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SAN LORENZO
WASTEWATER MANAGEMENT PLAN

PROGRAM STATUS REPORT
2002-2007

February 29, 2008

County of Santa Cruz
Health Services Agency
Environmental Health Services
Water Resources Program

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SAN LORENZO WASTEWATER MANAGEMENT PLAN PROGRAM STATUS REPORT, 2002-2007

Introduction and Summary

The County of Santa Cruz Environmental Health Services has been implementing the San Lorenzo Wastewater Management Program since 1986, when efforts to extend sewers to the San Lorenzo Valley were abandoned due to high cost and adverse environmental impact. The San Lorenzo Wastewater Management and San Lorenzo Nitrate Management Plan were adopted by the County of Santa Cruz and the Central Coast Regional Water Quality Control Board in 1995. These plans formalized the framework for efforts to upgrade and manage onsite wastewater sewage disposal systems and improve water quality in the San Lorenzo River. These efforts have been undertaken by the County in conjunction with other countywide programs for wastewater management, beach water quality monitoring, and water quality improvement. This status report on Wastewater Management efforts in the San Lorenzo River Watershed summarizes the results of those efforts and builds on previous status reports completed in 2000 and 2003, along with information obtained during the Assessment of Sources of Contamination at Santa Cruz County Beaches (2006).

The Wastewater Program has experienced considerable success. Key points include:

- There are 13,900 onsite sewage disposal systems in the San Lorenzo Watershed located on 13,000 properties.
- 11,700 parcels have been inspected for system performance by county staff and information for 12,000 parcels on system characteristics and history has been entered into the county database.
- At least 4200 of the system shave been upgraded to current standards under permit since 1986.
- Etc.

Despite the success so far, there is a need for ongoing maintenance of effort. 20% of contamination is from humans during the wet seasons. River stil considered impaired for nitate and pthogens Althugh there are no reported impacts at this time from elevated nitrate, Nitrate is not declingin as rapidly as expected. .

Water Quality Impacts of Wastewater Disposal

Nitrate and pathogens are the two water quality parameters in the San Lorenzo Watershed that can be affected by wastewater disposal, among other sources. Parts of the San Lorenzo River and its tributaries have been designated as impaired due to pathogens, nitrate and sediment. The nitrate Total Maximum Daily Load and Implementation Plan were based on the nitrate management plan and were adopted in 2003. The pathogen TMDL is currently in preparation.

Nitrate

Nitrate levels in the River were estimated to be 5-7 times above natural background levels as a result of human settlement and other activities in the Watershed (SCCHSA, 1995). At about 0.4 mg-N/l, nitrate levels in the River are well below the safe drinking water standard of 10 mg-N/l. However, nitrate is the limiting nutrient in the River and increased nitrate levels can stimulate biological growth of algae, molds, fungi, and other organisms. This increased biological activity may threaten drinking water supply by releasing organic compounds, which cause noxious tastes and odors and produce potentially carcinogenic disinfection byproducts when the water is treated. In the past localized concentrations of nitrate in groundwater had at times threatened to violate the drinking water standard in areas of Ben Lomond, Boulder Creek, and Scotts Valley.

The San Lorenzo Nitrate Management Plan (SCCHSA, 1995) determined that an estimated 84% of the current nitrate load in the River results from human activities in the watershed. Calculations of relative contributions to present summer nitrate levels in the lower River (at Felton) are as follows:

- Septic Systems in sandy areas	38%
- Septic Systems in non-sandy areas	19%
- Natural sources in sandy areas	12%
- Sewer discharge from B.C. Country Club	10%
- Scotts Valley nitrate plume	9%
- Livestock and stables	6%
- Natural sources in non-sandy areas	4%
- Landscaping/fertilizer use	2%

Approximately 67% of the nitrate in the River during the summer periods that the study was conducted came from areas underlain by sandy soils of the Santa Margarita Sandstone. A septic system in sandy soils contributes 10-15 times as much nitrate to the River as a septic system in less permeable soils. Nitrogen reduction efforts are most needed and will be most effective in areas with sandy areas.

Nitrate trends are measured in terms of nitrate concentration and nitrate load, which is a product of the concentration and the stream discharge. Nitrate concentrations tend to fluctuate significantly with the season and with the amount of flow. Except for runoff periods, nitrate concentrations tend to be higher with lower flows and less dilution. Loading fluctuates even more and is very sensitive to the amount of flow. These variations make determining trends in nitrate levels challenging. The ultimate objective is to reduce or control nitrate concentrations as the relative availability of nitrate for uptake in the stream ecosystem is the factor that impacts beneficial uses. Long term reductions in concentrations require long term reductions in nitrate loads. Figure 1 shows nitrate concentrations over time in the San Lorenzo River at Big Trees.

Figure 1: Nitrate Trend in San Lorenzo River at Big Trees (1976-2004)

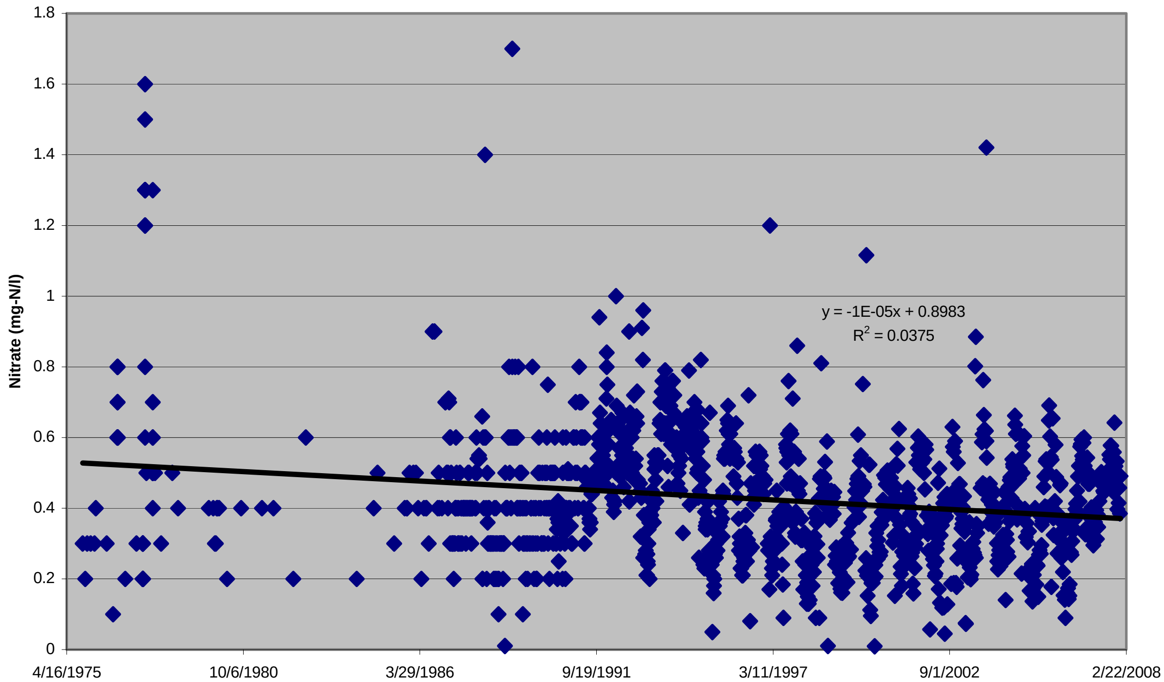


Figure 2: Nitrate Trend, San Lorenzo at Big Trees (1990-2007)

