Morro Bay National Monitoring Program Final Report R3

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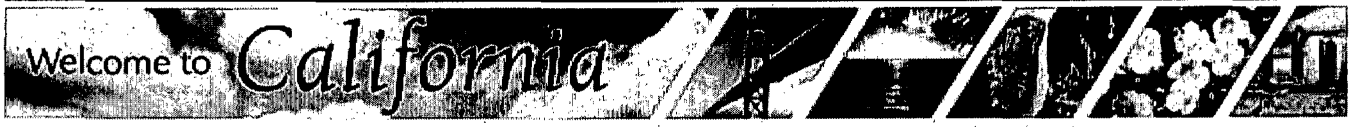

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Applications
Board Members
Board Meetings
Facilities
Job Opportunites
Org Charts
Permits/Orders
Phone List
Programs
Regional Awards
Watershed Management
Workshops

R3 Dairy creek

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Back to Top of Page

Phase 5: Regulatory Action Selection

Final Project Report

Total Maximum Daily Load for Dissolved Oxygen in Dairy Creek, San Luis Obispo County, California

October 2004

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

CONTENTS

FIGURES

TABLES

1. INTRODUCTION

Dairy Creek was included on California's section 303(d) list of impaired waters for dissolved oxygen. The Clean Water Act requires a Total Maximum Daily Load (TMDL) be developed to restore impaired waterbodies to their full beneficial uses. This report presents the dissolved oxygen TMDL for Dairy Creek. This section presents background information on the creek's 303(d) listing, describes the watershed and summarizes this report's outline and content.

1.1. Project Definition

Dairy Creek was listed as impaired for dissolved oxygen on the 2002 303(d) list. Review of available water quality monitoring data from the Morro Bay National Monitoring Program (NMP) and the Morro Bay Volunteer Monitoring Program (VMP) (1993-2004) indicate that dissolved oxygen is falling below the numeric water quality objectives at one of the three stations in Dairy Creek.

To further characterize the impairments in the creek and identify potential causes, data analyses were conducted to examine relationships between nutrient levels, algal growth, water temperature, and dissolved oxygen. Results of evaluating the effectiveness of implementing Management Practices (MPs) in improving water quality (i.e. dissolved oxygen, nutrients, and temperature) were also reviewed.

The conclusions that can be drawn from available data include:

- The water quality objective for the freshwater habitat beneficial use (COLD) of 7 mg/l and the general dissolved oxygen water quality objective (that median values should not fall below 85 percent saturation as a result of controllable water quality conditions) are not being met in portions of Dairy Creek where MPs have been implemented.
- Significant increases in dissolved oxygen levels have been observed as a result of MP implementation.
- Nutrient levels are typically low; nitrate levels do not exceed the water quality objective for the municipal and domestic water supply (MUN) use of 10 mg/L.
- No significant reductions in nitrates or phosphates were observed as a result of MP implementation; the relationship to dissolved oxygen levels is indeterminate.
- Limited algae has been observed, and, insufficient algal growth information are available to determine if it is contributing to depressed dissolved oxygen levels.
- Significant decreases in water temperature have been observed as a result of MP implementation, however, the relationship to dissolved oxygen levels is indeterminate.
- Multiple factors (canopy, temperature) are likely to have contributed to the dissolved oxygen impairment
- While data coverage is insufficient to derive an explicit linkage between dissolved oxygen levels and other environmental conditions (e.g., canopy); improvements as a result of implementing MPs are occurring.

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

1. Develop a dissolved oxygen TMDL to attain the current numeric water quality objectives.
2. Continue to implement existing MPs. Improvements in dissolved oxygen levels are already occurring as a result of implementation and are expected to result in TMDL achievement.
3. The solution to the impairment being addressed by the TMDL is being implemented by a non-regulatory agency, the County, and the solution will correct the impairment. Recommend that the Regional Board approve a resolution indicating that existing efforts will implement the Dairy Creek TMDL and ultimately result in attainment of the associated water quality objectives.

1.2. Watershed Description

Dairy Creek is located in San Luis Obispo County on the central coast of California. The watershed is in a Mediterranean climate, with warm dry summers and cool wet winters. The geology of the watershed is a mix of igneous, metamorphic and sedimentary rock less than 200 million years old. Average temperature is about 12°C (54°F). Average annual rainfall ranges from 45 cm (18 inches) at the coast to 89 cm (35 inches) on the ridge; most of this rainfall occurs between November and April (sources: Department of Water Resources, 1958; Ernstrom, 1984).

Dairy Creek is tributary to Chorro Creek and drains to the Morro Bay estuary (Figure 1). Land use in the Dairy Creek watershed is primarily rangeland, with a golf course and park draining to the lower portions of the creek. Dairy Creek flows through El Chorro Regional Park, and is the site of a Management Practice implementation project (Figure 1). The land has a history of grazing without creek corridor protection, and in many areas the riparian vegetation was damaged. The Natural Resources Conservation Service, in partnership with the County of San Luis Obispo (County), and land managers voluntarily implemented MPs in 1994 and 1995. MPs implemented at Dairy Creek included cattle exclusionary fencing with water gaps and riparian revegetation. Improvements to approximately one mile of Dairy creek were completed during the summer of 1994, with an additional half-mile of the creek fenced during the summer of 1995.

In the past, approximately twenty head of cattle grazed along Dairy Creek on the County property (pers comm. J. Guidetti, 2002). The new fencing encloses the riparian corridor on both sides of the creek, excluding it from the grazing areas. Two water gaps were left between the lower and upper cattle fencing and just below the upper Dairy Creek site (DAU) to allow cattle access to the creek for water. The number of acres available for grazing has been reduced from 750 to less than 400. Of the 750 acres previously grazed, 150 acres have been designated as a botanical area. The lower portion of El Chorro Regional Park was developed as a golf course beginning in 1995 and completed in 1997.

