Nitrate Total Maximum Daily Load
for
San Lorenzo River, Carbonera Creek, Shingle Mill Creek, and Lompico Creek

Prepared by Staff of the
Central Coast Regional Water Quality Control Board

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Central Coast Regional Water Quality Control Board
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EXECUTIVE SUMMARY

Problem Statement: This Total Maximum Daily Load (TMDL) addresses the nitrate threat to water quality within the San Lorenzo River watershed.

Nitrate concentrations have increased in the San Lorenzo River watershed since the 1950s. In addition, nitrate concentrations are threatening violations of the *Water Quality Control Plan, Central Coast Region* (Basin Plan)as one constituent or factor that may contribute to taste and odor problems in drinking water.

The Basin Plan contains the following objective for taste and odor:

> "Waters shall not contain taste or odor-producing substances in concentrations that impart undesirable tastes or odors to fish flesh or other edible products of aquatic origin, that cause nuisance, or that adversely affect beneficial uses."

A taste and odor problem is affecting the Municipal and Domestic Water Supply beneficial use. The *San Lorenzo Nitrate Management Plan, Phase II Final Report,* County of Santa Cruz Health Services Agency, Environmental Health Service, February 1995 (Nitrate Management Plan) states that the City of Santa Cruz paid $60,000 a year to remove taste and odor. If taste and odor were not a problem, the City would not need to spend $60,000 a year for treatment.

The taste and odor problem is the most sensitive impact that may be linked to nitrate in the San Lorenzo River (Nitrate Management Plan page 15). The taste can be quite obnoxious and lead to a public perception that the water is unclean and unsafe to drink.

Numeric Target: The target for the San Lorenzo River Watershed is 1.5 mg/l. This level would reduce the nitrate threat and represent a 30 percent reduction in total nitrate loading by the year 2020. This reduction equates to a nitrate level that occurred prior to the late 1970's before taste and odor became a significant problem in the City water supply (Nitrate Management Plan, page four).

Source Analysis: The primary sources of nitrate include the following, at the relative percent contribution indicated:

- septic systems (57%),
- agriculture (livestock/stables and landscaping/fertilizer use)(8%),
- sewage discharge from the Boulder Creek Country Club (10%),
- the Scott's Valley ground water nitrate plume (9%), and
- natural sources (16%).

Total Maximum Load and Load Allocations:

The Total Maximum Loads are shown below in bold.

Target Attainment Station	Nitrate Levels before Reduction (lbs/nitrate/month)	Percent Loading Reduction	TMDL* (lbs/nitrate/month)	Target Attainment Year
San Lorenzo River at Felton	4752			1995
	4980	15%	4233	2005
	5095	20%	4076	2010
	5327	**30%**	**3728**	**2020**
Carbonera Creek at the confluence of Branciforte Creek	381			1995
	399	15%	339	2005
	408	20%	326	2010
	427	**30%**	**299**	**2020**
Shingle Mill Creek at the confluence of San Lorenzo River	87			1995
	91	15%	77	2005
	93	20%	74	2010
	97	**30%**	**68**	**2020**

* Measured in July, August, and September

Load allocations are shown below.

Source	Pounds per Month, Felton	Pounds per Month, Carbonera Creek	Pounds per Month, Shingle Mill Creek
URBAN SOURCES (Nonpoint Sources)			
Septic Systems in Sandy Areas	1,316	105	26
Septic Systems in Non-Sandy Areas	810	65	17
Sewer Discharge from Boulder Creek County Club	53	4	0
Scott's Valley Nitrate Plume	479	38	0
AGRICULTURE SOURCES			
Livestock & Stables	112	9	4
Landscaping/ Fertilizer Use	106	9	3
NATURAL SOURCES			
Natural Sources in Non-Sandy Areas	213	17	5
Natural Sources in Sandy Areas	639	52	13
TOTAL	3728	299	68

Linkage: A linkage analysis is necessary to demonstrate that load/wasteload allocations will attain the numeric target. The load allocation table above indicates a 30 percent nitrate load reduction is possible. A 30 percent reduction results in adequate protection of water quality and results in concentrations that existed prior to the late 1970s when taste and odor became a problem.

Margin of Safety: This report provides targets and loading capacity that includes a 15 percent margin of safety.

Seasonal Variation/Critical Condition: The proposed loading capacity for nitrate in the San Lorenzo River is a 30 percent loading reduction measured during the summer months (July-September). The worst odors generally occur in the late summer according to the *Preliminary Report, An Evaluation of Wastewater Disposal and Water Quality in the San Lorenzo River Watershed,* County of Santa Cruz Health Services Agency, Environmental Health Service, September, 1989 *(*Evaluation of Wastewater Disposal), page 164. The Total Maximum Load is the loading capacity (and associated allocations) that will attain the target. The loading capacity and the associated allocations were developed from data for July 1-September 30 as representative of the summer critical condition and to take advantage of the previous data analysis in the San Lorenzo River Nitrate Management Plan that evaluated summer data for the months of July through September. The loading capacity and allocations apply all year long.

Implementation: The County of Santa Cruz is currently implementing the Nitrate Management Plan to reduce nitrate discharges to the San Lorenzo River watershed. The Nitrate Management Plan provides control measures for septic tank systems, the Boulder Creek County Club wastewater discharge, livestock/stable operations, and land use.

The Regional Board adopted the implementation plan as an amendment to the Water Quality Control Plan in 1995.

INTRODUCTION

TMDLs are required for waters placed on the State of California 303(d) list. The 303(d) list identifies water quality limited water bodies. A water quality limited segment is any known segment that is not expected to meet applicable water quality standards, even after the application of technology-based effluent limitations or other Regional Board requirements. San Lorenzo River and several of its tributaries (Carbonera Creek, Shingle Mill Creek, and Lompico Creek) are currently on the 303(d) list.

The objective of a TMDL is to define maximum allowable point and non-point source pollutant loads that will lead to compliance with water quality standards. The total allowable point source loading is termed wasteload allocation (WLA) and the total of non-point source loading is termed load allocation (LA). The TMDL is the sum of the WLA and the LA plus a margin of safety (MOS).

TMDL = ∑WLA + ∑LA + MOS

Where

- ∑ = the sum,
- WLA = waste load allocation from point sources,
- LA = load allocation from nonpoint sources (including natural background), and
- MOS = margin of safety.

A description of the requirements of a TMDL can be found in 40 CFR 130.2 and 130.7 as well as Section 303(d) of the Federal Clean Water Act (CWA).

The San Lorenzo Watershed encompasses approximately 140 square miles within Santa Cruz County. Santa Cruz County is located approximately 50 miles south of San Francisco. Most of the watershed is rugged mountainous terrain and is densely forested. Maximum elevation is approximately 3200 feet. The San Lorenzo River flows generally south-southeast in a narrow highly developed valley. The towns of Boulder Creek, Ben Lomond, and Felton are located along the upper watershed. The river generally flows southerly to the City of Santa Cruz before emptying into the Pacific Ocean. The San Lorenzo River spans 25 miles from Waterman Gap to the Pacific Ocean. Tributaries include Bean, Bear, Boulder, Branciforte, Carbonera, Clear, Fall, Kings, Lompico, Newell, and Zayante Creeks. The River and its tributaries provide silver salmon and steelhead trout habitat. A map of the watershed is shown in Figure One.

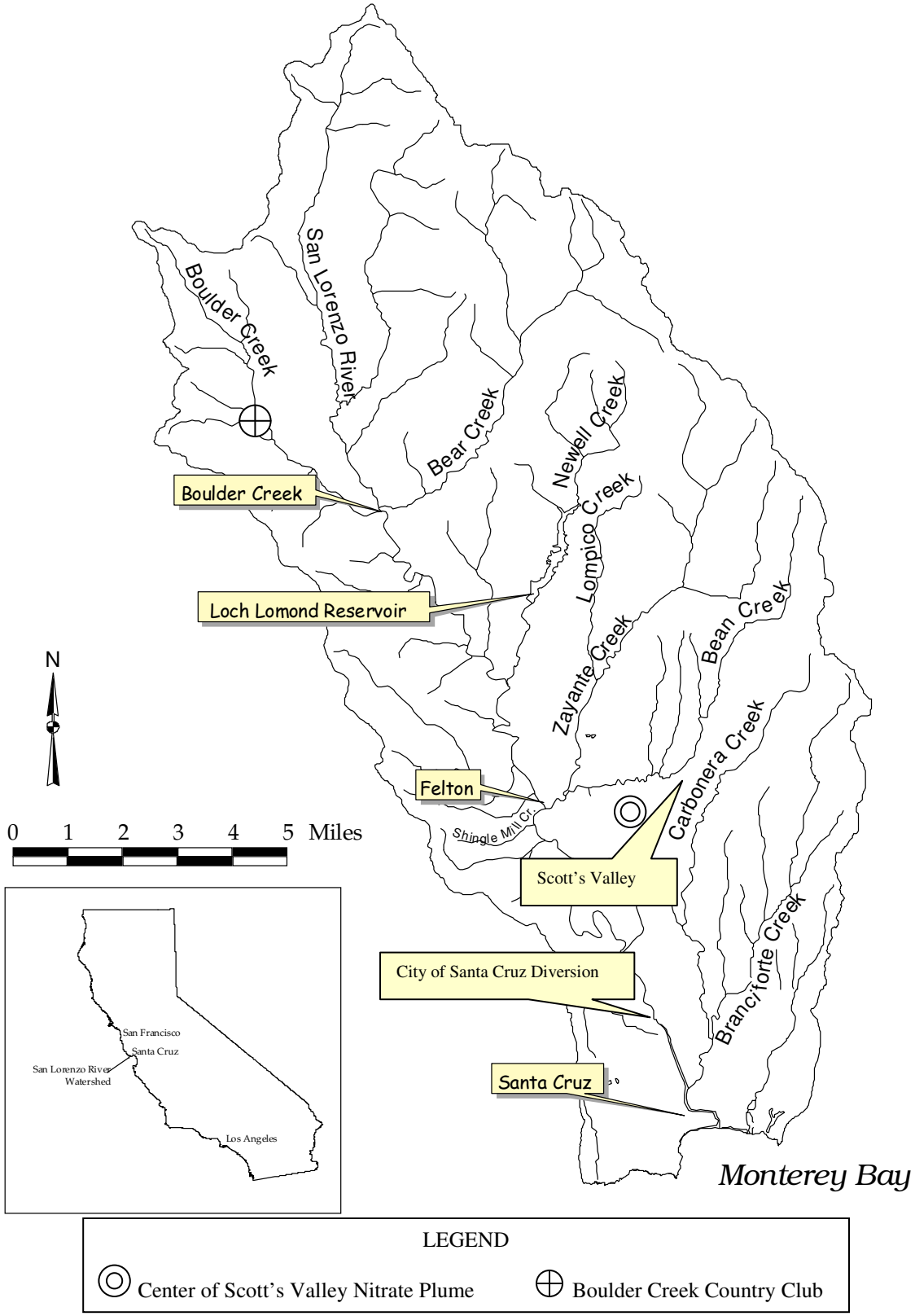

Figure One. San Lorenzo River Watershed.

Major land uses in the San Lorenzo River watershed are:

- Forest (Timber roads, timber harvest, etc.)
- Openland (Rangeland, pasture, recreation, etc.)
- Urban (septic systems, etc.)
- Recreation (Golf Courses)
- Agriculture (Livestock, etc.)
- Water

Beneficial Uses for the San Lorenzo River Watershed are listed in Table One below.

