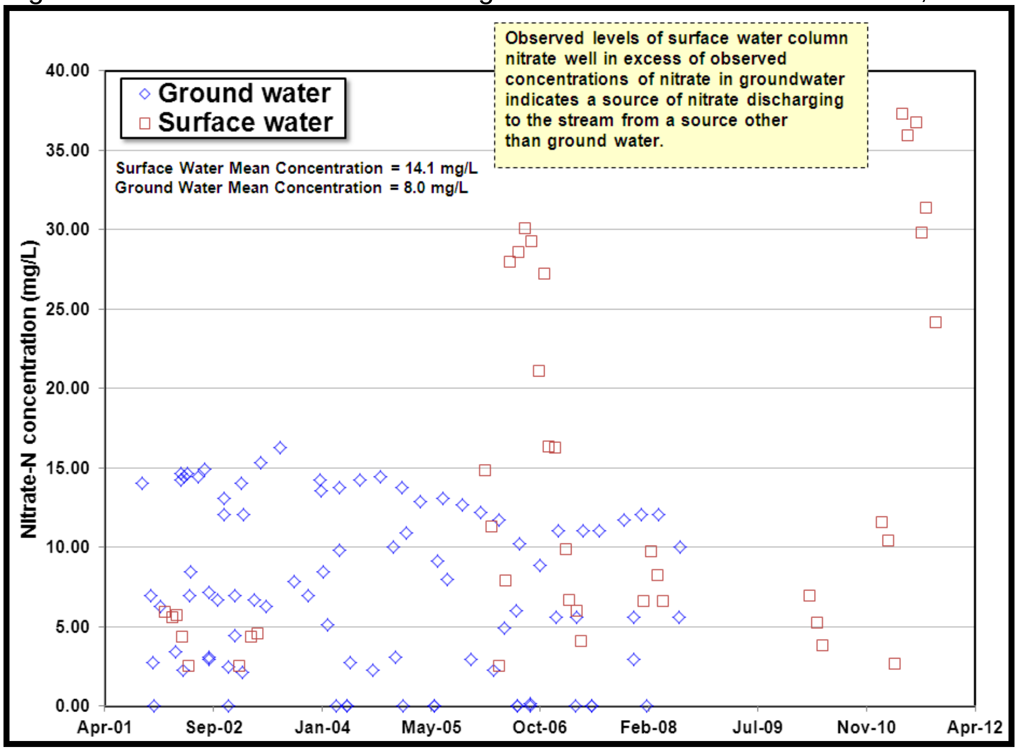


Figure 5-5 illustrates a time series of both ground water nitrate concentrations and surface water nitrate concentrations in the lower Los Berros Creek subdrainage. Mean surface water concentrations are, on average, higher than the observed groundwater concentrations. Observed groundwater concentrations are virtually always below 15 mg/L, with an average concentration of 8 mg/L. In contrast, surface water concentrations are frequently above 15 mg/L, with an average of 14.1 mg/L. This suggests that ground water baseflow contribution to the creek is not the sole source of nitrate loading to the waterbody. This observation is consistent with the summary source analysis as presented in Section 5.10

Figure 5-5. Nitrate concentrations in groundwater versus surface water, lower Los Berros Cr.



5.8 Atmospheric Deposition

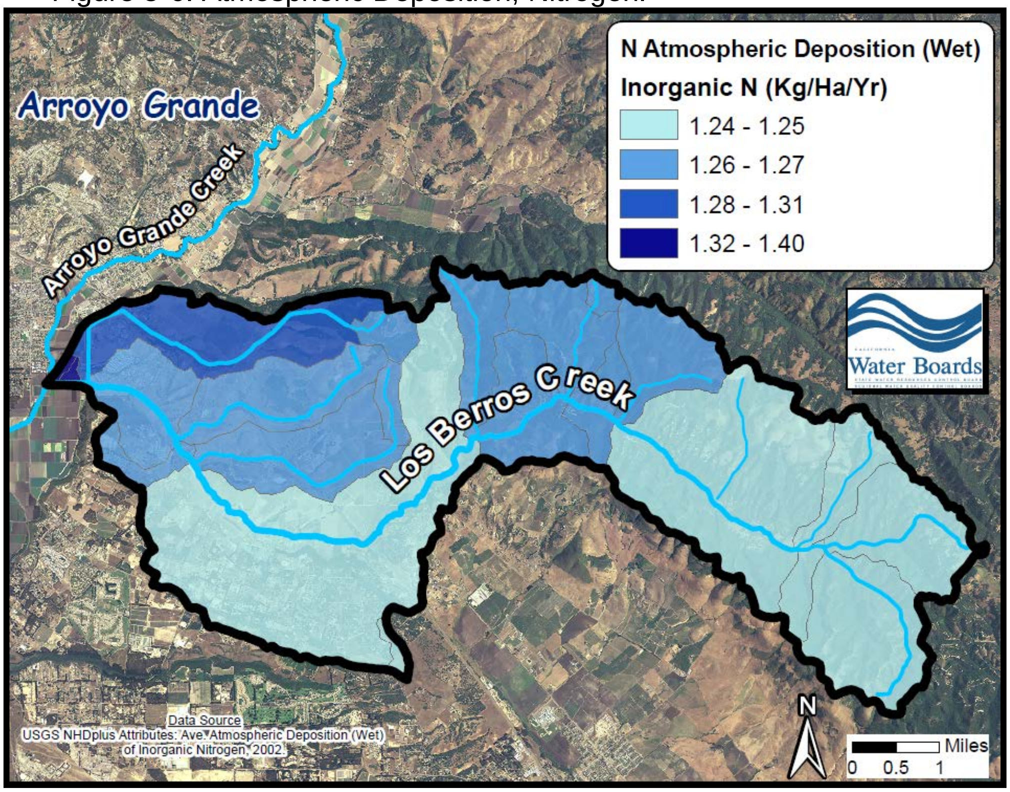
Input of nitrogen in rainfall may sometimes be a significant source of loading. Because nitrogen can exist as a gaseous phase nitrogen is prone to atmospheric transport and deposition. It is important to recognize however that atmospheric deposition of nutrients is typically more significant in lakes and reservoirs, than in creeks or streams (USEPA, 1999). This is because the surface area of a stream is typically small compared to the area of a watershed. Atmospheric deposition to Los Berros Creek was estimated using estimates of the surface area of all surface waterbodies in the TMDL project area (estimated from NHDplus flowline data); wet deposition of inorganic nitrogen from USGS raster datasets available in NHDplus (inorganic nitrogen = 1.3 kg/ha/year); and a literature values of dry atmospheric deposition of 0.93 kg/ha/year nitrate-N (Rast and Lee, 1983). Wet atmospheric deposition rates are illustrated in Figure 5-6.

The length of all NHDplus surface water flowlines in the project area is approximately 184,000 feet, and the average width of all streams in the project area is assumed to be approximately 5 feet. Accordingly, the total surface area of project area surface waterbodies is approximately 920,000 square feet, or approximately 8.5 hectares. With an estimated combined dry and wet atmospheric deposition rate of 2.23 kg N/ha/yr, the typical annual load from atmospheric deposition would be approximately 19 kg N/year, or 42 pounds N/year (see Table 5-9).

Table 5-9. Atmospheric deposition annual load (lbs./year).

Source	N Load (lb./yr)
Atmospheric deposition	42

Figure 5-6. Atmospheric Deposition, Nitrogen.



5.9 Other NPDES-Permitted Facilities

With the exception of NPDES-permitted MS4 urbanized areas that are no other NPDES-permitted point source facilities discharging to surface waters in Los Berros Creek TMDL project area; as such waste load allocations for these types of facilities are set at zero. Note that MS4 stormwater NPDES point source entities are addressed in Section 5.2

5.10 Summary of Sources

Table 5-10 shows the summary of nutrient source categories and estimated annual nitrate loads[43]. Also, the estimated relative magnitude of sources are shown graphically in Figure 5-7.

It is worth reiterating that these are estimates for the TMDL project area. It is understood there will be substantial variation due to real-time conditions or due to local and site specific

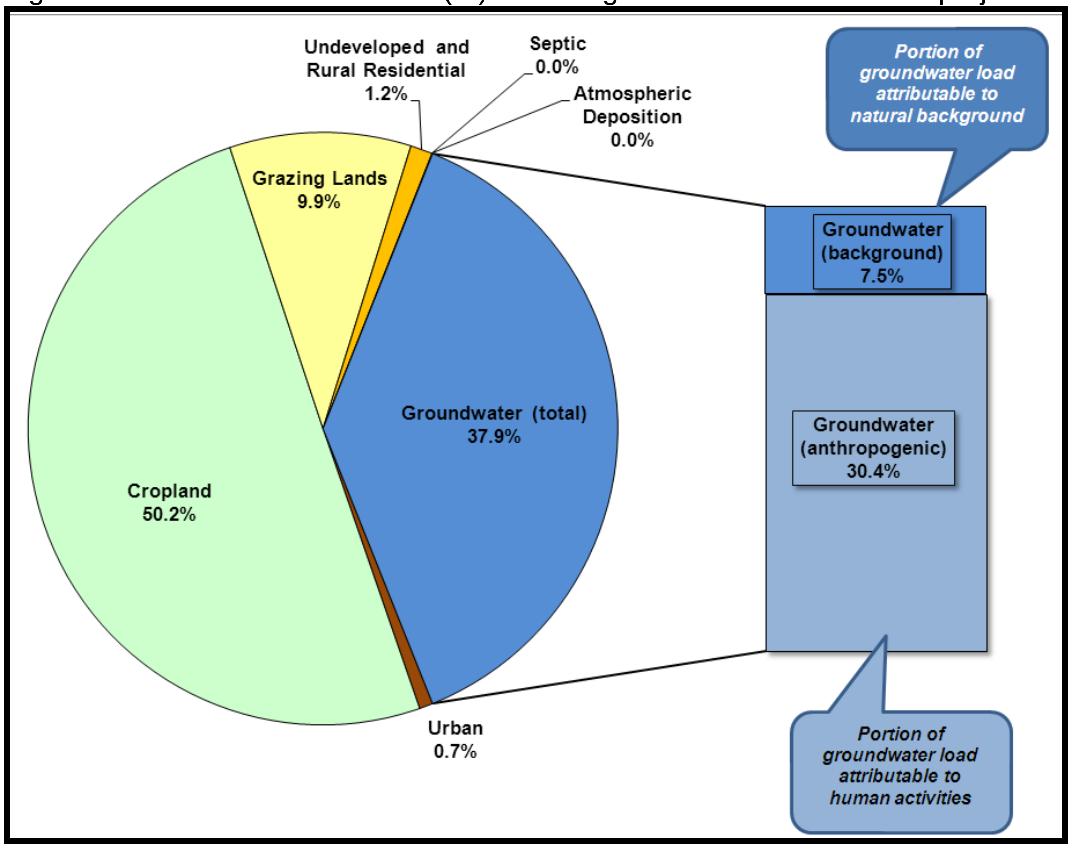
43 While the STEPL tool calculates "total nitrogen" not nitrate, nitrate is in fact over 98% of total water column nitrogen in the TMDL project area; therefore nitrate is a reasonable surrogate and close approximation for totally nitrogen.

conditions. More information will be collected during TMDL implementation to assess controllable sources of nitrate pollution.