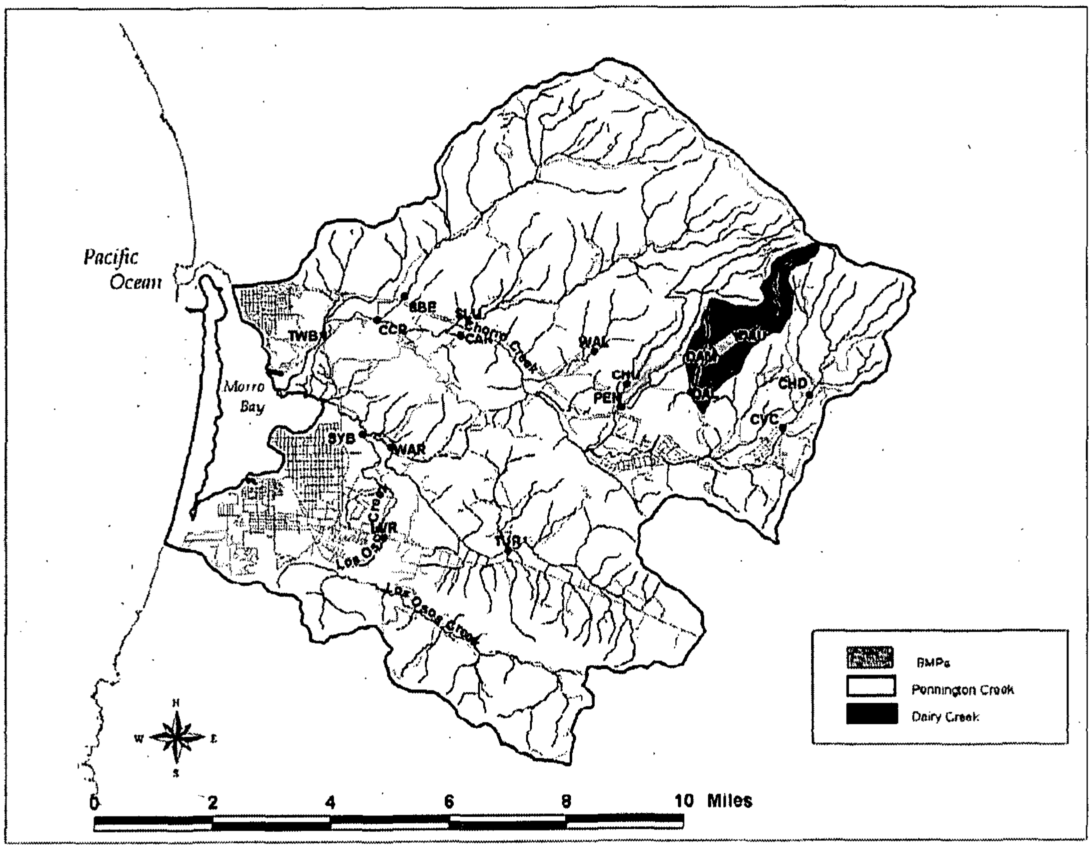

Figure 1. Watershed and monitoring sites within Dairy Creek and MP project boundaries

1.3. Structure of Document

The following sections are included in this TMDL report:

- Project Definition: Identifies the 303(d) listing for Dairy Creek and summarizes available information to characterize impairment.
- Water Quality Standards: Identifies the water quality standards applicable to the listing.
- Data Review: Provides an inventory and analysis of available water quality data.
- Source Analysis: Identifies potential sources of dissolved oxygen impairment in the watershed.
- Dissolved Oxygen TMDL: Identifies the dissolved oxygen TMDL for the Dairy Creek watershed, including allocations and considerations of seasonality and margin of safety.
- Monitoring: Discusses follow-up monitoring to track water quality improvements from the dissolved oxygen TMDL.
- Implementation: Discusses existing implementation activities for the dissolved oxygen TMDL, including plans for tracking the progress of implementation and the timeline for TMDL achievement.

2. WATER QUALITY STANDARDS

Regional Water Quality Control Boards (Regional Boards) define beneficial uses for waterbodies in their Water Quality Control Plans (Basin Plans). Also included in the Basin Plan are numeric and narrative objectives to be protective of the beneficial uses designated for each waterbody. The following sections discuss the applicable beneficial uses and water quality objectives related to the 303(d) listings in Dairy Creek.

2.1. Beneficial Uses

Table 1 summarizes the beneficial uses of Dairy Creek

Table 1. Beneficial uses for Dairy Creek.

Waterbody	Dairy Creek
Municipal and Domestic Supply (MUN).	X
Agricultural Supply (AGR)	X
Industrial Process Supply (PROC)	
Industrial Service Supply (IND)	
Ground Water Recharge (GWR)	X
Water Contact Recreation (REC-1)	X
Non-Contact Water Recreation (REC-2)	X
Wildlife Habitat (WILD)	X
Cold Fresh Water Habitat (COLD)	X
Warm Fresh Water Habitat (WARM)	
Migration of Aquatic Organisms (MIGR)	X
Spawning, Reproduction, and/or Early Development (SPWN)	X
Preservation of Biological Habitats of Special Significance (BIOL)	
Rare, Threatened, or Endangered Species (RARE)	X
Estuarine Habitat (EST)	
Freshwater Replenishment (FRSH)	
Navigation (NAV)	
Hydropower Generation (POW)	
Commercial and Sport Fishing (COMM)	X
Aquaculture (AQUA)	
Inland Saline Water Habitat (SAL)	
Shellfish Harvesting (SHELL)	

2.2. Water Quality Objectives

Water quality objectives applicable to the 303(d) listing Dairy Creek include numeric objectives for dissolved oxygen. Numeric objectives for dissolved oxygen are listed in Table 2.

Table 2. Water quality objectives for dissolved oxygen.

Beneficial Use	Dissolved Oxygen Objective
General Objective	Median values should not fall below 85 percent saturation as a result of controllable water quality conditions.
AGR	Minimum of 2 mg/L
COLD	Minimum of 7 mg/L
SPWN	Minimum of 7 mg/L

3. DATA REVIEW

This section summarizes the data collected by the Regional Board and volunteers as part of the Morro Bay National Monitoring Program (NMP) and the Volunteer Monitoring Program (VMP). Data include dissolved oxygen, nutrient concentrations, temperature, and anecdotal information on algal growth in Dairy Creek. Figure 1 shows the locations of monitoring stations on Dairy Creek (DAU, DAM, and DAL).

3.1. Dissolved Oxygen

Tables 3 and 4 summarize available dissolved oxygen data and Figure 2 shows the observed dissolved oxygen at stations on Dairy Creek. At one of the monitoring sites, DAM, 24% of dissolved oxygen data collected between 1993 and 2004 fell below the COLD water quality objective. Median percent saturation values also fell below the percent saturation water quality objective of 85 at DAM. Because dissolved oxygen levels are meeting WQOs at DAU and DAL, the upstream and downstream reaches of Dairy Creek are not considered impaired for dissolved oxygen.

Table 3. Summary of dissolved oxygen data for Dairy Creek (concentration).