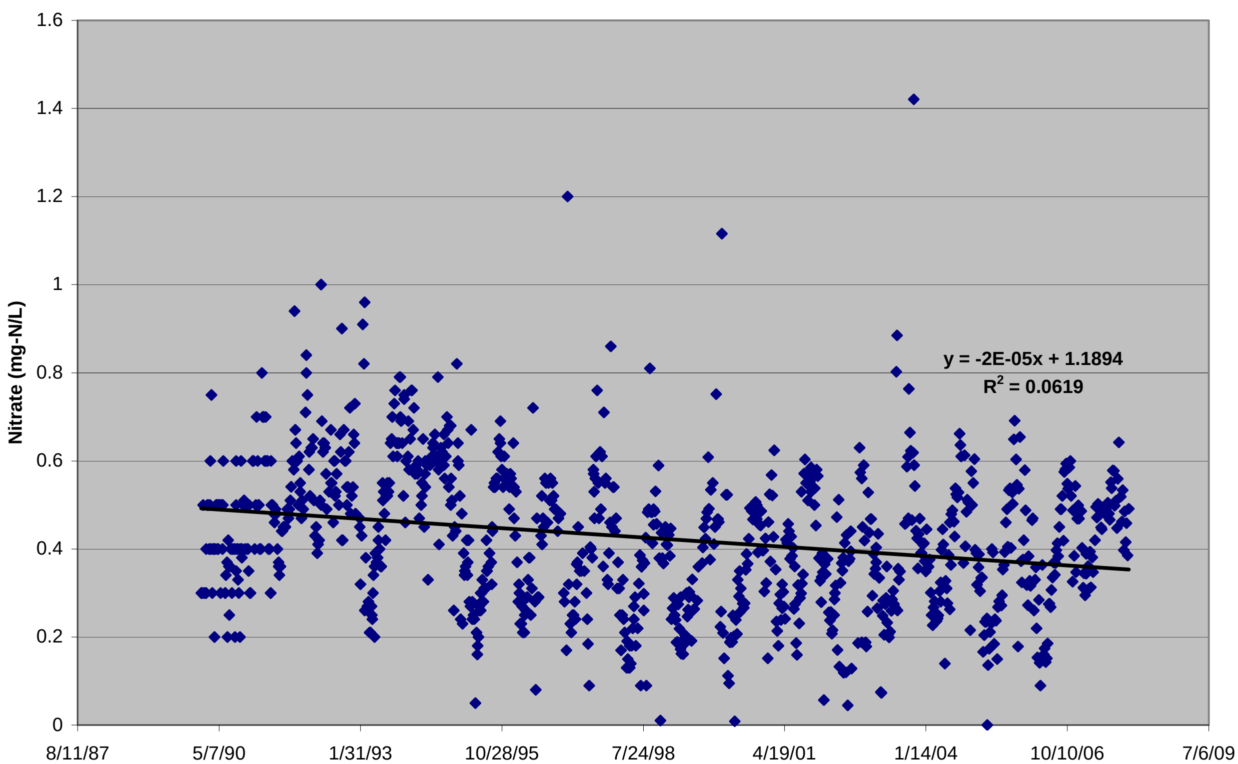
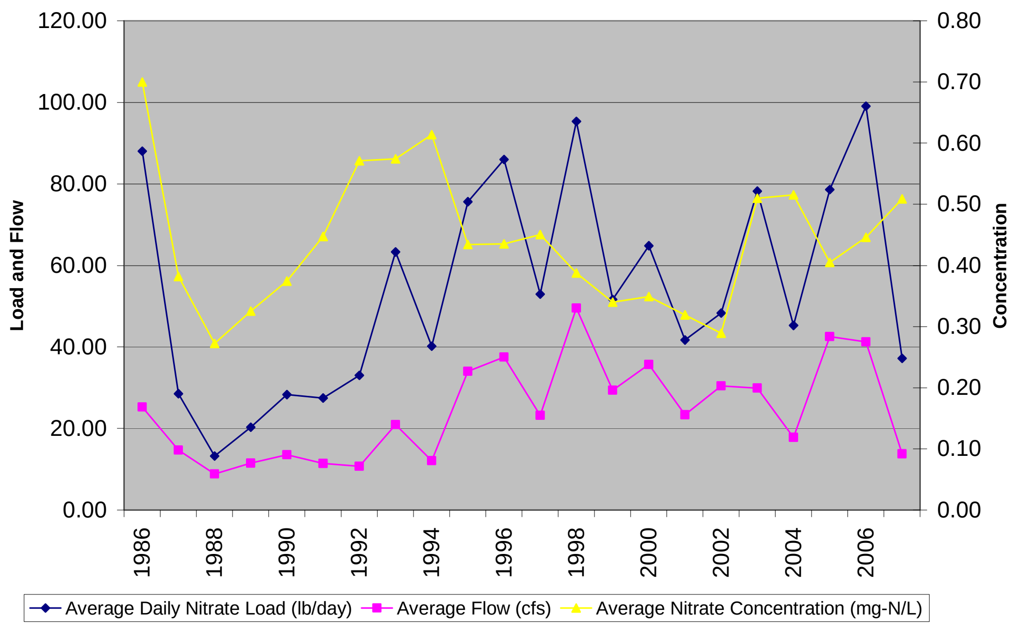


Figure 2 focuses on the more recent period since the County began implementing the San Lorenzo Wastewater Management Program in 1986. Although the correlation coefficient of the trend line is low, the trend in nitrate concentration is decreasing at a rate of about 11% over fifteen years. This is double the rate of decline for the long term trend of 1975-2007.

Both the San Lorenzo Nitrate Management Plan and the Nitrate TMDL focus on summer nitrate levels. Those levels tend to be more stable and those are also the levels that affect growth of algae and creation of taste and odor problems in the drinking water supply that is derived from the San Lorenzo River. For aggregating summer water quality data, a flexible time period is assigned that is based on flow regimes, water temperatures, timing of spring rainfall and timing of fall rainfall. Generally summer begins in June and end in September or early October. Summer nitrate concentrations were more elevated during dry years. There has been a general decreasing trend since the mid 1990s until 2003 and 2004, when nitrate concentrations increased significantly during late summer as the flows declined below median levels. A chart of summer nitrate loads at Big Trees shows almost an opposite trend of increasing loads with more recent wet years, until the dry year of 2007 when the load dropped, but concentration increased.

Figure 3: Average Summer Nitrate Load, Concentration and Flow at Big Trees



The following tables show average summer nitrate concentrations and loads from various stations in the San Lorenzo Watershed during the past 19 years. The loading calculations are not as precise as those presented in the nitrate management plan, as most stations had only 2-3 flow measurements during the summer periods.

The tables generally show that nitrate concentrations are lower, but loads are higher in most of the watershed in the more recent time period. This is consistent with the wetter conditions that prevailed after the nitrate management plan was completed. The one clear exception is Boulder Creek, and the River below Boulder Creek where both concentrations and loads are down, further indicating the effectiveness of the wastewater plant upgrades in reducing nitrogen discharge in that watershed.

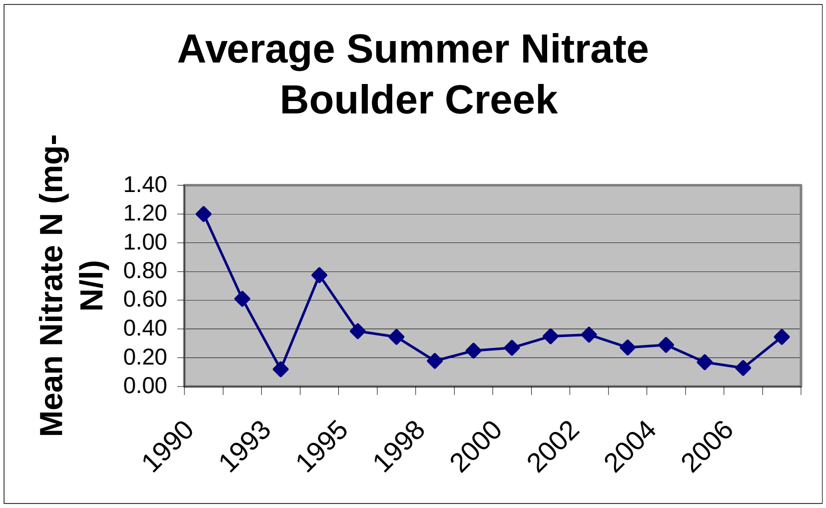
Table 1: Average Summer Flow and Nitrate Load, 1986-2004

Station Number	Location	Years of Record	Number of Flow Measure-ments	Average Flow (cfs)	Number of Nitrate Samples	Average Nitrate (mg-N/L)	Average Nitrate Load (lb-N/day)	Percent of Big Trees Load
0110	Carbonera Cr.	10	12	0.91	13	0.59	3.1	6.1%
022	SLR at Sycamore Grove	19	32	23.41	203	0.27	34.6	67.0%
050	Shingle Mill Creek at SLR	19	25	0.32	58	0.93	1.9	3.6%
060	**SLR at Big Trees**	19	260	23.14	282	0.44	**51.7**	100.0%
070	Zayante at SLR	19	41	6.37	70	0.59	22.0	42.5%
071	Bean Creek at Zayante	14	19	2.97	20	0.57	9.3	17.9%
07106	Bean Cr. At Mt. Hermon Rd	16	34	2.37	36	0.48	6.3	12.2%
07528	Lompico Cr. at Carrol Ave.	19	26	0.31	53	0.17	0.2	0.5%
140	SLR at Mt Cross	19	31	11.83	44	0.54	32.0	61.9%
150	Newell Cr at SLR	19	33	1.99	64	0.88	12.0	23.2%
245	SLR bl Boulder Creek	19	30	6.04	280	0.25	8.1	15.6%
250	Boulder Cr. at SLR	15	26	2.66	45	0.44	4.7	9.2%

Table 2: Comparison of Dry Year Nitrate Loads, 1990 and 2007

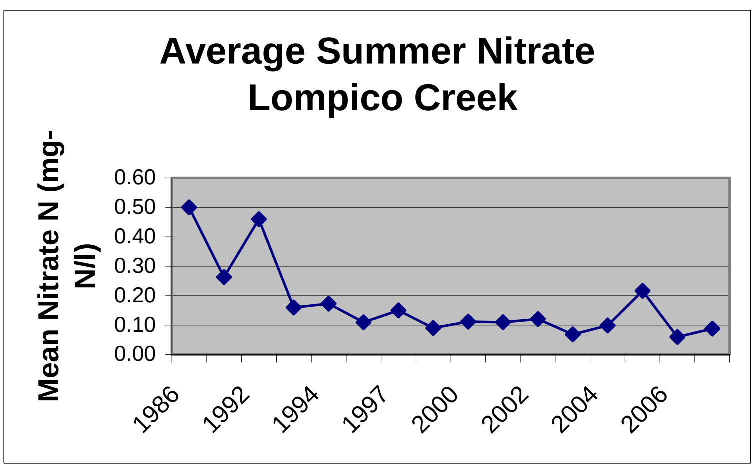
Nitrate Management Plan (1990-93)					2007 (Similar Dry Year)		
Station Number	Location	Average Nitrate (mg-N/L)	Estimated Load from Nitrate Mgt.Plan (lb-N/day)	Percent of Big Trees Load	Average Nitrate (mg-N/L)	Average Load (lb-N/day)	Percent of Big Trees Load
110	Carbonera Cr.	-	-	-	0.48	1.27	3.42%
022	SLR at Sycamore Grove	0.33	19	52.80%	0.25	19.78	53.12%
050	Shingle Mill Creek at SLR	-	-	-	1.13	1.61	4.31%
060	**SLR at Big Trees**	0.48	**36**	100.00%	0.51	**37.24**	100.00%
070	Zayante at SLR	0.58	13	36.10%	0.60	14.58	39.15%
071	Bean Creek at Zayante	0.65	9	25.00%	0.52	6.07	16.30%
7106	Bean Cr. At Mt. Hermon Rd	0.57	-	-	0.52	5.42	14.55%
7528	Lompico Cr. at Carrol Ave.	-	-	-	0.09	0.06	0.16%
140	SLR at Mt Cross	0.58	21	58.30%	0.67	26.32	70.68%
150	Newell Cr at SLR	0.87	6	16.70%	0.73	4.72	12.67%
245	SLR bl Boulder Creek	0.43	7	19.44%	0.18	2.88	7.73%
250	Boulder Cr. at SLR	0.94	6	16.70%	0.34	2.16	5.81%