Table One. Summary of Beneficial Water Uses for San Lorenzo River and Tributaries[1]

	MUN	AGR	IND	GWR	REC-1	REC-2	WILD	COLD	WARM	MIGR	SPWN	BIOL	RARE	FRESH	NAV	COMM
San Lorenzo River	X	X	X	X	X	X	X	X		X	X	X	X	X		X
Branciforte Creek	X	X		X	X	X	X	X		X	X					X
Carbonera Creek	X	X	X	X	X	X	X	X		X	X					X
Zayante Creek	X	X	X	X	X	X	X	X		X	X					X
Bean Creek	X	X	X	X	X	X	X	X		X	X					X
Mountain Charlie Gulch	X			X	X	X	X	X		X	X					X
Lompico Creek	X	X		X	X	X	X	X		X	X					X
Mill Creek	X			X	X	X	X	X								X
Newell Creek	X	X		X	X	X	X	X		X	X			X		X
Loch Lomond Res.	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X
Love Creek	X		X	X	X	X	X	X		X	X					X
Spring Creek Gulch	X			X	X	X	X	X		X	X					X
Bear Creek	X	X		X	X	X	X	X		X	X					X
Two Bar Creek	X			X	X	X	X	X		X	X					X
Kings Creek	X			X	X	X	X	X		X	X					X
Spring Creek	X			X	X	X	X	X		X	X					X
Boulder Creek	X	X		X	X	X	X	X		X	X					X
Malosky Creek	X			X	X	X	X	X		X	X					X
Clear Creek	X			X	X	X	X	X		X	X					X
Alba Creek	X			X	X	X	X	X		X	X					X
Marshall Creek	X			X	X	X	X	X		X	X					X
Manson Creek	X			X	X	X	X	X		X	X					X
Fall Creek	X	X	X	X	X	X	X	X		X	X					X
Bull Creek	X			X	X	X	X	X		X	X					X
Shingle Mill Creek	X			X	X	X	X	X		X	X					X
Gold Gulch Creek	X			X	X	X	X	X		X	x					X

[1] Beneficial Use abbreviations used: Mun=Municipal and Domestic Supply, Agr= Agricultural Supply, Proc=Industrial Process Supply, Ind-=Industrial Service Supply, GWR=Ground Water Recharge, Frsh=Freshwater Replenishment, Nav=Navigation, Pow=Hydropower Generation, Rec-1=Water Contact Recreation, Rec-2=Non-Contact Water Recreation, Comm=Commercial and Sport Fishing, Aqua=Aquaculture, Warm=Warm Fresh Water Habitat, Cold=Cold Fresh Water Habitat, Sal=Inland Saline Water Habitat, Est=Estuarine Habitat, Mar=Marine Habitat, Wild=Wildlife Habitat, Biol=Preservation of Biological Habitats of Special Significance, Rare=Rare, Threatened, or Endangered Species, Migr=Migration of Aquatic Organisms, Spwn=Spawning, Reproduction, and/or Early Development, Shell=Shellfish Harvesting, ASBS=Areas of Special Biological Significance

Historical Efforts to Improve Water Quality

San Lorenzo watershed water quality has been monitored since the late 1960's. (Limited data is available for the 1950's at a few stations.) California Regional Water Quality Control Board, Central Coast Region,(Regional Board) reviewed data and determined nitrate concentrations were increasing.

In response to this condition (and other conditions such as inappropriate septic system locations), the Regional Board adopted Resolution 82-10 in 1982. Resolution 82-10 adopted on-site sewage disposal system prohibition areas and mandated an on-site wastewater disposal program in other areas. Regional Board actions became effective on July 1, 1986.

To meet the Resolution 82-10 mandated solutions, Santa Cruz County and Regional Board staff worked to develop the *Wastewater Management Plan for the San Lorenzo River Watershed* and the *San Lorenzo Nitrate Management Plan, Phase II Final Report,* February 1995 (Nitrate Management Plan). Santa Cruz County adopted these documents in 1995.

These reports (referred to as the Nitrate Management Plan above) were developed through a comprehensive Santa Cruz County effort. The County Environmental Health Services collected data and documented water quality conditions in the San Lorenzo Valley watershed from 1986 through 1995. Regional Board staff and Santa Cruz County staff also worked to develop the solutions contained in the above two reports.

In 1995, the Regional Board rescinded Resolution 82-10 and adopted the Nitrate Management Plan as the solution to San Lorenzo Watershed nitrate problems (Regional Board Resolution 95-04). While Regional Board Resolution 95-04 adopted an implementation plan to correct nitrate impairment, Regional Board action did not completely fulfill the requirements of the Clean Water Act Section 303(d). Section 303(d) of the Federal Clean Water Act requires States to develop Total Maximum Daily Loads (TMDL's) for waterbodies not meeting applicable water quality standards. TMDLs must include a (1) problem assessment; (2) numeric targets that are consistent with the narrative objective and numeric water quality objectives and beneficial uses; (3) an assessment of sources impacting the river system; (4) an estimate of the loading capacity necessary to attain the numeric targets: (5) allocation of load responsibility among different sources; (6) a margin of safety, consideration of seasonal variations, and critical conditions; and (7) public participation.

The Nitrate Management Plan (adopted by the Regional Board in Resolution 95-04) identifies the problem, sources, and implementation measures. The Plan contains information regarding nitrate loading capacity and provided the information that supports the numeric target consistent with water quality objectives, and the load allocation contained within this TMDL. Extensive public participation contributed to the Nitrate Management Plan. The implementation plan provides the tools to attain the proposed target.

The Regional Board did not adopt a numeric target as part of Resolution 95-04. (The Nitrate Management Plan provides nitrate reduction goals that are not clear specific targets with clear specific time frames.) The numeric target developed in this TMDL finds a measure where implementation of the Nitrate Management Plan reaches objectives contained in the *Water Quality Control Plan, Central Coast Region* (Basin Plan).

This TMDL is largely based upon the Nitrate Management Plan. This Nitrate Management Plan utilizes many historical reports to develop a program to reduce nitrate. The reader should refer to appendix titled "References Considered" to review all the reports that went in to the developing the Nitrate Management Plan. Because the Nitrate Management Plan is a synopsis of several investigations, the Nitrate Management Plan is often used as a reference for this TMDL.

The Nitrate Management Plan presents results and recommendations of elevated nitrate level investigations in surface water and ground water in the San Lorenzo River Watershed, Santa Cruz County, California. The report includes water quality data; nitrate budgets by geographic area and land use; effects of increased nitrate on biostimulation, algae growth, and beneficial uses; measurement of nitrate levels in the vadose zone beneath shallow and deep septic system leachfields in sandy soils; cost-effectiveness evaluation of

potential nitrate control measures; recommendations for a surface water nitrate target; and nitrate management plan.

PROBLEM IDENTIFICATION

Beneficial Use Impacts

The purpose of this section is to document beneficial use impacts and violations of water quality objectives-both numeric and narrative. This section will conclude that nitrate is not impacting beneficial uses. However, there is evidence to indicate that nitrate is *threatening* to adversely affect the "Municipal and Domestic Water Supply" beneficial use and is *threatening* to violate the taste and odor narrative water quality objective. Nitrate could also be threatening to adversely affect the water contact and non-contact water recreation beneficial uses. This section discusses all likely affected beneficial uses by similar categories.

Water Contact and Non-Contact Water Recreation (REC-1) and (REC-2) Beneficial Uses

Literature indicates nitrate is not impairing the REC-1 or REC-2 beneficial use, but nitrate could be a potential problem. For example, the Nitrate Management Plan states:

> "During assessments of algae growth conducted by the County, assessments of potential impact on recreation or aesthetics have been made. There are times when conditions of sliminess, murkiness, or prolific algae growth have been observed, but no complaints, or documentation of actual impact have been received to date (page 13)."

The lack of recreational use impact is supported by the *Preliminary Report: An Evaluation of Wastewater Disposal and Water Quality in the San Lorenzo River Watershed* (Evaluation of Wastewater Disposal Study), September 1989. This report states:

> "There has been no documentation of historical loss of recreation due to algae growth in the San Lorenzo River, although this is mentioned as a potential problem in 1964 (DWR, 1966) and in 1978 (Santa Cruz County Planning Dept., 1979) (page 163)."

Commercial and Sport Fishing (COMM); Warm Fresh Water Habitat (WARM); Cold Fresh Water Habitat (COLD); Rare, Threatened, or Endangered Species (RARE); Migration of Aquatic Organisms (MIGR); Spawning, Reproduction, and/or Early Development (SPWN); and Wildlife Habitat Beneficial Uses

The Nitrate Biostimulation Study indicates neither dissolved oxygen nor pH is a problem in the San Lorenzo River. The Biostimulation Study states:

> "Results from the diel (a 24 hour period of time) investigation indicate that algae growth has not resulted in deleterious effects on dissolved oxygen, or pH. The lowest oxygen concentration (7.7 mg/l) was measured at Sycamore Grove prior to sunrise. Although below the oxygen saturation of 9.6 mg O_2/L, the lowest oxygen measured was still higher than that required to sustain fishery resources."

Staff reviewed all dissolved oxygen data contained within the *San Lorenzo Wastewater Management Plan Program Status Report, 1996-1998,* County of Santa Cruz Health Services Agency, Environmental Health Service, March, 2000 (Program Status Report). This report contains Santa Cruz County sampling results from 1985 to 1998. To protect these beneficial uses, the Basin Plan dissolved oxygen objective for the San Lorenzo River requires waters to be no less than 7.0 mg/l. According to the Program Status Report, the Basin Plan dissolved oxygen concentration was only violated once out of over 500 reported concentrations. The one violation occurred on August 28, 1998 in Carbonera Creek at the Glen Canyon Road station. In staff's opinion, this demonstrates dissolved oxygen is not a problem in the San Lorenzo River watershed.

Staff also reviewed pH data for the San Lorenzo River watershed. Santa Cruz County has been monitoring pH since the mid -1970s. To protect these beneficial uses, the Basin Plan requires pH to be no less than 7.0 nor higher than 8.3. According to data submitted by the County, pH was violated approximately 10 percent of the time. According to Bob Golling of the Santa Cruz County Water Lab, these violations may be attributed to inaccurate pH meter readings. The County will investigate and improve pH quality assurance practices. (Santa Cruz County pH data may be viewed at the Regional Board web page, http://www.swrcb.ca.gov/~rwqcb3/. Click on "Central Coast Ambient Monitoring Program (CCAMP)." Click on "Support Data for Basin Plan Amendments.")

Pages 123 and 124 of the *San Lorenzo River Nitrate Biostimulation Assessment, Final Report*, prepared for Santa Cruz County Environmental Health by San Jose State University Department of Civil Engineering and Applied Mechanics, 1993 (Biostimulation Study) also states:

> "Algae are an important component of food webs that include fish in that in order to support a fishery, algae must be present in sufficient amounts. Phytoplankton and attached algae are consumed by zooplankton, insects, and herbivorous fish, which are in turn consumed by larger, predatory zooplankton, insects and fish. Top carnivores, large fish, birds, humans, are in effect gaining most of the energy present in their prey, from the basis of the food web-the algae (Goldman and Horne, 1983). In the San Lorenzo River, algae have been described as beneficial to the system in that they provide a food resource available for consumption by aquatic insects (Ricker and Butler, 1979). In unpublished data by Horne and Johnson, an analysis of the ingestion of benthic diatoms by benthic insects in a stream in California indicated that the diatom *Cocconeis* is the diatom of preference by four of the five insect herbivores collected, including mayflies, stoneflies, and caddisflies, all of which are consumed by fish (Goldman and Horne, 1983). *Cocconeis* was one of the most common diatoms identified as epiphytic on *Cladophora* at all locations and dates throughout this study. In addition, *Cocconeis*, was present between 79 to 90 percent of the time on artificial substrates collected at four locations on the San Lorenzo River between 1988 and 1991 (Table 18).
>
> Prolific growths of *Cladophora* were documented along the River Great Stour in England between 1987 and 1982 (Wharfe *et al*., 1984). They determined that nuisance effects would occur if greater than 10 percent of the river substrate were covered by growths of *Cladophora* longer that 110 centimeters. Filament lengths in the San Lorenzo were typically 1 to 2 centimeters long, with a maximum length of 5 centimeters measured at Rincon Trail riffle during the course of this study. Steve Peters of the Environmental Health Services has recorded *Cladophora* filaments over 61 centimeters (2 feet) in length at Waterman Gap (Steve Peters, personal communication)." (Note: Waterman gap is located at the headwaters to this watershed.)

The Journal of Environmental Toxicology and Chemistry also published an Oregon State University report titled *Sensitivity of Nitrate and Nitrite in Pond –Breeding Amphibians from the Pacific Northwest, USA*. This report indicates that nitrite showed a high mortality for warm water fishes at 5 mg N/l (or 16.5 mg NO2/l) and a significant larval mortality at nitrite concentrations at 1 mg N/l (or 3.3 mg nitrate/l, as NO_3). Nitrate concentrations at 90 mg N/l (or 396 mg nitrate/l, as NO_3) are highly toxic to *Rano pretiosa and Ambystoma gracile.* Nitrate at the drinking water standard 10 mg N/L (or 45 mg nitrate/l, as NO_3) is moderately toxic for *R. pretiosa.* The nitrate concentrations in the San Lorenzo River watershed are well below these toxic concentrations. (The average nitrate at Felton from 1997-98 is approximately 1.6 mg nitrate/l, as NO_3, and 1.8 mg nitrate/l, as NO_3, at the river mouth.)