Year	DAU			DAM			DAL		
	No. of Samples	No. of Exceedances	% of Samples Exceeding	No. of Samples	No. of Exceedances	% of Samples Exceeding	No. of Samples	No. of Exceedances	% of Samples Exceeding
1993	16	0	0%	16	10	63%	3	1	33%
1994	31	4	13%	35	24	69%	20	5	25%
1995	35	0	0%	34	10	29%	1	0	0%
1996	37	0	0%	38		0%	37	0	0%
1997	35	0	0%	34		0%	30	0	0%
1998	25	0	0%	25		0%	16	0	0%
1999	16	0	0%	20	1	5%	14	0	0%
2000	21	1	5%	21	12	57%	21	0	0%
2001	20	0	0%	20	2	10%			
2002							7	0[1]	0%
2003				8	1[1]	13%	7	1[1]	14%
2004				3	0	0%	4	0	0%

[1] measurements taken in stagnant flow conditions omitted from analysis and are not displayed as exceedances

Table 4. Summary of Dissolved Oxygen Data for Dairy Creek (concentration and percent saturation).

Station	Start Date	End Date	Applicable WQO	No. of Samples	No. Below WQO	% Below 7 mg/l	Applicable WQO	No. of Samples	Median (%)
DAU	6/08/93	5/15/01	7 mg/l	236	5	2%	≥85%	236	86
DAM	6/08/93	4/20/04	7 mg/l	254	60	24%	≥85%	252	82
DAL	12/14/93	4/20/04	7 mg/l	168	8	5%	≥85%	163	86

The monitoring site, DAM, was established because this segment of Dairy Creek was targeted for a MP implementation project, as it was heavily impacted by cattle grazing. Dairy Creek was included in the Morro Bay National Monitoring Program (NMP), a ten-year MP implementation and monitoring project (RWQCB, 2003). Two control sites were established as comparisons to DAM, including DAU on Dairy Creek and PEN on Pennington Creek (Figure 1).

According to the NMP, an increase in dissolved oxygen was detected at DAM following MP implementation. Before MP implementation, dissolved oxygen at DAM was on average 1.75 mg/l lower than at a control site on Pennington Creek (PEN). Following MP implementation, dissolved oxygen (mg/l) concentrations at DAM on average increased by 0.90 ppm and were found to be statistically significant (p=<0.0001). Comparisons between DAM dissolved oxygen (ppm) concentrations and another upstream control site (DAU) yielded similar results. After MP implementation, DAM dissolved oxygen concentrations increased on average 0.85ppm.

While dissolved oxygen levels are improving at DAM as a result of MP implementation, dissolved oxygen levels do not yet meet WQOs. As shown previously in Table 3, dissolved oxygen levels continue to fall below water quality objectives at DAM following MP implementation. Median values at DAM following MP implementation also continue to fall below 85 percent saturation.

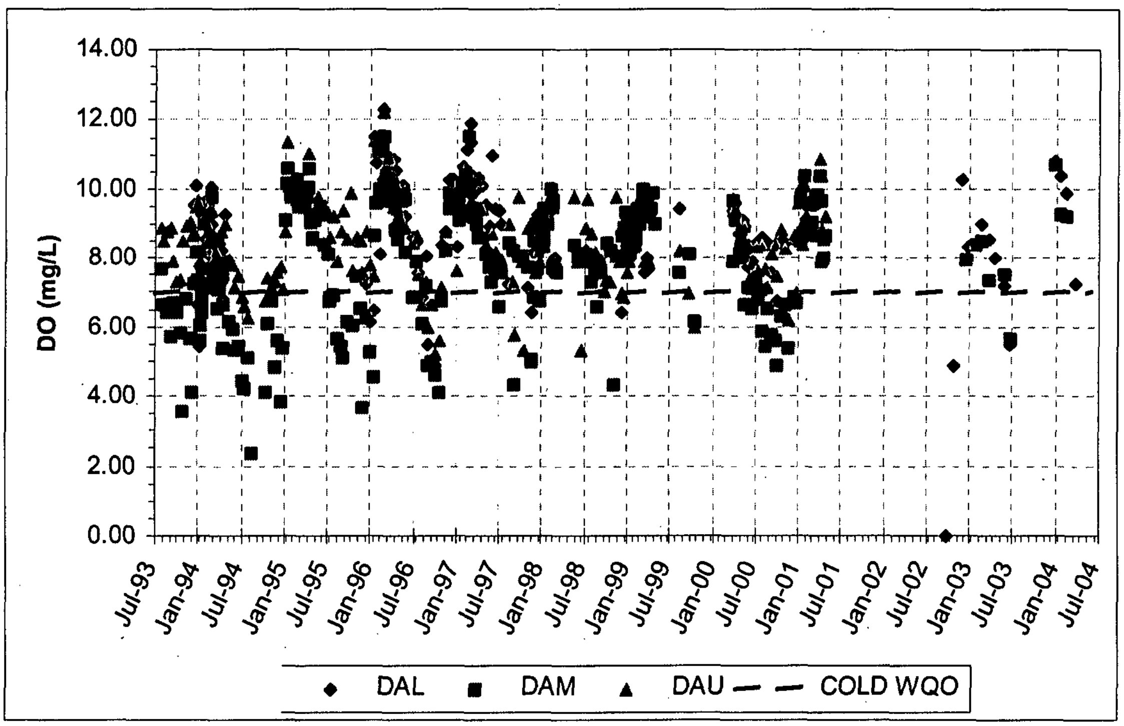

Figure 2. Dissolved oxygen levels at Dairy Creek

3.2. Nutrients

Figures 3 and 4 show the observed nitrate and phosphate concentrations at stations on Dairy Creek. Nutrient levels are typically low; nitrate levels do not exceed the water quality objective for the municipal and domestic water supply (MUN) use of 10 mg/L. Nitrate levels are typically less than 5 mg/l and phosphate levels less than 0.5 mg/l.

The National Monitoring Program (NMP) study in the Morro Bay watershed demonstrated that nutrients in the creek were not reduced significantly even though rangeland MPs were implemented. This suggests that rangeland nutrient loading is not causing increases in nutrient concentrations and therefore rangeland loading is not treated as a source of impairment in this TMDL analysis.