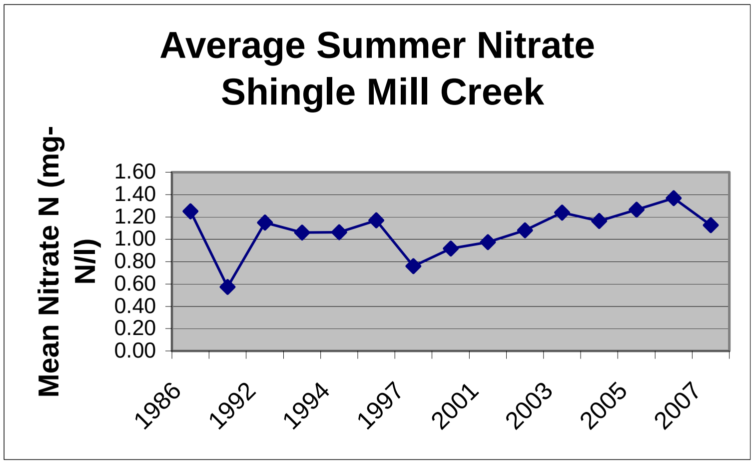
Figure 4: Average Summer Nitrate Concentration, Boulder Creek, 1990-2007

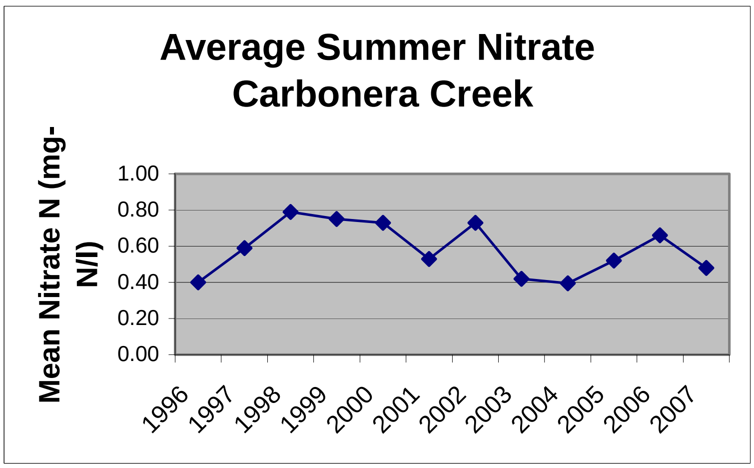


The nitrate TMDL for the San Lorenzo Watershed also targets Lompico Creek, Shingle Mill Creek and Carbonera Creek. Following are plots of average summer nitrate concentrations for those locations. Nitrate concentrations are quite low at Lompico Creek, but continue to be elevated at Carbonera and particularly Shingle Mill Creeks.

Figure 5: Average Summer Nitrate Concentrations, Lompico, Shingle Mill and Carbonera Creeks



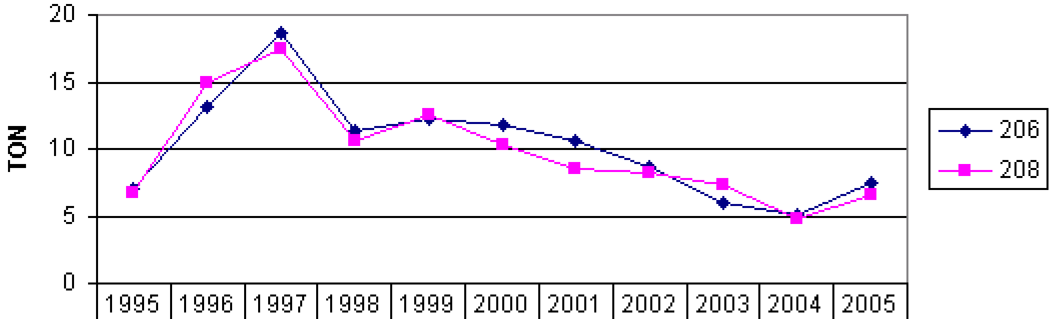




The San Lorenzo Valley Water District utilizes groundwater from the Quail Hollow Groundwater Basin, which discharges to Newell Creek and the River above Mt. Cross. The district analyzes for nitrate in its wells every two years during the summer. Nitrate levels at Quail Hollow Well 4A were 0.47, 0.64, 0.60, 0.71, and 0.73 mg-N/L in August 2002, July 2004, September 2005, September 2006, and September 2007, respectively. Concentrations in Quail Hollow Well 5A were 1.96, 2.67, 2.67, 2.67, and 2.67 mg-N/L during the same period. The levels in QH 5A are comparable to levels found when the nitrate management plan was being prepared in 1986-1993.

The City of Santa Cruz has not reported any significant episodes of taste and odor problems in the River in recent years. This would be consistent with the generally declining nitrate concentrations. No other adverse impacts attributable to elevated nitrate have been noted.

Figure 6: Trends in Threshold Odor Number (TON) for San Lorenzo River at Tait Street (206) and Big Trees (208)



	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
206	7	13	19	11	12	12	11	9	6	5	7
208	7	15	17	11	13	10	9	8	7	5	7

Year

Notes:
1. Location 206 is at the Tait Street Diversion
2. Location 208 is at the Felton Diversion
3. Data is the average for the months of April through September of the listed year
4. Displayed data for 2005 is for April through June only.
5. Average April-September TON levels at Station 208 for 2005, 2006, and 2007 were 6, 7, and 12, respectively.

Pathogens

Presence of bacteria, virus, giardia, cryptosporidium, and other pathogens can make the water unsafe for swimming and require more expensive treatment efforts for drinking water supply. Practically all of the testing for pathogens involves testing for indicator bacteria (total coliform, fecal coliform, E. coli, and enterococcus) that would suggest the possible presence of pathogens from sewage, fecal contamination, or other contamination. Limited testing for pathogens by the City of Santa Cruz has confirmed the presence of cryptosporidium and giardia in the San Lorenzo River. The presence of indicator bacteria, while not necessarily causing illness, causes beaches to be posted with warning signs and significantly impacts recreational opportunity. The frequency of posting of swimming areas in the watershed has declined significantly since the 1970's and the 1980's, as septic systems have been upgraded and better maintained (Figure 7). The frequency of exceedence of the one time standard of 400 cfu/100ml has also declined and is now less than the criteria for impairment (10%) at all the River stations except the Rivermouth (Figure 8). However, the Rivermouth continues to have consistently high bacteria levels and is permanently posted as unsafe for swimming. Sources of pathogens and indicator bacteria are non-point source urban runoff, failing septic systems, sewer system leaks, pet waste, livestock, homeless encampments, and waterfowl.

There are almost 14,000 septic systems in the San Lorenzo Watershed upstream from Santa Cruz. Under current wastewater management programs, the occurrence of septic system failures is relatively low. Since 1986, the wintertime septic failure rate has declined from 5-14% to 1-3%, depending on the area (SCCHSA, 2000). However, during rainfall periods, partially treated sewage which comes to the ground surface from individual septic failures may be readily washed into ditches, roadways, creeks and then the River. For brief periods after storms and in the early spring when water tables are high, ditches may continue to run, and some may convey diluted sewage to creeks. Ditch testing during recent years has shown a much lower incidence of elevated bacteria levels. During dry periods, sewage from failing septic systems would not reach a waterway unless the failure was right on the banks of the creek.

Programs implemented since 1986 have required system upgrades, increased setbacks from creeks, separation from groundwater, and identification of failures. Summer bacteria levels have shown substantial improvement, and the River generally meets standards for safe swimming at all areas upstream from Santa Cruz. Subsurface contribution of bacteria from apparently functioning septic systems has not been found to occur in the San Lorenzo Watershed (SCCHSA, 1989). Dry season bacteria in the upstream areas are most likely from nonspecific urban sources and waterfowl. The highest levels of indicator bacteria are consistently observed in the more dense urban areas of Santa Cruz and Scotts Valley, which are sewered, indicating most of the bacterial contamination is more related to urban runoff than septic systems. Bacteria levels drop substantially as the River flows out of the suburban areas and through the State Parks or other low-density areas.

Livestock operations are also a potential source of bacterial contribution during storm periods. It is estimated there may be some 400-600 head of livestock kept in the watershed, primarily horses in commercial stables and small homeowner operations. Runoff from paddock areas, trails and manure stockpiles during storms can contribute elevated levels of fecal coliform, Cryptosporidium, and other organisms. Except where animals are allowed into creeks, stables are not a significant source of microbiologic contamination during nonstorm periods. County Environmental Health and the Resource Conservation District of Santa Cruz County has had success with encouraging improvement of runoff and manure management at many of the larger operations. However, additional effort is needed.

As a part of the San Lorenzo River Watershed Management Plan Update, the County conducted extensive testing in the lower River area from 1995 through 1997 to better assess the sources of high bacteria in the urban reach of the River. Further work was done in 2002-04 in order to assess sources of bacterial contamination at the beaches. The work found consistently high levels of bacteria downstream from the confluence with Branciforte Creek, which originate from storm drain discharges to the River and Branciforte Creek, as well as the concentrations of waterfowl that congregate in that area. Although the storm drains typically have very high bacteria levels, their dry weather flow is generally light and intermittent. High levels of bacteria in storm drains originate from decaying organic material (including garbage, leaves, and pet waste), occasional sewage spills, and possible subsurface leakage of sanitary sewer systems. Sewage leaks have been confirmed in several storm drains and subsequently corrected, resulting in a decline in bacteria levels in those drains. Leakage may persist in some drains. Since the 1997 sampling, the sewer lines in the vicinity of Branciforte Creek were upgraded and bacteria levels from the Creek have declined significantly. However, the general nonspecific urban contamination keeps the bacteria levels elevated well above standards for safe swimming. Storm sampling of ditches and gutters with no likely sewage influence frequently yielded high levels of indicator bacteria. It has not been confirmed whether pathogens are also present.