Table 5-10. Tabulation of estimated source loads in project area.

Sources	Nitrate Load (lb./yr)
Urban	1,103
Cropland	74,295
Grazing lands	14,712
Undeveloped and rural residential	1,786
Septic systems	31
Groundwater	56,088
Atmospheric deposition	42
Total	148,034

Figure 5-7. Estimated distribution (%) of average annual nitrate loads in project area.



Regarding Figure 5-7, it is important to recognize that each land use category has a certain, natural background level of nitrate contribution to creek waters that are unrelated to human activities. For example, although staff has estimated cropland as the overwhelming majority of the controllable nitrate load contribution to the creek (when also including the agricultural fertilizer impacts to shallow groundwater baseflow sources), staff expects a relatively small fraction of this aggregate contribution is from natural, background conditions.

Since limited water quality data and indirect evidence suggest that grazing lands plausibly comes reasonably close to representing a lightly disturbed, or relatively unimpacted background condition in this particular subwatershed, setting all land use categories in the lower Los Berros Creek subdrainage equal to the STEPL source analysis input parameters (see Section 5.1) for "grazing lands" indicates that the collective sum of natural background input to Los Berros Creek from runoff from all land use categories plus the natural, ambient background groundwater baseflow contribution is about 52% of the average annual total nitrate load contribution to the creek. (see Table 5-11). It is important to recognize however, that an "annual" nitrate load estimate does not adequately capture the seasonal and flow-based nature of the nitrate impairment of Los Berros Creek. During higher flows and wet-season conditions, the creek generally does not show nitrate impairment and the loading capacity for nitrate during these time periods is generally is not being exceeded. However, during low flow, baseflow-dominated, and dry season conditions, the nitrate loading capacity of the creek is frequently exceeded due to discharges from controllable sources (e.g., refer back to Section 3.5.3 and Section 3.5.4).

Also, as illustrated in Table 5-11, the overwhelming majority of controllable nitrate loads (both from runoff and ground water baseflow contributions to the creek) are attributable the cropland source category. Contributions from other controllable sources are relatively negligible; even if those other controllable source were eliminated the water column impairment by nitrate would still exist due to controllable discharges from the cropland source. Therefore, cropland is the controllable source category responsible for causing the observed impairment of creek waters.

Table 5-11. Attribution of annual total loads, background loads, and controllable loads by land use categories (units=pounds).

Land Cover Category-Source Category		**Current Annual Total Nitrate Load**	**Annual Nitrate Natural Background Load**	**Annual Controllable Nitrate Load** *(attributable to human activities)*	**Source Category Currently Meeting Receiving Water Load Allocation (WLA or LA) @ 10 mg/L nitrate?**
Urban		1,103	305	798	Yes[A]
Cropland		74,295	49,472	24,823	No[B]
Grazing lands		14,712	>14,000	negligible	Yes[C]
Undeveloped and rural residential		1,786	1,071	715	Yes[A,C]
Septic systems		31	0	31	insignificant source
Groundwater	**Total Groundwater**	56,088	11,040	45,048	N.A. [D]
	from Cropland	38,427	-	-	N.A. [D]
	from Grazing Lands	10,406	-	-	N.A. [D]
	from Urban	2,198	-	-	N.A. [D]
	from Rural Residential	5,057	-	-	N.A. [D]
Atmospheric deposition		42	42	0	insignificant source
Total		148,034	76,620	71,414	-

[A] See Report Section 5.2
[B] See Report Section 5.3
[C] See Report Sections 3.5.5 and 5.4
[D] Waste load Allocations and Load Allocations are CWA regulatory terminology which apply to the receiving surface waters, not to ground waters. However, baseflow from ground water is a contributing source of nitrate loads to the surface waters. A substantial portion of this ground water load is attributable to human activities.

6 TOTAL MAXIMUM DAILY LOAD AND ALLOCATIONS

6.1 Introduction

The TMDL represents the loading capacity of a waterbody—the amount of a pollutant that the waterbody can assimilate and still support beneficial uses. The TMDL is the sum of allocations for nonpoint and point sources and any allocations for a margin of safety. TMDLs are often expressed as a mass load of the pollutant but can also be expressed as a unit of concentration (40 CFR 130.2(i)).

The TMDLs for nitrate for project areas waterbodies are set at a maximum concentrations (numeric targets) in receiving water as previously presented in Section 4. The TMDL allocations, which include background levels, are also equal to the numeric targets. Expressing the TMDL as a nitrate concentration equal to the water quality objective provides a measurable target for sources to monitor and with which to comply. Requiring the responsible parties for nitrate loading to reduce nitrate discharges to the numeric water quality objectives and targets will establish a direct link between the TMDL target and sources.

Load allocations for nitrate are assigned to each source, including background. This allocation will require a reduction of existing loads by cropland landowners and operators.

MS4 entities and owners/operators of grazing operations on grazing lands are given an allocation from these source categories. At this time, these source categories are in compliance with their allocations, consequently this TMDL does not require additional implementation requirements for MS4 entities or owners/operators of grazing operations.

6.2 Loading Capacity

The loading capacity for waterbody segments in the TMDL project area is the amount of nitrate that can be assimilated without exceeding the water quality objectives. The Basin Plan contains water quality objectives for nitrate, and thus the loading capacities for the TMDL project area waterbodies are:

The following Total Maximum Daily Load is applicable to Los Berros Creek and its tributaries and is applicable to each day of all seasons:

Waters shall not contain concentrations of nitrate as nitrogen in excess of 10 mg/L nitrate as nitrogen.

6.3 Linkage Analysis

The goal of the linkage analysis is to establish a link between pollutant loads and water quality. This, in turn, supports that the loading capacity specified in the TMDLs will result in attaining the numeric target. The Linkage Analysis therefore represents the critical quantitative link between the TMDL and attainment of the water quality standards.

The proposed TMDLs will result in the attainment of the nitrate water quality objective for municipal and domestic water supply, and therefore the restoration of beneficial uses of waterbodies in the TMDL project area. This is because the numeric target and allocations are set equal to the nutrient water quality objectives. The numeric targets are used directly to calculate the loading capacity (TMDLs). Requiring the responsible parties for nitrate loading to reduce nitrate discharges to the numeric water quality objectives and targets will establish a direct link between the TMDL target and sources.

6.4 TMDL Allocations

Table 6-1 presents the final load allocations assigned to implementing parties. Note that USEPA policy explicitly specifies NPDES-regulated urban stormwater discharges are point source discharges and, therefore, must be addressed by the WLA component of a TMDL The allocations are equal to the TMDLs. The allocations are receiving water allocations. Final allocations should be achieved 12 years after the effective date of this TMDL (which is upon approval by the Office of Administrative Law). .

Table 6-1. TMDL Allocations.

LOAD ALLOCATIONS			
Waterbody	**WBID**	**Implementing Party (Source)**	**Receiving Water Nitrate (mg/L)**
Los Berros Creek and its tributaries	CAR3103102319990304143314	Owners/operators of irrigated cropland (Cropland- fertilizer application)	Allocation-1
Los Berros Creek and its tributaries	CAR3103102319990304143314	Owners/operators of land used for/containing domestic animals/livestock (Grazing lands - livestock waste)	Allocation-1
Los Berros Creek and its tributaries	CAR3103102319990304143314	No implementing party (All land use categories: natural sources, ambient-unimpacted groundwater contributions, atmospheric deposition)	Allocation-1
WASTE LOAD ALLOCATIONS			
Waterbody	**WBID**	**Implementing Party Responsible for Allocation (Source) NPDES/WDR number**	**Receiving Water Nitrate (mg/L)**
Los Berros Creek and its tributaries	CAR3103102319990304143314	City of Arroyo Grande Storm Water General Permit NPDES No. CAS000004 County of San Luis Obispo Storm Water General Permit NPDES No. CAS000004	Allocation-1
Allocation-1: Maximum nitrate concentration shall not exceed 10 mg/L as nitrogen.			

6.4.1 Percent Load Reductions to Achieve Loading Capacity

Staff includes a “percent reduction” that was calculated for informational purposes only, to illustrate the difference between existing conditions and the loading capacity at the time the creek was sampled. The percent reduction is based on the load duration curve data presented in Section 3.5.4 and uses the methodology for calculating percent reduction as described in the Central Coast Water Board's Lower Salinas River Watershed TMDL for Fecal Coliform[44].