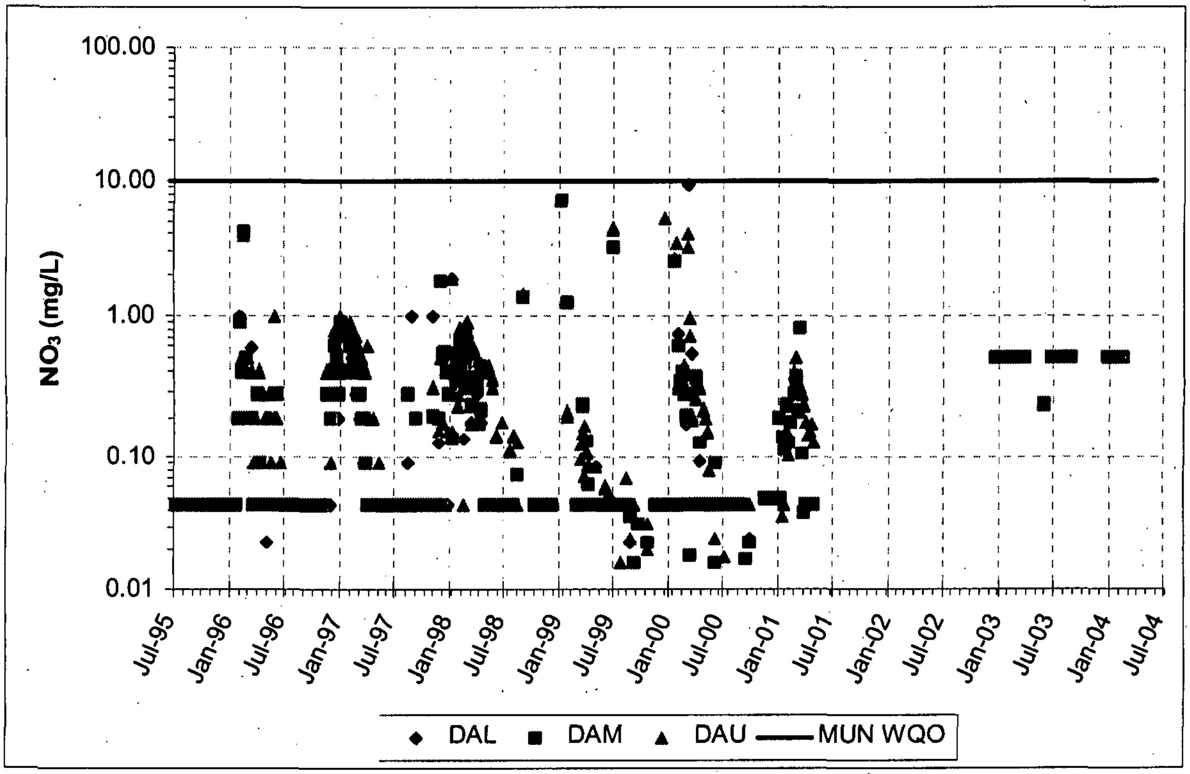

Figure 3. Nitrate (NO_3-N) levels at Dairy Creek
Note: non-detectable, or lower limit levels vary depending on laboratory methods

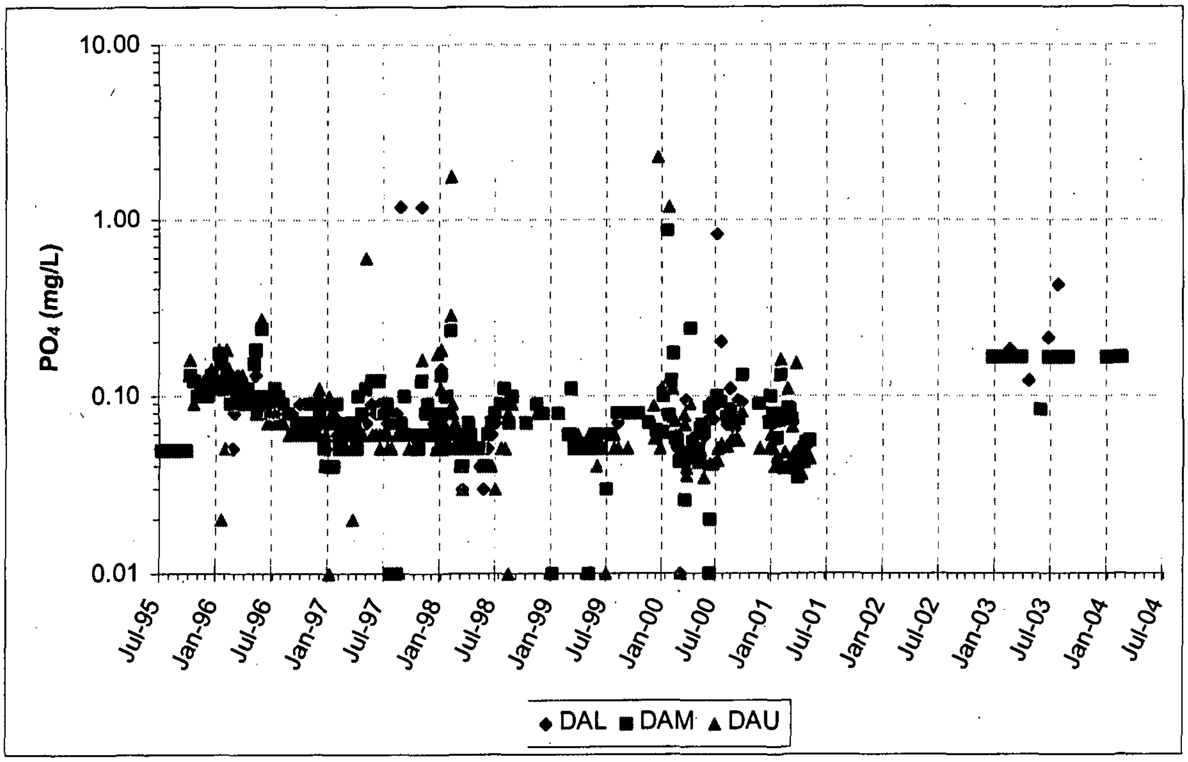

Figure 4. Phosphate (PO_4-P) levels at Dairy Creek
Note: non-detectable, or lower limit levels vary depending on laboratory methods

3.3. Algal Growth

Algal growth has been observed in Dairy Creek; however, documentation between 1993 and 2003 is very limited. Algal data are primarily anecdotal and do not provide consistent documentation on severity and extent of coverage and effect on use, making it difficult to clearly identify the impact of algal growth on uses in Dairy Creek. Information documents the presence of algal growth, but does not demonstrate a connection to depressed oxygen levels.

3.4. Water Temperature

According to the NMP study on Dairy Creek, significant decreases in water temperatures were observed as a result of MP implementation, however the relationship between temperature and dissolved oxygen levels is indeterminate.