Water quality sampling using the four standard bacteria indicators was coupled with a health risk survey of persons in the water to determine the health risk of swimming in areas adjacent to the San Lorenzo River mouth as well as other areas designated as swimming/surfing areas. The health risk survey showed that there are generally low levels of indicator bacteria producing a good quality swimming water in the beaches adjacent to the mouth of the San Lorenzo River as well as upstream of the City of Santa Cruz in the San Lorenzo River. While the safe swimming standard was almost always exceeded at the mouth of the river only one person out of the 165 persons interviewed that had been swimming or wading in that area became ill. During the study, a total of 1325 people were interviewed at all areas. Eleven cases of illness from swimming were reported. During a follow up health risk study in 2003-04, 47 swimmers were interviewed during winter periods and 11% reported illness from the water, a similar rate to amount of illness reported from the beach in winter at Capitola. During the summer, 300 swimmers were interviewed in the vicinity of the Rivermouth at Main Beach and Seabright Beach, with a 1% rate of reported illness form the water.

Figure 7: Summer Fecal Coliform Levels in the San Lorenzo River (Logmean of weekly samples)

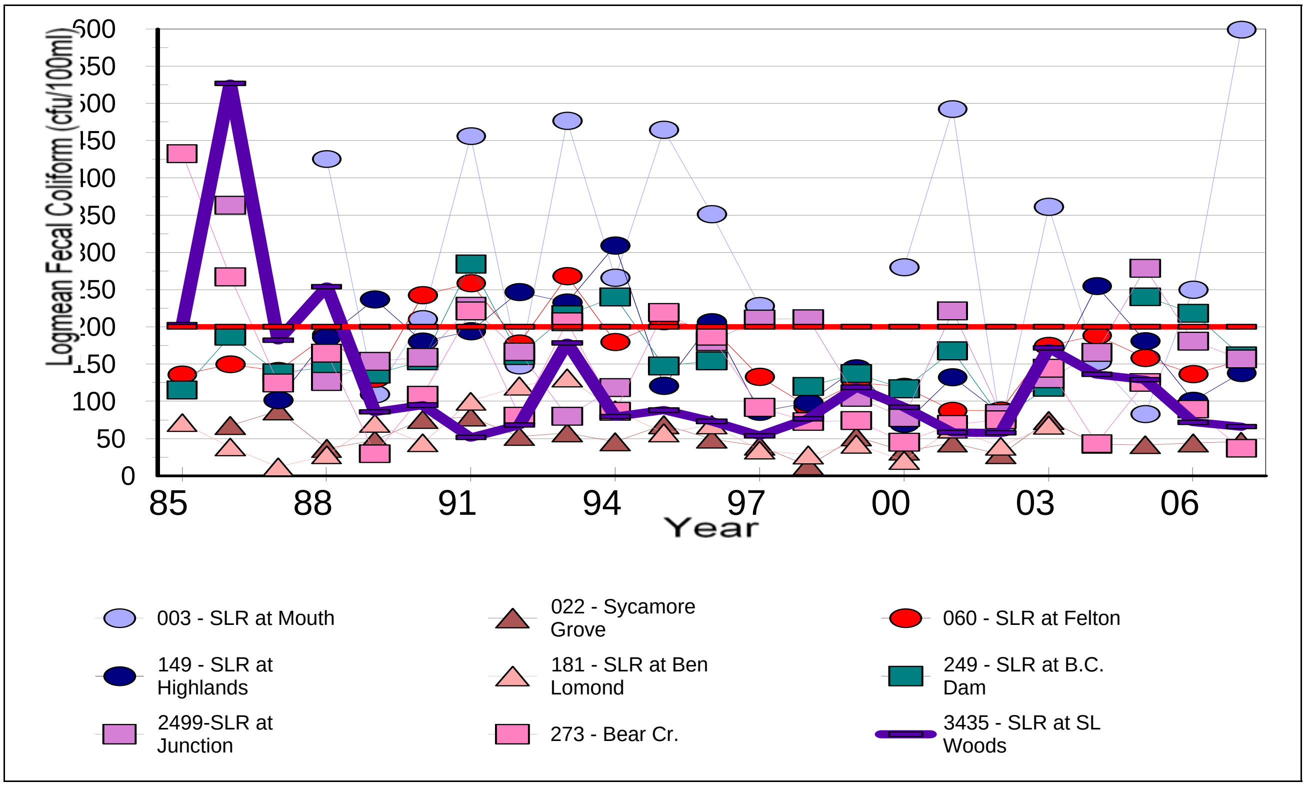
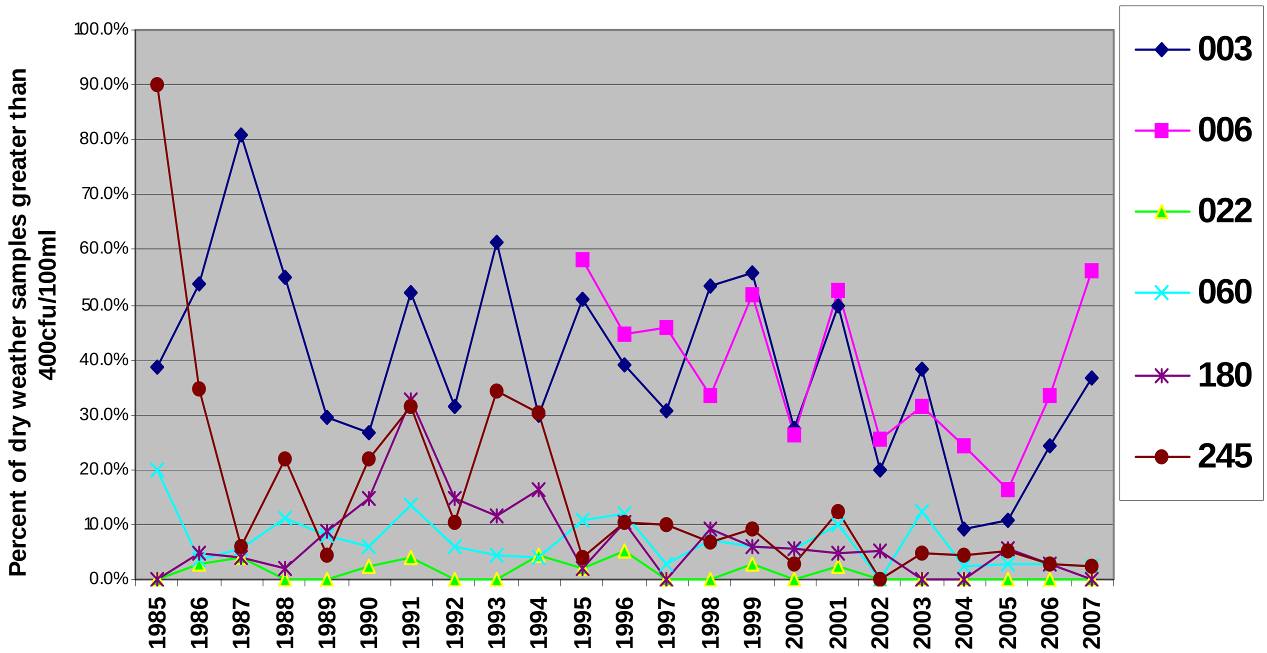


Figure 8: Trend of Fecal Coliform Exceedence of 400 cfu/100ml in Year Round Dry Weather Samples



Bacteria Source Assessment

The San Lorenzo Watershed contains waterfowl, wildlife, domestic animals, suburban development, septic systems and sewered areas. All of these can contribute indicator bacteria and potential pathogens to the River. There is a general perception that the greatest degree of health risk comes from exposure to water with human fecal contamination, although animal sources can also present risk. It is useful to know the source of contamination in order to develop appropriate control measures. Unfortunately, none of the indicators typically used are particularly indicative of the type of source. Many researchers are skeptical of finding a single organism or chemical indicator that is specific to contamination but believe that a suite of several indicators may provide a specific look at the severity of contamination.

Enterococcus, *E. coli, and Clostridium* have all been suggested as potential replacement indicators for fecal coliform bacteria. Researchers argue that each has merit as an indicator but there is relatively little information on health risk associations. In addition, all three of these organisms are found in high levels in most warm-blooded animals and with the exception of *E. coli* are also found on decaying vegetative matter. The fact that no indicator has yet been proven to be human specific makes the replacement of present indicators very difficult. A number of other compounds have been suggested to assess presence of human contamination: caffeine, cholesterol, laundry whiteners, antibiotics, etc. None of these has yet confirmed to be consistently useful.

Many researchers and agencies are looking at various microbiological source tracking methods to characterize sources of contamination. A variety of methods assess the compounds produced by microorganisms (phenotypic methods), or evaluate genetic material (genotypic methods) to determine the source of the microorganism.The Southern California Coastal Water Research Project (SCCWRP) is completing an evaluation of various methods of microbial source tracking to determine how accurately the different methods identified sources of fecal contamination in prepared water samples (SCCWRP, 2002). Preliminary results have been presented at several workshops and the results are to be published in December, 2003. It appeared that genotypic methods were much more accurate that phenotypic methods. The most accurate method was Pulsed-Field Gel-Electrophoresis, followed by the ribotyping method, which was a little less accurate. The best methods were 75% accurate and all methods had false positives, indicating more human contribution than there was. The techniques require comparison of samples to a library of known genotypes linked to particular classes of organisms. The study found that the libraries should include samples from known sources from the same geographic area that the unknowns come from. In order to accurately characterize the relative contribution from different sources of fecal contamination at a particular location, it is important to analyze 50-100 bacterial isolates (individual colonies) collected from that location over time.