A TMDL provides a foundation for identifying, planning, and implementing water quality-based controls to reduce pollution. Though the data used to calculate the percent reductions may be considered "historical", because it does not include "real time" data, it provides a representation of the existing nitrate loads in Los Berros Creek over a range of hydrologic conditions. Therefore, the percent reduction *should not be viewed as the TMDL but rather a goal to work towards* in the implementation phase of the TMDL process with the ultimate goal being the restoration and maintenance of in- stream water quality so that beneficial uses are met. The percent reduction can be calculated as:

Percent reduction = [(existing load) - (allowable load)/(existing load)] *100

Percent reduction goals are presented in Table 6-2. Note that the "existing load" in each flow regime was estimated as the 90th percentile[45] of the observed loads sampled within that flow regime. As such, this illustrates an estimated **"worst case scenario"** of necessary nitrate load percent reductions to meet the allowable loading capacity. Actual nitrate percent load reductions to meet the allowable loading capacity could be substantially lower than the estimated "worst case scenario" percent load reductions shown in Table 6-2[46].

Table 6-2. Estimated existing daily flow-based nitrate loads in Low Berros Creek, and estimated percent load reductions needed to achieve the creek's loading capacity for nitrate (with critical condition highlighted.

Flow Regime	**Loading Capacity** (pounds)	**Estimated Existing Load** @ 90th percentile of observed loads in flow regime (pounds)	**Nitrate Percent Reduction Goal**
High flows	1,800	1,682	**0%** (no reduction needed)
Moderate flows	54	187	**71.2%**
Low Flows	11	59	**81.7%**

6.4.2 USEPA Guidance on Daily Load Expressions

In light of a court decision (Friends of the Earth, Inc. v. EPA, et al., No. 05-5015, D.C. Cir. 2006), USEPA recommends incorporating a daily load expression for certain types of TMDLs which are based on a concentration-based loading capacity (USEPA, 2007); e.g., when the concentration-based numeric loading capacity has a time-step, or temporal component embedded in the numeric target (for example, the 30-day geometric mean Basin Plan numeric objective for fecal coliform). In other words, a loading capacity based on a 30-day average, a seasonal mean, or a mean annual numeric target does not represent a "daily load." However,

[44] Lower Salinas River Fecal Coliform TMDL – Central Coast Water Board, 2010. Online linkage: http://www.swrcb.ca.gov/rwqcb3/water_issues/programs/tmdl/docs/salinas/lower_fecal/index.shtml

[45] The 90th percentile was chosen to represent existing loads because the California 303(d) Listing Policy allows between approximately 8% to 12% exceedances of the water quality numeric objective before a waterbody can be deemed "impaired" for toxicants. Therefore, the 90th percentile threshold appropriately accounts for the fact that about 10% of samples are allowed to exceed the water quality objective without indicating a condition of impairment.

[46] For example, if the existing nitrate load within the "moderate flow" regime is in fact presumed to be equal to the median of all observed loads, the percent reduction in nitrate loading to meet the allowable loading capacity would be 43.5%. This is substantially lower than the "worst case" scenario of a 71.2% reduction scenario where exisiting load is calculated as the 90th percentile of observed loads.

the loading capacity for this TMDL is based on the Basin Plan nitrate water quality objective, which is an instantaneous, "do not exceed" water quality objective. USEPA considers an instantaneous water quality numeric objective to be equivalent to daily-time step measurement and therefore representative of a daily load expression (USEPA, 2007). Therefore a mass-based daily load expression is not warranted for this concentration-based TMDL.

6.5 Margin of Safety

The Clean Water Act and federal regulations require that TMDLs provide a margin of safety to account for uncertainty concerning the relationship between pollution controls and water quality responses (see 40 CFR 130.7(c)(1)). The margin of safety for this TMDL is implicitly included through the use of the drinking water nitrate water quality objective as the TMDL. The water quality was established using conservative assumptions, translating to an implicit margin of safety.

6.6 Critical Conditions and Seasonal Variation

Critical conditions occur when the prescribed load allocation results in achieving the water quality standard by a narrow margin. The condition is considered critical because any unknown factor regarding environmental conditions or the calculation of the load allocation could result in not achieving the water quality standard. Therefore, critical conditions are particularly important with load-based allocations and TMDLs. However, this TMDL is a concentration-based TMDL. As such, the numeric targets and allocations are the concentrations equal to the water quality objectives. Therefore, there exists no uncertainty as to whether the allocations and TMDLs will result in achieving water quality objectives.

Staff determined there are patterns of seasonal and flow-based variation based on review of the monitoring data. While exceedances were found at monitoring sites year round, seasonal and flow analysis suggests that Los Berros Creek is subject to higher nitrate concentrations during the dry season months (May 1 to Oct. 31) and during low to moderate flow conditions – refer back to Section 3.5.3 and Section 3.5.4, respectively. Seasonal or flow-based variability is accounted for and addressed by use of the allocations equal to the water quality objectives and concentration-based allocations; this assures the loading capacity of the water body be met under all flow and seasonal conditions.

7 IMPLEMENTATION AND MONITORING

7.1 Introduction

The purpose of the proposed TMDL Implementation Plan is to describe the steps necessary to reduce nutrient loads and to achieve these TMDLs. The TMDL Implementation Plan provides a series of actions and schedules for implementing parties to implement management practices to comply with the TMDL. The TMDL Implementation Plan is designed to provide implementing parties flexibility to implement appropriate management practices and strategies to address nitrate impairment. Implementation consists of 1) identification of parties responsible for taking these actions 2) development of management/monitoring plans to reduce controllable sources of nitrate in surface waters; 3) mechanisms by which the Central Coast Water Board will assure these actions are taken; 4) reporting and evaluation requirements that will indicate progress toward completing the actions; 5) and a timeline for completion of implementation actions.

7.2 Legal Authority and Regulatory Framework

This section presents information on the legal authority and regulatory framework which provides the basis for assigning specific responsibilities and accountability to implementing parties for implementation and monitoring actions. The laws and policies pertaining to point sources and nonpoint sources are identified. The legal authority and regulatory framework are described in terms of the following:

- Controllable Water Quality Conditions
- Manner of Compliance
- Nonpoint Source Enforcement Policy

7.2.1 Controllable Water Quality Conditions

In accordance with the Water Quality Control Plan for the Central Coast Basin (Basin Plan) Controllable water quality shall be managed to conform or to achieve the water quality objectives and load allocations contained in this TMDL. The Basin Plan defines controllable water quality conditions as follows:

> *"Controllable water quality conditions are those actions or circumstances resulting from man's activities that may influence the quality of the waters of the State and that may be reasonably controlled."*
>
> Source: Water Quality Control Plan for the Central Coast Basin, Chapter 3. Water Quality Objectives, page III-2.

Examples of non-controllable water quality conditions may include atmospheric deposition of nitrogen and phosphorus, and non-controllable natural sources of nutrient compounds.

7.2.2 Manner of Compliance

In accordance with Section 13360 of the Porter-Cologne Water Quality Control Act (California Water Code, Division 7) the Water Board cannot specify or mandate the specific type, manner, or design of on-site actions necessary to reduce nutrient loading, or to meet allocations by the various responsible parties. Specific types of potential management practices identified in this TMDL project report constitute examples or suggestions of management practices known to mitigate or reduce nutrient loading to waterbodies. Stakeholders, local public entities, property owners, and/or resource professionals are in the best position to identify appropriate management measures, where needed, to reduce nutrient loading based on site-specific conditions, with the Water Board providing an oversight role in accordance with adopted permits, waivers, or prohibitions.

7.2.3 Nonpoint Source Enforcement Policy

Nonpoint sources (NPS) refer to pollution that is not released through pipes but rather originates from multiple sources over a relatively large area. Nonpoint sources are assigned the load allocation (LA) component of a TMDL. The LA is the portion of the receiving water's pollutant loading capacity attributed to (1) the existing or future nonpoint sources of pollution and (2) natural background sources. While nonpoint source discharges are not controlled directly by the federal Clean Water Act's NPDES permit program, direct control of nonpoint source pollution is left to state programs developed under state law. California's Porter- Cologne Water Quality Control Act applies to both point and nonpoint sources of pollution and serves as the principle legal authority in California for the application and enforcement of TMDL load allocations for nonpoint sources.

In July 2000 the State Water Resources Control Board and the California Coastal Commission developed the Plan for California's Nonpoint Source Pollution Control Program to reduce and prevent nonpoint source pollution in California, expanding the State's nonpoint source pollution control efforts. The NPS Program's long-term goal is to "improve water quality by implementing the management measures identified in the California Management Measures for Polluted Runoff Report (CAMMPR) by 2013. Under the California NPS Program Pollution Control Plan, TMDLs are considered one type of implementation planning tool that will enhance the State's ability to foster implementation of appropriate NPS management measures.

The Policy for Implementation and Enforcement of the Nonpoint Source Pollution Control Program adopted in August 2004, explains how Water Board authorities granted by the Porter-Cologne Water Quality Control Act will be used to implement the California NPS Program Plan The Nonpoint Source Implementation and Enforcement Policy requires the Regional Water Boards to regulate all nonpoint sources (NPS) of pollution using the administrative permitting authorities provided by the Porter-Cologne Act. Nonpoint source dischargers must comply with Waste Discharge Requirements (WDRs), waivers of WDRs, or Basin Plan Prohibitions by participating in the development and implementation of Nonpoint Source Pollution Control Implementation Programs. NPS dischargers can comply either individually or collectively as participants in third-party coalitions. (The "third-party" Programs are restricted to entities that are not actual discharges under Regional Water Board permitting and enforcement jurisdiction. These may include Non-Governmental Organizations, citizen groups, industry groups, watershed coalitions, government agencies, or any mix of the these.) All Programs must meet the requirements of the following five key elements described in the NPS Implementation and Enforcement Policy. Each Program must be endorsed or approved by the Regional Water Board or the Executive Officer (if the Water Board has delegated authority to the Executive Officer).

Key Element 1: A Nonpoint Source Pollution Control Implementation Program's ultimate purpose must be explicitly stated and at a minimum address NPS pollution control in a manner that achieves and maintains water quality objectives.

Key Element 2: The Program shall include a description of the management practices (MPs) and other program elements dischargers expect to implement, along with an evaluation program that ensures proper implementation and verification.