Staff also reviewed nitrite data for the San Lorenzo River watershed. Santa Cruz County has been monitoring nitrite since the mid -1970s. There are approximately 70 nitrite samples and no nitrite values that exceed 1 mg N/l. (Santa Cruz County nitrite data may be viewed at the Regional Board web page, http://www.swrcb.ca.gov/~rwqcb3/. Click on "Central Coast Ambient Monitoring Program (CCAMP)." Click on "Support Data for Basin Plan Amendments.")

The Central Coast Ambient Monitoring Program (CCAMP) has collected data on nutrient concentrations, algae blooms, and health of benthic invertebrate communities in various watersheds throughout the Central Coast Region. Preliminary statistical analysis of the CCAMP data suggest that increasing nitrate concentrations are associated with declining benthic community indices, and CCAMP has set the tentative attention level for nitrate at 5.0 mg nitrate/l, as NO_3 (CCAMP website). The tentative attention level is defined as the level at which a problem may be occurring (CCAMP website). Personal communications with CCAMP personnel suggest that declining benthic indices occur when nitrate concentrations rise above 10 mg/l (K. Worcester and D. Paradies, personal communication, 2000). The CCAMP Action Level is tentatively set at 10 mg nitrate/l, as NO_3. The CCAMP Action Level is the concentration indicating Regional Board action is necessary.

Staff determined San Lorenzo nitrate concentrations are not threatening the benthic invertebrate population. Staff made this determination based on evaluating nitrate data contained within the Program Status Report. This report indicated nitrate concentrations were in the 5-10 mg nitrate/l, as NO_3 range only for 0.5 percent of the samples. This report also indicated nitrate concentrations were above 10 mg nitrate/l, as NO_3 for only one sample (or 0.02 percent of the samples). (Note: nitrate data contained in the March, 2000 Program Status Report are expressed as nitrogen. Data expressed as nitrogen must be multiplied by 4.4 to correlate the data to nitrate data.)

Municipal and Domestic Supply Beneficial Use

Nitrate is not violating the drinking water standard for nitrate (45 mg nitrate/l, as NO_3). This standard is imposed to prevent methomoglobinemia, commonly referred to as blue baby syndrome. Nitrate concentrations in the San Lorenzo watershed are much lower than this standard. However, nitrate can cause taste and odor problems at much lower nitrate concentrations. In the San Lorenzo watershed, nitrate concentrations are threatening violation of the *Water Quality Control Plan, Central Coast Region* (Basin Plan) taste and odor objective. The Basin Plan objective for tastes and odors is:

> "Waters shall not contain taste or odor-producing substances in concentrations that impart undesirable tastes or odors to fish flesh or other edible products of aquatic origin, that cause nuisance, or that adversely affect beneficial uses."

An odor problem is affecting the Municipal and Domestic Supply beneficial use. The Nitrate Management Plan states that the City of Santa Cruz paid $60,000 a year to remove odor (Nitrate Management Plan, page 7). The lower San Lorenzo River provides 60 percent of the drinking water for the City of Santa Cruz. If odor was not a problem, the City would not need to spend $60,000 per year for treatment.

Increased odor problems have been reported since the late 1970's. According to the Evaluation of Wastewater Disposal, page 9 and Biostimulation Study, pages iii-vi, this is the most significant threat caused by nitrate in the San Lorenzo River. The taste (odor) can be quite obnoxious and lead to a public perception that the water is unclean and unsafe to drink (Nitrate Management Plan, page 15).

The sensitive period or critical seasonal conditions occur in the summer. The worst odors generally occur in the late summer and may be related to algae decomposition *(*Evaluation of Wastewater Disposal and Water Quality), page 164. Summertime is the period of interest when nitrate levels may have its most significant impacts on biological growth, and when delivery of nitrate from the watershed is not complicated by factors of storm runoff. The summer dry period is typically May through October. (Nitrate Management Plan, page 25).

Additionally, in 1986, an investigator working with the County compiled records of taste and odor problems experienced by the City of Santa Cruz in water diverted from the San Lorenzo River. From 1983 through 1986 preventative treatment was regularly used from May to November of each year (Evaluation of Wastewater Disposal and Water Quality, page 150). Since October of 1986, the City has analyzed the water for odor, and calculated a "threshold odor number" twice a month. The worst odors generally occur in late summer, and are probably related to algae decomposition (Evaluation of Wastewater Disposal and Water Quality, pages 163-164). Because the problem is worse during the late summer, this TMDL was

based on data for summer conditions. This provides a level of protection for all months of the year when conditions are not as critical.

Components other than nitrate were investigated as possible pollutants. These included phosphate, nitrite, ammonia, dissolved oxygen, pH, and algae. The San Lorenzo River watershed is naturally rich in phosphates. In fresh water ecosystems, a lack of phosphate usually limits growth. However, in the San Lorenzo Watershed, phosphate-rich rocks release phosphates to ground water and surface water—a process that may be accelerated by high erosion rates. Phosphate levels in the streams have been relatively stable and high during the past several years that water quality has been measured. Because phosphate is readily available, nitrate is the factor that limits algae growth in the Watershed: any increase in nitrate will lead to an increase in algal growth [*The San Lorenzo River Watershed Management Plan,* Santa Cruz County Planning Department, December 1979, page 124 (Watershed Management Plan)]. Nitrogen and phosphate are needed in a ratio of 7:1 for growth of microorganisms. An N: P ratio of 16:1 is considered average. An N: P ratio less than 16:1 indicates a nitrogen limited system. Using historical data from Sylvester and Covay (1978), the N: P ratio for the San Lorenzo River ranged between 0.13:1 to 2.08:1 indicating that the San Lorenzo River is a nitrogen limited system. Increases in nitrogen in a nitrogen limited system can, given that all other growth conditions are met, result in an increase in productivity within the system. The increase in nitrogen in the San Lorenzo River is considered cause for concern (Butler, 1978). (Biostimulation Study, pages 6-7)

Only small quantities of ammonia and nitrite were found in the samples tested (when levels were even detectable). "Ammonia and nitrate are typically below detection levels in San Lorenzo watershed surface water. Of the 146 samples analyzed for ammonia, 85 percent of the samples had non-detectable levels of ammonia. (The detection level was typically 0.1 mg-N/L.) Nitrite (with a typical detection limit of 0.04) was detected only 2 percent of the samples analyzed for nitrite." (Nitrate Management Plan, page 31)

"Results from the diel investigation (a 24 hour investigation) indicate that algae growth has not resulted in deleterious effects on dissolved oxygen, or pH. The lowest oxygen concentration (7.7 mg/l) was measured at Sycamore Grove prior to sunrise. Although below the oxygen saturation of 9.6 mg O_2/L, the lowest oxygen measured was still higher than that required to sustain fishery resources" *(*Biostimulation Study, pg v*).*

Staff reviewed pH data collected by the City of Santa Cruz Environmental Health Services and data from an USEPA database collected by the USGS and DWR for the San Lorenzo River watershed. Santa Cruz County has been monitoring pH since the mid 1980s. To protect beneficial uses, the Basin Plan requires pH to be no less than 7.0 nor be higher than 8.3. According to data submitted by the County, pH was violated approximately 10 percent of the time.

Nitrate is threatening the municipal and domestic supply beneficial use of and threatening violation of the narrative objective for taste and odor. Nitrate is also threatening the water contact beneficial use. Nitrate is threatening violations of water quality standards for the following reasons:

1. Statistical analysis determined nitrate concentration has a significant effect on the growth of attached micro-algae and some effect on macro-algae. (Evaluation of Wastewater Disposal Study page 160).

2. *Solanastrum capricornutum*, a green alga, can increase in algae biomass with increased nitrate (Biostimulation Study, page vi).

3. *Lyngbya,* a cyanobacteria, is known to produce odors in concentrations strong enough to smell in the air. *Lyngbya* was collected throughout the San Lorenzo River and was the most obvious at Felton. It was present on all cobbles and had an earthy odor. *Lyngbya* is capable of nitrogen fixation (utilizing atmospheric nitrogen), however, it will preferentially utilize other forms of nitrogen when available (Biostimulation Study, page 121).

4. Actinomycetes are filamentous bacteria widely distributed in soil, leaf litter, and to a much lesser extent in stream sediments. These bacteria result is a musty smell or taste. Actinomycetes are

suspected as a major factor causing taste and odor problems in drinking water. Actinomycetes can increase as nitrogen increases (Nitrate Management Plan, page 18).

5. During assessments of algae growth conducted by the County, assessments of potential impact on recreation or aesthetics have been made. There are times when conditions of sliminess, murkiness, or prolific algae growth have been observed (Nitrate Management Plan, page, 13). The Evaluation of Wastewater Disposal Study indicates that nitrate may be a potential problem to the water contact recreation beneficial use (Evaluation of Wastewater Disposal Study, September 1989, page 163).

6. Table Two below shows historical nitrate levels within the watershed. Table Two shows that the average summer concentration for the period increased from the period of 1963 to 1975 to the next period of 1976 to 1977. The Nitrate Management Plan (page 15) further reports that taste and odor problems increased in the late 1970's during the same period that nitrate concentrations increased.

   The increase in nitrate concentrations is closely related to increases in development. During the late 1960's to the mid 1970s, a shift from summer occupancy to year around residency occurred. A large number of large subdivisions were also developed. Septic systems or sewers with in-basin effluent disposal were used for all of this development. From 1960 to 1976, there was a 180 percent increase in the permanent population (Evaluation of Wastewater Disposal Study, page 141). As mentioned earlier in this report, the Regional Board adopted an on-site system prohibition for problem areas. The prohibition became effective in 1986.

Table Two. Historical Summer Nitrate Levels in Various Parts of the San Lorenzo Watershed, 1952-95

STATION NUMBER	LOCATION	MEAN SUMMER NITRATE CONCENTRATION (MG NO_3/l, as NO_3) (Based upon July – September sampling)											
		1952-62	1963-75	1976-77	1978-79	1980-81	1982-83	1984-85	1986-87	1988-89	1990-91	1992-93	1994-95
349	SLR @ Waterman Gap		0.72	0.66	0.22	0.44	0.44		0.70	0.88	0.48	1.01	0.39
310	Kings Creek		0.82						1.14	0.70	1.23	1.01	0.88
289	SLR @ Brimblecom Rd.								0.92	0.57			
271	Bear Creek		0.40	1.76	0.00	0.00	0.00		0.53	0.39	0.53	1.1	
251	Boulder Creek @ San Lorenzo River (SLR)		0.80	2.2	2.42	1.32	1.32		2.37	4.14	5.01	2.24	
245	SLR @ River Street		0.20						1.1	1.6	2.02	1.67	1.27
180	SLR @ Ben Lomond								0.8	0.84	0.92	0.88	1.01
140	SLR below Glen Arbor		0.52						2.46	1.89	2.06	3.17	3.08
0762	Upper Zayante Creek		0.90	5.06	0.88	0.44	0.00		1.10	0.92	1.23	1.10	1.18
07528	Lompico Creek		0.90						1.01	0.66	0.79	1.36	0.66
07109	Bean Cr. @ Lockhart Gulch		2.27						3.96	3.34	2.94	1.76	1.45
070	Zayante Creek @ SLR		1.52						3.34	2.11	2.2	3.26	3.08
060	SLR @ Big Trees (Felton Target Attainment Station)	0.37	0.53	2.02	1.84	1.76	2.64		2.38	1.36	1.76	2.51	2.28
022	SLR @ Sycamore Grove	0.50	0.62					0.44	0.70	0.44	0.92	1.54	1.63
0121	Branciforte Creek		1.53	0.0	1.10	0.44	0.88		0.62	0.44	1.01	3.21	1.50
0110	Carbonera Cr. @ Santa Cruz (Carbonera Creek Target Attainment Station)		1.16	1.76					5.94				
050	Shingle Mill Creek @SLR (Shingle Mill Target Attainment Station)								4.00	3.17	2.86	4.40	4.66

[1]Reference: John Ricker, County of Santa Cruz, Health Services Agency, Environmental Health Services

Another potential issue is future Trihalomethane (THM) violations. THMs are formed when water containing dissolved organic compounds is treated with chlorine. To date, there have been no THM violations. The City of Santa Cruz and the County of Santa Cruz have expressed concern that TMH violations may occur in the future. Future violations may occur if the THM standard is reduced from the current requirement of 80 ug/l to 40 ug/l. The State and U.S.EPA are considering reducing the standard to 40 ug/l in perhaps two – three years. Staff is mentioning this issue because nitrate may be causing increases in Total Organic Carbon (TOC) concentrations. Increased TOC concentrations may increase THM concentrations.

THM violations are not presently occurring. (Reference: Richard Lee, City of Santa Cruz). In the event future THM violations occur, the Regional Board is required by federal law to place the impairment condition on the 303(d) list and provide a TMDL to mitigate the impairment.