Ribotyping is a method of microbiological source tracking that differentiates human *E. coli* from other types of *E. coli*. Dr. Mansour Samadpour of the University of Washington Public Health Department has worked with over 80, 000 samples of *E. coli* and is developing a genetic fingerprinting that he believes is human specific to human *E. coli*. Ribotype matching is a method of analyzing band patterns of RNA extracted from *E. coli* isolates collected from contaminated sites on a stream and matching them to band patterns from *E. coli* extracted from a known source. He has used this to assess the relative contributions of fecal bacteria contamination in a stream system in Washington from human and various animal sources and believes he can separate *E. coli* found in domestic dogs and cats from humans based on these RNA band comparisons. Numerous other agencies in the State of California have used Dr. Samadpour's method with great success in Southern California and Morro Bay, among other places.

Santa Cruz County EHS contracted with Dr. Samadpour to conduct an assessment of bacteria samples collected from several locations in the San Lorenzo River during the winter months from January 2002 to March 2003. Approximately 100 samples from four locations on the River as well as 50-60 samples from known local sources of fecal material were submitted for analysis. The genetic material is assessed from 3-5 bacterial isolates taken from each sample. Often several samples from the same location and date were submitted to provide a greater cross-section. Findings are presented in Table 3. Follow up testing was done from October 2003 to August 2004, including the summer period.

These results confirm previous findings regarding contamination sources at the San Lorenzo Rivermouth that birds and humans are significant sources of fecal contamination. Although this does not confirm the pathway by which human fecal contamination reaches the River, the storm drain system is considered the most suspect, given the high bacteria levels and the likelihood of sewage entering through spills and seepage. Although homeless populations are also a potential source, previous sampling did not reveal a significant increase in bacteria levels downstream of homeless encampments.

Both the absolute amount and the relative amount of human contribution (21%) to fecal contamination is significantly diminished upstream of the water supply diversions near Sycamore Grove (200 yards upstream from Tait Street) and Big Trees (just below Felton Diversion Dam). The combined contribution from birds, wildlife and rodents is relatively high at 45-49%. Horse and dogs are also a significant source at Felton where a large stable is located just upstream from the intake.

The moderate contribution from humans suggests that wastewater management programs are relatively effective at minimizing sewage discharge to the River, but that ongoing work is needed. The contribution from humans is greater during periods of runoff and high groundwater, as indicated by Table 4. There was no detection of human contamination during summer sampling. This would suggest a continued contribution by a small number of septic systems that fail in the winter.

The human sewage contribution is much less in areas served by septic systems than downstream urban areas served by sewers. During the wet seasons, the contribution to the bacteria levels at the Rivermouth from upstream human sources (septic systems) is only about 4% of the total bacteria load and only 14% of the total human bacteria load at the Rivermouth (based on data in Table 3). During the summer months, there is presently no apparent human contribution from septic systems to the bacteria load at the Rivermouth or anywhere else in the River.

Table 3: Percent Contribution of Sources of E. coli Bacteria - San Lorenzo River

Based on Ribotyping (Most samples collected during wet periods with some rain in the previous 3 days) (2002-03)

Source	**Station** **Rivermouth** **Station 003**	**Sycamore Grove** **Station 022**	**Felton** **Station 060**	**Boulder Creek** **Station 245**	**Combined**
Avian	39%	29%	23%	34%	31%
Bovine	1%	5%	1%	0%	1%
Canine	5%	6%	12%	9%	8%
Feline	0%	1%	1%	1%	1%
Horse	1%	1%	10%	1%	4%
Human	30%	21%	21%	26%	25%
Rodent	4%	9%	7%	5%	6%
Unknown	15%	17%	11%	10%	13%
Wildlife	4%	11%	15%	13%	11%
Total Isolates	**147**	**114**	**151**	**140**	**552**
Logmean E.coli (cfu/100ml)	434	84	181	117	
Human x Logmean	130	18	38	31	
(Hum.+unk) x Logmean	195	32	59	43	

Figure 9: Magnitude of Bacteria Contribution from Various Sources at Several Stations, San Lorenzo River (2002-03)

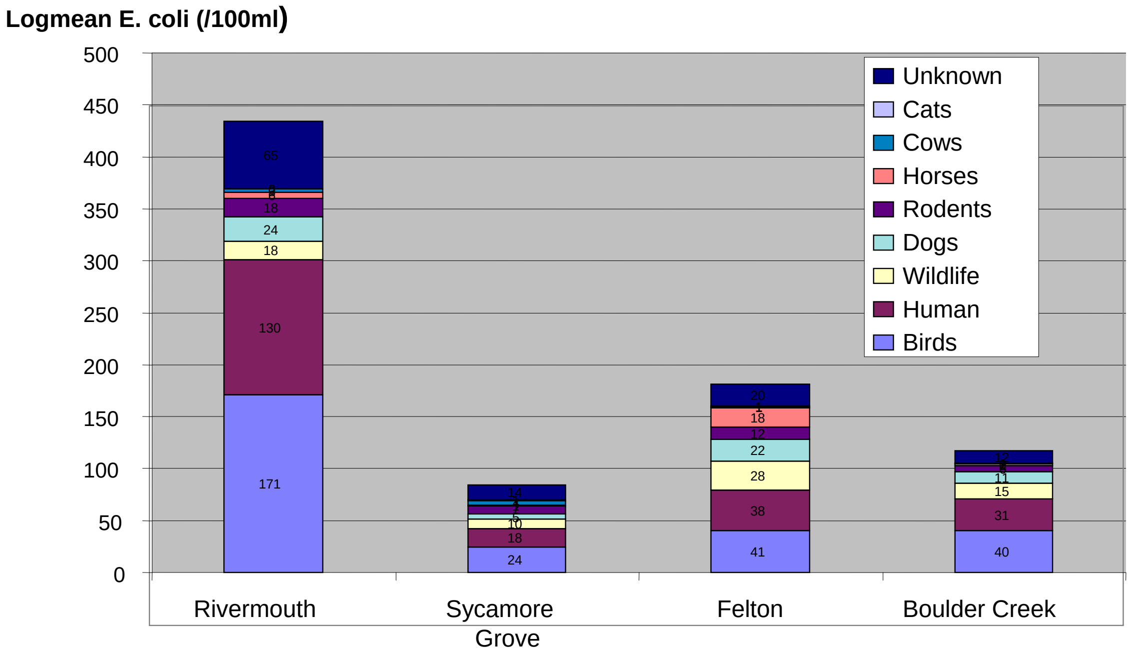


Table 4: Percent E. coli contribution of source by season, for Upper San Lorenzo Stations (022, 060, and 245), 2002-04 Ribotyping

Source/ Season	Winter	Spring	Summer	Fall	All Seasons	Dry Weather (<0.1 inch rain in previous 3 days)	Wet Weather (>=0.1 in)
Bird	31.7%	27.7%	63.8%	46.5%	36.0%	45.5%	29.5%
Cat	0.9%	0.0%	0.0%	1.4%	0.7%	0.9%	0.6%
Cow	2.2%	0.0%	0.0%	1.4%	1.4%	1.7%	1.2%
Dog	8.6%	10.1%	6.9%	9.9%	8.9%	10.4%	7.9%
Horse	5.2%	0.8%	0.0%	1.4%	3.3%	1.7%	4.4%
Human	**22.2%**	**18.5%**	**0.0%**	**12.7%**	**18.0%**	**15.6%**	**19.6%**
Rodent	7.7%	7.6%	17.2%	14.1%	9.4%	10.4%	8.8%
Wildlife	8.6%	21.8%	6.9%	7.0%	11.0%	6.9%	13.7%
Unknown	12.9%	13.4%	5.2%	5.6%	11.3%	6.9%	14.3%
Number of Isolates	325	119	58	71	573	231	342
Percent of Isolates	56.7%	20.8%	10.1%	12.4%	100.0%	40.3%	59.7%
Isolates in 2002-03					405		

Status of San Lorenzo Wastewater Management Program

The San Lorenzo Wastewater Management Program has been implemented by the Santa Cruz County Environmental Health Services since 1986 and was formalized through the adoption of the San Lorenzo Wastewater Management Plan by the County Board of Supervisors and the California Central Coast Regional Water Quality Control Board in the spring of 1995.

The program provides for management and improvement of approximately 13,900 individual onsite sewage disposal systems in the 138 square mile San Lorenzo River Watershed. Prior to implementation of this program, these systems historically contributed to elevated nitrate and pathogen levels in the River. Proper septic system functioning has been challenged by age of systems, small lot size, high winter groundwater levels, steep slopes, close proximity to waterways, and common occurrence of clay soils or excessively drained soils. The Wastewater Management Program has sought to overcome these constraints through water quality monitoring, system inspection, upgrade of systems to effective standards, public education, and tracking of system performance. Activities within the main elements of the Wastewater Program are summarized in Table 5 and described briefly in the following sections.

Table 5: Summary of Wastewater Management Activities in the San Lorenzo Watershed, 1990-2007

Details are presented in Table 6.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Inspections - Surveys and Rechecks	284	1842	1723	1658	1343	1169	1532	1795	1562	1745	792	1633	502	420	728	364	186	434
Repair Permit Applications	235	268	361	336	310	303	317	333	277	320	358	358	337	304	290	269	227	207
Tank Pumping (Private Pumpers)	1789	1796	1893	1752	1954	1984	1936	2039	2072	2099	2074	1869	1900	1972	2071	1932	1667	1057
Water Samples	1056	1087	1293	1227	1164	1623	1243	827	1198	790	810	983	844	928	945	806	826	804

Evaluation of Existing Onsite Sewage Disposal Systems

There are 13,000 parcels with septic systems and a total of 13,900 systems in the county's database. A number of parcels have multiple systems serving multiple uses. During the initial years of the wastewater management program, the status of the 13,900 systems in the watershed has been evaluated by: site inspections for failures; assessment of groundwater levels; water quality monitoring of creeks, ditches, and shallow groundwater; and, compilation and analysis of data on system characteristics, site characteristics, and records of septic tank pumping and inspection. 11,700 parcels have been inspected and over 80 boreholes or shallow monitoring wells have been installed to evaluate soil and groundwater conditions. Approximately 10 monitoring wells continue to be monitored on an annual basis to indicate the times the groundwater levels are elevated. Site reinspections continue, but at a reduced frequency. Data on inspection results, pumping history, septic system characteristics, and site characteristics has been entered into the computerized database for 12,000 of the 13,900 septic systems in the Watershed.