Key Element 3: The Program shall include a time schedule and quantifiable milestones, should the Regional Water Board require these.

Key Element 4: The Program shall include sufficient feedback mechanisms so that the Regional Water Board, dischargers, and the public can determine if the implementation program is achieving its stated purpose(s), or whether additional or different MPs or other actions are required (See Section 12, Monitoring Program).

Key Element 5: Each Regional Water Board shall make clear, in advance, the potential consequences for failure to achieve a Program's objectives, emphasizing that it is the responsibility of individual dischargers to take all necessary implementation actions to meet water quality requirements.

7.3 Implementation and Monitoring for Discharges from Irrigated Lands

The primary irrigated agricultural land TMDL implementation mechanism under direct Water Board regulatory authority is the Conditional Waiver of Discharge Requirements for Discharges from Irrigated Lands [Agricultural Order No. R3-2012-0011 (Agricultural Order) including any pending and future renewals or revisions of the Agricultural Order. Irrigated agricultural operations must sign a Notice of Intent to comply with the Ag. Order and submit it directly to the Water Board. Owners and operators of irrigated lands in the project area are required to comply with the conditions and requirements of the current Agricultural Order and any renewals thereof.

As such, load allocations for irrigated lands for this TMDL will be implemented through the Agricultural Order. Implementation and monitoring requirements are established in this TMDL and in the Agricultural Order including any pending and future renewals or revisions of the Agricultural Order; the following are recommendations to help facilitate TMDL implementation. The Agricultural Order will prioritize implementation and monitoring efforts the lower Los Berros Creek subdrainage area as evidence suggests this is the reach most at risk for nitrate impairment.

Table 7-1 presents the implementing parties responsible for implementation load allocations for discharges of agricultural fertilizer.

Table 7-1. Implementing Parties for Discharges of Agricultural Fertilizer.

Source Category	**Implementing Parties**	**Land Use Category**[1]
Agricultural Fertilizer	Owners/operators of irrigated lands in the Los Berros Creek subdrainage	Farmland – cultivated crops

[1] FMMP, 2008 landuse/land cover datasets

The goals of implementing these load allocations can be summarized as follows:

1) Control discharges of nitrate to impaired waterbodies and groundwater[47]; and
2) Implement management practices capable of achieving Load Allocations identified in this TMDL and demonstrate progress towards this goal during the TMDL implementation phase.

7.3.1 Implementation Requirements

Load allocations for owners/operators of irrigated lands will be implemented through the requirements described in this TMDL and the Agricultural Order, including future renewals or revisions of the Agricultural Order. The Agricultural Order will prioritize implementation efforts in the Los Berros Creek subwatershed aimed at addressing discharges of nitrate.

Implementing parties will comply with the Agricultural Order, and if/where appropriate and as consistent with the current Agricultural Order or renewals of the Agricultural Order[48], implementing parties will:

Table 7-2. Implementation Actions

Implementation Action [A]	**When**
Protect existing aquatic/riparian habitat to	Ongoing

[47] Shallow, recently recharged groundwater is identified in this TMDL as a substantial source contributor of nitrate loads to creek waters of the TMDL project area.

[48] Proposed revisions of the Agricultural Order are intended to address the fact that not all irrigated lands, and not all farming operations pose the same level of risk to water quality, and will likely have tiered-regulatory and reporting requirements depending on level of risk.

Implementation Action [A]	When
prevent/mitigate nutrient loading to receiving waters	
Develop/update and implement Farm Plan	Within one year of TMDL approval, or as consistent with the Agricultural Order
Implement, and update as necessary, management practices to achieve compliance with the Agricultural Order and to make progress towards achieving Load Allocations	Within one year of TMDL approval
Properly destroy abandoned groundwater wells	Within two years of TMDL approval, or as consistent with the Agricultural Order
Determine crop nitrogen uptake (if discharge has a highnitrate loading risk)	Within two years of TMDL approval, or as consistent with the Agricultural Order
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 plan must include effectiveness assessment of implemented management measures of progress toward achieving the load allocation.	Within three years of TMDL approval, or as consistent with the Agricultural Order
As an alternative to the development and implementation of an INMP, implementing parties may propose an individual discharge groundwater monitoring and reporting program (GMRP) plan for approval by the Executive Officer. The GMRP plan must evaluate waste discharge to groundwater from each ranch/farm or nitrate loading risk unit and assess if the waste discharge is of sufficient quality that it will not cause or contribute to exceedances of any nitrate water quality standards in groundwater.	
Monitoring and Reporting	**When**
Submit groundwater monitoring results and information	First year after TMDL approval: Spring and Summer. Every year thereafter: annually
Calculate nitrate loading risk level and report	Within two years of TMDL approval, or as consistent with the Agricultural Order
Report total nitrogen applied	Annually beginning one year after TMDL approval or as consistent with the Agricultural Order
Submit INMP elements, including nitrogen balance ratio.	Within three years of TMDL approval, or as consistent with the Agricultural Order and annually thereafter
Submit progress towards nitrogen balance ratio target equal to 1.2 for annual crops occupying the ground for the entire year (e.g., strawberries or raspberries) or alternative	Within three years of TMDL approval, or as consistent with the Agricultural Order
Submit INMP effectiveness report	
Nitrogen concentration in irrigation water	Quarterly beginning one year after TMDL approval, or as consistent with the Agricultural Order
Receiving water nitrate concentration	Quarterly beginning one year after TMDL approval Sampling shall be sufficient to capture a range of seasonal and flow conditions.

[A] The degree and scope of necessary implementation actions on a site-specific basis will be based on the level of risk to water quality, for example as identified in the Agricultural Order No. R3-2012-0011

It should be noted that current monitoring efforts through the Cooperative Monitoring Program and anticipated monitoring efforts of the Water Board's Central Coast Ambient Monitoring Program may be used to help demonstrate compliance and progress. It is also important to note that the Cooperative Monitoring Program is already currently collecting monthly nitrate data from Los Berros Creek when flow is present, and this is sufficient to meet the proposed receiving water quality monitoring frequency requirement, as shown in Table 7-2 . Therefore, additional receiving water monitoring by implementing parties in the subwatershed are not being proposed at this time.

The Agricultural Order, and any renewals or revisions thereof, will include monitoring and reporting requirements that assess progress toward achieving load allocations (refer back to 7.3 for a description of implementation of load allocations).

The Irrigation and Nutrient Management Plans (INMP) proposed by implementing parties must satisfy a sufficient number of samples needed to evaluate progress towards, and achievement of numeric targets for nitrate.

To limit the burden of monitoring, staff is proposing one monitoring site location to be used in assessing compliance with the TMDL and the load allocations, as shown in Table 7-3. Alternate monitoring sites to resolve the spatial extent or nature of nitrate pollution problems may be identified or proposed in the future by implementing parties, subject to Executive Officer approval. The Water Board may require additional monitoring, if needed and as appropriate, pursuant to authorities granted the Water Board under the Porter-Cologne Water Quality Control Act.

Table 7-3. Recommended receiving water monitoring sites for TMDL progress assessment for discharges from irrigated lands.

Impaired Waterbody	Impairment(s) / Water Quality Objective	Recommended Monitoring Site
Los Berros Creek	Nitrate (Drinking water standard)	310LBC

It is recognized that not all owners/operators of irrigated lands are necessarily contributing to, or causing a surface water impairment by nitrate. As such, the next section of this report outlines a variety of ways that implementing parties can demonstrate compliance with load allocations for irrigated croplands.

7.3.2 Determination of Compliance with Load Allocations

Load reductions are proposed for discharges of nitrate from irrigated lands. Staff has estimated that nitrate loads from irrigated lands overwhelmingly comprise the largest source category of controllable nitrate loading to waterbodies in the TMDL project area (refer back to Section 5). Therefore, implementation of management measures will be needed to implement the proposed load allocations for irrigated lands.

Load allocations will be achieved through a combination of implementation of management practices and strategies to reduce nitrate loading, and water quality monitoring. For nonpoint source load allocations, USEPA generally expects that the State's, Territory's, or authorized Tribe's Clean Water Act Section 319 nonpoint source management programs will be the basis for implementing load allocations[49]. California's Nonpoint Source Pollution Control Program was previously described in Section 7.2.3. In practical terms, this means load allocations are addressed though the implementation of management practices (e.g., land, irrigation and nutrient management practices)[50]. It is important to note that although load allocations are typically addressed by adoption of specific management practices, it is not always easy to evaluate the effectiveness of nonpoint source management practices. As this TMDL is heavily

[49] See USEPA, "Establishing and Implementing TMDLs" at http://water.epa.gov/lawsregs/lawsguidance/cwa/tmdl/TMDL-ch3.cfm

[50] See USEPA, Protocol for Developing Nutrient TMDLs. EPA 841-B-99-007 (November, 1999)

dependent on nonpoint source loading reductions through load allocations, long-term watershed water quality monitoring is proposed to evaluate the effectiveness of implemented management practices and nonpoint source load reductions. Existing monitoring programs in conjunction with proposed monitoring requirements in this TMDL can be used synergistically to provide for long-term water quality monitoring.

Staff is proposing flexibility in allowing owners/operators from irrigated lands to demonstrate compliance with load allocations; additionally, staff is aware that not all implementing parties are necessarily contributing to or causing a surface water impairment. However, it is important to recognize that impacting shallow groundwater with nitrate pollution may also impact creek water quality via baseflow loading contributions to the creek.

Accordingly, owners/operators of irrigated lands may demonstrate compliance with load allocations quantitatively through a combination of the following:

1) Attaining the load allocations in the receiving water; or
2) Implementing management practices that are capable of achieving Load Allocations identified in this TMDL; or
3) Provide sufficient evidence to demonstrate that the owner/operator is 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.

7.4 Implementation for Discharges from Urban Lands (MS4 Stormwater Entities)

Urban lands are considered relatively minor loads of nitrate in lower Los Berros based on the source analysis presented in Section 5 and are not causing exceedance of water quality objectives for nitrate.