3.5. Data Summary

Dissolved oxygen levels do not meet WQOs at one station in Dairy Creek (DAM) and support WQOs at the other stations (DAU and DAL). MPs implemented along Dairy Creek (at DAM) are resulting in improvements to dissolved oxygen, however; dissolved oxygen levels do not yet meet WQOs. The segment of Dairy Creek downstream of the Dairy Creek Golf Course (DAL) and upstream (DAU) are not considered as impaired.

Multiple factors (canopy, temperature) are likely to have contributed to the dissolved oxygen impairment. While data coverage is insufficient to derive an explicit linkage between dissolved oxygen levels and other environmental conditions (e.g., canopy); improvements as a result of implementing MPs are occurring. Because data suggest a continued impairment by dissolved oxygen, a TMDL has been developed for dissolved oxygen in Dairy Creek.

4. SOURCE ANALYSIS

This section identifies potential sources of the dissolved oxygen impairment in Dairy Creek.

The land use along Dairy Creek upstream of DAM, where the impairment exists, is rangeland. Rangeland MPs installed along Dairy Creek have resulted in significant improvements in dissolved oxygen, according to the NMP study. As a result, staff determines that the source of impairment, rangeland, is being corrected, and anticipates that ultimately the WQOs in Dairy Creek will be met. The Dairy Creek Golf Course does not appear to be contributing to the impairment of dissolved oxygen in Dairy Creek as the WQOs at DAL are being met.

5. DISSOLVED OXYGEN TMDL

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

The dissolved oxygen TMDL for Dairy Creek is set at 1) a minimum concentration for dissolved oxygen of 7 mg/l to protect the COLD beneficial use and 2) a <u>median</u> value equal to or greater than 85 percent saturation. The allocations, which include background levels, are also equal to the numeric targets. The County of San Luis Obispo Parks Department (County) is given a load allocation equal to the two numeric targets. Monthly concentrations may not fall below 7 mg/l and annual median values may not fall below 85 percent saturation.

Staff has not identified any point source discharges that contribute to the impairment so no wasteload allocation is necessary.

Expressing the TMDL as a dissolved oxygen concentration in receiving water equal to the WQO provides a direct measure of the dissolved oxygen levels in the watershed to compare with water quality objectives and provides a measurable target for sources to monitor and with which to comply. Requiring the responsible parties to maintain minimum dissolved oxygen levels at the numeric target of 7 mg/l and median percent saturation values at or above the numeric target of 85% establishes a direct link between the TMDL target and sources.

Seasonality is not a determining factor in the TMDL because the TMDL is equal to the dissolved oxygen WQOs, which must be met at all times. In addition, while dissolved oxygen levels are typically less in the summer and fall months, existing data indicate that WQO violations occur during both wet and dry seasons.

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

No reasonable alternatives exist for either the TMDL or the implementation plan. The "no project" alternative would not provide a plan of action for the Regional Board to ensure that the County's activities resolve the impairment and would not comply with the Clean Water Act. Staff does not believe that more stringent numeric targets are necessary to protect beneficial uses or to comply with water quality objectives. This complies with Clean Water Act requirement to develop TMDLs for listed waterbodies to the extent possible based on available information.

6. MONITORING

This section discusses the planned monitoring in the Dairy Creek watershed. Monitoring will include continued water quality monitoring to measure the progress of the creek in meeting the dissolved oxygen TMDL targets.

Monitoring will be performed by the Morro Bay Volunteer Monitoring Program (VMP) in Dairy Creek to ensure that the numeric targets are met. Volunteer monitors will measure dissolved oxygen concentrations at Dairy Creek (DAM) on a monthly basis. The County will coordinate with the VMP to allow access for continued monitoring. If VMP monitoring efforts cease, the Executive Officer will require the County to monitor pursuant to Clean Water Act Section 13267 or 13225(c). Regional Board staff will conduct additional dissolved oxygen monitoring at pre-dawn hours to obtain information relative to diurnal fluctuations.

7. IMPLEMENTATION

The County partnered with the NRCS and land managers to implement MPs along a mile-long corridor through County owned, El Chorro Regional Park that was impacted by grazing practices. Funding was provided by federal, state, and local entities through the United States Department of Agriculture's Hydrologic Unit Area Project. Completion of the cattle exclusionary fencing and riparian revegetation occurred in 1995. The County is committed to maintaining the MPs.

The solution to the impairment being addressed by the TMDL is being implemented by a non-regulatory agency, the County, and the solution will correct the impairment. Staff is confident that existing efforts will implement the Dairy Creek TMDL and ultimately result in attainment of the associated water quality objectives.

The implementation plan will not have any adverse environmental impacts so no mitigation measures are necessary.

7.1. Measuring Progress

The County will submit a technical report that includes an inventory of existing MPs and annual reports to the Regional Board. The annual reports will identify any proposed changes to MPs along Dairy Creek and include VMP monitoring data that Regional Board staff will use to confirm that progress is made towards TMDL achievement.

Regional Board staff will conduct a review of Dairy Creek to evaluate implementation efforts every three years. Regional Board staff will utilize information submitted by the County and the VMP to evaluate MP implementation efforts and dissolved oxygen conditions. Regional Board staff will review data collected by the VMP and/or Regional Board staff in order to report attainment or number of exceedances of water quality objectives, if any, and ultimate achievement of the TMDL.

If the Regional Board does not receive a technical report and annual report within one year, staff will request reporting pursuant to California Water Code Section 13267 or 13225(c). Section 13267 states that the Regional Board may investigate the quality of a waterbody when establishing or reviewing a water quality control plan or waste discharge requirement. The Section provides the Regional Board the authority to 1) require any person who has, is, proposes to, or is suspected of discharging to furnish a technical or monitoring program report and/or 2) to inspect the facilities of any person to ascertain water quality conditions. If the Regional Board does require a person to furnish a report, as in 1) above, failure to produce the report by the date required subjects the person to monetary penalties. Section 13225(c) provides that the Regional Board shall Require as necessary any state or local agency to investigate and report on any technical factors involved in water quality control or to obtain and submit analyses of water; provided that the burden, including costs, of such reports shall bear a reasonable relationship to the need for the report and the benefits to be obtained therefrom.

Regional Board staff may conclude and articulate in the review that ongoing implementation efforts may be insufficient to ultimately achieve the allocations and numeric target. If this occurs, Regional Board staff will recommend revisions to the implementation plan. Regional Board staff may conclude and articulate in the three-year review that, to date, implementation efforts and results are likely to result in achieving the allocations and numeric target, in which case existing and anticipated implementation efforts should continue.

