Item No. XX
Attachment B

December 2, 2005

Phase 6: Regulatory Action Selection

Final Project Report

Pajaro River and Llagas Creek
Total Maximum Daily Load for Nitrate

November 2005

Central Coast Regional Water Quality Control Board
895 Aerovista Place, Suite 101
San Luis Obispo, CA 93401

Staff contact information:
Larry Harlan
895 Aerovista Place, Suite 101
San Luis Obispo, CA 93401
(805) 594-6195
lharlan@rb3.swrcb.ca.gov

CONTENTS

LIST OF FIGURES

LIST OF TABLES

1. INTRODUCTION

In 1998, the Pajaro River and one of its tributaries, Llagas Creek, were included on California's section 303(d) list of impaired waters for nutrients. The Clean Water Act requires a Total Maximum Daily Load (TMDL) be developed to restore impaired waterbodies to their full beneficial uses. This report addresses the nitrate portion of the nutrient impairment in the Pajaro River and Llagas Creek watersheds and discusses follow-up monitoring to address the remaining impairment to ensure that beneficial uses are protected. The following section outlines the contents and structure of the report, includes a project definition with background of the 303(d) listing, and provides a description of the watersheds.

1.1. Structure of Document

The following sections are included in this TMDL report:

- Project Definition: Identifies the 303(d) listing for Pajaro River and Llagas Creek and summarizes the information that was used to characterize impairments.
- Watershed Description: Presents general characteristics and location of the watersheds.
- Water Quality Standards: Identifies the water quality standards applicable to the listing.
- Data Review: Provides an inventory and analysis of available water quality data.
- Nitrate Source Analysis: Identifies potential sources of nitrates in the watershed.
- Nitrate TMDL: Identifies the nitrate TMDL for Pajaro River and Llagas Creek, including allocations and considerations of seasonality and margin of safety.
- Monitoring: Discusses follow-up monitoring to track water quality improvements.
- Implementation: Discusses implementation activities for the nitrate TMDL, including control activities, plans for tracking the progress of implementation and the timeline for implementation activities.

1.2. Project Definition

Pajaro River and Llagas Creek were identified as impaired for nutrients and included on the 1998 303(d) list. Figure 1-1 shows the location of the Pajaro River watershed and Figure 1-2 depicts nutrient impaired segments of the Pajaro River and Llagas Creek. The listings do not specify whether it was based on violation of the narrative objective for biostimulatory substances, for violations of objectives for particular nutrients, or a combination. In addition, staff reports recommend listing of Llagas Creek due to violation of the municipal and domestic supply (MUN) numeric water quality objective of 10 milligrams per liter (mg/L) nitrate as nitrogen (nitrate-N). Except for violation of the nitrate water quality objective for Llagas Creek, neither the staff reports nor the actual listing specify a particular nutrient as cause for the impairment of Pajaro River or Llagas Creek.

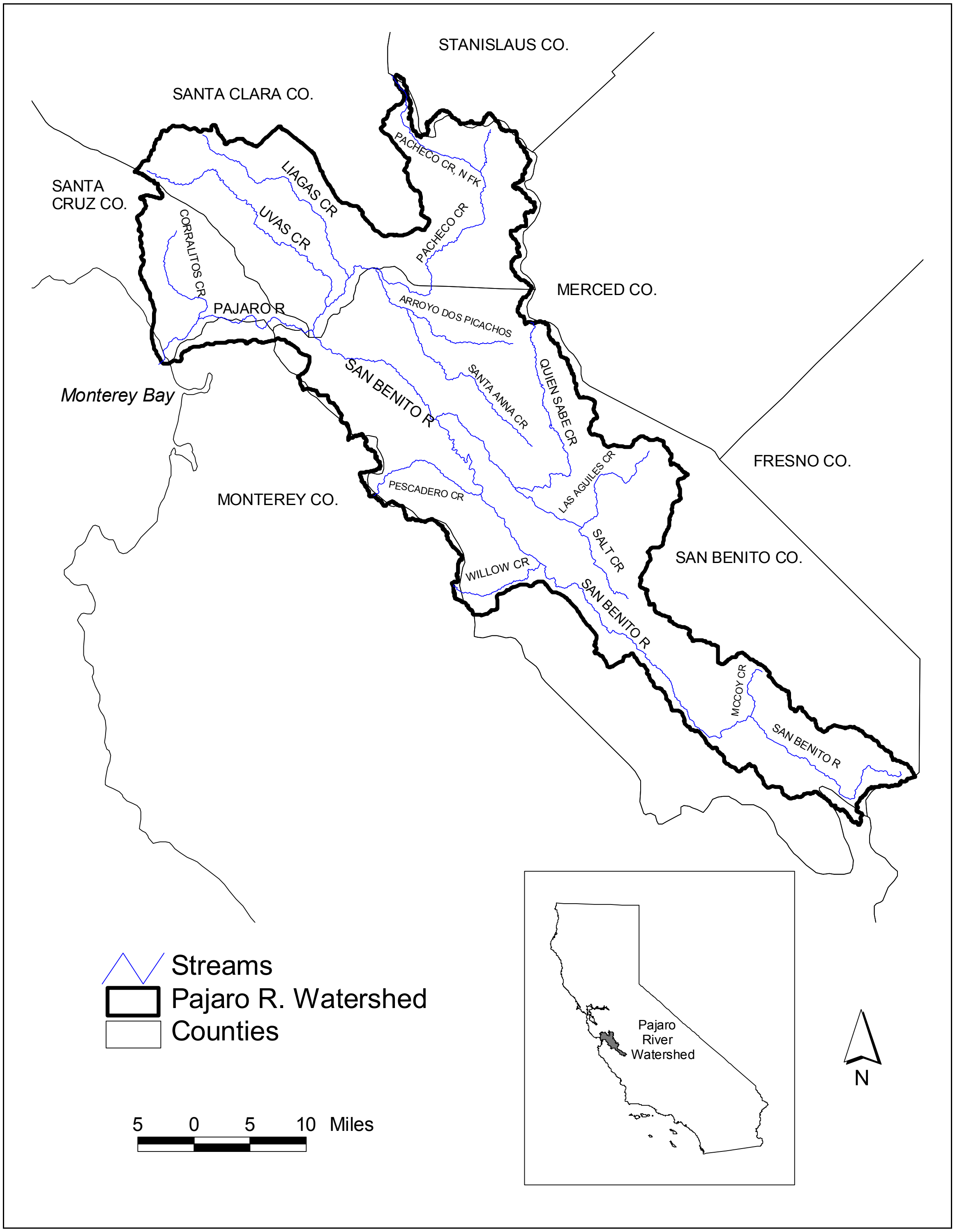


Figure 1-1. Location of the Pajaro River watershed.

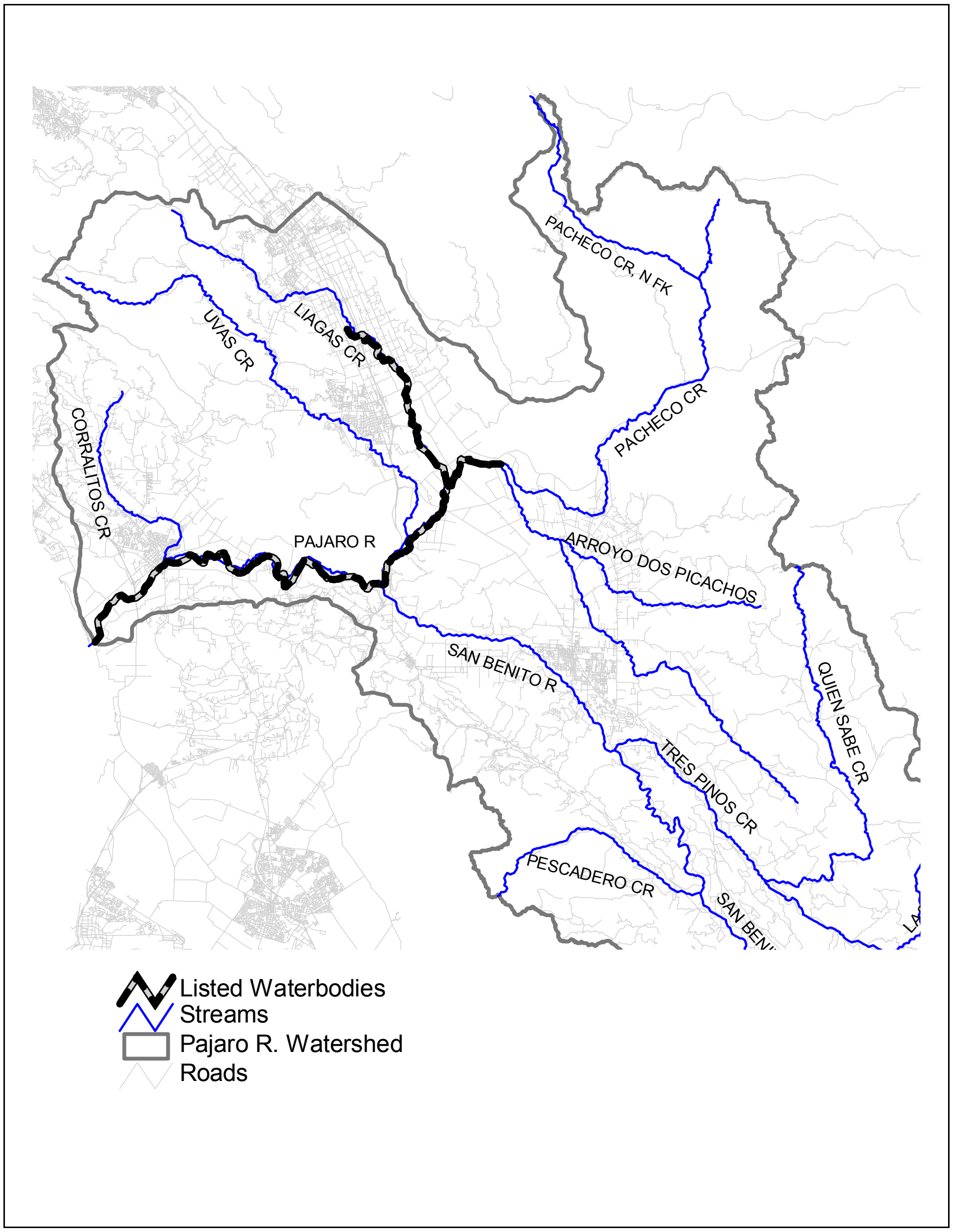


Figure 1-2. Nutrient Impaired Waterbodies on 1998 Section 303(d) List, Pajaro River Watershed.