Urban lands include the small Municipal Separate Storm Sewer System (MS4) entities of the City of Arroyo Grande and the County of San Luis Obispo. These entities are currently required to implement urban runoff management measures. These MS4 entities are covered individually under a Phase II National Pollutant Discharge Elimination System (NPDES) MS4 General Permit. Each of the aforementioned permitted MS4 entities have prepared a Stormwater Management Plan that outlines specific implementation measures, time schedules, and reporting requirements.

Based on available information, **these entities are meeting the nitrate waste load allocations for Los Berros Creek.** Therefore, at this time staff is not proposing waste load allocations (WLAs) be incorporated as enforceable effluent limitations and associated monitoring requirements into the applicable NPDES MS4 stormwater permits.

To protect and maintain water quality, and to continue meeting nitrate waste load allocations, these MS4 entities shall continue to implement their Water Board-approved Storm Water Management Plans or approved substitutes of them.

7.5 Implementation for Discharges from Grazing Lands

Water quality data and/or indirect evidence available to staff for TMDL project area stream reaches that exclusively drain grazing lands, or lands where grazed animals can be expected to occur indicate nitrate water quality targets, and thus load allocations, are being met in these reaches. At this time, **owners of grazing lands are meeting their load allocation in the TMDL project area**.

As such, no new regulatory mechanisms, reporting requirements, and formal regulatory oversight are deemed necessary for this source category.

To maintain and protect existing water quality, owners and operators of grazing operations should continue or begin to self-monitor, self-assess and make management decisions (where and if appropriate) consistent with technical guidance from existing rangeland water quality management plans; for example, the California Rangeland Water Quality Management Plan, the Central Coast Cattlemen's Grazing Lands Nonpoint Source Approach, or in conjunction with other resources appropriate to private grazing lands.

7.6 Suggested Implementation Options

7.6.1 Potential Management Measures for Agricultural Sources

The SWRCB, California Coastal Commission and other State agencies have identified management measures (MMs) to address agricultural sources of nutrient pollution that affect State waters. The agricultural MMs include practices and plans installed under various NPS programs in California, including systems of practices commonly used and recommended by the U.S. Department of Agriculture as components of Resource Management Systems (RMS), Water Quality Management Plans and Agricultural Waste Management Systems. These RMSs are planned by individual farmers and ranchers using an objective-driven planning process outlined in the NRCS National Planning Procedures Handbook.

As described in Section 7.2.2, the Water Board cannot specify the specific type or design of onsite actions necessary to reduce nutrient loading to waterbodies; however the California Nonpoint Source Pollution Control Program contains information on the general expectations and types of MMs (see Management Measure 1C – Nutrient Management) that will reduce nutrient loading; this information may be viewed at the following link:

http://www.swrcb.ca.gov/water_issues/programs/nps/docs/cammpr/cammpr_agr.pdf

Further, the State Water Resources Control Board's (SWRCB) Nonpoint Source Management Program provides an on-line reference guide designed to facilitate a basic understanding of nonpoint source (NPS) pollution control and to provide quick access to essential information from a variety of sources. The purpose of this on-line resource guide is to support the implementation and development of NPS total maximum daily loads (TMDLs) and watershed (action) plans with a goal of protecting high-quality waters and restoring impaired waters. Relevant information from the SWRCB Nonpoint Source (NPS) – Encyclopedia for nutrient management is available online at:

http://www.swrcb.ca.gov/water_issues/programs/nps/encyclopedia.shtml

The California Department of Food and Agricultural Fertilizer Research and Education Program (FREP) funds and coordinates research to advance the environmentally safe and agronomically sound use and handling of fertilizer materials. FREP serves growers, agricultural supply and service professionals, extension personnel, public agencies, consultants, and other interested parties. FREP is guided by the Technical Advisory Subcommittee (TASC) of the Fertilizer Inspection Advisory Board (FIAB). This subcommittee includes growers, fertilizer industry professionals, and state government and university scientists. The TASC directs FREP activities, and reviews, selects and (after peer review) recommends to the FIAB funding for FREP research and education projects. Information on FREP and nutrient management research and education can be found at: http://www.cdfa.ca.gov/is/ffldrs/frep.html

Nutrient Management Plans

Where needed and appropriate, implementation of nutrient management plans may be an effective management option to reduce nitrate loads to waters of the State. The California Nonpoint Source Pollution Control Program states that development and implementation of a nutrient management plan should include the following goals:

1) Apply nutrients at rates necessary to achieve realistic crop yields,
2) Improve the timing of nutrient application, and
3) Use agronomic crop production technology to increase nutrient use efficiency.

The California Nonpoint Source Pollution Control Program states that core components of a nutrient management plan should include:

- Farm and field maps with identified and labeled: acreage and type of crops, soil surveys, location of any environmental sensitive areas including any nearby water bodies and endangered species habitats.
- Realistic yield expectations for the crop(s) to be grown based primarily on the producer's yield history, State Land Grant University yield expectations for the soil series, or USDA NRCS Soils-5 information for the soil series.
- A summary of the nutrient resources available to the producer, which (at a minimum) include (a) soil test results for pH, phosphorus, nitrogen, and potassium; (b) nutrient analysis of manure, sludge, mortality compost (birds, pigs, etc.), or effluent (if applicable); (c) nitrogen contribution to the soil from legumes grown in rotation (if applicable); and (d) other significant nutrient sources (e.g., irrigation water).
- An evaluation of the field limitations and development of appropriate buffer areas, based on environmental hazards or concerns such as (a) sinkholes, shallow soils over fractured bedrock, and soils with high leaching potential; (b) lands near or draining into surface water; (c) highly erodible soils; and (d) shallow aquifers.
- Use of the limiting nutrient concept to establish a mix of nutrient sources and requirements for the crop based on realistic yield expectations.
- Identification of timing and application methods for nutrients to (a) provide nutrients at rates necessary to achieve realistic yields, (b) reduce losses to the environment, and (c) avoid applications as much as possible to frozen soil and during periods of leaching or runoff.
- Provisions for the proper calibration and operation of nutrient application equipment.
- Provisions to ensure that, when manure from confined animal facilities (excluding CAFOs) is to be used as a soil amendment or is disposed of on land, subsequent irrigation of the land does not leach excess nutrients to surface or ground waters.
- Vegetated Treatment Systems are discussed in Management Measure 6C of the NPS Encyclopedia.[51]

Recent peer-reviewed literature has examined the efficacy and efficiency of agricultural solutions to reducing nitrogen pollution. As reported in Davidson et al. (2012), many existing mitigation strategies[52] for farms have been demonstrated to potentially reduce nitrogen losses within the existing agricultural system by 30 to 50% or more. However, Davidson et al. (2012)

[51] http://www.swrcb.ca.gov/water_issues/programs/nps/encyclopedia/6c_vts.shtml

[52] Davidson et al. (2012) define existing mitigation strategies as those that could be accomplished under the current agricultural subsidy system.

note that improved fertilizer management, better education and training of crop advisors, and willingness by farmers to adopt these practices are needed. An ecologically intensive approach that integrates complex crop rotations, cover crops, perennials could also reduce nitrogen loses by as much as 70 to 90%.

7.7 Timeframe and Evaluation of Progress

7.7.1 Timeline to Achieve Loading Capacity

Water Board staff proposes a 12-year timeframe to achieve the TMDL. The timeframe for TMDL completion is based primarily on the expectation that nearly all landowners and operators of irrigated agricultural activities will have completed Farm Water Quality Plans and be implementing management practices by the end of the first waiver cycle (5 years). Water quality benefits resulting from implementing nutrient-control management measures (e.g., grass swales and riparian buffers, etc.) may take a few years to be realized. Water Board staff believes 12 years is a reasonable timeframe to implement management measures and reduce nitrate levels consistent with the allocations and the numeric target.

This time frame was also identified because:

1) Nitrate polluted shallow groundwater appears to be a major source of nitrate exceedances in Los Berros Creek; and
2) Available data indicates there do not appear to be legacy pollutant loads (loads related to land use practices from many years or decades ago) present in shallow groundwater[53] that could impact creek water quality, and which would take many years or decades to dissipate or attenuate;
3) Available data indicate that baseflow mean contact time (e.g., the residence time of groundwater baseflow in the subsurface before it is expressed as stream flow) appears to be relatively short (on the order of week, months, or less than one year);
4) Consequently, improved irrigation and nutrient management practices could potentially express themselves as improvements to shallow or perched groundwater quality, and surface water quality relatively rapidly;
5) The 12 year time frame is consistent with the Water Board's vision for the central coast region of healthy functioning watersheds, and clean groundwater by the year 2025.

7.7.2 Evaluation of Progress

Water Board staff will review data and evaluate implementation efforts every three years. Water Board staff will utilize information submitted pursuant to the Agricultural Order to evaluate efforts on croplands. When and as appropriate, Water Board staff will rely on information generated by the County Farm Bureaus, University of California Cooperative Extension, and/or Natural Resources Conservation Service as part of existing and future projects (i.e. Clean Water Act Section 319(h) grants) to determine that existing rangeland efforts continue to protect water quality. Staff will also review annual reports submitted under the Phase II NPDES MS4 General Permit and the monitoring and reporting program to evaluate if MS4 entities are continuing to meet waste load allocations.

Measures of TMDL implementation progress will not necessarily be limited to concentration-based metrics and/or time-weighted average concentrations of water column nitrate. Other metrics that can provide insight on interim progress to reduce nitrate pollution may be utilized,

[53] Deep groundwater and deeper aquifers likely have longer residence times for nitrate; however deep groundwater-bearing strata are unlikely to be a contributor to baseflow and nitrate loads to the creek. The nitrate loads to the creek likely originate from shallow or perched, recently-recharged groundwater sources.

for example assessments of mass-based load reductions, flow-weighted concentrations, implementation of management practices capable of ultimately achieving load allocations, etc. In addition, while the load allocations are based on the MUN water quality standard of 10 mg/L, restoration of the AGR beneficial use (based on the 30 mg/L nitrate-N Basin Plan guideline value) during TMDL implementation can be used as an indication of interim progress.