San Lorenzo River

San Lorenzo River is threatened by nitrate. San Lorenzo River was placed on the 303 (d) list to address increased nitrate concentrations since the 1950s and potential threats to water quality from these increases. For example, at Felton, nitrate concentrations increased from 0.37 mg/l nitrate, as nitrate, during the early 1950s to 2.28 mg/l nitrate, as nitrate, in the mid- 1990s. See Table Three.

As stated earlier, the River is used as a water supply for the City of Santa Cruz. Odors have been documented in this water body and nitrate is one factor that may threaten violation of the taste and odor objective contained in the Basin Plan.

Lompico Creek

Lompico Creek is probably not threatened by nitrate. Lompico Creek was placed on the 303(d) list to address potential nitrate problems. The Lompico Water District uses Lompico Creek for a water supply. Taste and odor problems have not been documented in this water body, but based on similar watershed characteristics, nitrate may threaten violation of the taste and odor objective contained in the Basin Plan. Management measures implemented to attain the target in this subwatershed will provide future protection in Lompico Creek. This is based on the County's decision to apply the Nitrate Management Plan to all of the watersheds due to subwatershed influences on San Lorenzo River.

Shingle Mill Creek

Shingle Mill is threatened by nitrate. Shingle Mill Creek was placed on the 303(d) list because of high nitrate concentrations. Table Two indicates Shingle Mill Creek experiences among the highest nitrate concentrations within the watershed. Based on similar watershed characteristics, nitrate may be threatening potential water supplies with a taste and odor problem. These levels of nitrate indicate taste and odor problems may exist if the surface water is used for drinking water. (Shingle Mill is not currently used as a water supply, but the Regional Board must protect this water body for potential drinking water beneficial uses.) Therefore, nitrate concentrations are high relative to other San Lorenzo watershed areas and may be threatening potential water supplies with a taste and odor problem.

Carbonera Creek

Carbonera Creek is threatened by nitrate. Carbonera Creek was placed on the 303(d) list to address potential nitrate problems. Table Two indicates Carbonera Creek had the highest annual average concentration within the watershed in 1986-87. Based on similar watershed characteristics, nitrate may be threatening potential water supplies with a taste and odor problem. In addition, the Scotts Valley ground water nitrate Plume influences Carbonera Creek, (Carbonera Creek is not currently used as a water supply, but the Regional Board must protect this water body for potential drinking water beneficial uses.)

Problem Identification Summary

In summary, nitrate concentrations within the San Lorenzo watershed have increased since the 1950s. Nitrate is not documented to affect beneficial uses. However, nitrate may be *threatening* violation of the Basin Plan taste on odor narrative objective in the San Lorenzo River. The odor problem occurs during summer months. Nitrate may also be threatening the water contact recreation beneficial use. Since the summer months are the most critical to address for water quality protection, data for summer months were used to develop the loading capacity and allocations in this TMDL. This provides protection for nitrate impacts throughout all months of the year at a level that is protective of the critical conditions in the summer season.

NUMERIC TARGET

Conceptually, the water quality goal/target is a level that existed in the early 1970s, prior to documented odor problems. To quantify this goal, staff utilized the following approach.

First, staff analyzed nitrate concentrations at Felton. Staff graphed nitrate data and plotted a trendline based on linear regression. This graph is seen in Figure Two below. The nitrate concentration trendline shows that mid-1970s nitrate concentration was approximately 1.8 mg/l.

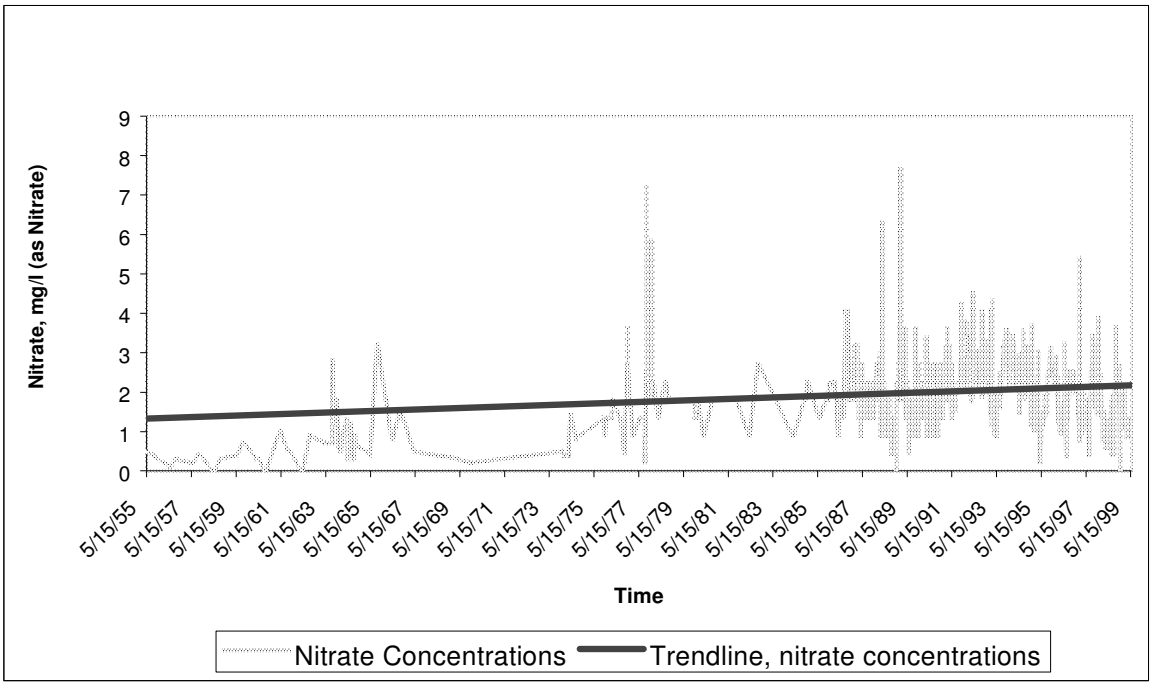

Figure Two. Nitrate Concentrations and Trend at Felton, California

Secondly, staff applied the Nitrate Management Plan goal of 30 percent nitrate reduction to the current nitrate concentration. The current concentration (based on Figure Two) is 2.25 mg nitrate/l, as NO_3. (2.25 mg nitrate/l, as NO_3, is the concentration at which the trend line intersects the year 1999.) If the current concentration is reduced by 30 percent, 1.6 mg nitrate/l, as NO_3, is protective. This concentration can represent concentrations that existed in the early 1970s, prior to odor problems.

Thirdly, staff developed a target to provide a Margin of Safety. The recommended target is set at 1.5 mg nitrate/l, as NO_3. Because this concentration is more protective than the first or second approach, this target provides a Margin Safety, as required by Federal Law.

Based on Figure Two above, 1.5 mg nitrate/l, as nitrate, represents a quality that occurred in 1966, approximately ten years before the late 1970s when odors became a problem, which also provides a margin of safety.

(Table Two also shows 1.5 mg nitrate/l, as nitrate, is also lower than late 1970s nitrate concentrations at Carbonera Creek and Shingle Mill Creek which also provides a margin of safety.)

Target Sites

The target will apply at three locations: (1) the San Lorenzo River at Felton, (2) Carbonera Creek at the confluence of the Branciforte and Carbonera Creeks, and (3) Shingle Mill Creek at the San Lorenzo River.

Felton is a target site for the following reasons. Nitrate reduction measures will protect the City of Santa Cruz drinking water supply located downstream of Felton. Felton is downstream of most of the San Lorenzo Valley nitrate influences (Reference: John Ricker, County of Santa Cruz). Therefore, reductions at Felton will also achieve reductions at the City of Santa Cruz water diversion location. The Program Status Report indicates that the nitrate water quality near the City water diversion (located near station 022, San Lorenzo River at Sycamore Grove) is lower than nitrate at Felton (station 060, San Lorenz River at Big Trees) (see Appendix A, pages 2-4). Because the Sycamore Grove location is always lower than the Big Trees (Felton) location, reductions at Felton are expected to result is reductions at Sycamore Grove (which is close to the City's extraction location). The Felton target site will also address Lompico Creek since Felton is downstream of Lompico Creek. Also there is a vast quantity of historical data for this site. Water quality data has been collected since the 1930s.

The Felton target site is also expected to protect the City water supply diversion point at Tait Street because the septic systems and livestock/stable discharges below Felton are minimal. This area has minimal development. Below Felton, the river passes through Henry Cowell Redwoods State Park. The eastern bank flows past Paradise Park and Pasatiempo Golf Course. Portions of the Pasatiempo unit have been sewered in the early 90's [*A Nitrate Budget-Based Assessment of Potential Nonpoint-Source Control Measures to Reduce Nitrate Delivery to the San Lorenzo Watershed, Santa Cruz County, California,* Balance Hydrologics Inc., July 1991 (Nitrate Budget), page 29]. There are no nitrate discharges to the river from this system. When the river reaches the City of Santa Cruz city limits, the river flows past an Open Space Preserve before it enters the City at Tait Street water diversion point. Although these land uses may be contributing some nitrate to the river, the consistently lower values at Tait Street suggest that target attainment at Felton is protective of water quality at Tait Street.

Target attainment must apply to Carbonera Creek and Shingle Mill Creek because they are individually included on the 303(d) list. Protective measures will be implemented within the Carbonera Creek and Shingle Mill Creek subwatersheds to reduce nitrate and prevent impairment for these waters. (See Problem Identification section for more information.) These waters are also target sites because these subwatersheds flow into the San Lorenzo River downstream of Felton.

Target Attainment Date

The target is proposed to be achieved by the year 2020. This attainment date is based on the approach utilized to implement nitrate reduction measures for septic systems, the predominate nitrate source in the watershed is septic systems (as identified later in this report). For existing septic systems, reduction measures are imposed when an old septic system is found to be failing or no longer functional, when a major remodel take place, or when the property owner makes a voluntary decision to upgrade their system. Consequently, improvement measures will be attained when the attrition rates for replacing the old systems produces the necessary load allocation.

Staff discussed the target attainment date with John Ricker of the County of Santa Cruz Health Services Agency, Environmental Health Service. Mr. Ricker believes the year 2020 represented a realistic time frame to account for replacement of old systems.

SOURCE ANALYSIS

Significant nitrate sources are identified and quantified in the Nitrate Management Plan. According to the Nitrate Management Plan, an estimated 84 percent of the current nitrate load in the River results from human activities in the watershed. There are no nitrate point source discharges within the San Lorenzo River watershed.

The identification of nitrogen sources in the watershed is based on water quality data from surface and ground water, development of budgets of nitrate discharge in tributaries and reaches of the River, field assessment, quantification of land uses which release nitrogen, and preparation of area and basin budgets which relate the calculated potential nitrogen release to the observed nitrogen loads in order to determine the proportion of nitrate which originates from the various sources [*San Lorenzo Nitrate Management Study Phase I Final Report*, County of Santa Cruz Health Services Agency Environmental Health Service (Phase I Nitrate Management Study), page 19]. Balance Hydrologics, Inc. constructed a nitrate budget in 1991 for the San Lorenzo Watershed. The budget was tabulated by sub-basin. The budget accounts for nitrogen removal in upper soil layers, dilution by ground water recharge, nitrogen removal by water extraction from ground water, removal of nitrogen as water percolates through the ground water, expected nitrate concentration in the ground water, nitrate load discharged to surface water, and expected nitrate concentrations in the stream (accounting for observed stream flow). The budgets were calibrated by comparing the estimates to observed conditions and adjusting the delivery factors until calculated values matched the observed values. Therefore, these budgets account for the fate and effect of nitrate (Nitrate Management Plan, page 43). County staff further refined the watershed budget to reflect data gathered from 1990 to 1993.

In order to relate the instream nitrate loads back to specific land uses and other sources in the watershed, County staff undertook a field survey during Phase 1 to identify and quantify all potentially significant sources of nitrogen release. These efforts focused on the sandy areas of the watershed and assessed the amount of nitrogen release from onsite wastewater disposal systems, fertilizer applications, livestock, and any other potential sources in individual sub-basins.

Relative present summer contributions in the lower River (at Felton) are shown below. Staff estimates similar relative loadings to Carbonera Creek and Shingle Mill Creek based on similar relative land uses. Although loading was estimated with data from summer months only, these sources contribute nitrogen similarly in all months of the year. The source reduction activities are not considered seasonal or temporal in nature.