This information has been combined with data from water quality monitoring to evaluate the current performance and the potential for continued use of individual onsite disposal systems in various communities of the Watershed. Despite the constraints present, the large majority (at least 85%) of the systems evaluated were found to be functioning well, and it expected that all but about 10% can ultimately be upgraded to meet current standards using conventional technology. It was projected that the remainder would likely require use of alternative systems or nonconforming systems with a higher level of oversight. These initial conclusions have been confirmed by the types of system repairs that have taken place over the past 20 years.

Disposal System Improvements Completed

Minimum standards for septic system repairs were established by ordinance in 1993, and were strengthened further in 1995, pursuant to the adopted Wastewater Management Plan. At least 4200 systems have been substantially upgraded under permit since 1986, with 1500 disposal system upgrades completed since 2000. The number of system repair applications submitted annually increased by about 50% when the program was first initiated to over 300 per year. In recent years as the number of observed failures has declined, the number of repair applications has also declined, suggesting that most of the systems are performing well. Since 1995, 86% of the major system upgrades were able to meet the requirements for a standard conventional system, 10% used alternative systems, and 4% were approved as nonconforming systems that did not fully meet standards (subject to annual inspections).

The large majority (75%) of system repairs are initiated by the property owners voluntarily without any direction from the County. Another 15% of the upgrades are done as a requirement for building permits. Whenever a property owner wants to add more than 500 square feet or add bedrooms, they must upgrade their septic system to meet current standards.

Alternative Systems

Since 1995, 10% of the system upgrades have used alternative technology systems to accommodate site constraints or to provide for required nitrogen reduction in sandy soils. More recently, the proportion of system repair/upgrades using alternative technology has been averaging 15%. At the end of 2007, 300 alternative systems had been installed in the Watershed: 24 mounded bed systems, 4 at-grade systems, 15 sand filters, and 257 enhanced treatment units (primarily Advantex, Biomicrobics FAST,and Multiflo systems). Many of the enhanced treatment systems also use geoflow drip disposal or other methods of very shallow effluent disposal. The most significant constraints addressed by alternative systems in the watershed are high groundwater, fast percolation soils and limited disposal area. Approval of alternative systems requires recordation of a notice on the property deed, maintenance of an annual service contract, annual reporting, and payment of an annual fee for county oversight of the alternative systems.

Over 21% of the alternative systems have been installed on parcels with high permeability sandy soils, which make up only 10% of the total systems in the watershed. The nitrate management plan requires use of treatment for 50% nitrogen reduction for all new development and major remodels in sandy soils. System repairs must utilize shallow trenches or enhanced treatment. Of all the repair/upgrades in sandy soils, 22% have utilized enhanced treatment. Based on the nitrogen budgets in the nitrate management plan, the combined repair/upgrades that have occurred have reduced nitrogen loading form those systems by an average of 28%, and have reduced overall nitrogen loading to the River by 6%.

Loan Program

In late 1995, the State Water Resources Control Board approved the County's request for $2.2 million from the State revolving Fund to set up a loan program to facilitate septic system repairs using more expensive alternative systems. This program was initially available summer of 1998, but was suspended for a number of years to reconfigure the program for the County to provide the loans directly. Only one loan was made under the old program. Since the program was reestablished in November 2005, seven loans of $22,000 at 2.6% interest rate have been made. Substantial public outreach has been done, but potential applicants may be deterred by the administrative fees and the availability of generally low commercial loan rates.

Inspection and Maintenance

Inspection and maintenance activities consist of County inspections, public education, private pumping activities, maintenance by service providers, and management activities by homeowners. Frequently septic problems have been corrected through improved system management by the property owners without the need to repair the system. The County program initially provided for conducting inspections of properties for signs of system failure or greywater discharge once every 6 years. That frequency has been reduced because most problem areas have been inspected at least twice and few problems are now being found. Some systems do not fully meet standards and are operated subject to limits on water use. County staff conduct annual inspections of these systems and also recheck systems that have had a history of marginal performance or signs of intermittent failure during wet weather conditions. Staff also conduct inspections in response to complaints or high bacteria levels found in creeks or ditches. The total number of inspections has declined in recent years in response to the declining failure rate and other workload demands. The inspection rate is being increased in 2008 in response to wet conditions and a need to check again on potential problem areas.

The County also maintains the program of certified Onsite System Service Providers. In the past five years, approval of an installation permit for use of an alternative technology system has required that the property owner maintain a service contract with an Onsite Service Provider (OSSP) approved by the County (and by the manufacturer of the treatment system, if applicable). Property owners of older alternative systems are also being brought into the program. The OSSP is responsible for conducting an annual inspection, collecting and analyzing effluent samples, performing any needed maintenance or improvements, and submitting an annual report to the county. The county tracks all the systems, ensures that they have service contracts on file and that the annual reports are submitted. County staff also conduct occasional inspections and collect effluent samples to verify the work of the OSSP. As a result of that program it has been determined that some of alternative systems are not providing the expected level of treatment as a result of inadequate maintenance. These systems are now being brought into compliance.

Table 6: San Lorenzo Wastewater Management Program Activities, 1995-2007

YEAR	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
ACTION													
Total Inspections	1408	1798	2172	1838	1989	898	1633	502	420	728	364	186	434
Surveys	472	989	1076	1249	1051	663	1309	252	208	273	212	44	104
Problems	38	67	82	62	50	18	29	10	2	5	5	2	3
	8.1%	6.8%	7.6%	5.0%	4.8%	2.7%	2.2%	4.0%	1.0%	1.8%	2.4%	4.5%	2.9%
Rechecks	697	543	719	313	694	129	144	91	48	263	0	59	13
Problems	34	35	33	9	16	14	7	2	2	2	0	5	0
	4.9%	6.4%	4.6%	2.9%	2.3%	10.9%	4.9%	2.2%	4.2%	0.8%	0.0%	8.5%	0.0%
Annual Rechecks	74	76	98	91	99	0	91	88	105	126	102	30	81
Problems	3	1	1	0	1		0	0	0	0	1	0	1
	4.1%	1.3%	1.0%	0.0%	1.0%		0.0%	0.0%	0.0%	0.0%	1.0%	0.0%	1.2%
Total Survey /Recheck Results	1250	1608	2023	1661	1844	792	1544	434	363	672	314	137	384
Problems	75	103	116	71	67	32	36	12	4	7	6	7	4
Problem Rate	6.0%	6.4%	5.7%	4.3%	3.6%	4.0%	2.3%	2.8%	1.1%	1.0%	1.9%	5.1%	1.0%
Complaints	136	164	135	165	142	104	89	68	57	56	50	49	50
Problems	91	104	65	69	75	66	50	41	38	26	27	26	22
	66.9%	63.4%	48.1%	41.8%	52.8%	63.5%	56.2%	60.3%	66.7%	46.4%	54.0%	53.1%	44.0%
County Loan Insps.	22	26	14	12	3	2	0	0	0	0	0	0	0
Problems	2	0	0	0	1	1							
	9.1%	0.0%	0.0%	0.0%	33.3%	50.0%							
Total Insp. Results													
Failures	64	83	72	76	90	67	45	32	36	24	25	26	21
Greywater	58	73	86	55	52	14	43	16	6	9	7	7	5
Failure Rate	8.7%	8.7%	7.3%	7.1%	7.1%	9.0%	5.4%	9.6%	10.0%	4.5%	8.8%	17.7%	6.0%
Annual Rainfall (in.)	67.6	54.9	54.1	72.2	43.4	44.2	34.0	38.2	39.3	35.5	64.8	67.8	25.0
Tank Pumping	1984	1936	2039	2072	2101	2117	1896	1900	1972	2071	1932	1667	1057
Cited Cause													
Maintenance	1089	923	1024	1107	1160	1257	1217	1167	1264	1191	1119	1022	690
Loan Inspec.	345	432	487	488	541	544	422	472	492	605	512	371	214
Failure	203	238	202	85	49	73	87	96	61	77	75	66	31
Haulaway	137	143	146	129	78	39	20	8	8	5	11	46	38
Other	210	200	180	263	273	204	150	157	147	193	215	162	84
Reported Failure	208	189	92	151	144	130	110	97	87	78	110	70	26
Failure Rate	10%	10%	5%	7%	7%	6%	6%	5%	4%	4%	6%	4%	2%
Area Fail. Rate	1.6%	1.5%	0.7%	1.2%	1.1%	1.0%	0.8%	0.7%	0.7%	0.6%	0.8%	0.5%	0.2%
Reported High Level	441	418	452	476	470	469	485	474	453	383	396	340	196
Pre-Failure rate	22%	22%	22%	23%	22%	22%	26%	25%	23%	18%	20%	20%	19%
Area Pre-Failure Rate	3.4%	3.2%	3.5%	3.7%	3.6%	3.6%	3.7%	3.6%	3.5%	2.9%	3.0%	2.6%	1.5%
Repairs/Upgrades													
Applications	303	317	333	290	320	358	345	337	304	286	269	227	207
Alternative Systems							42	40	47	42	30	32	33
New Systems													
Applications							33	26	29	42	26	24	20
Alternative							15	7	9	6	10	5	6

Notes for Table 6:

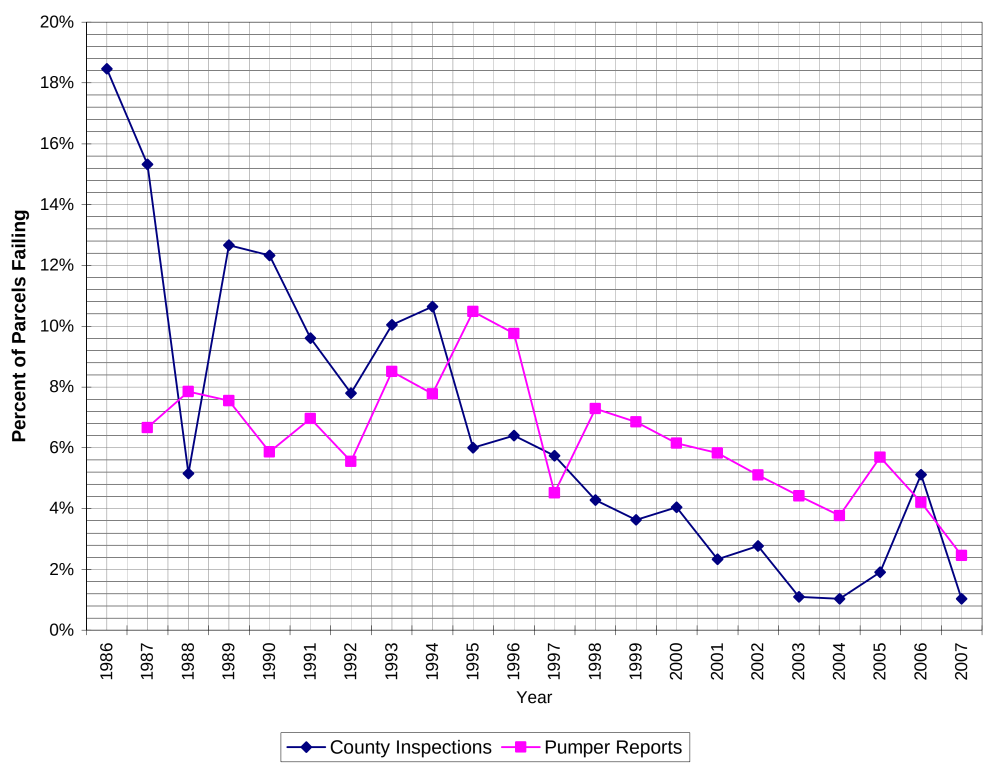
1. Inspections include: surveys, rechecks, complaint investigations, and loan inspections.

2. Numbers of problems under inspections, and total failure rates (unless otherwise indicated) are the total number of leachfield failures and greywater discharges for that year divided by the total number of inspections for that year. Under each type of inspection, the percentage of problems found during that type of inspection is also indicated for each year.

3. Under tank pumping, the area failure rate is the number of failures, divided by the total number of parcels in the study area.

4. Number of repairs is the number of repair and upgrade permits applied for in that year.

Figure 10: Observed Septic Failures During County Parcel Surveys and Rechecks and Private Pumper Inspections in the San Lorenzo Watershed



System upgrades and improved management have resulted in a significant decline in failure rates from 5-14% during the initial inspections of Class I areas to 1-3% during reinspections in 1995, and 1-5% during reinspections in the wet years of 1997 and 2006. Failure rates have generally continued to decline (Figure 10). and the frequency of reinspections The number of complaints has also declined from about 150 per year in 1995 to 50 per year in 2005-07. There has also been a decline in the reported failure and prefailure rate in reports from private septic tank pumpers. The failure rate has dropped form 10% to 5%. County staff conducted a program to revisit systems a year after they had been identified by pumpers as failing, but upon reinspection, most systems were not found to be failing. A total of 11,700 of the septic tanks have been pumped since pumping records started to be maintained in1988. Over 9200 of the systems have been pumped in the last ten years.

Property owner education on system maintenance has been conducted by distribution of brochures, mailings to new property owners, maintenance of the information on the county website, and periodic informative articles in local newspapers. A mass mailing to all septic system owners in the county is in preparation.

Evaluation of Potential for Community Disposal Systems

The Management Plan calls for an evaluation of the potential for use of community disposal systems for areas where there are severe constraints for meeting current standards using conventional septic systems. Under this program, community disposal alternatives have previously been explored for parts of Boulder Creek, Brook Lomond, Ben Lomond, Glen Arbor, and Felton. For all areas, community disposal systems were found to be less cost-effective than use of individual systems (including alternative systems) and were found to be unaffordable without some kind of grant funding. A community disposal feasibility study has been completed for 900 parcels in the Greater Pasatiempo area, in the lower part of the Watershed, and a sewer project is currently being pursued for that area.

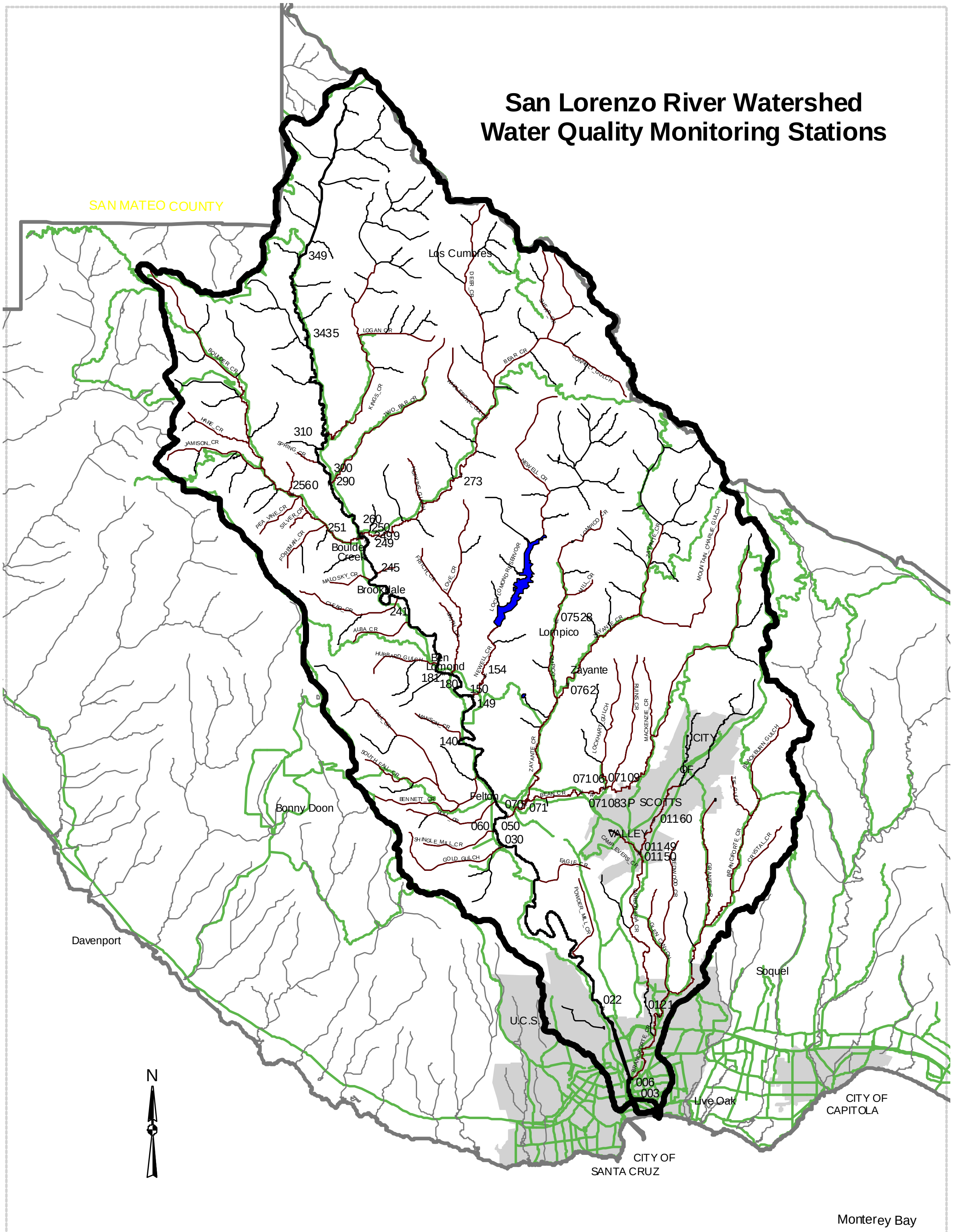
New Development

Rates of new development within the Watershed are relatively low, about 30 per year as indicated in Table 6. This represents a 0.2% growth rate. Most of the suitable parcels have been developed and 30% of the new development must use alternative systems. Any new development served by septic systems within the large part of the Watershed which directly provides water supply to the City of Santa Cruz, must meet a one acre minimum parcel size, regardless of the date of parcel creation. This requirement was implemented in 1983 in response to State direction to prevent an increase in cumulative impacts from septic systems. An exception was approved by the county in 2002 to allow the development of twenty commercial parcels in the village areas of the Valley. Much of the new development activity in the Watershed involves the remodel of existing homes which also requires bringing the septic system up to current standards.

Water Quality Monitoring

An average of about 1000 water samples per year are currently being collected to measure trends in water quality and identify problem areas. Sampling includes 7 weekly stations, 22 monthly stations, 5 summer swimming areas, and another 25 stations that are sampled four times during the summer for flow and nitrogen load. Both nitrate and bacteria levels are significantly elevated above natural background levels in the River and many of its tributaries. Although there have been episodes of bacterial contamination from individual septic system failures, much of the bacteria contamination seems to be related to nonspecific nonpoint contamination in the relatively dense urban areas. Most of the nitrate increase is attributable to septic systems, particularly in sandy soils. There have been significant localized improvements in bacteria levels, and there appears to be an improving trend in bacterial levels at most stations since 1996. Nitrate levels and loading in Boulder Creek and the River north of Ben Lomond declined significantly as a result of upgrades of the Boulder Creek Country Club (CSA 7) Treatment Plant.