The waterbodies, year listed for nutrients, cause for the listing, potential sources, priority and size, as referenced on the 303(d) list, are summarized in Table 1-1.

Table 1-1. Section 303(d) List, Pajaro River and Llagas Creek

Waterbody	Year Listed	Cause	Source	Priority	Size
Pajaro River	1998	Nutrients	Nutrients from agriculture, irrigated crop production, agriculture-storm runoff, agriculture-subsurface irrigation, agriculture-irrigation tailwater, agriculture-return flows, urban runoff/storm sewers, wastewater-land disposal, channelization, removal of riparian vegetation, nonpoint source	Medium	32 miles
Llagas Creek	1998	Nutrients	Nutrients from municipal point sources, agriculture, irrigated crop production, pasture grazing-riparian and/or upland, agriculture-storm runoff, agriculture-irrigation tailwater, agriculture-return flows, urban runoff/storm sewers, habitat modification, nonpoint source, unknown point source	Medium	9.5 miles (between confluence with Church Creek and confluence of Pajaro River)

The Pajaro River nutrient listing was based on information contained in the report "*The Establishment of Nutrient Objectives, Sources, Impacts, and Best Management Practices for the Pajaro River and Llagas Creek*," prepared by San Jose State University and Merritt Smith Consulting, 1994 (SJSU), as well as analytical results of the Central Coast Ambient Monitoring Program (CCAMP). The listing does not specify whether it was based on violation of the narrative objective for biostimulatory substances, for violations of objectives for particular nutrients, or a combination.

The Llagas Creek nutrient listing was based on the SJSU report, CCAMP data, a report titled the *Pajaro River Watershed Water Quality Management Plan*, dated June 1999, prepared by Applied Science and Engineering, Inc. (ASE), and a report titled *South County Regional Wastewater Authority Discharge Evaluation,* dated 1993, prepared by James Montgomery Engineering. Based on this information staff determined that water quality of Llagas Creek exceeded the nitrate water quality objective for the municipal and domestic water supply (MUN); however, the listing does not specify whether the nutrient listing was also based on violation of the narrative objective for biostimulatory substances.

To further characterize the nutrient impairments and identify potential causes, data analyses were conducted to examine relationships between nutrient levels, dissolved oxygen, and algal growth. An additional objective was to analyze historic data to evaluate potential targets that represent "nuisance" concentration, density or extent of algae that exceeds the narrative objective (i.e., growths that cause nuisance or adversely affect beneficial uses).

Examination of the historic data set was inconclusive based on the following:

- Several data components (canopy, flow) are missing;
- Data is insufficient to derive an explicit linkage between nutrient loading and other environmental conditions (e.g., canopy);
- There is no consistent method in which to measure the density or extent of attached algae and available information is qualitative; and,
- Multiple factors (not all measured) are contributing to algal productivity including physical, chemical and biological characteristics, stream canopy, temperature, phosphorus, and flow velocity.

Though the presence of algae and chlorophyll *a* (an important surrogate for evaluating algal biomass) has been observed in the Pajaro River and Llagas Creek, definitive conclusions regarding use support cannot be drawn. Nitrate data have been collected in the Pajaro River and Llagas Creek watersheds and both waterbodies experience violations of the nitrate water quality objective of 10 mg/L nitrate-N for the municipal and domestic water supply (MUN) use. Other nutrient data, such as ammonia and phosphate, have also been collected but results either do not exceed a standard or no standard exists with which to compare. Review of available dissolved oxygen data indicate that water quality objectives (WQO's) are exceeded in both waterbodies, however, a direct relationship between depressed dissolved oxygen levels and either excessive nutrients or increased algal densities does not exist.

Specific studies have been conducted to evaluate water quality and nutrient-related conditions within the Pajaro River and Llagas Creek watersheds. Summaries of these studies are presented in Section 3. Based on a review of theses studies, the following conclusions are made:

- The results of multivariate linear regression analyses have not found a significant correlation between the nutrients nitrate-N, ammonia-N, or orthophosphate with algal growth;
- Nutrient concentrations, temperature, pH, conductivity, or chlorophyll *a* concentrations did not predict dissolved oxygen concentrations or variation;
- Dissolved oxygen and chlorophyll *a* concentrations could not be explained by correlations with nutrient concentrations or stream features, such as canopy cover, substrate type, and the presence or absence of upstream reservoirs;
- Although the Pajaro River is not listed specifically for nitrates, water quality data indicate violations of the nitrate WQO for the municipal and domestic water supply (MUN) use of 10 mg/L. This supports the conclusion that the MUN beneficial use is impaired, or threatened in the Pajaro River;
- Because Water Board staff and other researchers as part of previous studies have identified the Pajaro River and Llagas Creek as impaired for nitrates, both Pajaro River and Llagas Creek should be considered for a nitrate TMDL; and,

- Both Pajaro River and Llagas Creek experience dissolved oxygen WQO violations.

Based on the review of available information the TMDL approach is as follows:

1. Develop a nitrate TMDL for Pajaro River and Llagas Creek to address the exceedences of the current numeric WQO's.
2. Design and implement a systematic monitoring program to further assess the relationship between flow, velocity, stream characteristics, sunlight, nutrients, algal growth, and dissolved oxygen conditions to better define the narrative biostimulatory WQO. If warranted, a subsequent TMDL will be developed to address excessive "nuisance" algae conditions. This future TMDL could result in further nutrient (TN, Nitrate, or TP) reductions as well as requirements for other practices such as riparian corridor restoration.
3. Present a resolution to the Water Board finding that compliance with the Conditional Waiver for Irrigated Agricultural Discharges by owners and operators of irrigated agricultural lands and additional monitoring by Water Board staff will implement the Pajaro River and Llagas Creek TMDL for Nitrate.

The TMDL will be revisited after further monitoring and the TMDL will be revised to include targets and allocations to address the biostimulatory water quality objective and dissolved oxygen, if necessary, or to justify delisting the Pajaro River and/or Llagas Creek for nutrients.

1.3. Watershed Description

The Pajaro River watershed encompasses approximately 1,263 square miles (807,940 acres). It is about 60 miles southeast of San Francisco and Oakland and 120 miles southwest of Sacramento (see Figure 1-1, page 2). The watershed is almost 90 miles in length and varies from 7 to 20 miles in width. The Pajaro River watershed drains into the Monterey Bay and is the largest coastal stream between San Francisco Bay and the Salinas River.

The watershed lies within Monterey, San Benito, Santa Cruz, and Santa Clara counties. Cities include Gilroy and Morgan Hill within the Llagas Creek subwatershed, and Hollister, San Juan Bautista, and Watsonville within other areas of the Pajaro River watershed. Major tributaries to the Pajaro River are San Benito River, Tres Pinos Creek, Santa Ana Creek, Pacheco Creek, Llagas Creek, Uvas Creek, and Corralitos Creek. Flood control projects in the Pajaro River and Llagas creek watersheds were designed to minimize the natural flooding characteristics and facilitate drainage. The watershed is predominantly mountainous and hilly with elevations ranging from sea level, where the Pajaro River enters the Monterey Bay, to over 4,900 feet in the headwaters of the San Benito River.

Land cover within the Pajaro River watershed is primarily comprised of herbaceous grassland, shrubland, and forested lands. Agricultural and urban land use development appears within the valley floors and hillsides. Cultivated cropland comprises nearly 31% of the area within the Llagas Creek subwatershed. Table 1-2 characterizes the various land uses within the Pajaro River watershed and the Llagas Creek subwatershed.

Table 1-2. Land Use

	Entire Pajaro River Watershed		**Llagas Creek Subwatershed**	
MRLC Land Use Classification [1]	**Area (mi2) [2]**	**% Area**	**Area (mi2)**	**% Area**
Grassland/Herbaceous	446.9	39.3	33.7	33.2
Deciduous Shrubland	203.1	17.9	4.7	4.6
Evergreen Forest	147.4	13	7.2	7.1
Pasture/Hay	92	8.1	4	3.9
Mixed Forest	73.1	6.4	7	6.9
Row Crops	47.3	4.2	4.7	4.6
Planted Cultivated (Orch/Vines/Groves)	45.1	4	26.8	26.4
Deciduous Forest	27.7	2.4	2.4	2.3
Bare Rock/Sand/Clay	20	1.8	0.1	0.1
Urban - Low Intensity Residential	19.6	1.7	8.2	8.1
Urban - High Intensity Comm/Ind/Trans	7.1	0.6	2.4	2.3
Other Grasses (urban/rec.)	2.5	0.2	0.2	0.2
Urban - High Intensity Residential	2.1	0.2	0	0
Bare Soil	1.3	0.1	0	0
Open Water	1.3	0.1	0.2	0.2
Small Grains	0.6	0.1	0	0
Quarries/Strip Mines/Gravel Pits	0.5	0	0	0
Emergent Herbacious Wetlands	0.1	0	0	0
Woody Wetlands	0	0	0	0
Total	**1,137.7**	100	**101.6**	100

[1] Geographic Information Systems (GIS) analysis using Multi-Resolution Land Characterization (MRLC) data.
[2] Area excludes Watsonville Slough subwatershed.

2. WATER QUALITY STANDARDS

Regional Water Quality Control Boards (Water Boards) define beneficial uses for waterbodies in their Water Quality Control Plans (Basin Plans). Also included in the Basin Plan are numeric and narrative objectives to protect the beneficial uses in each waterbody. The following sections discuss the applicable beneficial uses and water quality objectives related to the 303(d) listing for nutrients in Pajaro River and Llagas Creek.

2.1. Beneficial Uses

Pajaro River and Llagas Creek, along with several tributaries, have designated beneficial uses in the Basin Plan. Table 2-1 summarizes the designated beneficial uses for Pajaro River and Llagas Creek.