Water Board staff may conclude in future reviews that ongoing implementation efforts may be insufficient to ultimately achieve the allocations and numeric target. If this occurs, Water Board staff will recommend revisions to the implementation plan. Water Board staff may conclude and articulate in the three-year review that to date, implementation efforts and results are likely to result in achieving the allocations and numeric target, in which case existing and anticipated implementation efforts should continue. If allocations and numeric targets are being met, Water Board staff will recommend the waterbody be removed from the 303(d) list.

7.8 Cost Estimates and Funding Sources

Existing regulatory requirements are sufficient to attain water quality standards for nitrate in the project area. Therefore, Water Board staff are not required to develop cost estimates associate with implementing this TMDL; implementation of the TMDL will be accomplished through an existing permitting tools (e.g., the Agricultural Order).

For informational purposes, sstaff provides some examples of funding sources. Potential sources of financing to TMDL implementing parties are described in the Basin Plan, Chapter 4, in section VIII.C.6, as reproduced below.

On private lands whose owners request assistance, the U.S. Natural Resource Conservation Service (NRCS), in cooperation with the local Resource Conservation Districts (RCDs), can provide technical and financial assistance for range and water quality improvement projects. A Memorandum of Understanding is in place between the U.S. Soil Conservation Service and the State Board for planning and technical assistance related to water quality actions and activities undertaken to resolve nonpoint source problems on private lands.

Environmental Quality Incentives Program (EQIP)
EQIP is a program designed to address significant natural resources needs and objectives including: soil erosion and water pollution prevention, farm and ranch land production, agricultural water conservation, and wildlife habitat preservation and development. EQIP offers financial and technical assistance to eligible participants for the installation of vegetated, structural and management practices on eligible agricultural land. EQIP typically cost-shares at 90 percent of the costs of eligible conservation practices Incentive payments may be provided for up to three years to encourage producers to conduct management practices they would not otherwise do without the incentive. Limited resource producers and beginning farmers and ranchers may be eligible for cost-share up to 90 percent.

More information is also available from the local NRCS office or from the San Luis Coast Resource Conservation District website website at
http://www.coastalrcd.org/farmer_details.php?id=5

Clean Water Act 319(h) Grant Program
This program is a federally funded nonpoint source pollution control program that is focused on controlling activities that impair beneficial uses and on limiting pollutant effects caused by those activities. The 319(h) grant program offers funds to non-profit organizations, government agencies including special districts, and education institutions. Specific non-point source

activities that are eligible for 319(h) funds may include, but are not limited to: the implementation of best management practices for agricultural drainage, physical habitat alteration, channel stabilization, sediment control, hydrologic modification, livestock grazing, irrigation water management, and confined animal facilities management. Other eligible activities include technology transfer, ground water protection, pollution prevention, technical assistance, facilitation of citizen monitoring and facilities of education elements of projects.

More information is also available from the California State Water Resources Control Board site at http://www.swrcb.ca.gov/water_issues/programs/grants_loans/319h/index.shtml, or contact Melenee Emanuel, State Board Division of Water Quality, 319(h) Grants Program at (916) 341-5271.

Other Sources of Funding for Growers and Landowners

The Coastal San Luis Resource Conservation District (CSLRCD) maintains strong partnerships with local, state and federal organizations and agencies that provide funding and/or resources to conservation projects. Depending on available grant sources, the CSLRCD may be able to provide free planning and other technical assistance for eligible agricultural conservation projects on agricultural lands, including engineering design and permitting assistance. The CSLRCD can provide access to cost-share assistance for eligible projects through the USDA NRCS and other partner programs. For certain projects the CSLRCD may also be able to apply for other grant funds on behalf of a cooperating farmer, rancher or landowner. More information is available at the CSLRCD website at:

http://www.coastalrcd.org/

7.9 Existing Implementation Efforts

Protecting California's water resources depends on the proactive engagement of citizens, land owners, researchers, and businesses. Proactive efforts by citizens that result in improved water quality protection are commendable and should be recognized.

Staff learned at a December 2011 public workshop meeting that a prominent grower in the lower Los Berros Creek area has reportedly improved irrigation efficiency, by installing drip irrigation. Improved irrigation efficiency is not only potentially a good business practice, but may ultimately result in water quality improvements, by reducing runoff and/or reducing nitrate impacts to groundwater.

The Arroyo Grande Creek Watershed Management Plan (Plan), updated in 2009, was developed by Central Coast Salmon Enhancement through a grant funded by the California Department of Fish and Game. The Plan follows up on a grant that originally funded the establishment of the Arroyo Grande Creek Watershed Forum, a community-wide watershed organization. Information and projects identified in the Plan include water quality and habitat assessments and projects.

The Arroyo Grande Watershed and Creek Memorandum of Understanding (MOU) was developed and revised in 2007 and includes a range of signatory parties including local municipalities, resource organizations, non-profit environmental groups, and public agencies who collectively commit to cooperative watershed management by developing recommendations and policies for the maintenance, protection, and enhancement of the Arroyo Grande Creek Watershed, including tributary reaches such as Los Berros Creek. The MOU identifies tasks and responsibilities, including partnering on grant applications, and outreach, education and technical assistance to landowners in the watershed with the goal of creek maintenance, conservation and water quality improvements.

8 PUBLIC PARTICIPATION

Staff conducted stakeholder outreach efforts during TMDL development. Staff conducted public workshops in Santa Maria in December 2011 and in Nipomo in March 2012, and staff engaged with stakeholders during the development of the TMDL. Individuals and entities staff engaged with during the public workshop or during TMDL development included representatives of the following:

- Grower-Shipper Association of Santa Barbara and San Luis Obispo Counties
- Owners or operators of agricultural operations
- Central Coast Salmon Enhancement, Inc.
- Resource Conservation Districts
- City of Arroyo Grande Storm Water Program
- County of San Luis Obispo Storm Water Program
- Individuals representing agricultural interests

The Staff Report, Resolution, and technical project reports were made available for a 30-day public comment commencing on March 1, 2012. Water Board staff solicited public comment from a wide range of stakeholders including owners/operators of agricultural operations, agricultural representatives, environmental representatives, public agencies and City and County Storm Water Program representatives.

One public comment letter was received from:

1. Ms. Janet Parrish, U.S. Environmental Protection Agency, Region IX, San Francisco.

The comment letter from the U.S. Environmental Protection Agency (USEPA) states that USEPA supports adoption of the Los Berros Creek Subwatershed Nitrate TMDL. USEPA also requested two minor, administrative clarifications in the TMDL project report which staff incorporated in the final TMDL project documents.

REFERENCES

California Department of Water Resources (DWR). 2002. Water Resources of the Arroyo Grande-Nipomo Mesa.

Carle, S.f., B.K. Esser, J.E. Moran, High-Resolution Simulation of Basin-Scale Nitrate Transport Considering Aquifer System Heterogeneity, Geosphere, June 2006, v.2, no. 4, pg. 195-209.

CCSE (Central Coast Salmon Enhancement). 2009. Arroyo Grande Creek Watershed Management Plan Update. March 2009. Prepared for the Dept. of Fish and Game, State of California.

City of Arroyo Grande. 2008. Storm Water Master Management Plan. Public Works Department, June 2008.

Creager, C., J. Butcher, E. Welch, G. Wortham, and S. Roy. July 2006. Technical Approach to develop Nutrient Numeric Endpoints for California. Tetratech, Inc. Prepared for U.S. EPA Region IX and State Water Resources Control Board.

Davidson, E.A., Mark B. David, James N. Galloway, Christine L. Goodale, Richard Haeuber, John A. Harrison, Robert W. Howarth, Dan B. Jaynes, R. Richard Lowrance, B. Thomas Nolan, Jennifer L. Peel, Robert W. Pinder, Ellen Porter, Clifford S. Snyder, Alan R. Townsend, and Mary H. Ward. 2012. Excess Nitrogen in the U.S. Environment: Trends, Risks, and Solutions. Issues in Ecology, Number 15. Winter 2012.

Dodds, W.K., V.H. Smith, and B. Zander. 1997. Developing nutrient targets to control benthic chlorophyll levels in streams: A case study of the Clark Fork River. *Water Research*, 31(7): 1738- 1750.

Dodds, W.K., V.H. Smith, and K. Lohman. 2002. Nitrogen and phosphorus relationships to benthic algal biomass in temperate streams. *Canadian Journal of Fisheries and Aquatic Sciences*, 59: 865-874.

Generalized Watershed Loading Function. GWLF User's Manual, v. 2.0 (Cornell University, 1992) http://www.avgwlf.psu.edu/Downloads/GWLFManual.pdf

Manassaram, D.M., Backer, L.C., and Moll, D.M. 2006. A review of nitrates in drinking water: maternal exposure and adverse reproductive and developmental outcomes. Environmental Health Perspective. 2006: 114:320-327.

McMahon, G. and Roessler, C. 2002. A Regression-Based Approach To Understand Baseline Total Nitrogen Loading for TMDL Planning. National TMDL Science and Policy 2002 Specialty Conference.

Mitsova-Boneva, D. and Wang, X. 2008. A Cell-based Model for Identifying Contributing Areas of Nitrogen Loadings to Surface Water. Published by the American Society of Agricultural and Biological Engineers, St. Joseph, Michigan.

Moran, J.E., Esser B.K, Hillegonds D., Holtz M., Roberts S.K., Singleton M.M., and Visser A., 2011. California GAMA Special Study: Nitrate Fate and Transport in the Salinas Valley. Final

Report for the California State Water Resources Control Board. GAMA Special Studies Task 10.5: Surface water-groundwater interaction and nitrate in Central Coast streams. LLNL-TR-484186.

Nitchman, S.P.. 1988. Tectonic Geomorphology and Neotectonics of the San Luis Range, San Luis Obispo County, California (M.S. Thesis): Reno, University of Nevada.