Table Three. Summer Nitrate Contributions for Each Source (Reference: Nitrate Management Plan, page 3)

Urban/Nonpoint		
Septic Systems in Sandy Areas		38%
Septic Systems in Non-Sandy Areas		19%
Sewer Discharge from Boulder Creek Country Club		10%
Scott's Valley Nitrate Plume		9%
	Subtotal	76%
Agriculture		
Livestock & Stables		6%
Landscaping/Fertilizer Use		2%
	Subtotal	8%
Point Sources		
None		0%
Natural		
Natural Sources in Non-Sandy Areas		4%
Natural Sources in Sandy Areas		12%
	Sub-total	16%
	Total	100%

Sources are not distributed uniformly throughout the watershed and, hence, are difficult to map. Geographically contained sources or source areas (for example, Boulder Creek County Club) are indicated on Figure One. Other sources are distributed throughout the watershed (for example, septic systems and agriculture) are described narratively below.

A majority of parcels in the San Lorenzo River Watershed utilize on-site wastewater disposal systems (septic systems). Septic systems are utilized in sandy soil and other soil types. Many studies determined sandy soils provide minimal nitrate treatment (H. Esmaili and Associates, 1983, Ramlit Associates, 1982, and Nitrate Management Plan). The County performed lysimeter sampling below leachfields in sandy soils to determine discharge quantities (Nitrate Management Plan pp. 51-56). (To determine sandy areas, the reader should refer to the Nitrate Budget, Figure One.) The nitrate loadings to non-sandy soils are based on work done in the Nitrate Budget. The Nitrate Management Plan relied upon literature values obtained within the 1982 Ramlit Associates report for nitrate discharge quantities.

The Boulder Creek Country Club discharges wastewater to leachfields. Boulder Creek is impacted by this discharge downstream of the leachfields according to monitoring data required by the facility's waste discharge requirements

The Scotts Valley ground water basin contains high nitrate levels. Ground water nitrate concentrations are approximately 22 milligrams/liter (Nitrate Management Plan, page 43). The Nitrate Plan indicates nitrate originates from past on-site sewage disposal, (this area was sewered in 1986), landscape fertilization, golf course fertilization, land disturbance, and historical agricultural activities. The nitrate plume flows towards Bean Creek (Reference: Nitrate Management Plan page 43) and Carbonera Creek (Reference: John Ricker, phone conversation, January 28, 2000).

Wastes from stables, paddocks, and other livestock areas contribute an estimated 6 percent of the summer nitrate load in the San Lorenzo River. These operations tend to be scattered throughout the watershed.

The urban development in the San Lorenzo River Watershed tends to be concentrated close to river areas. There are residences in the steeper hills, but the population is generally concentrated in the lower elevation areas where hill slopes are not as great. The septic systems in the watershed are widely scattered. The areas of sandy soils that tend to contribute more nitrates to the system are in the lower southeastern portion of the watershed.

The Boulder Creek Country Club provides sewerage for approximately 300 homes. Boulder Creek is located in the northwestern portion of the watershed west of the San Lorenzo River. The center of the Scott's Valley nitrate plume is located approximately one mile south west of the town of Scott's Valley. (See Figure One.) The other sources of nitrate contribution (stables and livestock; landscaping and fertilizing; and natural sources) are all widely distributed throughout the watershed.

TOTAL MAXIMUM LOAD AND LOAD ALLOCATIONS

The Total Maximum Load is the loading capacity (and associated allocations) that will attain the target. Loading capacity was determined by first, estimating baseline loading, then factoring in increased loading that may result from future growth, and finally, reducing the baseline loading by an amount that will achieve the target. The proposed reduction in nitrate loading in the San Lorenzo River is a 30 percent loading reduction measured during the summer months (July-September). As mentioned earlier, the worst odors generally occur in the late summer (Evaluation of Wastewater Disposal, page 164). The loading capacity and the associated allocations were developed from data for July 1-September 30 as representative of the summer critical condition and to take advantage of the previous data analysis in the San Lorenzo River Nitrate Management Plan that evaluated summer data for the months of July through September. The loading capacity and allocations apply all year long. Since loading is constant all year long and critical conditions subside in winter months, year-round water quality protection and improvement is expected.

The loading capacity results in a reduction of total nitrate loading in the watershed by 30 percent by 2020. This loading capacity should result in target attainment as this level of reduction is greater than that presumed necessary to protect water quality (see section on Numeric Targets and Margin of Safety), resulting in water quality conditions that existed prior to conditions threatening beneficial uses. This level is predicted to be achievable by the Nitrate Management Plan. The Nitrate Management Plan indicates that a range of 15 to 30 percent reduction would be achieved by the Plan (Nitrate Management Plan, page 4). (The Plan also proposes 50 percent reduction for all existing systems in sandy soils if reduction measures become cost-effective.) This TMDL also encourages increased reductions better than 30 percent reduction should additional reduction measures become cost effective.

While the information in the Nitrate Management Plan was based on actual data from upstream of Felton, the results and recommendations account for the variability in physical features and land uses throughout the San Lorenzo River Watershed. Physical features and land uses in both Shingle Mill Creek and Carbonera Creek are similar to the watershed upstream of Felton so staff assumes the information in the Nitrate Management Plan can be extrapolated to these tributary watersheds (John Ricker, Santa Cruz County, phone conversation January 28, 2000). The Nitrate Management Plan will be implemented similarly in these tributary watersheds.

Felton Baseline Loading

In order to determine the loading capacity, current loading rates, or baseline loading rates, must be determined. The Nitrate Management Plan provides baseline loading rates for the San Lorenzo River at Felton in 1995. The values were based on values developed by the Nitrate Budget as part of the preliminary analysis for the Nitrate Management Plan for the Felton site. The baseline loading rate for nitrogen is 36 pounds/day (Nitrate Management Plan, page 41.) This is equivalent to 158 pounds nitrate/day or 4752 pounds nitrate/month. This represents loading that occurred before the County and the Regional Board adopted the Nitrate Management Plan.

This baseline loading does not include increased nitrate resulting from future growth. The Nitrate Management Plan provides baseline loading for summer months to account for increased nitrate loads for the next ten years. The baseline load in the next ten years under current policies is 3397 pounds nitrogen/summer or 4,982 pounds nitrate/month (Nitrate Management Plan, page 77). This represents a 4.8 percent increase in nitrate load between 1995 and 2005.

This report proposes the loading capacity be attained by the year 2020. Staff assumes the nitrate load will increase at the same rate (4.8 percent per ten years) for the 25 year time period from the initiation of the 1995 Nitrate Management Plan until 2020. Therefore the baseline load at Felton in the next twenty years (in year 2020) is expected to reach 5,327 pounds nitrate/month. Therefore, 25 years subsequent to the 1995 Nitrate Management Plan current conditions, baseline nitrate loads are projected to increase 12.1 percent. (See Appendix Five for calculation examples.)

Carbonera Baseline Loading

The current baseline summer nitrate load at Carbonera Creek at the confluence of Branciforte Creek is approximately 12.7 pounds nitrate/day or 381 pounds nitrate/month. The following table shows Carbonera Creek loading for summer 1996-99. This loading is based upon data collected during summer 1996-99. (There was no sampling during summer months prior to 1996. Staff assumes 1996-99 loadings are comparable to early 1990's loadings, before the Nitrate Management Plan was adopted.)

Table Four. Carbonera Creek Baseline Nitrate Load[1]

Date	Flow, cfs	Nitrate Concentration, mg/l NO_3 (as NO_3)	Nitrate Load, pounds NO_3 per day (as NO_3)
August 22, 1996	0.71	1.8	6.8
August 14, 1997	0.76	2.6	10.9
August 14, 1999	1.13	3.4	20.6
Average			12.7

[1]Reference: John Ricker, County of Santa Cruz, Health Services Agency, Environmental Health Service

The above baseline loading does not account for increased nitrate discharge resulting from future growth. Staff assumes the same rate of growth applicable to the Felton site is sufficient to predict the baseline load at Carbonera Creek for the year 2020. Therefore, The baseline load in the year 2020 is expected to reach 427 pounds nitrate/month [(381 pounds. nitrate/month + (381 pounds nitrate/month x 4.8% increase) x 25 years/10 years].

Shingle Mill Baseline Loading

The current baseline summer nitrate load for Shingle Mill Creek at the San Lorenzo River is 2.9 pounds nitrate/day or 87 pounds nitrate/ month. The following table shows Shingle Mill Creek loading for summer 1991-1993.

Table Five. Shingle Mill Creek Baseline Nitrate Load[1]

Date	Flow, cfs	Nitrate Concentration, mg/l NO_3 (as NO_3)	Nitrate Load, pounds NO_3 per day (as NO_3)
July 9, 1991	0.13	0.63	0.4
August 5,1991	0.1	3.4	1.8
September 11,1991	0.08	3.02	1.3
July 7,1992	0.14	3.9	3.0
August 4,1992	0.09	3.9	1.9
September 23,1992	0.08	7.7	3.3
July 8,1993	0.22	4.7	5.6
August 11, 1993	0.23	4.8	6.0
September 21, 1993	0.1	4.7	2.6
Average			2.9

[1]Reference: John Ricker, County of Santa Cruz, Health Services Agency, Environmental Health Service

The above baseline loading does not account for increased nitrate discharge resulting from future growth. Staff assumes the same rate of growth applicable to the Felton site is sufficient to predict the baseline load at Shingle Mill Creek for the year 2020. The baseline load in the year 2020 is expected to reach pounds 97 pounds nitrate/month [87 pounds nitrate/month + (87 pounds nitrate/month x 4.8% increase) x 25 years/10 years]

Loading Capacity

The Total Maximum Load or loading capacity is shown in bold in Table Six as a 30 percent reduction in baseline loading by 2020. Additionally, interim percent reductions at various milestones are shown in Table Six.

Table Six. Total Maximum Loads

Target Attainment Station	Nitrate Levels before Reduction (lbs/nitrate/month)	Percent Loading Reduction	TMDL* (lbs/nitrate/month)	Target Attainment Year
San Lorenzo River at Felton	4752			1995
	4980	15%	4233	2005
	5095	20%	4076	2010
	5327	**30%**	**3728**	**2020**
Carbonera Creek at the confluence of Branciforte Creek	381			1995
	399	15%	339	2005
	408	20%	326	2010
	427	**30%**	**299**	**2020**
Shingle Mill Creek at the confluence of San Lorenzo River	87			1995
	91	15%	77	2005
	93	20%	74	2010
	97	**30%**	**68**	**2020**

* Meaured in July, August, and September

The Regional Board will utilize Table Six to determine compliance with this TMDL. (See Monitoring Section for more information.)

Load Allocations

Load allocations were determined by considering the contributions for each source along with the appropriate control measures for each source. The current relative loading contribution (in percent) from each source was reduced by the percent nitrate removal expected for applicable control measures to determine a proposed allocation (in percent and pounds per month) for each source. The Nitrate Management Plan presents potential control measures to meet the target and the percent nitrate removal efficiencies expected for each control measure. It is assumed that the total load will be reduced by the amounts expected once these measures are in place for each source. The resulting load allocations are presented in Table Seven.

Table Seven. Percent Load Allocations

Source	Current Summer Loading Contribution (Nitrate Management Plan, Page 3)	% Nitrate Removal by Anticipated Control Measure	% Reduction in Loading Contribution	Resulting Load Allocation (% Current Loading Contribution Minus % Reduction in Loading Contribution)
URBAN SOURCES (Nonpoint Sources)				
Septic Systems in Sandy Areas	38%	35% (Rational explained above)	13.3%	24.7%
Septic Systems in Non-Sandy Areas	19%	20%(Reference: Nitrate Management Plan, page 61)	3.8%	15.2%
Sewer Discharge from Boulder Creek County Club	10%	90%(Reference: Nitrate Management Plan, Page 3)	9%	1.0%
Scott's Valley Nitrate Plume	9%	No reduction proposed in Nitrate Management Plan	0%	9%
AGRICULTURE SOURCES				
Livestock & Stables	6%	65%(Reference: Nitrate Management Plan, Page 3)	3.9%	2.1%
Landscaping/ Fertilizer Use	2%	No reduction proposed in Nitrate Management Plan	0%	2 %
NATURAL SOURCES				
Natural Sources in Non-Sandy Areas	4%	No reduction proposed in Nitrate Management Plan	0%	4%
Natural Sources in Sandy Areas	12%	No reduction proposed in Nitrate Management Plan	0%	12%
TOTAL	100%		30 %	70%

The rationale for Table Seven is as follows. Staff obtained the current relative loading contributions directly from the Nitrate Management Plan (page 3) and the Source Analysis. Staff used nitrate removal percentages for applicable control measures, as referenced in Table 8, with the exception of septic systems in sandy areas. For

septic systems in sandy areas, staff estimated an overall 35 percent reduction. Staff estimated this overall 35percent loading reduction based on the following information.