Table 2-1. Beneficial uses for Section 303(d) Listed Streams in the Pajaro River Watershed

Beneficial Use	**Waterbody Name**	
	Pajaro River	**Llagas Creek**
Municipal and domestic supply (MUN)	●	●
Agricultural supply (AGR)	●	●
Industrial (IND)	●	●
Groundwater recharge (GRW)	●	●
Water contact recreation (REC-1)	●	●
Non-contact water recreation (REC-2)	●	●
Wildlife habitat (WILD)	●	●
Cold fresh water habitat (COLD)	●	●
Warm fresh water habitat (WARM)	●	●
Migration of aquatic organisms (MIGR)	●	●
Spawning, reproduction, and/or early development (SPWN)	●	●
Rare, threatened, or endangered species (RARE)		●
Freshwater replenishment (FRESH)	●	
Commercial and sport fishing (COMM)	●	●

2.2. Water Quality Objectives

Water quality objectives applicable to the 303(d) nutrient listing include the following:

- The numeric objective for nitrate protective of the MUN beneficial use; and,
- The general narrative objective for biostimulatory substances applicable to Pajaro River and Llagas Creek.

Numeric objective for nitrate is listed in Table 2-2.

Table 2-2. Numeric water quality objective for nitrate.

Beneficial Use	Nitrate Objective
MUN	Maximum of 45 mg/L nitrate as NO_3[1]

[1]Equivalent to 10 mg/l nitrate as N.

The general narrative objective for biostimulatory substances 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."

3. DATA REVIEW

This section summarizes the data collected as part of various water quality assessment studies. The data reviewed include nutrients (nitrogenous and phosphorus compounds), dissolved oxygen, and algae.

Water quality data was obtained during the course of various assessment studies. Copies of the assessment reports are kept on file at the Water Board and include the following:

- South County Regional Wastewater Authority Discharge Evaluation, dated 1993, prepared by James Montgomery Engineering (JME);
- The Establishment of Nutrient Objectives, Sources, Impacts, and Best Management Practices for the Pajaro River and Llagas Creek, dated 1994, prepared by San Jose State University and Merritt Smith Consulting (SJSU);
- Central Coast Ambient Monitoring Program, sampling dates from December 1997 to January 1999 (CCAMP);
- Pajaro River Watershed Water Quality Management Plan, dated June 1999, prepared by Applied Science and Engineering, Inc. (ASE); and,
- Pajaro River Nutrient Loading Assessment, dated March 2004, prepared by the Center for Agroecology and Sustainable Food Systems, University of California, Santa Cruz (UCSC).

The 1993 JME report provided baseline data to evaluate predischarge conditions of the Pajaro River and Llagas Creek. The study was conducted for the South County Regional Wastewater Authority (SCRWA), located in Gilroy, in advance of their proposal to discharge treated wastewater into the Pajaro River. The facility maintains treatment ponds adjacent to Llagas Creek and SCRWA was evaluating various discharge options that included a potential surface water discharge into the Pajaro River, approximately 2-miles to the south. An algal growth bioassay was included in this study. Results of this bioassay indicated that it is difficult to accurately predict the response of Pajaro River periphyton and phytoplankton to nutrient additions on the basis of a single study. Nitrate concentrations exceeded the MUN WQO of 10 mg/L nitrate-N.

The goal of the 1994 SJSU study was to determine numerical nutrient water quality objectives and management practices for the Pajaro River and Llagas Creek. The study also included an assessment of water quality conditions that may lead to nuisance algal conditions. Data indicated that there is no one outstanding parameter, biological, chemical or physical that can be indicated as responsible for enhanced algae growth in the Pajaro River study area. The data also indicate that nitrate-N was not an important variable in predicting algal growth, however, turbidity and substrate availability were implicated as having the potential to regulate the amount of algae in the Pajaro River and Llagas Creek, respectively. Nitrate concentrations often exceeded the MUN WQO of 10 mg/L nitrate-N.

Regional water quality monitoring was conducted in 1998 as part of the Central Coast Ambient Monitoring Program (CCAMP). Results of this monitoring are contained in the Pajaro River Watershed Water Quality Management Plan (ASE). Nitrate concentrations often exceeded the MUN WQO.

The UCSC study provides the most recent and comprehensive water quality data. The primary objective was to provide a detailed assessment of nutrient water quality conditions, as well as flow conditions, for the estimation of nutrient loads. Water quality sampling was conducted during the 2003-2004 water year and results indicated that nutrient concentrations, temperature, pH, conductivity, or chlorophyll *a* concentrations did not predict dissolved oxygen concentrations or variation. Dissolved oxygen and chlorophyll *a* concentrations could not be explained by correlations with nutrient concentrations or stream features, such as canopy cover, substrate type, and the presence or absence of upstream reservoirs. Nitrate concentrations often exceeded the MUN WQO.

In summary, multiple evaluations of nutrient water quality data and conditions related to excessive algal growth and depressed dissolved oxygen were inconclusive. However, exceedance of the nitrate drinking water objective (MUN) was frequently observed.

3.1. Nitrate

The following section presents more specific results of the various studies referenced above, as related to exceedance of the nitrate drinking water objective.

For the JME study, nitrate concentrations were measured at two stations along Llagas Creek, and two stations along the Pajaro River. Concentrations at Llagas Creek ranged from 0.1 to 20 mg/L nitrate-N with a mean of 17 mg/L nitrate-N (n = 4) for the station upstream of the SCRWA treatment ponds. The Pajaro River monitoring sites had a range of 0.13 to 14 mg/L nitrate-N with 4 of the 42 samples (9.5 %) exceeding the MUN drinking water objective of 10 mg/L nitrate-N.

The SJSU study evaluated a total of six water quality monitoring stations, three along Pajaro River and three along Llagas Creek. Nitrate concentrations for Llagas Creek ranged from below the detection limit (ND) to 53 mg/L nitrate-N with 11 of the 52 samples (21%) exceeding the MUN water quality objective. Figure 3-1 is a graph of the Llagas Creek nitrate concentrations. The Pajaro River monitoring sites had a range of 0.03 to 21 mg/L nitrate-N with 9 of the 52 samples (17 %) exceeding the MUN water quality objective. Refer to Figure 3-2 for the Pajaro River monitoring results.

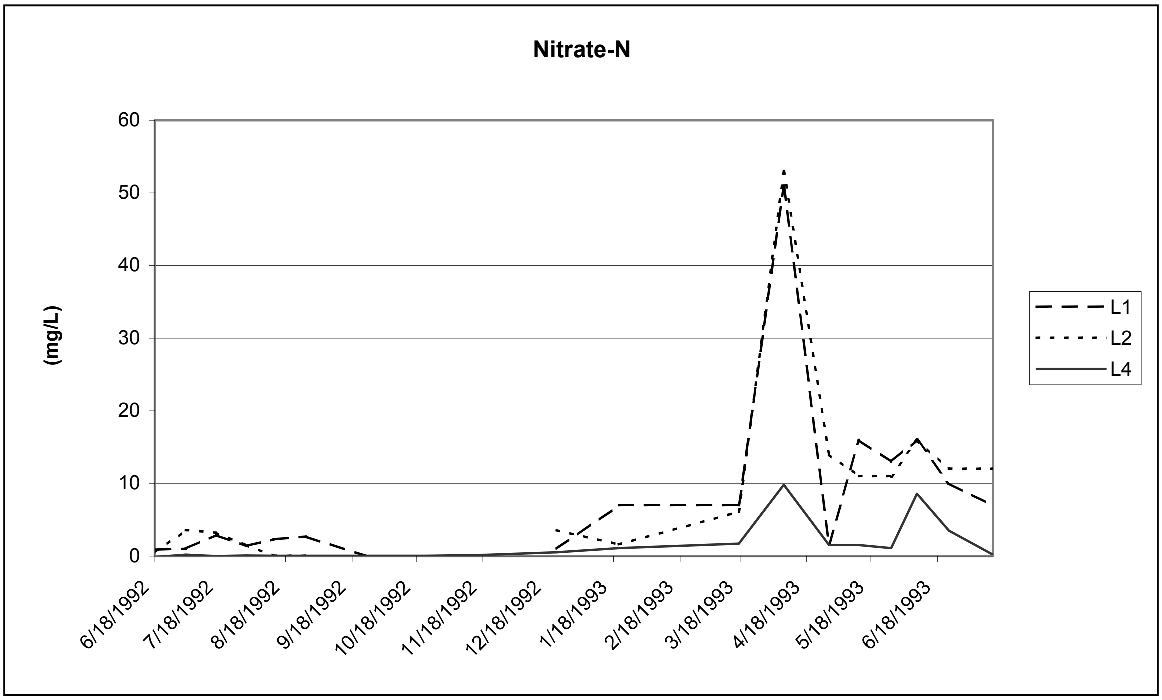


Figure 3-1. SJSU nitrate-N results for Llagas Creek.

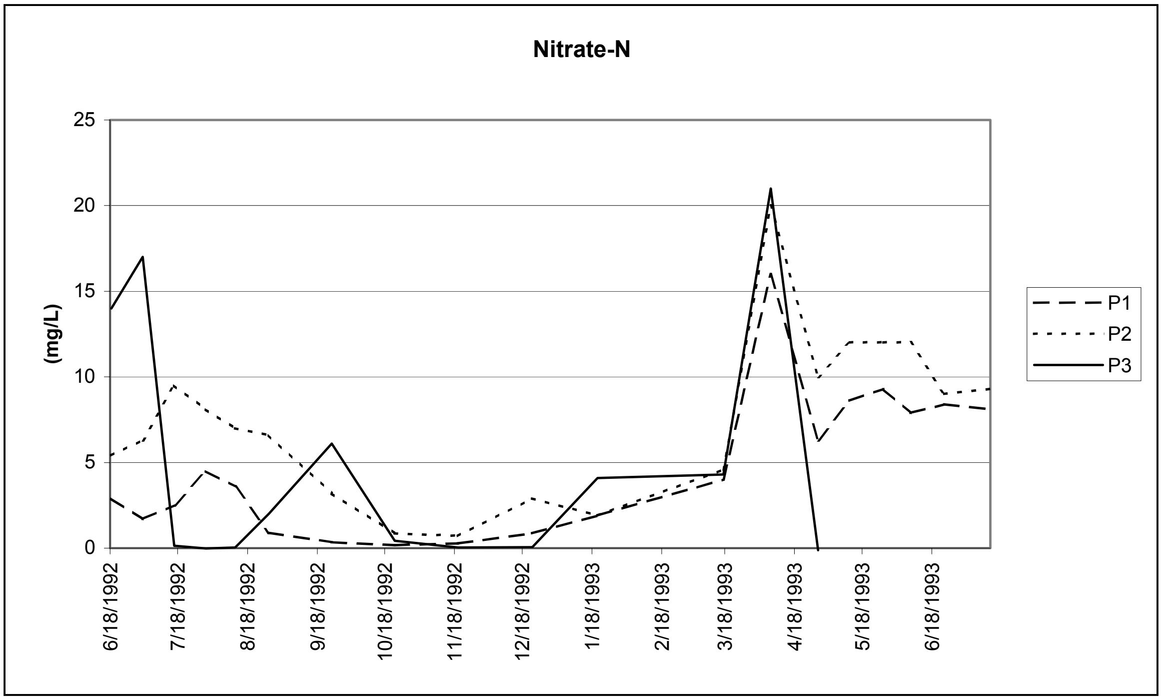


Figure 3-2. SJSU nitrate-N results for Pajaro River.