7.2. Timeframe

Regional Board staff will confirm that tracking and reporting mechanisms are in place in one year, and evaluate progress towards achieving the water quality objective every three years. Staff will review annual reports submitted by the County, along with monitoring information collected by the VMP relative to the numeric target.

The implementation period to meet the allocation and verify TMDL achievement is 6 years. This schedule is reasonable because MPs are in place and, while water quality objectives are not yet being met, improvements as a result of MP implementation are already occurring. Staff is confident that as riparian vegetation becomes further established, dissolved oxygen levels will continue to improve, and the water quality objectives will be attained.

If the allocated loads are not met within this timeframe, staff will re-evaluate the implementation plans and schedule, and if necessary recommend a more stringent approach to the board. If allocations and numeric targets are being met, Regional Board staff will recommend the waterbody be removed from the 303(d) list.

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4. Dairy Creek

4.1 Introduction

Dairy Creek is a tributary to Chorro Creek, which flows through El Chorro Regional Park, and is the site of a cattle exclusion project (Figure 4.1). The land has a history of grazing without creek corridor protection, and in many areas the riparian vegetation was damaged. The NRCS partnered with the San Luis Obispo County Parks Department to fence and revegetate the mile-long riparian corridor through the park. BMPs implemented at Dairy Creek included cattle exclusionary fencing with water gaps and riparian revegetation. Re-vegetation included planting arroyo willows (*Salix lasiolepis*) and coast live oaks (*Quercus agrifolia*). Improvements to the lower mile of creek were completed during the summer of 1994, with the remaining upper half-mile of creek fenced during the summer of 1995.

In the past, approximately twenty head (pers comm. J. Guidetti, 2002) of cattle grazed on the 750-acre property. The fencing encloses the riparian corridor on both sides of the creek, excluding it from the grazing areas. Two water gaps were left between the lower and upper cattle fencing and just below the upper Dairy Creek site (DAU) to allow cattle access to the creek for water. The number of acres available for grazing has been reduced from 750 to less than 400. Of the 750 acres previously grazed, 150 acres have been designated as a botanical area. A large portion of the park was developed as a golf course beginning in 1995 and completed in 1997. The lower mile of the creek was fenced in July of 1994 to protect the creek, to improve water quality, and to eliminate cattle access to the golf course area. The BMP strategy for Dairy Creek is referred to as 'cattle fencing with water gaps' as apposed to the 'total cattle exclusion' at upper Chorro Creek and 'rotational grazing with riparian pastures' at Chumash Creek. The pre-BMP data set includes results from June 1993 to June 1996. The post- BMP period is July 1996-June 2001.

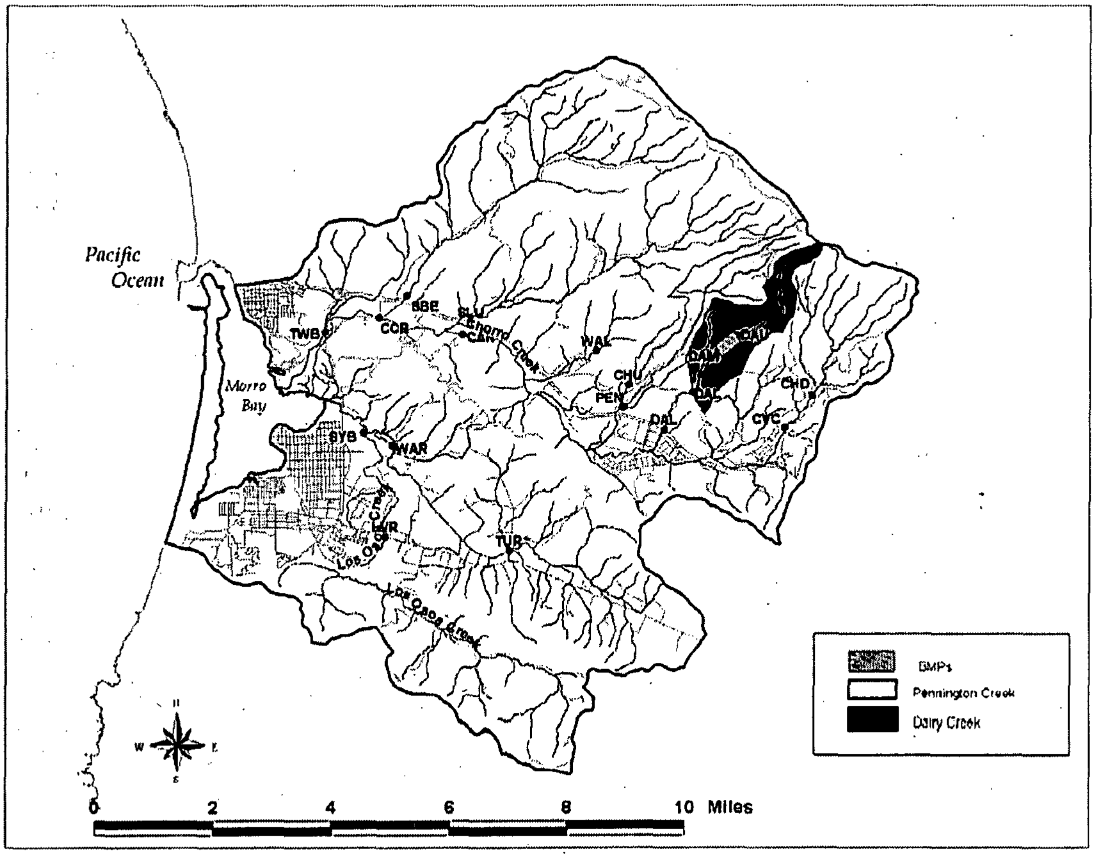


Figure 4.1 Dairy and Pennington Creek watersheds and BMP evaluation project location.

4.2 Methods

4.2.1 Even-interval water quality sampling

Dairy Creek was sampled biweekly at three different locations for nitrate, phosphate, and fecal coliform bacteria and weekly during the winter season for these parameters and suspended sediment. These locations included the upper (DAU) and lower (DAM) ends of the open space area and the lower end of El Chorro Park (DAL) below the open space area and the golf course. Pennington Creek (PEN) was also sampled at regular intervals at Pennington Creek (PEN) to provide reference data for Dairy Creek.

Pennington Creek serves as the control creek for Dairy Creek. The watershed is of similar size, although the lower half has not been grazed for a number of years. In addition, the upper watershed of Pennington Creek, owned by Cal Poly State University, is in relatively good condition compared to Dairy Creek, which is owned by the California Military Department. Unlike most of Dairy Creek, Pennington Creek supports a well-shaded corridor, with limited cattle access in the sample area. The upper half of Pennington Creek is grazed as part of Cal Poly's Escuela Ranch. PEN was sampled using the same regime as DAL, DAM, and DAU.