Figure 11: San Lorenzo Watershed Water Quality Monitoring Stations



Program Administration and Financing

The annual budget for countywide wastewater management activities and oversight of nonstandard systems is about $200,000, with an additional $260,000 for activities specific to the San Lorenzo Wastewater Management Program. (Roughly 60% of the parcels in the county with septic systems are located within the San Lorenzo Watershed.) These budget figures do not include permit processing activities. The program is funded primarily by annual service charges collected from property owners with septic systems. Since 1996-97, the countywide service charges have been $6.90 per parcel, with an additional $18.56 per parcel paid by property owners in the San Lorenzo Watershed. An additional $90 is collected from parcels with alternative systems to pay for the oversight of maintenance programs for alternative systems.

Additional Efforts for Pathogen Reduction

The San Lorenzo River and its tributaries have been designated as impaired due to pathogens pursuant to Section 303(d) of the Clean Water Act. As a result, the Regional Water Quality Control Board is currently working with the County to quantify sources, establish reduction targets and implement an implementation plan through the TMDL process. In the meantime, the County and other agencies have initiated a number of efforts to reduce bacteria and pathogens from septic systems, sewers, non-point urban sources, and livestock operations. It is expected that implementation of the stormwater management program will further reduce contributions from other non-point sources.

In addition to continued implementation of the San Lorenzo Wastewater Management Program, the following efforts are being implemented to reduce pathogen levels in the San Lorenzo River:

1. Complete the pathogen TMDL to identify continuing sources of pathogens and determine additional measures to reduce pathogen loads. (Regional Water Quality Control Board)

2. Implement urban runoff management measures to reduce dry weather and wet weather pathogen levels in urban and suburban areas (City of Santa Cruz, City of Scotts Valley, County of Santa Cruz Public Works, Environmental Health):
   a. Promote good housekeeping practices through education, ordinance, and agency practices for proper management of pet waste, garbage, storm drain inlets, food facilities, and other operations that contribute to elevated pathogen levels.
   b. Investigate and correct leaks and possible illicit connections between sanitary sewers systems and storm drains.
   c. Maintain and enhance efforts to regularly clean storm drains and catch basins, particularly before first flush events.
   d. Implement Phase II Storm Water Programs in urban areas. Consider expanding programs to suburban areas where benefit can be demonstrated.
   e. Develop and implement a strategy to eliminate potential water quality impacts from homeless camping and loitering in flood plain areas.

3. Promote good livestock management practices to reduce discharge of sediment, nitrate and pathogens. (Santa Cruz County Environmental Health, Resource Conservation District of Santa Cruz County, Santa Cruz County Horesemen’s Association, Ecology Action)
   a. Continue cost-sharing, technical assistance and general educational outreach for improved practices at stables.

b. Require preparation and implementation of manure management plans for development permits that include stable operations.
c. Respond to complaints and incidences of degraded water quality by conducting inspections and providing guidance and direction for improvement.

San Lorenzo Nitrate Management Plan and Nitrate TMDL

The San Lorenzo Nitrate Management Plan was developed to address all major sources of elevated nitrate in the River. A grant was obtained under Section 205j of the Clean Water Act to investigate the impacts of nitrate on algae growth and water supply, to determine the primary sources of nitrate in the watershed, and to evaluate various alternatives for nitrate reduction. The Plan includes a watershed nitrate budget, which was used to calculate resulting nitrate levels in the River under different scenarios. The adopted Plan represented a balance between cost and available technology and the need to reduce nitrate levels by a moderate amount in order to reduce potential threats to drinking water quality and recreation. The San Lorenzo Nitrate Management Plan was adopted by the County and State in 1995. The Plan findings and recommendations also formed the basis for the Nitrate TMDL (Total Maximum Daily Load Plan) that was adopted by the Central Coast Regional Water Quality Control Board in 2003.

The recommended nitrate management plan provides for implementing the most cost-effective measures to achieve the desired level of nitrate reduction. The plan provides for limiting increased nitrate release from new or expanded development in sandy soils, and gradually reducing nitrate discharge from existing sources as public and private funds become available and reduction technology improves. Implementation of the recommended policies was projected to provide for a 15-20% reduction in current nitrate levels over the next 10 years, with a further reduction of 10% in the following 10 years. Observations of actual nitrate trends suggest that these reductions are occurring more slowly, with an 11% reduction over the past 15 years. More significant reductions have occurred in Boulder Creek and the River above Ben Lomond where nitrate levels have declined by about 60%. No significant adverse impacts resulting from nitrate loading at the current level have been identified.

Following is a brief summary of the nitrate management measures that were included in the nitrate management plan, and the status of implementation:

Manage Wastewater Disposal for Nitrogen Reduction

1. Maintain the existing requirement of a one acre minimum parcel size for new development served by septic systems in the San Lorenzo Watershed (Ongoing)

2. Implement improved wastewater disposal management through the San Lorenzo Wastewater Management Plan (Ongoing).

3. Complete ongoing efforts to improve treatment procedures at Boulder Creek Country Club Treatment Plant to reduce nitrate discharge by using wastewater reclamation on the golf course. (The treatment process was refined and fully operational by May 1998. The improvements provide for treatment for nitrogen removal, with the possibility of wastewater reclamation on the

golf course much of the year. Effluent has generally not been used for reclamation on the golf course, due to strict regulations. However, the effluent that is delivered to leachfields for disposal has significantly lower nitrogen levels. Nitrogen levels in Boulder Creek are 60% less than the levels from the mid 1990's.)

4. Maintain the new requirement for shallow leachfields for new and repaired septic systems (less than 4 feet in sandy areas, and 4-6.5 feet in other areas). (Ongoing)

5. Implement enhanced technology for at least 50% nitrogen removal for septic system in sandy soils:
   a. Require septic systems serving new or expanded uses in sandy soils to install enhanced treatment measures which will reduce nitrogen discharge by at least 50%. (Implemented August 1995; existing systems to be upgraded at the time of major remodels (originally projected rate of 1.2% (20 systems) per year is actually 0.3%, or 5.25 systems per year over the past 12 years).)
   b. Encourage the use of nitrogen removal methods for any onsite disposal system which will use a nonstandard system. (Since 1995, 245 alternative systems with capability for nitrogen removal have been approved for use in the San Lorenzo Watershed: 15 sand filters, 63 Advantex Systems, and 167 FAST systems. The 61 systems installed in sandy soils will reduce the summer nitrate load from sandy areas by 6%.)
   c. Continue to evaluate new onsite wastewater disposal technology for nitrogen reduction to identify more cost-effective measures. Require higher levels of nitrogen removal if measures become available that are more cost-effective than sand filters. (Some new technology is becoming available, but the cost continues to be high.)
   d. Apply for State revolving funds and other funds to develop a funding source to assist property owners in repairing their systems to provide enhanced treatment. (Revised program is now being implemented, beginning June 2005. This could fund 100 upgrades over the next five years, although only 7 loans have been applied for in the past 2 years.)
   e. When more cost-effective technology and/or funding assistance becomes available, require all onsite system repairs in sandy areas to utilize enhanced treatment for nitrogen removal. (Implementation deferred, pending more inexpensive technology and documented need for further nitrogen reduction.)

6. Require all large onsite disposal systems which serve more than 5 residential units or dispose more than an average of 2000 gallons per day to utilize enhanced treatment to reduce nitrate discharge by at least 50%. Installation of such measures for existing systems shall be required at the time of system repair or upgrade. (Estimated 1-2 upgrades involving approximately 5000 gallons per day per year, but only about 8 upgrades have occurred in the past 12 years.)

7. Require all new or revised waste discharge permits and all new development projects in the San Lorenzo Watershed to include nitrogen control measures consistent with this Nitrate Management Plan. (County staff has worked with staff at the Regional Board to include nitrogen reduction requirements in new or amended waste discharge permits. This was included in the permits for expansion of the Mount Hermon Association system, the Boulder Creek Country Club system, the San Lorenzo Valley High School system, Brookdale Lodge, Pasatiempo Inn, and Bear Creek Estates.)

Livestock Management for Nitrogen Reduction

8. Continue to work with stable owners and develop a new ordinance requiring practices to reduce nitrate discharge: cover manure piles, maintain manure piles and paddock areas at least 50-100 ft from streams or drainageways, direct drainage away from paddock areas, and provide other measures as necessary to reduce discharge of nitrate, sediment, and contaminants. (Ongoing, after meetings with stable and horse owners, it was decided to pursue an approach of education, technical assistance, and voluntary compliance. A grant funded effort by the Resource Conservation District and Ecology Action got underway in 2001 and continues with new grant funds. This program has provided for 9 pilot projects implemented in the watershed, 13 area workshops, 30 site visits for technical assistance in the watershed, and significant outreach to the Horsemen's Association and horse owners. All new or modified horse operations now prepare and implement manure management plans to reduce the runoff or percolation of nitrate)

Land Use Regulations for Nitrogen Reduction

9. Maintain current density restrictions requiring 10 acres per parcel for new land divisions and other protective measures for groundwater recharge areas. (Ongoing)

10. Maintain current regulations on erosion control, land clearing, and riparian corridor protection. (Ongoing)

11. Do not approve new land use projects within the San Lorenzo Watershed which will increase the discharge of nitrate to groundwater or surface water by more than 15 pounds of nitrogen per acre per year from the project area. (Ongoing; a proposal to construct playing fields in the Quail Hollow area was not approved partly due to concerns over discharge of fertilizers and other chemicals.)

Ongoing Monitoring of Nitrogen Sources

12. Monitor the Scotts Valley nitrate plume, and identify potential ongoing sources of nitrate. Work with the City of Scotts Valley and property owners for reduction of nitrate discharge from Scotts Valley, if feasible. (Ongoing monitoring, nitrate concentrations seems to be diminishing by 30%).

13. Continue to monitor nitrate levels in surface and groundwater. Reevaluate implementation of more stringent control measures if summer nitrate levels in the River have not declined by at least 15% by 2010. (Ongoing monitoring, reevaluation in 2010).

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