Figure 3-3 depicts locations of the various water quality monitoring stations established for the CCAMP. Nitrate data indicate that the MUN water quality objective was frequently violated at three of the Llagas Creek monitoring stations (HOL, LLA, and LUC), with 33 of the 45 samples (73%) exceeding 10 mg/L nitrate-N. Figure 3-4 is a graph of nitrate-N water quality results from the CCAMP data.

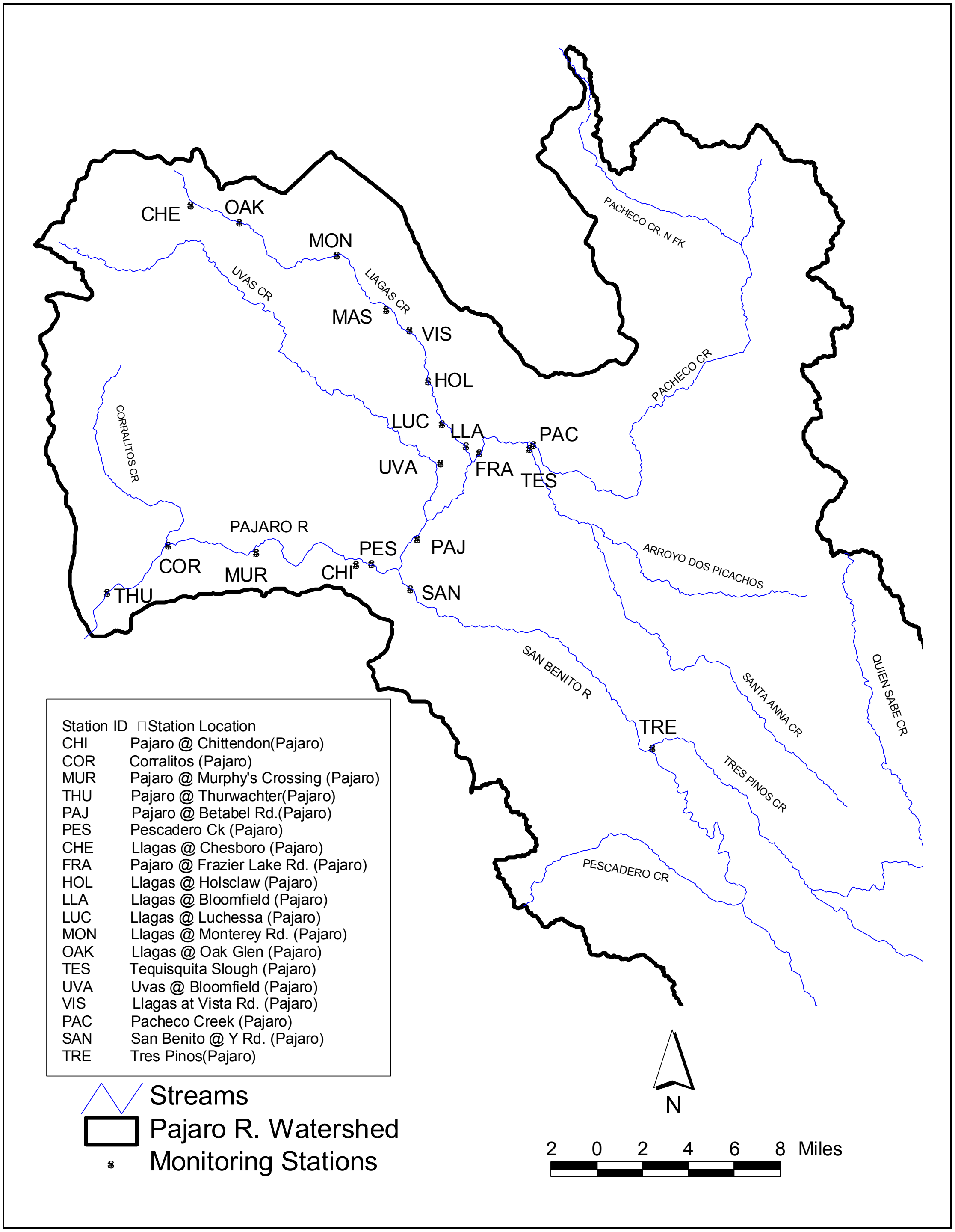


Figure 3-3. CCAMP Monitoring Stations

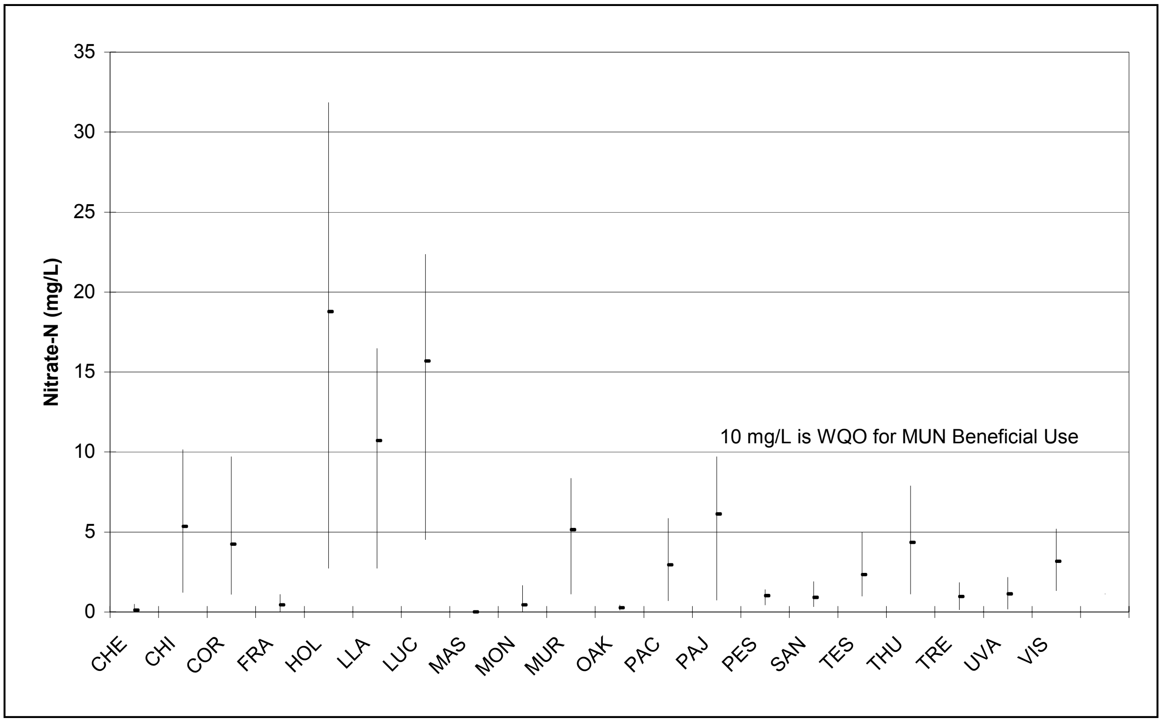


Figure 3-4. Maximum, minimum, and average nitrate-N concentrations from CCAMP data.

For the recent UCSC study, nitrogen data was collected and included nitrate-N (NO_3-N), ammonia-N (NH_4-N), organic-N, and total-N. Figure 3-5 depicts the statistical summary of nitrogen data from all of the UCSC monitoring stations. The box plots display the 10th, 25th (bottom of shaded box), 50th, 75th (top of shaded box), and 90th percentiles, as well as the mean (dotted line within box) and outliers for each site. The UCSC data indicate that nitrate concentrations exceed 10mg/L nitrate-N at two stations along Llagas Creek and three stations along the Pajaro River. No water quality objectives exist for ammonia-N, organic-N, and total-N.