Stream flow was measured with a pygmy flow meter by staff and volunteer monitors at the DAM and PEN sites. Flow was extremely low throughout the winter in 1993-94 on both Dairy and Pennington Creeks, never reaching one cubic foot per second during winter sampling efforts. In contrast, in 1994-95 Pennington Creek had flows so high data collection was not possible at times. Moderate rainfall during the 1995-96 season resulted in comparable flows for DAM and PEN. Logarithmic stream flow from Dairy and Pennington Creeks is strongly correlated (R^2=81.6%, p<0.0001). See Figure 4.2 for a fitted line plot. In several instances when flows were too high to be measured in one of the creeks, they were modeled using the relationship between the two creeks.

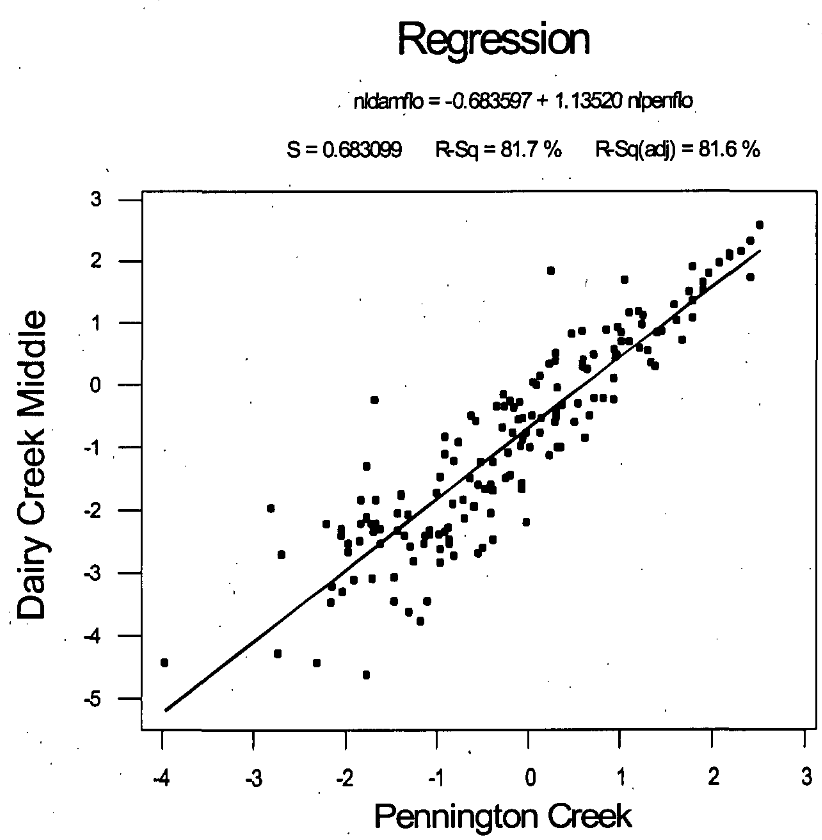


Figure 4.2. Fitted line plot for Dairy Creek Middle and Pennington Creek natural logged flow.

Data analyses performed on Dairy Creek (DAM) and Pennington Creek (PEN) were the same as those used for Chumash and Walters Creeks. For all normally distributed data and data sets without censored data, a repeated measure linear regression was used and for all other data a repeated measures binary regression was used.

4.2.2 Rapid Bioassessment

Dairy and Pennington Creeks were sampled annually at four different locations at reaches associated with water quality monitoring sites (DAU, DAM, DAL, and PEN). The methodology was identical to the rapid bioassessment conducted on the Chumash /Walters paired watershed study detailed in Chapter 3 of this report.

4.2.3 Stream profiles

Cross-sectional stream channel profiles were conducted along five permanent stations on Dairy Creek and Pennington Creek. Cross-sections were sampled across their width at one-foot intervals. At each interval, height was recorded along with substrate particle size at a point immediately beneath the stadia rod. Flood plain width, bankfull width, and average bankfull depth was estimated for each channel. Channel entrenchment was calculated as the ratio of flood prone area to bankfull depth. The width/depth ratio was calculated as the ratio of bankfull width to bankfull depth. See the Quality Assurance Program Plann (QAPP) for more detail on definitions of the above parameters.

Substrate size within bankfull width, was determined using the Wolman method (1954) at each cross-section. Particle size data is plotted on a logarithmic scale as a cumulative percentage of size classes. The dominant particle size is defined as the median size of channel materials (or D50), where 50% of the particles sampled were this size or smaller (Rosgen, 1996). The overall substrate size for the reach was determined by calculating the D50 for cumulative pebble size data from all five transects. Additionally, substrate type and size was also evaluated at each foot interval between the floodplain area and the bankfull width.

4.3 Results and Discussion

4.3.1 Even-interval water quality sampling

Stream Flow

Despite a strong correlation between creeks, flow at DAM is most typically lower than PEN. Figure 4.3 displays daily flow for DAM and PEN from 1993 to 2001.