The Nitrate Management Plan (page 3 and page 61) indicates the following methods will be used for septic systems in sandy soils

1. Shallow leachfields for septic system repairs: 20% reduction
2. Sand filter for septic system treatment: 50% reduction
3. Enhanced septic system denitrification system: 75% reduction
4. Sewage collection and treatment: 75% reduction

Staff assumes a property owner will install the least expensive (shallow leachfields) whenever possible. For example, the least cost alternative, shallow leachfields, cost $232 lb. nitrogen/yr. This method provides a 20 percent reduction in nitrate loading. However, a property owner may not always be able to install shallow leachfields. A property owner may need to install a more expensive, but better treatment option. For example, shallow ground water or small lots may force an individual to install a more expensive option such as options two through four above. Option Four provides 75 percent reduction but costs $3284. Therefore, the overall nitrate removal in sandy soils falls somewhere between 20 percent and 75 percent. Staff estimated an overall 35 percent loading reduction for septic systems in sandy soils in order to account for the most likely scenario that the least expensive option (at 20 percent reduction) will be used most frequently and occasionally a higher the higher treatment option (at 75 percent reduction) will be selected. This provides an additional, albeit small, implicit margin of safety.

Staff utilized a 20 percent loading reduction for septic systems in non-sandy areas. This estimate is based on the Nitrate Management Plan (page 3 and page 61). On page 61 of the Nitrate Management Plan, the least costly method is shallow systems. As shown in the Nitrate Management Plan, this method is expected to reduce nitrate loading by 20 percent.

The table above reveals a 30 percent loading reduction in nitrate load is possible (100% - 70%) at Felton.

Load allocations are shown in Table Eight below.

Table Eight. Load Allocations

Source	Pounds per Month, Felton	Pounds per Month, Carbonera Creek	Pounds per Month, Shingle Mill Creek
URBAN SOURCES (Nonpoint Sources)			
Septic Systems in Sandy Areas	1,316	105	26
Septic Systems in Non-Sandy Areas	810	65	17
Sewer Discharge from Boulder Creek County Club	53	4	0
Scott's Valley Nitrate Plume	479	38	0
AGRICULTURE SOURCES			
Livestock & Stables	112	9	4
Landscaping/ Fertilizer Use	106	9	3
NATURAL SOURCES			
Natural Sources in Non-Sandy Areas	213	17	5
Natural Sources in Sandy Areas	639	52	13
TOTAL	3728	299	68

MARGIN OF SAFETY

TMDLs must include either an explicit or implicit margin of safety to account for uncertainty in determining the relationship between discharges of pollutants and impacts on water quality. This TMDL provides an implicit margin of safety.

According to Figure Three a target of approximately 1.8 mg/l is a reasonable target reflecting concentrations in 1975 before higher nitrate concentrations of the late 1970s occurred (according to Table Two and Figure Three). However, staff is recommending a target of 1.5 mg/l to provide a margin of safety. 1.5 mg/l nitrate, as nitrate, represents a nitrate concentration based on a trendline that occurred in approximately 1966. This represents over a 15 percent factor of safety [(1.8-1.5)/1.8]. This indicates the 30 percent reduction used to calculate TMDLs provides a 15 percent factor of safety.

Figure Three. Margin of Safety at Felton

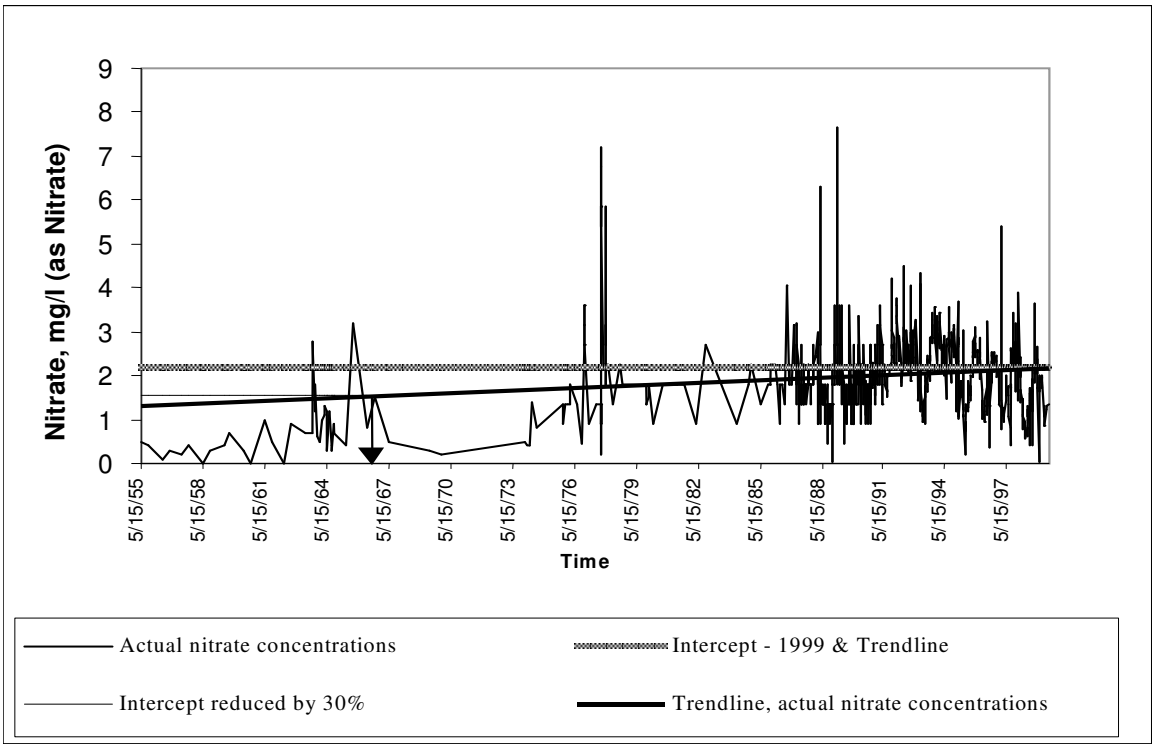

Figure Three, presents a graphical representation of the margin of safety. Actual data for Felton from the period 1955 – 1999 were graphed. The Felton and Waterman Gap stations are the two stations with most complete historic data. Of the two, the Felton site is downstream of most nitrate discharges in the watershed. Therefore, data from the Felton site were chosen for this graph. Linear regression was used to develop a trendline. The nitrate concentration predicted by the line described as "intercept-1999 & trendline" was used to establish a single value for 1999 from which to predict nitrate reductions (approximately 2.25 mg/l). The 1999 predicted trendline concentration (2.25 mg nitrate/l, as NO_3) was reduced by 30 percent to represent a 30 percent nitrate concentration reduction (shown by the line described as "intercept reduced by 30%"). This 30 percent reduction attains 1966 nitrate levels (shown by the arrow) which is earlier than the late 1970s concentrations. This represents a margin of safety because the goal of this TMDL is to attain nitrate levels that occurred during the early 1970s (before odor became a problem).

LINKAGE ANALYSIS

A linkage analysis is necessary to demonstrate that load/wasteload allocations will attain the numeric target. The linkage analysis for this TMDL is embedded in the discussion of targets, load allocations, and margin of safety. Table Seven indicates a 30 percent nitrate load reduction is possible and that it will protect water quality.

SEASONAL VARIATIONS/CRITICAL CONDITIONS

The proposed nitrate loading capacity in the San Lorenzo River is a 30 percent loading reduction measured during the summer months (July-September). As mentioned earlier, the worst odors generally occur in the late summer (Evaluation of Wastewater Disposal and Water Quality, page 164). The beneficial use impairment threat is greatest during summer months due to low flows relative to other months. Stream temperature also increases during summer months. Summer loads, flows, and river temperature do not fluctuate greatly within these months. Therefore, summer monthly loading is used for this TMDL. The loading capacity and the associated allocations were developed from data for July 1-September 30 as representative of the summer critical condition and to take advantage of the previous data analysis in the San Lorenzo River Nitrate Management Plan that evaluated summer data for the months of July through September. The loading capacity and allocations apply all year long. Sources and related contributions are constant all year long even though river conditions change in the summer. Therefore, year around water quality improvement is expected.

IMPLEMENTATION PLAN / SCHEDULE

The suggested 30 percent loading reduction of nutrients in the San Lorenzo Watershed can be obtained by several actions. A year by year chronology of work completed and work to be done is listed below.

There are no additional costs associated with these actions, since these actions (and associated costs) were previously adopted as part of Regional Board Resolution 95-04.

The actions below are obtained from the Nitrate Management Plan (pages 82-87).

1. Action - Maintain the requirement of one acre minimum lot size for new development served by onsite sewage disposal,
   Benefits - Reduces cumulative impacts of wastewater disposal and new development. Provides for dilution of nitrate and limits total amount of loading possible. Prevents underlying ground water from exceeding drinking water standards.
   Timing - Ongoing since 1983.
   Responsible Agencies - Santa Cruz County Environmental Health (Board of Supervisors).

2. Action - Implement the San Lorenzo Wastewater Management Plan,
   Benefits - Reduces impacts of wastewater disposal and provides mechanism for implementation of improved nitrate control practices during system repairs.
   Timing - Ongoing since 1986.
   Responsible Agencies - Santa Cruz County Environmental Health (Board of Supervisors) assisted by the Regional Water Quality Control Board.

3. Action - Resume wastewater reclamation at Boulder Creek Golf and Country Club,
   Benefits - Will greatly reduce summer nitrate levels in Boulder Creek and the San Lorenzo River north of Ben Lomond. Reclamation will reduce use of ground water and surface water for irrigation.
   Timing: Efforts began in 1991; implementation began in 1995.
   Responsible Agencies - Santa Cruz County Public Works Department (Board of Supervisors), with oversight by the Regional Water Quality Control Board and the State Department of Health Services.

4. Action - Require shallow leachfields for new development and system repairs,

Benefits - Provides for improved wastewater treatment.
Timing - Ongoing since March 1993.
Responsible Agencies - Santa Cruz County Environmental Health (Board of Supervisors).

5. Action - Require enhanced nitrate removal in sandy soils,
   Benefits - Will reduce nitrate discharge from individual systems
   Timing – Amended in 1995.
   Responsible Agencies - Santa Cruz County Environmental Health (Board of Supervisors).

6. Action - Require enhanced treatment for new systems and during upgrade of large sewage disposal systems,
   Benefits - Will reduce nitrate discharge. Nitrogen removal is much more cost-effective for large systems. Treatment will also allow the discharger to significantly reduce the amount of disposal area needed.
   Timing – Amended in 1995.
   Responsible Agencies - Santa Cruz County Environmental Health (Board of Supervisors).

7. Action - Require nitrogen control when issuing new or revised waste discharge permits,
   Benefits - Will ensure compliance with this Plan by all large dischargers under jurisdiction of the Regional Board.
   Timing – Adopted in April 1995. (Resolution 95-04)
   Responsible Agencies - Central Coast Regional Water Quality Control Board.

In addition to the above actions already included in the Nitrate Management Plan, the County should consider implementing additional protective measures to prevent illegal septic pump truck discharges. One measure might include keyed meters on pump trucks that are reset by wastewater treatment plan operators at the time of legal discharge to a wastewater treatment plant.

Livestock management measures

Although controlling nitrogen discharged from onsite wastewater disposal is important, it is also important to prevent percolation of nitrogen-containing wastewater from livestock areas. Nitrogen delivery from livestock can be significantly reduced by runoff control, manure management, and siting of paddock areas to reduce percolation and runoff of nitrogenous wastes. If measures summarized in the San Lorenzo Nitrate Management Plan (phase II) for livestock management are implemented, it is estimated that nitrate loadings from those operations will be reduced by 25 - 50percent. There is potential for substantial loading reductions of up to a targeted 85percent if all the measures are implemented by most livestock owners.
Action - Require runoff control, manure management and other measures to control discharge of nitrate and fecal matter for new and existing stables or livestock operations,
Benefits - Reduces nitrate loading by 70percent.
Timing - Ongoing implementation through education and permit review for new operations. Voluntary livestock management program developed in 1996.
Responsible Agencies - Santa Cruz County Environmental Health, Planning Department, Zoning Administrator, Planning Commission, Board of Supervisors, City of Scotts Valley.

Land use regulations

Land use regulations can also serve to minimize nitrogen delivery to ground water and surface water by 30 percent (standard reduction goal). These regulations constitute:

1. Action - Maintain minimum parcel size requirement and other protective measures of ground water recharge areas (10 acre minimum),
   Benefits - This reduces nitrate discharge from new development and provides protection of water supply aquifers, particularly where existing development densities are so high that severe degradation would result if past development trends continued. Also promotes ground water recharge, reduces land disturbance and erosion, and protects unique biotic resources.