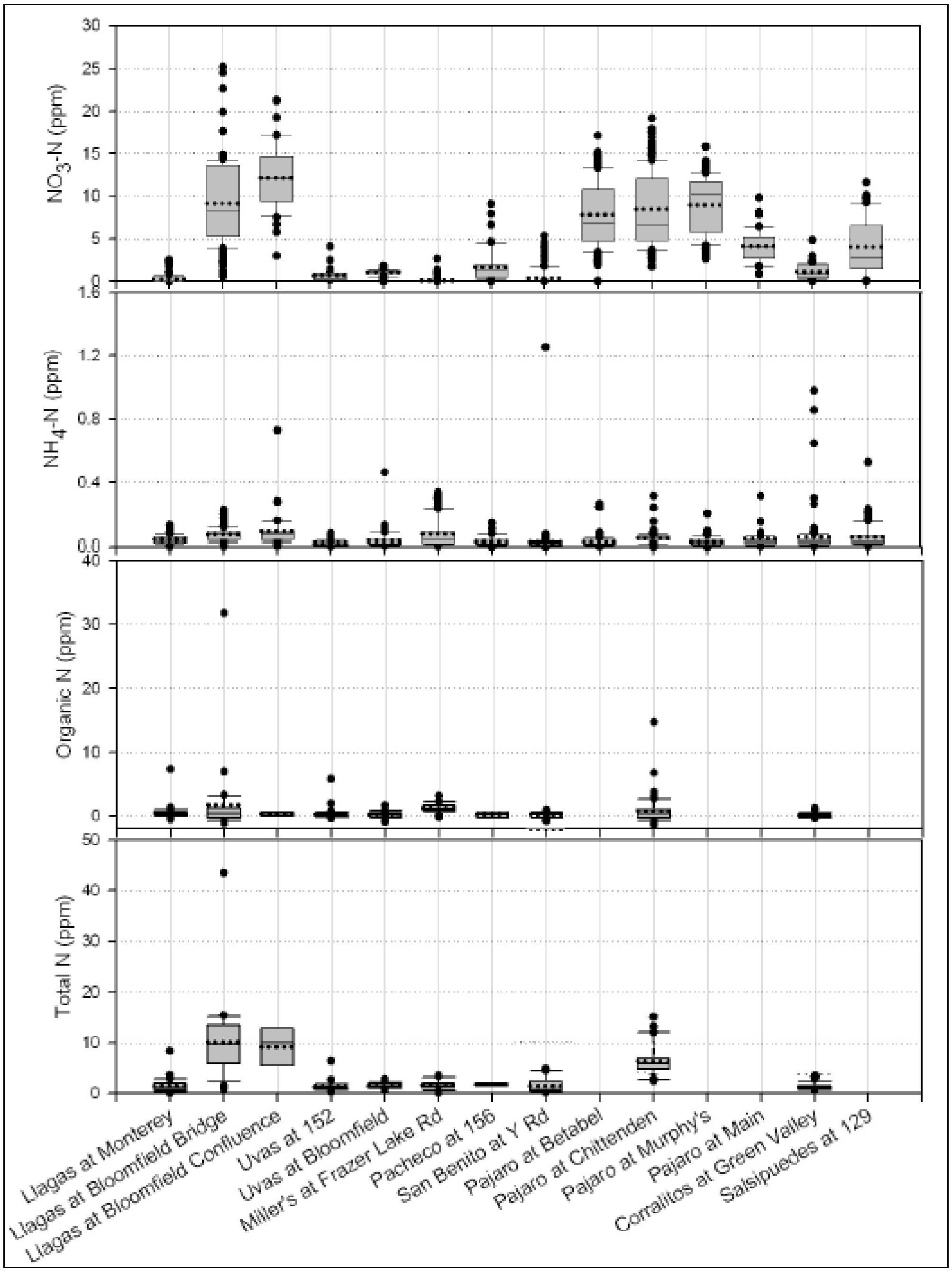


Figure 3-5. UCSC statistical summary of nitrogen data.

In summary, data support the conclusion that the water quality objective of 10mg/L nitrate-N for the MUN beneficial use is not being attained for waters of Llagas Creek and the Pajaro River.

3.2. Phosphorus

Phosphorus water quality data was collected as part of the various studies, however, the UCSC is presented here because is the most recent and comprehensive. Phosphorus data included the compounds dissolved reactive phosphorus (DRP), organic phosphorus (organic P), and total phosphorus. Figure 3-6 shows the statistical summary of phosphorus data for the Pajaro River and Llagas Creek, although there is no WQO with which to compare the data.

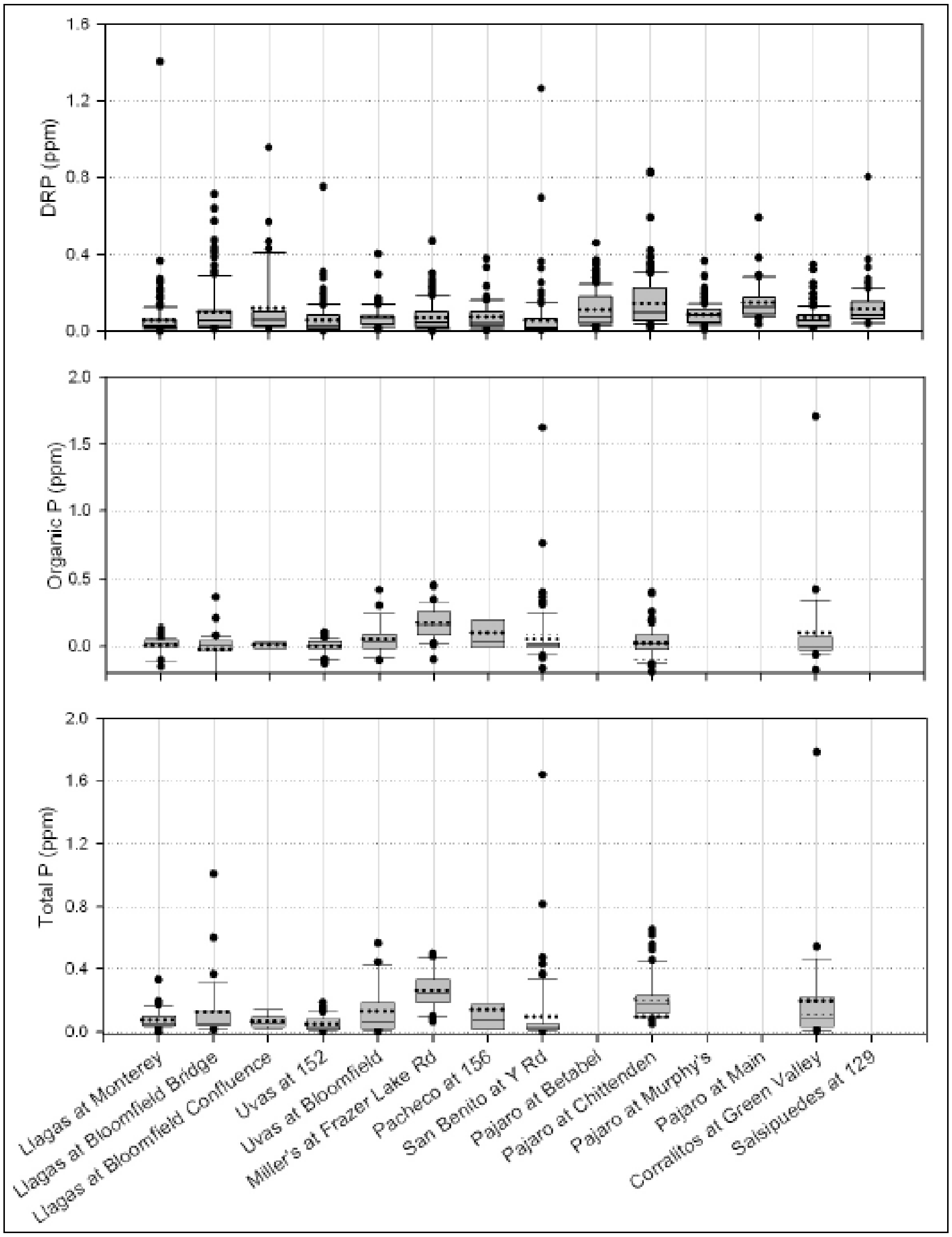
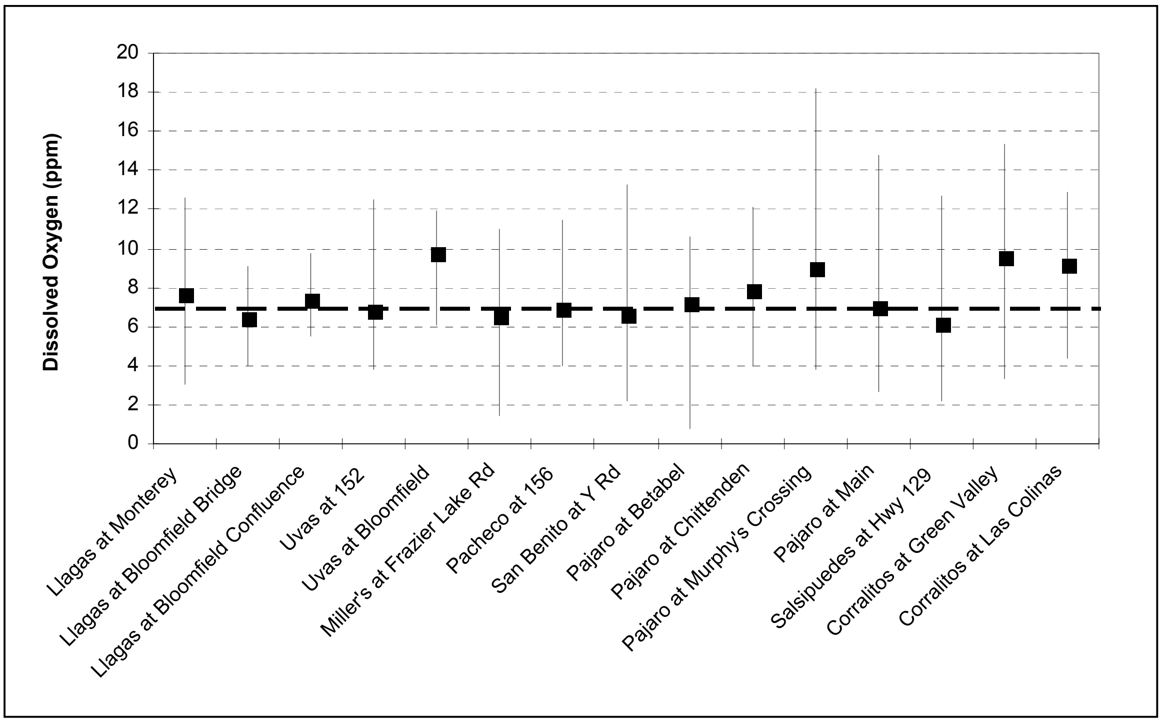


Figure 3-6. UCSC statistical summary of phosphorus data.

3.3. Dissolved Oxygen

The UCSC study provided an extensive evaluation of dissolved oxygen conditions within the Pajaro River and Llagas Creek, including tributaries. Also, a diel dissolved oxygen study, consisting of four 72-hour sampling events conducted on a quarterly basis, was performed for eleven of the fifteen sampling sites. Four diel sites were omitted during the study due to safety concerns; these included Pacheco Creek at Highway 156, Pajaro at Murphy's, Pajaro at Main, and Salsipuedes at Highway 129. The range of dissolved oxygen concentrations is presented in Figure 3-7 and the dissolved oxygen numeric objective of not less that 7 mg/l for the COLD beneficial use is indicated as a horizontal dashed line. Please note that data depicted in Figure 3-7 below include all sampling events, including the diel study.