Shaver, E., Horner R., Skupien J., May C., and Ridley G. 2007. Fundamentals of Urban Runoff Management – Technical and Institutional Issues (2nd Edition)

Stein, E and Kyonga-Yoon, V. 2007. Assessment of Water Quality Concentrations and Loads from Natural Landscapes. Southern California Coastal Water Research Project, Technical Report 500.
http://www.sawpa.org/documents/SCCWRP500_natural_loading.pdf

Stetson Engineers Inc., Hanson Environmental, Inc., and Ibis Environmental Services. 2004. Final Draft Arroyo Grande Creek Conservation Plan (HCP And Environmental Assessment/Initial Study (EA/IS) For the Protection of Steelhead and California Red-Legged Frogs. (February 2004 Revised).

Stiles, T. and Cleland, B. 2003. Using Duration Curves in TMDL Development & Implementation Planning. Accessed Nov. 2010 at
http://www.in.gov/idem/tmdl_durationcurveshscall.pdf.

State Water Resources Control Board (SWRCB). 2002. *Proration of U.S. Geological Survey Streamflow Data*. In, Example Format for WAA/CFII Report: Water Availability Analysis (WAA) for Application or Petition on Application.

SWRCB (State Water Resources Control Board). 2004. Water Quality Control Policy for Developing California's Clean Water Act Section 303(d) List.
http://www.swrcb.ca.gov/water_issues/programs/tmdl/docs/ffed_303d_listingpolicy093004.pdf

SWRCB. 2008. Program Draft Environmental Impact Report, AB885 Onsite Wastewater Treatment Systems. State Clearing House # 2005062049. Accessed February 2009 at:
http://www.waterboards.ca.gov/water_issues/programs/septic_tanks/

Tetratech. 2003. 2003 Progress Report Ecoregion 6 (Southern and Central California Oak and Chaparral
Woodlands) Pilot Study for the Development of Nutrient Criteria
Prepared for: US EPA Region IX Regional Technical Advisory Group & CA SWRCB State Regional Board Advisory Group:
http://rd.tetratech.com/epa/Documents/Pilot%20Project%20Draft%20October%202003a.pdf

TetraTech. 2004. Overview of Nutrient Criteria Development and Relationship to TMDLs. accessed at http://rd.tetratech.com/epa/

TetraTech. April 29, 2004. White Paper (j): Non-Modeling Methods for Estimating Nutrient Loads from Various Sources.
http://rd.tetratech.com/epa/Documents/White%20Paper%20_j_%20Nutrient%20Source%20Estimation.pdf

TetraTech. 2006. Technical Approach to Develop Nutrient Numeric Endpoints for California. July 2006. http://rd.tetratech.com/epa/Documents/CA_NNE_July_Final.pdf

Todd Engineers. 2007. Water Balance Study for the Northern Cities Area.

USDA MANAGE Database (U.S. Department of Agriculture). Available for download at: http://www.ars.usda.gov/Research/docs.htm?docid=11079 (last accessed June 2010).

USEPA. 1999. Protocol for Developing Nutrient TMDLs. EPA 841-B-99-007. http://www.epa.gov/owow/tmdl/nutrient/pdf/nutrient.pdf

USEPA, 2000. Nutrient Criteria Technical Guidance Manual, Rivers and Streams. EPA 822-B-00-002. USEPA, Office of Water, Washington, D.C. July 2000. http://water.epa.gov/scitech/swguidance/standards/criteria/nutrients/upload/2009_04_22_criteria_nutrient_guidance_rivers_rivers-streams-full.pdf

USEPA. 2000. Ambient Water Quality Recommendations – Information Supporting the Development of State and Tribal Nutrient Criteria: Rivers and Streams in Ecoregion III. EPA 822-B-00-016

USEPA. 2007(a). Options for Expressing Daily Loads in TMDLs. USEPA Office of Wetlands, Oceans, and Watersheds, Draft Guidance, June 22, 2007.

USEPA Science Advisory Board (EPA-SAB). SAB Review of Empirical Approaches for Nutrient Criteria Derivation. Memo to USEPA Administrator dated April 27, 2010. http://yosemite.epa.gov/sab/sabproduct.nsf/0/E09317EC14CB3F2B85257713004BED5F/$File/EPA-SAB-10-006-unsigned.pdf

Ward, M. H., Briseis A. K., Weyer P. J., Anderson, K.E., Folsom A.R. and Cerhan J.R. 2010. Nitrate Intake and the Risk of Thyroid Cancer and Thyroid Disease. Epidemiology, 2010 May; 21(3). Doi:10.1097/EDE.0b013e3181d6201d.

Worcester, K., Paradies D.M., and Adams, M. 2010. Interpreting Narrative Objectives for Biostimulatory Substances for California Central Coast Waters. Central Coast Ambient Monitoring Program, California Central Coast Water Board, Technical Report. http://www.swrcb.ca.gov/water_issues/programs/swamp/docs/reglrpts/rb3_biostimulation.pdf

APPENDIX A: SYNTHETIC FLOW RECORD

To develop flow duration curves, and ultimately conduct a load duration curve analysis, it is necessary to have a continuous flow record covering a broad range of flow conditions during times of water quality sampling in the impaired stream. Los Berros Creek has a limited amount of instantaneous flow data collected by CMP. However, due to the limited amount of data collected, flow estimation techniques are required in develop a daily flow record. Ungaged flow can be estimated for the impaired waterbody based on nearby USGS gages draining creeks with similar watershed characteristics, or from instantaneous flow measurements and water budget analyses from literature sources. Based on knowledge of climatic and unregulated flow conditions that would be expected in the Los Berros Creek subwatershed, USGS 11137900 at the Huasna River (Santa Barbara County) was used as a suitable reference gage to infill flow data for days that do not have instantaneous flow measurements.

A simple and widely used analytical method to develop a flow record for ungaged watersheds, is the drainage area ratio method (DAR). The DAR method is a simple, widely used analytical approach for developing discharge for ungaged watersheds/sites using discharge data from gaged watersheds. DAR is recognized by USEPA as a standard flow estimation method for ungaged sites (USEPA, 2007(a) and 2007(b)). The DAR method is most reliable when land use characteristics of the ungaged and gaged watersheds are similar, and when the size ratio between the drainage areas of the ungaged site and the gaged site is between 0.3 and 1.5 (USGS, 2000). DAR assumes that flow at the ungaged stream is proportional to the ratio of the drainage areas between the ungaged stream, and the gaged stream. The DAR flow transfer method is calculated as:

$$Flow_{ungaged} = Flow_{gaged} \times \frac{Area_{ungaged}}{Area_{gaged}}$$

Because DAR simply assumes that the streamflow at an ungaged site is the same per unit area as a nearby hydrologically similar stream gaged station, and the method does not account for spatial variations in precipitation and runoff, the DAR method is generally best used for transferring flows between sites within the same drainage basin.

To minimize uncertainty in flow estimates in this project report, the State Water Resources Control Board DAR method (SWRCB, 2002b) was used, making corrections for spatial variation in precipitation. Unlike the standard DAR method, which simply transfers flows between gaged and ungaged sites by making a correction based on the drainage area ratio (i.e., ratio of ungaged watershed size to the gaged watershed size), the SWRCB DAR method incorporates a correction factor for spatial precipitation variations. The SWRCB method can be used to transfer flow statistics from one drainage basin to another basin (personal communication, Bill Cowen, SWRCB). The DAR equation used by the SWRCB to estimate streamflow statistics is:

$$Q_{ug} = Q_g \times \frac{A_{ug}}{A_g} \times \frac{I_{ug}}{I_g} \qquad \text{(equation 1)}$$

Where

Q_{ug} is the mean daily flow (cfs) at ungaged location.
Q_g is the mean daily flow (cfs) at gaged location.

A_{ug} is the watershed drainage area above the ungaged site (acres).
A_g is the watershed drainage area above the gaged site (acres).
I_{ug} is mean annual precipitation in the ungaged watershed.
I_g is mean annual precipitation in the gaged watershed.

USGS 11137900 at the Huasna River was used as a reference gage for Los Berros Creek at site 310LBC. Estimated precipitation records for Los Berros Creek and the Huasna River are available from the PRISM dataset developed in the project report.

Using the SWRCB DAR relationship between the USGS 11137900 reference gage, and water quality monitoring site 310 LBC on Los Berros Creek is shown in the table below.

Topography	Location	Drainage Area (sq. mi.)	DAR A_{ug}/A_g	Precipitation (inches)	Precipitation Ratio I_{ug}/I_g	Final Flow Adjustment Ratio
Rolling	Huasna River @ USGS 11137900	103	-	23.0	-	-
	Los Berros Creek @ 310LBC	28	0.272	19.4	0.84	0.23

Accordingly, estimated unregulated flow for Los Berros Creek at 310LBC was derived instantaneous flow measurements provided by CMP, with the rest of the estimated daily flow record derived from the 11137900 reference stream gage record using the flow adjustment ratio of 0.23. In other words, the mean daily 11137900 flow record was adjusted by a factor of 0.23 to derive a synthetic unregulated flow record to infill the missing flow records. . The flow duration summary for the flow record developed for water quality monitoring site 310ADC is shown in the figure below.