Timing - Ongoing since 1978.
Responsible Agencies - Planning Department, Planning Commission, Board of Supervisors, City of Scotts Valley.

2. Action - Maintain measures to prevent excessive land clearing, require erosion control and protect riparian corridors,
Benefits - This reduces nitrate discharge from new development and clearing activities and protects the capability of riparian corridors to very significantly reduce nitrate in ground water entering the streams. Undisturbed riparian corridors reduce nitrate discharge to streams by up to 90percent. Also reduces land disturbance and erosion, and protects unique biotic resources.
Timing - Ongoing since 1980.
Responsible Agencies - Planning Department, Planning Commission, Board of Supervisors.

The County should make every reasonable effort to protect riparian corridors. The County should review the policy of granting Riparian Excerptions and determine is unreasonable exceptions have been approved in the past and implement corrective actions to prevent the County from granting unreasonable exceptions in the future.

3. Action - Review of all large development applications to ensure substantial new nitrate discharges are not approved,
Benefits - Prevents significant increase in nitrate discharge, and allow other proposed control measures to bring about an overall reduction in current nitrate loads.
Timing - Ongoing.
Responsible Agencies - Planning Department, with consultation from Environmental Health, ongoing Administrator, Planning Commission, Board of Supervisors, City of Scotts Valley
The use of special technologies, improved management practices, and land use regulations can reduce nitrogen discharge.

If further reduction measures become economically feasible, the County is encouraged to further reduce nitrate loading more than the 30 percent reduction currently specified.

Nitrate Management Plan Effectiveness to Date

The County of Santa Cruz prepared a status report in March 2000 describing the actions taken to reduce nitrate discharges. The report also describes the effectiveness of activities implemented to through 1998. The report states " nitrate levels in the San Lorenzo River at Big Trees, the primary monitoring location, have generally maintained the same average level for the past thirteen years (approximately 0.45 mg-N/l). Levels do vary significantly from year to year, apparently due to differential rainfall, which affects both the flushing of nitrate and dilution. Levels at Big Trees were lower in 1995 than they were in 1986, both comparatively wet years. Mean levels dropped to 0.35 mg-N/l in 1998, the lowest they have been since regular monitoring started in 1986" (San Lorenzo Wastewater Management Plan Progress Report 1996-1998, page 22). The report also indicates "nitrate concentrations and loads have declined in Boulder Creek (from over 1 mg-N/l in 1990 to 0.2 mg-N/l in 1998) and to a lesser extent in the River downstream from Boulder Creek (from 0.4 mg-N/l to 0.23 mg-N/l in the same time period). This is probably related to improvements in the treatment plant at the Boulder Creek Country Club to reduce nitrate discharge and promote wastewater reclamation" (San Lorenzo Wastewater Management Plan Progress Report 1996-1998, page 23).

MONITORING PROGRAM

In years 2005, 2010, and 2020, the County will submit a Report on Nitrate Management Plan Implementation. The report will include nitrate loading at target stations for the months of July, August, or September. The reports shall be due December 31 beginning year 2005. The Regional Board will compare actual loading to target loading and evaluate compliance with this TMDL. In the event nitrate loads are not met, the County will perform a nitrate budget within six months. Major nitrate sources will be expressed in terms of loading. The Regional Board will determine additional monitoring, implementation, or enforcement measures necessary upon receiving the County's

loading evaluation report. Furthermore, the County will submit a Program Status Report every three years. The report will provide County actions and progress toward implementing the Nitrate Management Plan.

In order to calculate nitrate loads, water quality monitoring will be performed according to the program contained within the *San Lorenzo Wastewater Management Plan, Program Status Report, 1989-95.* Staff added one station to this program, Carbonera Creek at Branciforte Creek because this site is a target attainment station. The sampling station sites are included in Figure Four below.

Table Nine. Water Quality Sampling Program

STATION NUMBER LOCATION (See Figure Four)		TYPE OF SAMPLING		
		Weekly[2]	Monthly[3]	Nitrogen[4]
349	San Lorenzo River (SLR) @ Waterman Gap		M	N
310	Kings Creek @ HWY 9		M	
300	SLR above Two Bar Creek		M	
290	Two Bar Creek @ SLR		M	
271	Bear Creek Near SLR		M	
268	SLR below Bear Creek			N
2590	Boulder Creek @ Melissa Lane			N
2581	Boulder Creek @ Jamison Creek			N
2580	Boulder Creek above Brackenbrae			N
251	Boulder Creek @ Hwy 9		M	
2499	SLR below Boulder Creek			N
245	SLR @ River Street		M	N
241	SLR @ Pacific Street Brookdale			N
225	SLR @ Larkspur Street			N
200	SLR @ Gunther			N
180	SLR above Love Creek		M	N
160	SLR above Newell Creek			N
158	Newell Creek below Dam			N
154	Newell Creek @ Rancho Rio			N
150	Newell Creek @ SLR		M	N
140	SLR @ Mt Cross Bridge		M	N
0762	Zayante Creek @ Zayante		M	
07528	Lompico Creek @ Carrol Ave		M	
0749	Zayante Cr below Lompico Cr			N
073S	McEnery Rd Spring			N
07145	Bean Cr above Grazing Area			N
0711	Lockhart Gulch @ Bean Cr			N
07109	Bean Creek below Lockhart Gulch			N
07106	Bean Creek @ Mt. Hermon Rd		M	N
071	Bean Creek above Zayante Creek			N
070	Zayante Creek @ SLR		M	N
060	SLR @ Big Trees (Target Attainment Station)	W	M	N
050	Shingle Mill Cr @ SLR (Target Attainment Station)	Bi-weekly[1]	M	
030	Gold Gulch @ SLR, Hwy 9		M	
025	SLR @ Rincon			N
022	SLR @ Sycamore Grove		M	N
01149	Carbonera Cr below Scotts Valley (2 locations)		M	
0110	Carbonera Creek @ Branciforte Creek (Target Attainment Station)	Bi-weekly[1]	M	
0121	Branciforte Creek @ Isbel Dr		M	
003	River mouth @ Trestle		M	

[1]Regional Board will require bi-weekly nitrate sampling at these stations in addition to monitoring program already implemented Sampling shall include streamflow

[2]Weekly Sampling: pH, temperature, dissolved oxygen, electro-conductivity, turbidity, fecal coliform, nitrate, stream flow

[3]Monthly Sampling: pH, temperature, dissolved oxygen, electro-conductivity, turbidity, fecal coliform, nitrate, streamflow,

[4]Nitrogen Sampling (quarterly sampling): pH, temperature, dissolved oxygen, electo-conductivity, turbidity, streamflow, nitrate, ammonia, nitrite, Kjeldahl nitrogen

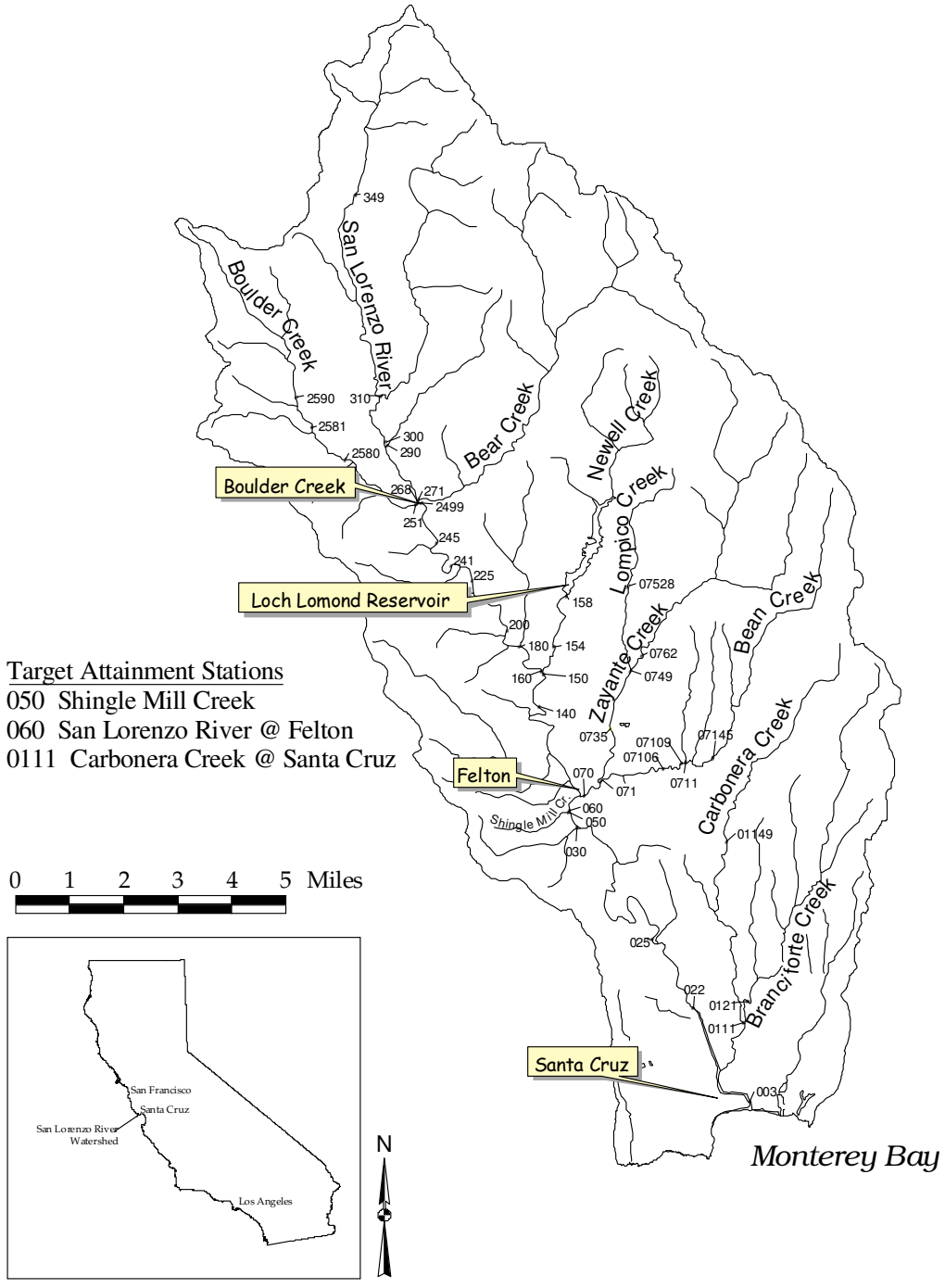

Figure Four. San Lorenzo River Watershed Sampling Stations

PUBLIC PARTICIPATION

The Nitrate Management Plan was developed with the ongoing participation of a technical advisory committee (TAC) and the public. The TAC comprised of membership from Santa Cruz County, Santa Cruz City Water Department, San Lorenzo Valley Water District, the Association of Monterey Bay Area Governments, Santa Cruz Board of Supervisors, City of Scotts Valley, San Jose State University, Santa Cruz Water Quality Task Force, consultants, and an interested citizen.

The County of Santa Cruz processed the review and adoption of the Nitrate Management Plan in conjunction with the Wastewater Management.

Public participation comprised of the following activities:

- Review of the Administrate Draft by the TAC on February 9, 1995.
- Public meeting on March 8, 1995
- Press coverage of report findings before and after public meetings
- County Board of Supervisors public hearing, March 14, 1995
- Regional Board public hearing, April 14, 1995.

Public comments can be reviewed in the attachments to this document. There were no controversial issues.

Public participation will also occur during the approval process of this document. The Regional Board and State Board utilize a public participation process that involves a public notice and mailing of the staff report and proposed TMDL to interested persons and a public hearing where oral or written testimony may be provided.