Note: The Miller's at Frazier Lake Road sampling location is for Miller's Canal, which does not have a specific beneficial use. As such, the general objective applies where dissolved oxygen shall not be reduced below 5 mg/L. The San Benito at Y Road sampling location is for San Benito River, which maintains WARM beneficial use and dissolved oxygen objective of 5 mg/L.

Figure 3-7. Maximum, mean, and minimum dissolved oxygen concentrations from UCSC data.

Dissolved oxygen data indicate that minimum concentrations were below WQOs for all of the waterbodies contained in the figure above.

3.4. Algae

Algae data that consisted of percent coverage (e.g. attached and/or floating), suspended chlorophyll *a* concentrations, and nutrient concentrations that may produce nuisance algal conditions (SJSU) were reviewed. The algae percent coverage data is primarily anecdotal and do not provide consistent documentation on severity and extent of coverage nor the affect on beneficial use. This makes it difficult to clearly identify the impact of algae on beneficial uses of the Pajaro River and Llagas Creek and to identify an appropriate algal target representing use support.

An evaluation of suspended chlorophyll *a* data was similarly inconclusive with respect to identifying impact to beneficial use of the waterbodies. Research studies indicated that chlorophyll *a* concentrations were not correlated to either nitrogen, phosphorus, or dissolved oxygen concentrations.

The 1994 SJSU study was conducted to identify nutrient levels that do not support the growth of nuisance algae. Nuisance algae was identified as the formation of algae populations in such profusion as to:

- Reduce dissolved oxygen below water quality objectives;
- Result in odor problems from algal blooms;
- Interfere with a balanced aquatic population;
- Create slime, discoloration, foam, or other aesthetic problems which offend the senses and interfere with the comfortable enjoyment of the stream by any considerable number of persons; or,
- Interfere with water diversion equipment.

The SJSU report contained the following conclusions based on their investigation:

- There was no one outstanding parameter, biological, chemical or physical, that can be indicated as responsible for enhanced algae growth in the Pajaro River Subbasin.
- At current nutrient concentrations (0.1 to 16 mg/L nitrate-N and 0.01 to 0.33 mg/L orthophosphate as phosphate), there was no indication of nuisance or excessive attached algae growth in the Pajaro River or Llagas Creek, except for that associated with irrigation return water in the West Branch of Llagas Creek in June 1993. During the June event a bloom of attached algae was observed and was coincident with elevated nitrate nitrogen concentrations (32 mg/L nitrate-N), increased temperature, plentiful sunlight, and the presence of water at low but sustained flows from irrigated fields.
- Data indicate that nitrate nitrogen was not an important variable in predicting algal growth, however, turbidity and substrate availability were implicated as having the potential to regulate the amount of algae in the Pajaro River and Llagas Creek, respectively.

The various studies have documented the presence of algae, but they have not demonstrated a violation of the biostimulatory objective (i.e., concentrations that “promote aquatic growths to the extent that such growths cause nuisance or adversely affect beneficial uses”). As such, this data is not sufficient enough to confirm use support. Additional data that uses a systematic methodology of quantitatively evaluating or scoring the creek’s algal condition is necessary to evaluate the algal growth, frequency, and impacts.

3.5. Data Summary

Data indicate that nitrate and dissolved oxygen WQOs are not being met in Pajaro River and Llagas Creek. The presence of algae has been observed, but documentation is not sufficient to determine whether there are impacts to designated uses. Data analyses are inconclusive in establishing a relationship between nutrients, dissolved oxygen and algal growth. Data indicate that nitrate nitrogen was not an important variable in predicting algal growth. While algae and corresponding low dissolved oxygen may be influenced by other nutrient forms, they are likely driven by low flow, substrate conditions, sunlight, temperature and other environmental conditions.

Further monitoring will be conducted to evaluate dissolved oxygen and algal conditions and to identify causes or sources of the impairments and appropriate targets that will support uses. TMDLs to address excessive algae in the Pajaro River and Llagas Creek will be developed, if necessary, when the additional data are collected. The additional monitoring may also provide information for addressing the Llagas Creek low dissolved oxygen TMDL. Because data suggest nitrate impairment, a nitrate TMDL will be developed for the Pajaro River and Llagas Creek.

4. Nitrate Source Analysis

This section identifies potential sources of nitrate within the Pajaro River and Llagas Creek watersheds and estimates nitrate loading. The estimates will be helpful in prioritizing control efforts and focusing source reductions, but because they do not provide a direct link to the instream conditions, they are not used in calculating the TMDL.

Land uses in the Pajaro River watershed were determined using the Multi-Resolution Land Characteristics (MRLC) data set acquired from the Central Coast RWQCB. The MRLC data was provided by a consortium of federal government agencies acting together to acquire satellite imagery for various environmental monitoring programs. One program that resulted from the MRLC effort is the National Land Cover Data (NLCD) program, which used images acquired from LANDSAT's Thematic Mapper sensor, as well as ancillary data sources, to produce a national land cover data set.

The Source Analysis identifies known sources that may contribute to elevated nitrate concentrations and is based on land use. Nitrate sources in the Pajaro River and Llagas Creek watersheds were generally classified as:

- Agricultural land use
- Urban land use
- Open space

Agricultural land uses are identified as irrigated cropland, orchards, nurseries, pasture, and confined animal feedlots. These agricultural land uses, with the exception of feedlots, contribute nitrate to the watershed by fertilizer application. Feedlots may potentially contribute manure. Urban land uses include residential, commercial, industrial and transportation corridors. Urban land uses contribute nitrate via septic tank disposal systems, landscape maintenance, pet and/or backyard livestock wastes. Open space includes forested lands, rangeland, wetlands, and bare rock/sand. Due to a low grazing density of approximately one animal per acre (SJSU), rangeland was placed in the open space category. Open space contributes nitrate via decaying plant material, soil erosion, and wild animal waste. Atmospheric deposition is presumed to occur upon each of these land uses and each of the sources mentioned above are considered nonpoint.

Nitrate from these source areas reach the Pajaro River and Llagas Creek directly by overland flow of stormwater runoff and dry weather irrigation return flow, and indirectly via groundwater exfiltration. Nitrate applied directly to land (e.g. fertilizers, pet wastes, atmospheric deposition) can be carried overland via stormwater runoff and irrigation or can percolate through the soil to reach groundwater. Septic tank disposal systems and municipal wastewater treatment ponds contribute nitrate primarily to groundwater. Nitrate in groundwater may then be transferred to surface water via exfiltration (emergence).

Based on the UCSC study, nitrate exfiltration is believed to occur along a segment of Llagas Creek where high concentrations have been observed. Samples were collected from the main flowing portion of Llagas creek in the eastern side of the channel, as well as from discontinuous, non-flowing pools in the western side of the channel, and from Miller's Slough, a western branch of Llagas creek which also contained discontinuous pools. Nitrate levels along this stretch ranged from < 1 to 21.9 ppm (mg/L). The non-flowing pools along the west side of Llagas Creek and in Miller's Slough were densely vegetated and had nitrate-N concentrations over 14 ppm. In the channel with continuous flow, the uppermost location where water emerged was 15.5 ppm nitrate-N. However, just downstream nitrate concentrations were less than 1 ppm. Water samples collected further downstream also showed wide variations in nitrate concentrations. Mechanistic explanations of this variability were not investigated and could include variation in nitrate concentrations in groundwater entering the creek and/or in-stream biological transformations that are affected by the extent of canopy development, but this question needs further research. However, while it is clear that the shallow water table is enriched in nitrate, it is unclear if the base flow generated from the shallow groundwater is uniformly high or if there are different localized sources with variable nitrate concentrations.

The land use categories used in this analysis do not specify rangeland loads within the open space source category. Therefore staff looked at information developed in other watersheds to make the distinction between rangeland and other open space loads. The National Monitoring Program study in the Morro Bay watershed (2003) demonstrated that nitrate concentrations in the creek were not reduced significantly even though rangeland management practices were implemented. This suggests that rangeland nitrate loading is not causing increases in the nitrate concentration. Therefore, rangeland is not treated as a source that requires further reductions in this TMDL analysis.

In order to determine the significance of the urban land use loading, staff reviewed available stormwater runoff data from the City of Salinas and the County of Los Angeles, as nitrate data are not available from urbanized areas within the Pajaro River. Staff concluded that median storm water nitrate concentrations in the City of Salinas were 1.17 mg/L-N. Data from 1994-2000 collected in the Los Angeles Region indicated that cumulative event mean nitrate concentrations in runoff were 0.93 mg/L-N. Staff concludes nitrate concentrations in urban runoff to be less than the numeric target of 10 mg/l nitrate-N. Therefore, urban land uses are not treated as sources that require further reductions in this TMDL analysis.

Currently, there are no wastewater treatment plants or other point sources that discharge directly to the Pajaro River or Llagas Creek. However, the Water Board has permitted a new discharge to the Pajaro River. The South County Regional Wastewater Authority (SCRWA) facility currently uses at wastewater treatment pond system and a permit to release tertiary treated wastewater into the Pajaro River during specific flow conditions has recently been granted. The discharge is planned to begin in 2006 and is provided effluent limits that meet the nitrate numeric targets established for this TMDL. The nitrate-related effluent limits that have been permitted are 5 mg/L nitrate-N as a 30-day mean and 10 mg/L nitrate-N for a daily maximum. The facility is implementing best available technologies to reduce nitrate concentrations to these levels.

Staff concludes that the primary source of nitrates to Pajaro River and Llagas Creek is croplands. Our rationale is that elevated nitrate levels were found adjacent to croplands.

4.1. Method Used to Determine Nutrient Loads

Several types of land uses were identified as potential sources of nitrate, as described above. Nitrate loads from these potential sources were calculated using an export coefficient method as defined by the following equation:

$$L_P = \Sigma_U(L_{PU} * A_U)$$

Where: L_P = Pollutant load, lbs;

L_{PU} = Pollutant loading rate for land use type u, lbs/acre/year; and

A_U = Area of land use type u, acres

A geographic information system (GIS) was used to characterize various land uses and perform watershed delineations. MRLC data was used for land use cover and subwatersheds were delineated using a 30-meter resolution digital elevation model (DEM). Ten (10) subwatersheds were created in this process and are depicted in Figure 4-1 with the various land uses.