	A	B	C	D	E	F	G	H	I	J
1	FLOW DURATION SUMMARY				Station ID:	1.23E+08				
2		Peak to Low			Station name:	Anyplace, IN				
3		cfs	mm		1-day	High	Moist	Mid	Dry	Low
4	0.033%	788.90	0.92	Peak	323	11	0	0	0	0
5	0.01%	770.66	0.90		0.376	0.013	0.001	0.000	0.000	0.000
6	0.27%	323.06	0.38	1-day						
7	1%	82.79	0.10		Average					
8	5%	11.04	0.01		5					
9	10%	4.60	0.01		0.005	10.2%	0.1	inches		
10	15%	2.28	0.00							
11	20%	0.99	0.00							
12	25%	0.46	0.00							
13	30%	0.30	0.00							
14	35%	0.23	0.00							
15	40%	0.20	0.00							
16	45%	0.15	0.00							
17	50%	0.11	0.000							
18	55%	0.06	0.00							
19	60%	0.01	0.00							
20	65%	0.00	0.00							
21	70%	0.00	0.00							
22	75%	0.00	0.00							
23	80%	0.00	0.00							
24	85%	0.00	0.00							
25	90%	0.00	0.00							
26	95%	0.00	0.00							
27	99%	0.00	0.00							
28	100%	0.00	0.000	Low						
29										
30	10.2%	4.58	0.01	Average						
31										

Raw_Data | Flow_Duration | Load_Duration_Target | WQ_Data | Calc_Percent

APPENDIX B: WATER QUALITY DATA

Program	SiteTag	Sample Date	AnalyteName	Result (mg/L)
R3_CMPSouth	310LBC	9/29/2011	Nitrate+Nitrite as N	24.20
R3_CMPSouth	310LBC	8/18/2011	Nitrate+Nitrite as N	31.40
R3_CMPSouth	310LBC	7/27/2011	Nitrate+Nitrite as N	29.90
R3_CMPSouth	310LBC	6/29/2011	Nitrate+Nitrite as N	36.80
R3_CMPSouth	310LBC	5/26/2011	Nitrate+Nitrite as N	36.00
R3_CMPSouth	310LBC	4/28/2011	Nitrate+Nitrite as N	37.40
R3_CMPSouth	310LBC	3/23/2011	Nitrate+Nitrite as N	2.73
R3_CMPSouth	310LBC	2/23/2011	Nitrate+Nitrite as N	10.50
R3_CMPSouth	310LBC	1/27/2011	Nitrate+Nitrite as N	11.60
R3_CMPSouth	310LBC	4/28/2010	Nitrate+Nitrite as N	3.83
R3_CMPSouth	310LBC	3/31/2010	Nitrate+Nitrite as N	5.30
R3_CMPSouth	310LBC	2/23/2010	Nitrate+Nitrite as N	6.99
R3_CMPSouth	310LBC	4/25/2008	Nitrate+Nitrite as N	6.68
R3_CMPSouth	310LBC	3/26/2008	Nitrate+Nitrite as N	8.24
R3_CMPSouth	310LBC	2/27/2008	Nitrate+Nitrite as N	9.77
R3_CMPSouth	310LBC	1/24/2008	Nitrate+Nitrite as N	6.60
R3_CMPSouth	310LBC	4/11/2007	Nitrate+Nitrite as N	4.10
R3_CMPSouth	310LBC	3/21/2007	Nitrate+Nitrite as N	6.04
R3_CMPSouth	310LBC	2/14/2007	Nitrate+Nitrite as N	6.75
R3_CMPSouth	310LBC	1/31/2007	Nitrate+Nitrite as N	9.90
R3_CMPSouth	310LBC	12/14/2006	Nitrate+Nitrite as N	16.30
R3_CMPSouth	310LBC	11/16/2006	Nitrate+Nitrite as N	16.40
R3_CMPSouth	310LBC	10/25/2006	Nitrate+Nitrite as N	27.30
R3_CMPSouth	310LBC	9/27/2006	Nitrate+Nitrite as N	21.10
R3_CMPSouth	310LBC	8/23/2006	Nitrate+Nitrite as N	29.30
R3_CMPSouth	310LBC	7/27/2006	Nitrate+Nitrite as N	30.20
R3_CMPSouth	310LBC	6/28/2006	Nitrate+Nitrite as N	28.60
R3_CMPSouth	310LBC	5/16/2006	Nitrate+Nitrite as N	28.00
R3_CMPSouth	310LBC	4/27/2006	Nitrate+Nitrite as N	8.00
R3_CMPSouth	310LBC	3/30/2006	Nitrate+Nitrite as N	2.62
R3_CMPSouth	310LBC	2/23/2006	Nitrate+Nitrite as N	11.30
R3_CMPSouth	310LBC	1/26/2006	Nitrate+Nitrite as N	14.90
RWB3_CCAMP	310BER	3/19/2003	Nitrate+Nitrite as N	4.58
RWB3_CCAMP	310BER	2/19/2003	Nitrate+Nitrite as N	4.40
RWB3_CCAMP	310BER	12/19/2002	Nitrate+Nitrite as N	2.56
RWB3_CCAMP	310BER	5/7/2002	Nitrate+Nitrite as N	2.58
RWB3_CCAMP	310BER	4/9/2002	Nitrate+Nitrite as N	4.47
RWB3_CCAMP	310BER	3/12/2002	Nitrate+Nitrite as N	5.78
RWB3_CCAMP	310BER	2/19/2002	Nitrate+Nitrite as N	5.65
RWB3_CCAMP	310BER	1/15/2002	Nitrate+Nitrite as N	5.93

APPENDIX C: LOAD DURATION ANALYSIS

Load duration curves provide a graphical context for looking at monitoring data and can also potentially be used to focus and inform implementation decisions (Stiles and Cleland, 2003). A load duration curve is the allowable loading capacity of a pollutant, as a function of flow. The flow duration curve is transformed into a load duration curve by multiplying the flow by the water quality objective and a conversion factor. The water quality objective that staff selected to calculate the load duration curve was the instantaneous fecal coliform Basin Plan criterion 400 MPN/100 mL. The load duration curve is thus calculated by multiplying the flow at the given flow exceedance percentile, by the instantaneous fecal coliform criteria and unit conversion factors; therefore the loading capacity is:

Water Quality Criterion ↓ — Flow ↓ — Unit Conversion Factors

Loading Capacity (MPN/day) = 400 MPN/100mL * Q (cfs) * 283.2 100mL/ft^3 * 86400 sec/day

The load duration method essentially uses an entire stream flow record to provide insight into the flow conditions under which exceedances of the water quality objective occur. As such, the load duration curve may illustrate how flow conditions relate to a variety of pollutant sources, and therefore load duration curves can be useful in differentiating between loading from point and nonpoint sources, as shown in the table below. Load duration data (shown below) for Los Berros Creek at site 310LBC was constructed using estimated daily flow records and a spreadsheet tool developed by Bruce Cleland, USEPA (Cleland, 2002). The load duration calculations, using Bruce Cleland's (2002) spreadsheet tool, are presented below.

R30

	A	B	C	D	E	F	G	H	I	J	K
1	LOAD DURATION SUMMARY				Station ID:	123456789					
2		Peak to Low			Station name:	Anyplace, IN					
3		cfs	mm	Load	812.0	= Drainage Area (square miles)					
4	0.004%	788.9	0.918	723.5	High	Moist	Mid	Dry	Low		
5	0.01%	770.7	0.897	706.7	11	0	0.1	0.0	0.0		
6	0.10%	323.1	0.376	296.3	0.013	0.001	0.000	0.000	0.000		
7	1%	82.8	0.096	75.9	10.12	0.42	0.10	0.00	0.00		
8	5%	11.0	0.013	10.1							
9	10%	4.6	0.005	4.2							
10	15%	2.3	0.003	2.1		0.17	WQ Criteria				
11	20%	1.0	0.001	0.9							
12	25%	0.5	0.001	0.4		Key Loading Equations					
13	30%	0.3	0.000	0.3							
14	35%	0.2	0.000	0.2		Load (lb/day) = Criteria * Flow * (5.3945)					
15	40%	0.2	0.000	0.2							
16	45%	0.2	0.000	0.1		TSS Load (tons/day)					
17	50%	0.1	0.000	0.1		= Criteria * Flow * (5.3945/2000)					
18	55%	0.1	0.000	0.1							
19	60%	0.0	0.000	0.0							
20	65%	0.0	0.000	0.0		Bacteria Load (counts/day)					
21	70%	0.0	0.000	0.0		= Criteria * Flow * ((28317/100)*60*60*24)					
22	75%	0.0	0.000	0.0		Note : 1 ft^3 = 28,317 mL					
23	80%	0.0	0.000	0.0							
24	85%	0.0	0.000	0.0							
25	90%	0.0	0.000	0.0							
26	95%	0.0	0.000	0.0							
27	99%	0.0	0.000	0.0							
28	100%	0.0	0.000	0.0							
29											

APPENDIX D: STEPL SPREADSHEETS

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	San Luis Obispo	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	Undeveloped	User Defined	Feedlots	Feedlot Percent Paved	Total	Annual Rainfall	Rain Days	Avg. Rain/Event
W1	274	2822	3879	1885	0	0	0-24%	8860	19.4	45	0.892

2. Input agricultural animals

Watershed	Beef Cattle	Dairy Cattle	Swine (Hog)	Sheep	Horse	Chicken	Turkey	Duck	# of months manure
W1	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0	

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	Direct Discharge Reduction, %
W1	100	2.43	1	0	0

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	52.823	0.305	7.787	0.200	1.000	52.823	0.305	7.787	0.040	1.000	52.823	0.305	7.787	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	⦿	○	○	○	A	0.100	0.031	0.200

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
Transportatio	98	98	98	98
Multi-Family	77	85	90	92
Single-Family	57	72	81	86
Urban-Cultiva	67	78	85	89
Vacant-Deve	77	85	90	92
Open Space	49	69	79	84

7. Nutrient concentration in runoff (mg/l)

Land use	N	P	BOD
1. L-Cropla	**13.8**	**0.3**	**4**
1a. w/ manure	8.1	2	12.3
2. M-Cropl	**13.8**	**0.4**	**6.1**
2a. w/ manure	12.2	3	18.5
3. H-Cropl	**13.8**	**0.5**	**9.2**
3a. w/ manure	18.3	4	24.6
4. Pasturel	**1.26**	**0.3**	**13**
5. Undevel	**2.76**	**0.1**	**0.5**
6. User De	**0**	**0**	**0**

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

Landuse	N	P	BOD
Urban	8.02	0.063	0
Cropland	8.02	0.063	0
Pastureland	1.58	0.063	0
Forest	1.58	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-Cultivate	Vacant (develope	Open Space %	Total % Area
W1	274	0	0	5	10	10	60	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	Water Depth (in) per Irrigation - After	Irrigation Frequency (#/Year)
W1	2822	0	0	0	0

Input Ends Here.