ATTACHMENT ONE. REFERENCES USED

Balance Hydrologics, Inc, *A Nitrate Budget-Based Assessment of Potential Nonpoint-Source Control Measures to Reduce Nitrate Delivery to the San Lorenzo Watershed, Santa Cruz County, California,* July 1991

California Regional Water Quality Control Board Resolution 95-04

County of Santa Cruz Health Services Agency, Environmental Health Service *Preliminary Report, An Evaluation of Wastewater Disposal and Water Quality in the San Lorenzo River Watershed,* September, 1989 (Evaluation of Wastewater Disposal Study)

County of Santa Cruz Health Services Agency, Environmental Health Service *San Lorenzo Nitrate Management Plan, Phase II Final Report*, February, 1995 (Nitrate Management Plan)

County of Santa Cruz Health Services Agency, Environmental Health Service *San Lorenzo Nitrate Management Study, Phase I Final Report*, May 1992 (Phase I Nitrate Management Study)

County of Santa Cruz, Health Services Agency, Environmental Health Service *Wastewater Management Plan for the San Lorenzo River Watershed*, February 1995, (Wastewater Management Plan)

County of Santa Cruz Health Services Agency, Environmental Health Service, *San Lorenzo Wastewater Management Plan, Program Status Report, 1989-95, July*, 1996 (Program Status Report)

County of Santa Cruz Health Services Agency, Environmental Health Service, *San Lorenzo Wastewater Management Plan, Program Status Report, 1996-98, March 2000* (Program Status Report)

County of Santa Cruz, Planning Department, *The San Lorenzo River Watershed Management Plan,* December 1979 (Watershed Management Plan)

Williamson, Rhea L., Naresh Channaveerappa, and Leopoldo Sanchez, *San Lorenzo River Nitrate Biostimulation Assessment, Final Report*, prepared for Santa Cruz County Environmental Health, San Jose State University Department of Civil Engineering and Applied Mechanics, 1993 (Biostimulation Study)

ATTACHMENT TWO: REFERENCES CONSIDERED

California Regional Water Quality Control Board, Central Coast Region, *A Review of Water Quality Standards for the San Lorenzo and Salinas Rivers*, Jagger, Paul; Van Voris, Bert; 1981

California Regional Water Quality Control Board, Central Coast Region, *Water Quality Control Plan, Central Coast Region*, September 8, 1994 (amended April 14, 1995)

California Regional Water Quality Control Board, Central Coast Region, *Water Quality Control Plan, Central Coast Region, Part II,* April 1975

Capitain, S.; Jagger, P.; Kolb, H., (November 1993), *Final Report: Literature Review of Non-Point Source Impacts in the San Lorenzo River Watershed*. Published by: California Regional Water Quality Control Board, Central Coast Region #3

County of Santa Cruz, Health Services Agency, Environmental *Health Service, (July 1996)* San Lorenzo Wastewater Management Plan, Program Status Report, 1989-1995

Williamson, Rhea L., Naresh Channaveerappa, and Leopoldo Sanchez, *San Lorenzo River Nitrate Biostimulation Assessment, Final Report*, Appendices, prepared for Santa Cruz County Environmental Health, San Jose State University Department of Civil Engineering and Applied Mechanics, 1999

Hecht, B.; White, C., (September 1993), *A Comparative Study of Nitrate Movement Below a Deep and a Shallow Leachfield in Zayante Soils, Glen Arbor, Santa Cruz County*. Published by: Balance Hydrologics, Inc.

Pettit, W., (September 1995), *Submittal of Regulatory Provisions of an Amendment to the Water Quality Control Plan for the Central Coast Basin*. Published by: State Water Resource Control Board, 901 P Street, Sacramento, CA 95814.

Questa Engineering Corporation, (October 1991), *Final Project Report: Boulder Creek Wastewater Feasibility Study*. By: Questa Engineering Corporation, 1220 Brickyard Cove Road, Point Richmond, CA.

Questa Engineering Corporation, (September 1994), *Final Project Report: San Lorenzo Valley Community Wastewater Feasibility Studies*. By: Questa Engineering Corporation, 1220 Brickyard Cove Road, Point Richmond, CA.

ATTACHMENT THREE: PUBLIC COMMENTS RECEIVED BY SANTA CRUZ COUNTY FOR 1995 NITRATE MANAGEMENT PLAN ADOPTION

San Lorenzo Nitrate Management Plan (Phase 2 Report)

Public Review and Response to Comments

Review and adoption of the San Lorenzo Nitrate Management Plan, Phase 2 Report, was combined with review and adoption of the San Lorenzo Wastewater Management Plan. Review of the Nitrate Plan consisted of:

- Review of the Administrative Draft by the TAC on February 9, 1995.
- A public meeting on March 8, 1995, attended by 10 members of the general public; a summary of the findings and recommendations of the report was distributed and discussed.
- Press coverage of the report findings before and after the meeting.
- Presentation and discussion of the report and its recommendations at publicly noticed meetings of the County Board of Supervisors on March 14, 1995 and the Central Coast Regional Water Quality Control Board on April 14, 1995.
- Distribution of the draft report to the Technical Advisory Committee, consultants, affected agencies, and interested members of the public who requested copies. Copies of the draft report were distributed to:
  - Steve Peters, Santa Cruz County Environmental Health
  - Jim Safranek, Santa Cruz County Environmental Health
  - Bob Golling, Santa Cruz County Water Quality Chemist
  - Terry Tompkins and Richard Lee, Santa Cruz City Water Department
  - Al Haynes, San Lorenzo Valley Water District
  - Frank Barron, Association of Monterey Bay Area Governments
  - Howard Kolb, Regional Water Quality Control Board, Central Coast
  - Paul Lillebo, State Water Resources Control Board
  - Diane Evans, Santa Cruz County Environmental Health Director
  - Fred Keeley, Fifth District Supervisor, County Board of Supervisors
  - Ken Hart, Santa Cruz County Planning Department
  - Robert Hanna, City of Scotts Valley Planning Director
  - Robert Muir, interested citizen, Felton
  - Patrick and Tammy Boole, Chaparral Stables
  - Barry Hecht and Chris White, Balance Hydrologics, Inc.
  - Rhea Williamson, San Jose State University
  - Norm Hantzsche, Questa Engineering Corporation
  - Ken Mabie, Septic System Consultant
  - Steve Homan, Septic System Consultant
  - Sharon Erspamer, Santa Cruz Water Quality Task Force

Following is a summary of the substantive comments received during review of the report, and the response to those comments. The comments are shown in italics. Comments regarding grammar, spelling, minor clarifications, and minor corrections are not listed.

Comment: Would community collection systems with enhanced treatment be more cost-effective for sandy soils than individual treatment systems?

Reply: We evaluated the cost-effectiveness of community systems as a part of the Wastewater Management Plan and found that in this area, individual alternative systems are more cost-effective.

Comment: How is cost-effectiveness evaluated? Who determines when the cost of treatment is low enough to require it for all system upgrades?

Reply: This is not an easy question. We have looked at some measures of affordability used in the old studies, but that does not provide good guidance. We have only recommended adoption of measures which will provide for significant nitrate reduction at the source, and which have generally small incremental cost compared to the overall project. We have also recommended control whenever a new discharge or potential increase in an existing discharge is proposed.

Comment: A technical report should not be guided too much by cost.

Reply: We have presented the findings and possible alternatives regardless of cost. However, in presenting recommendations for implementation, County staff believes cost and effectiveness must be taken into account.

Comment: Cryptosporidium does not come from horses.

Reply: There seems to be some diversity of opinion on this matter The City will be looking into this more in their Watershed Sanitary Survey.

Comment: Were taste and odors documented in water supply from the River only since 1976 because the problem began then, or just because record keeping and measurement began then?

Reply: Taste and odor measurements are quite subjective. However, City of Santa Cruz staff believe that taste and odors have increased since 1976, and particularly since 1983.

Comment: The problems related to increased nitrate in the River don't seem that bad and levels are only 5percent of the drinking water standard. Why does money need to be spent to reduce nitrate?

Reply: There are documented impacts on beneficial uses, with potentially more significant impacts on drinking water supply due to biostimulation. The River is also in violation of the State's anti-degradation policy. The Regional Board has required a reduction in nitrate levels.

Comment: The findings and recommendations presented in the Phase 2 report seem to be contrary to the findings presented in Rhea Williamson's technical report that indicated algae growth was not stimulated by nitrate levels in the River.

Reply: Rhea's report did indicate that growth of macro algae, particularly Cladophora, was most likely not increased as a result of the increased nitrate levels in the River. There are indications in Rhea's laboratory work and other investigations that increased nitrate levels can increase the rate of microalgae growth.

Comment: Is there a way to reduce nitrogen loads in septic tank effluent at the source, through diet or other means?

Reply: It would be difficult to get at that at the diet level. There are some filter methods that do remove nitrogen from effluent, but those also require maintenance.

Comment: **If the riparian corridors are so effective at removing nitrogen, why not pump water out of the River and let it flow back in through the riparian corridor?**

Reply: This would be a very energy and maintenance intensive method of treatment. It would probably also result in significantly reduced streamflow due to loss from increased evapotranspiration.

Comment: **Could special vegetation be planted to remove nitrogen?**

Reply: This can be done, but also requires maintenance for mowing and removal of the vegetation.

Comment: **We don't want to take too much nitrate out of the River. It helps increase productivity for fish.**

Reply: We are only proposing a 30percent reduction. Fish seem to be much more adversely impacted by sedimentation and flow reduction.

ATTACHMENT FOUR: PUBLIC COMMENTS RECEIVED BY THE REGIONAL BOARD FOR 1995 NITRATE MANAGEMENT PLAN ADOPTION

Several comments from Diane L. Evans, County of Santa Cruz Environmental Health Service, Letter received March 20, 1995:

1. For consistency the watershed should be referred to as the San Lorenzo River Watershed.
   Response: Agree. The staff report now uses the San Lorenzo River Watershed.

2. Page 3, Le. of the staff report should refer to County Code 7.38, not County Ordinance No. 4220, Chapter 7.38.
   Response: Agree. This reference is now on page four of the staff report.

3a. The recommendations for nitrate management have been refined since the staff report was prepared. On page 5, 2.d sandy soils are defined as having a percolation rate faster than 6 minutes per inch.
   Response: Agree. This reference is now on page six of the staff report.

3b. Under 2.e, large systems are defined as those serving more than five residential units or having a peak daily flow of more than 2000 gallons per day.
   Response: Agree. This reference is now on page six of the staff report.

4. On page 9 of the staff report, item 11.2, the estimated annual CSA 12 service charge may need to be increased to $3.00 per year per parcel to provide for increased inspections.
   Response: Agree. This reference is now on page ten of the staff report.

5. On page 9 of the staff report, under III.B, Time Schedule, item c. should read: "Require Upgrade of all Failing Prestandard Systems". The County does not have the authority to require upgrades unless the systems are found to be failing.
   Response: Agree. This reference is now on page eleven of the staff report.

6. Request for editorial changes to the proposed Basin Plan amendment contained in Attachment A.
   Response: Agree. Editorial changes made to Attachment A which is now Attachment B of the staff report.

7. Request for the Board to consider revision of the nitrate objective for the San Lorenzo River.
   Response: Disagree. The proposed Basin Plan amendment for the San Lorenzo River Watershed only addresses changes to Resolution 82-10. Staff does agree that the nitrate objective for the San Lorenzo River should be' reviewed at a later date.

David Ross, President, Board of Directors San Lorenzo Valley Water District, Letter received March 20, 1995:

The letter urges the Board to approve and adopt Resolution 95-04.
   Response: Agree.

ATTACHMENT FIVE: EXAMPLE LOADING CAPACITY CALCULATIONS

(Equations for determining nitrate reduction using Felton Station information)

Determining the Per Cent Growth Rate:

Given: 1995 baseline: 4,720 lbs. nitrate/month
Given: Nitrate Management Plan 10 year growth estimate: 4,982 lbs. nitrate/month. (The Nitrate Management Plan gives growth rate as 3,397 pounds nitrogen / summer, or 4.982 pounds nitrate/month), (To convert nitrogen to nitrate, multiply by 4.4, which is the conversion factor.)

$$\left(\frac{Nitrate\,Management\,Plan\ 10\,year\,baseline\,loading - 1995\,baseline\,loading}{1995\ baseline\ loading} \right) = \%\,increase\ \ in\ \ nitrate\,loading\,in\ 10\,years$$

Determining Nitrate Baseline for 2020:

$$\left(\frac{4{,}982\ \ lbs\,.nitrate\ \ /\,month\ - 4{,}752\ \ lbs\ \ nitrate\ \ /\,month}{4{,}752\ \ lbs\ \ \ nitrate\ \ /\,month} \right) = 4.8\ \%\ \ \ growth\ \ \ rate\ \ over\ \ 10\ \ years$$

1995 Baseline Loading + (Baseline loading in 10 years – 1995 baseline loading) x time adjustment factor = Baseline loading at time t

25 year prediction example for nitrate levels at Felton:

4,752 lbs nitrate/ month + (4,982 lbs nitrate/ month – 4,752 lbs nitrate/ month) x 25 years /10years =
5, 328 lbs nitrate / month in 25 years time

Loading Capacity:

Baseline nitrate loading/month at time T x 30% reduction = Nitrate Level Reduced by 30% for time T

5,328 lbs nitrate / month x 30% = 3,730 lbs nitrate / month in 2020 (25 years from baseline)