The export coefficient method uses a pollutant loading equation that is accepted by the U.S. Environmental Protection Agency, as contained in PLOAD Version 3.0, An ArcView GIS Tool to Calculate Nonpoint Sources of Pollution in Watersheds and Stormwater Projects, User Manual (U.S. EPA, 2001).

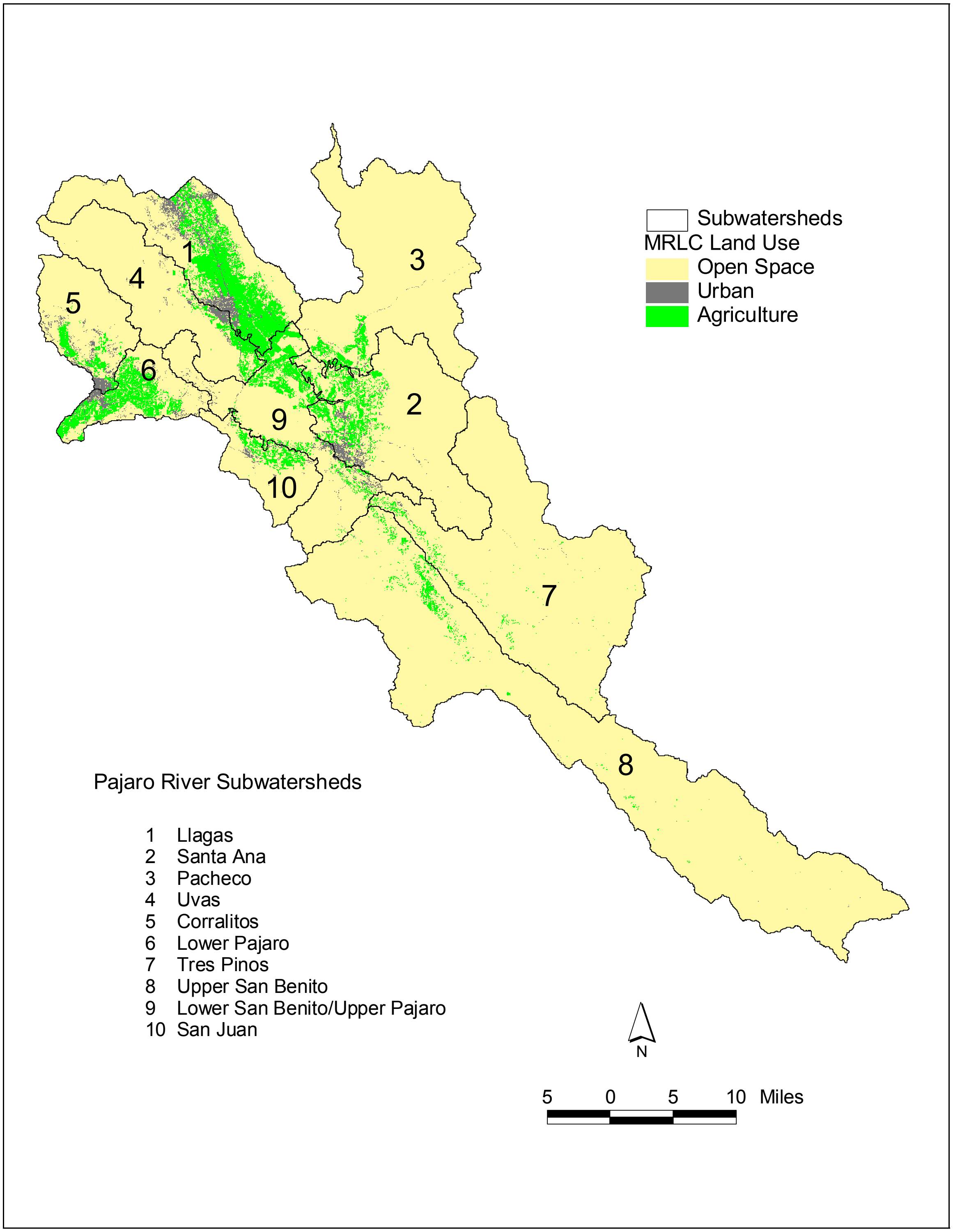


Figure 4-1. Land use map and subwatershed delineation.

The MRLC land use data contains nineteen (19) land use classes for the Pajaro River watershed. These land use classes were then aggregated (generalized) into three general land use categories (agriculture, open space, and urban), which were then used in the export coefficient model. Table 4-1 contains a description of the land use classifications and the nitrate export coefficient values that were used to estimate nitrate loads.

Table 4-1. Land Use Classification and Nitrate export coefficient values (lbs/ac/yr).

		SCCWRP *
MRLC Land Use Description	**Aggregated Land Use Class**	**Nitrate**
Low Intensity Residential	Urban	5.52
High Intensity Residential	Urban	5.52
High Intensity Comm/Ind/Trans	Urban	5.52
Other Grasses (Urban/Rec; e.g. parks)	Urban	5.52
Open Water	Open Space	1.44
Bare Rock/Sand/Clay	Open Space	1.44
Quarries/Strip Mines/Gravel Pits	Open Space	1.44
Deciduous Forest	Open Space	1.44
Evergreen Forest	Open Space	1.44
Mixed Forest	Open Space	1.44
Deciduous Shrubland	Open Space	1.44
Grassland/Herbaceous	Open Space	1.44
Woody Wetlands	Open Space	1.44
Emergent Herbaceous Wetlands	Open Space	1.44
Planted/Cultivated (orch, vines, groves)	Agriculture	15.5
Row Crops	Agriculture	15.5
Small Grains	Agriculture	15.5
Pasture/Hay	Agriculture	15.5
Bare Soil	Agriculture	15.5

Notes: * Values (expressed as nitrate fluxes) contained in *Pollutant Mass Emissions to the Coastal Ocean of California: Initial Estimates and Recommendations to Improve Stormwater Emission Estimates*, Appendix C1-11, Southern California Coastal Water Research Project, Nov. 2000.

Table 4-2 contains land use area information for each of the delineated subwatersheds as derived from the GIS analysis. Using the export coefficients (as presented in Table 4-1), the model was utilized to compute average annual nitrate loads per subwatershed. Table 4-3 contains the land use information and model results using Southern California Coastal Water Research Project (SCCWRP) export coefficients. These coefficients were obtained in a joint project conducted by SCCWRP, the San Francisco Estuary Institute, and Moss Landing Marine Laboratories. Researchers used methodology that included an assessment of stormwater runoff data collected throughout the central coast region, including sites within the Pajaro River watershed.

Table 4-2. Subwatershed land use area and composition.

Subwatershed Land Use (acres)											
Land Use	Entire Pajaro	Lower Pajaro	Corralitos	Upper Pajaro / Lower San Benito	San Juan	Uvas	Llagas	Pacheco	Santa Ana	Tres Pinos	Upper San Benito
Agriculture	121,324	13,315	3,944	18,679	6,551	4,837	23,160	5,883	25,268	9,504	10,185
Open Space	668,169	11,492	28,408	40,675	15,960	50,231	34,873	97,022	52,948	128,363	208,196
Urban	18,255	1,834	2,378	1,575	713	1,494	6,653	379	2,695	293	241
Total Area	807,748	26,640	34,730	60,929	23,224	56,562	64,686	103,284	80,911	138,160	218,622
% Area by Subwatershed		3.3	4.3	7.5	2.9	7.0	8.0	12.8	10.0	17.1	27.1
Subwatershed Land Use (%)											
Land Use	Entire Pajaro	Lower Pajaro	Corralitos	Upper Pajaro / Lower San Benito	San Juan	Uvas	Llagas	Pacheco	Santa Ana	Tres Pinos	Upper San Benito
Agriculture	15.0	50.0	11.4	30.7	28.2	8.6	35.8	5.7	31.2	6.9	4.7
Open Space	82.7	43.1	81.8	66.8	68.7	88.8	53.9	93.9	65.4	92.9	95.2
Urban	2.3	6.9	6.8	2.6	3.1	2.6	10.3	0.4	3.3	0.2	0.1

Table 4-3. Nitrate (NO^3) loading results based on SCCWRP loading rates.

Subwatershed Loading (lbs. NO^3/yr)											
Land Use	Entire Pajaro	Lower Pajaro	Corralitos	Upper Pajaro / Lower San Benito	San Juan	Uvas	Llagas	Pacheco	Santa Ana	Tres Pinos	Upper San Benito
Agriculture	1,880,527	206,377	61,136	289,522	101,544	74,967	358,985	91,179	391,646	147,305	157,866
Open Space	962,163	16,548	40,908	58,572	22,982	72,333	50,217	139,712	76,245	184,843	299,802
Urban	100,770	10,121	13,126	8,695	3,936	8,249	36,723	2,093	14,879	1,620	1,328
Total Load	2,943,460	233,046	115,170	356,789	128,462	155,548	445,926	232,984	482,770	333,768	458,996
Load %	100	7.9	3.9	12.1	4.4	5.3	15.1	7.9	16.4	11.3	15.6
Load (lbs Nitrate/ac/yr)	3.6	8.7	3.3	5.9	5.5	2.8	6.9	2.3	6.0	2.4	2.1

A cursory review of the load estimates in Table 4-3 indicates that the highest rates occur in the Lower Pajaro River and Llagas Creek subwatersheds. Though this analysis does provide an estimate of nitrate loading, it does not predict the instream nitrate levels, which are ultimately used to evaluate attainment of water quality objectives. Therefore, the loading estimates were only used to identify the potential nonpoint sources of nitrates and illustrate their relative magnitudes. The estimates will be helpful in prioritizing control efforts and focusing source reductions, but because they do not provide a direct link to the instream conditions, they are not used in calculating the TMDL.

5. Nitrate TMDL

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 nitrate TMDL for Pajaro River and Llagas Creek is set at a maximum concentration of 10 mg/l nitrate-N in receiving water to protect the MUN beneficial use. The allocations, which include background levels, are also equal to the numeric targets. Expressing the TMDL as a nitrate concentration equal to the WQO provides a direct measure of the nitrate levels in the watershed to compare with water quality objectives and 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 target of 10 mg/l nitrate-N will establish a direct link between the TMDL target and sources.

Load allocations of 10 mg/l nitrate-N are assigned to each source, including background and all watershed land uses (e.g., cropland and rangeland). This allocation will require a reduction of existing loads by cropland landowners and operators. Therefore implementation by cropland landowners and operators will consist of compliance with the Conditional Waivers of Waste Discharge Requirements for Discharges from Irrigated Lands in the Central Coast Region (conditional waiver).

Rangeland is given an allocation, which is presumed to be equal to the existing load from rangeland. As such, there are no additional requirements for rangeland landowners or operators. The municipalities of Watsonville, Hollister, Gilroy, and Morgan Hill are also each assigned a wasteload allocation equal to their existing load. As such, discharges from rangeland and urban land uses shall not cause an increase in receiving water nitrate-N concentration greater than the current increase of nitrate-N concentration resulting from the discharge. No additional requirements are necessary for municipalities.

A new discharge to the Pajaro River has been permitted. The South County Regional Wastewater Authority (SCRWA) facility was granted a permit to release treated wastewater into the Pajaro River during specific flow conditions. The discharge is planned to begin in 2006 and is provided effluent limits of 5 mg/L nitrate-N as a 30-day mean and 10 mg/L nitrate-N for a daily maximum. The SCRWA facility is given a waste load allocation that will be equal to the effluent limit in the permit. When the facility starts discharging, they will not cause an increase in receiving water nitrate-N concentration above the numeric target. Therefore no additional requirements are necessary.

Seasonality is not a determining factor in the TMDL because the TMDL is equal to the nitrate WQO, which must be met at all times. In addition, existing data indicate that WQO violations occur during both wet and dry seasons.

The margin of safety for this TMDL is implicitly included through the use of the nitrate WQO as the TMDL. The WQO was established using conservative assumptions, translating to an implicit margin of safety.

6. MONITORING

This section discusses the planned and recommended monitoring in the Pajaro River and Llagas Creek watersheds. Monitoring will include continued water quality monitoring to measure progress of the waterbodies towards attaining the nitrate TMDL target and also additional studies and monitoring to further evaluate potential impairment due to exceedance of the biostimulatory objective and low dissolved oxygen.

6.1. Follow-up Monitoring for Nitrate TMDL

Monitoring for nitrate by landowners, as required according to the Monitoring and Reporting Program set forth in the conditional waivers, will provide information for this TMDL. Landowners have the option of performing individual monitoring or participating in a cooperative monitoring program. Water Board staff will review data every three years to determine compliance with the TMDL. If the executive officer determines additional monitoring is needed, he shall request it pursuant to Section 13267 of the California Water Code.

6.2. Additional Monitoring to Characterize Excessive Algae and Low Dissolved Oxygen

The Water Board will conduct additional monitoring and data collection to assess causes of excessive algae and low dissolved oxygen conditions that may be causing impairments (flow, DO, temperature, total nitrogen, total phosphorous, nitrate, phosphate, algal biomass, chlorophyll *a*, benthic and biotic characteristics). Water Board staff will develop a monitoring plan to assess potential excessive algae conditions and address existing dissolved oxygen impairment to ensure that beneficial uses are protected. The monitoring plan will be developed by or before the first three-year review period.

Additional monitoring throughout the Pajaro River and Llagas Creek watersheds is necessary to confirm and further characterize potential impairments due to excessive algae and low dissolved oxygen. Monitoring will be designed to answer the following key questions:

- What metric should be used to best evaluate excessive algae (percent coverage, suspended or benthic chlorophyll *a*)?
- At what level should the presence of algae be considered excessive or a nuisance (are these conditions persistent)?
- What is the frequency, duration, and spatial extent of excessive algae?
- Does excessive algae impair uses (e.g., visual/aesthetic, aquatic life, recreation)?
- What are contributing factors to excessive algal growth? What are the shade, temperature, and flow conditions during times of impairment and attainment?
- Are low dissolved oxygen conditions a result of excessive algae in the waterbody or are these conditions attributed to other chemical or physical characteristics (nutrients, flow, temperature, shade, benthic and biotic characteristics)?

A key element of the additional monitoring will be to establish a metric with which to quantify and define excessive algal growth and corresponding conditions in the waterbodies. It is important to document algal conditions using a consistent methodology and to quantify, to the extent possible, the severity and extent of the algal growth. Corresponding water quality (e.g., dissolved oxygen, nutrients, etc.) and physical data (e.g., shading conditions, temperature, flow, etc.) should be collected at times of algal documentation to build a database of environmental conditions during times of algal growth and to better clarify conditions. In addition, periodic biological monitoring should be conducted to assess use support. The combination of consistent chemical and physical data supported by biological data will facilitate the determination of whether there are impairments from excessive algae.

Another important aspect of the additional monitoring is to evaluate the conditions that lead to low dissolved oxygen concentrations. While excessive algae may potentially contribute to low dissolved oxygen, previous studies have not provided or confirmed a consistent relationship. Based on previous studies, it is believed other factors such as canopy cover, temperature, and flow may be partially attributable for low oxygen levels. The monitoring plan will outline the specific elements that are necessary to evaluate dissolved oxygen impairment in Pajaro River and Llagas Creek

In addition, Water Board staff are involved in a state-wide effort to establish protocols for evaluating algal blooms and low dissolved oxygen conditions which cause impairment and for proposing control options, where reduction of nutrient loading alone is unlikely to generate a response in the waterbody.

Staff will implement the monitoring plan and collect data for three years; staff believes this period of data collection will be sufficient to make a definitive assessment of whether there are exceedences of the narrative biostimulatory objective in the Pajaro River and Llagas Creek watersheds. Water Board staff will review the continuing and expanded monitoring results every three years. At each three-year review, Water Board staff will determine whether these studies result in improved information by which to evaluate whether there are exceedences of the narrative biostimulatory objective and, if so, to set numeric targets for such impairment. Staff will also review the TMDL to determine if revisions are necessary. Water Board staff will present to the Water Board for approval any necessary revisions of this TMDL (problem statement, numeric targets, implementation plan, etc.), or, if appropriate, a separate TMDL for overall nutrient or biostimulatory substance impairment to address the algal growth and corresponding low dissolved oxygen. However, if protection of beneficial uses is demonstrated (i.e., the data do not show exceedences of the biostimulatory objective and the nitrate objectives are attained) then Water Board staff will propose de-listing of the waterbody for nutrient impairments.

7. IMPLEMENTATION

Implementation activities will be required to achieve nitrate load reductions such that numeric targets are met. This section describes the various implementation methods and parties that are responsible for the implementation as related to controllable nitrate sources from crop, orchard, pasture, rangeland, and urban land uses.

7.1. Crop and Orchard Lands

Landowners and operators of crop and orchard land uses will implement agricultural management measures and perform monitoring and reporting pursuant to the conditional waiver.

7.2. Pasture and Range Lands

Landowners and operators of pasture and range land uses will implement rangeland management measures, independently or in cooperation with partnering agencies and organizations, under guidance of the Plan for California's Nonpoint Source Pollution Control Program (NPS Program) and the California Rangeland Water Quality Management Plan (Rangeland Plan). Partnering agencies include the National Resource Conservation Service (NRCS) and the University of California Cooperative Extension (UCCE).

7.3. Urban Lands

Urban lands include the small Municipal Separate Storm Sewer System (MS4) communities of Watsonville, Hollister, Gilroy, and Morgan Hill and are required to implement urban runoff management measures. These urban land use areas are covered individually under a Phase II National Pollutant Discharge Elimination System (NPDES) MS4 General Permit. Each of these permitted municipalities have prepared a Stormwater Management Plan (Plan) that outlines specific implementation measures, time schedules, and reporting requirements.

7.4. South County Regional Wastewater Authority

Waste discharge requirements (WDR) and monitoring and reporting program (MRP) for South County Regional Wastewater Authority (SCRWA) facility are contained in Order R3-2004-0099.

7.5. Measuring Progress

Water Board staff will review data and evaluate implementation efforts every three years. Water Board staff will utilize information submitted pursuant to the conditional waivers to evaluate efforts on croplands. 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. Staff will also review annual reports submitted under the Phase II NPDES MS4 General Permit and the monitoring and reporting program for the SCRWA facility.

Water Board staff may conclude and articulate in the review 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.

7.6. Timeframe

Water Board staff proposes a twenty-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 twenty (20) years is a reasonable timeframe to implement management measures and reduce nitrate levels consistent with the allocations and the numeric target.

8. CITED REFERENCES

Applied Science and Engineering, Inc. 1999. *Pajaro River Watershed Water Quality Management Plan.*

CCAMP. 2000. Central Coast Ambient Monitoring Program*. Available at http://www.ccamp.org/ca/3/305/305.htm.*

James Montgomery Engineering (JME). 1993. South County Regional Wastewater Authority Discharge Evaluation.

Los Huertos, M., Gentry, L.E., and Shennan, C. 2001. *Land Use and Stream Nitrogen Concentrations in Agricultural Watersheds Along the Central Coast of California*. In Optimizing Nitrogen Management in Food and Energy Production and Environmental Protection: Proceedings of the 2nd International Nitrogen Conference on Science and Policy. *The Scientific World* **1**.

Los Huertos, M., Phillips, C., Fields, A., and Shennan, C. 2004. *Pajaro River Nutrient Loading Assessment.* Center for Agroecology and Sustainable Food Systems. University of California, Santa Cruz.

Regional Water Quality Control Board, Central Coast Region. 1994. Water Quality Control Plan.

Regional Water Quality Control Board, Central Coast Region. 2003. National Monitoring Program: Nonpoint Source Pollution and Treatment Measure Evaluation for the Morro Bay watershed, Final Report 1992-2002, Final Report

San Jose State University and Merritt Smith Consulting. 1994. *The Establishment of Nutrient Objectives, Sources, Impacts, and Best Management Practices for the Pajaro River and Llagas Creek,* February 28, 1994.

Southern California Coastal Water Research Project (SCCWRP), 2000. *Pollutant Mass Emissions to the Coastal Ocean of California: Initial Estimates and Recommendations to Improve Stormwater Emission Estimates*, Appendix A. November 10, 2000. Available from http://www.sccwrp.org/pubs/appendix_title.htm. Internet; accessed July 2003.

U.S. EPA. 2001. Users Manual: *PLOAD Version 3.0, An ArcView GIS Tool to Calculate Nonpoint Sources of Pollution in Watersheds and Stormwater Projects*.