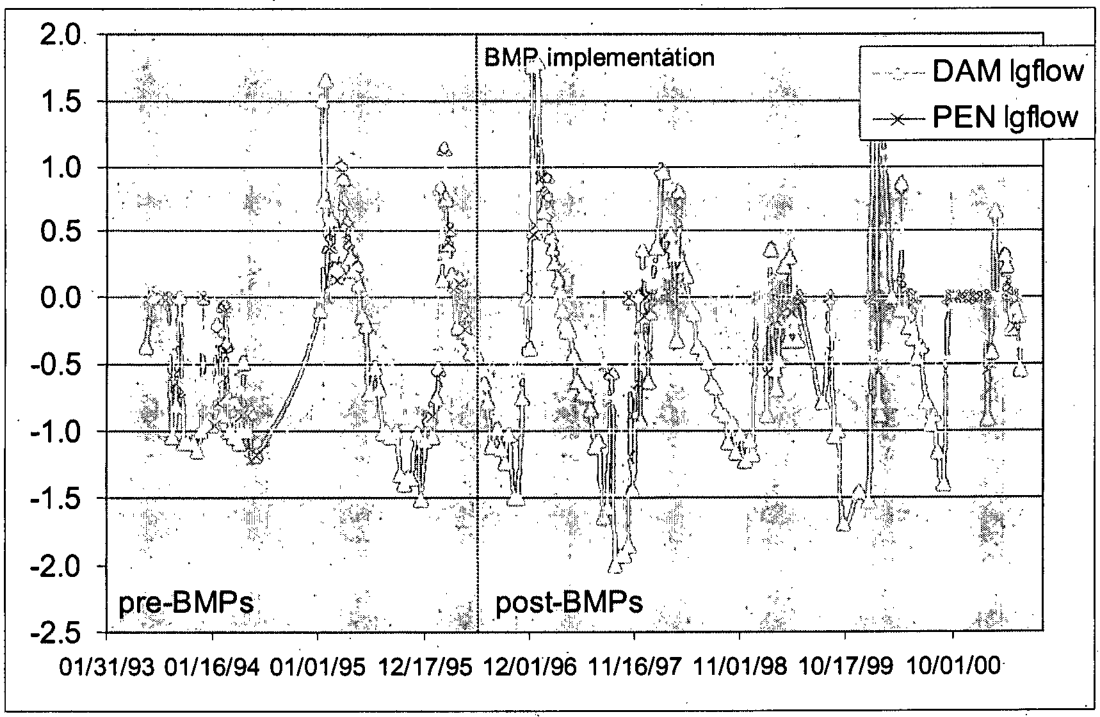


Figure 4.3. Daily flow (cfs) of DAM and PEN from 1993 to 2001.
Note: Flow scale is in natural logarithms.

Water Temperature

Changes in water temperature due to BMP implementation at Dairy Creek Middle (DAM) were detected. The average water temperature at the control creek, Pennington Creek (PEN), from 1993 to 2000 was 14.71°C. Before BMP treatment, DAM water temperature was on average 0.89°C degrees higher than PEN and was found to be statistically different ($p=<0.0001$). In the years following cattle exclusion fencing and revegetation at DAM (1996-2000), water temperature dropped on average 0.50°C and again was found to be statistically significant ($p=0.045$, Table 4.1). Therefore, a change resulting from BMPs occurred.

When data collected at DAM were compared to another control site upstream, Dairy Creek Upper (DAU), results were similar (Table 4.2). DAU mean water temperature between 1993 and 2000 was 15.30°C. DAM mean temperature pre-BMPs exceeded DAU by 0.74°C. . Following BMPs, DAM water temperature dropped on average 0.99°C. Both pre- and post BMPs time periods were statistically significant ($p<0.0001$, Table 4.2). Again, the results indicate a positive influence of BMPs on water temperature. .

Table 4.1. Repeated Measures linear regression results for water temperature °C between DAM and PEN.

Time Period	PEN	DAM	P-value
Pre-BMPs mean	14.71*[1]	15.61	<0.0001***
Post-BMPs mean		15.10	0.045*

*<α=0.05, **<α=0.01, ***<α=0.001 *[1]The mean of Pennington Creek water temperature for the study. It is used as the intercept for the regression model (see Chapter 3, Methods for further detail).

Table 4.2. Repeated Measures linear regression results for water temperature °C between DAM and DAU.

Time Period	DAU	DAM	P-value
Pre-BMPs mean	15.31*[1]	16.04	<0.0001***
Post-BMPs mean		15.06	<0.0001***

***<α=0.001 *[1]The mean of Pennington Creek water temperature for the study. It is used as the intercept for the regression model (see Chapter 3, Methods for further detail).

Figure 4.3 displays yearly means between DAM and PEN from 1993 through 2000.

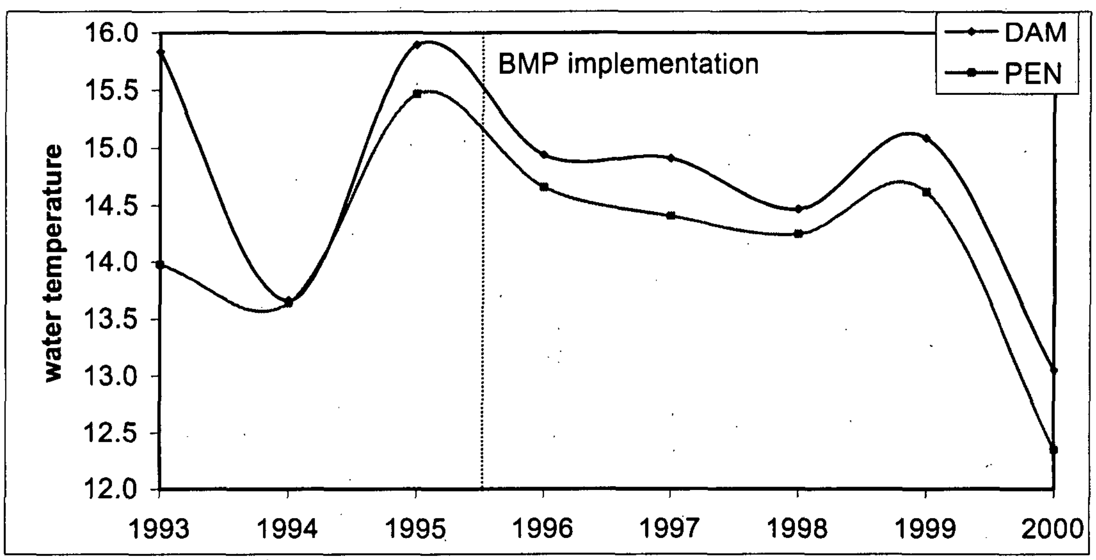


Figure 4.4. Yearly mean water temperature values measured at DAM and PEN from 1993 through 2000. BMPs were implemented in 1994.

Air Temperature

In the post-BMP time period, DAM air temperature on average dropped 0.35°C between DAM and PEN and 0.037°C between DAM and DAU. Neither were found to be significant (α=0.05, Table 4.3 for DAM and PEN and Table 4.4 for DAM and DAU). Because no statistical difference occurred, air temperature results further support that the drop in water temperature was due to BMP implementation. .

Table 4.3. Repeated Measures linear regression results for air temperature °C between DAM and PEN.

Time Period	PEN	DAM	P value
Pre-BMPs mean	20.55*[1]	20.04	0.0688
Post-BMPs mean		19.68	0.3488

*[1]The mean of Pennington Creek air temperature for the study. It is used as the intercept for the regression model (see Chapter 3, Methods for further detail).

Table 4.4. Repeated Measures linear regression results for air temperature °C between DAM and DAU.

Time Period	DAU	DAM	P value
Pre-BMPs mean	20.04*[1]	19.89	0.5011
Post-BMPs mean		19.85	0.9059

*[1]The mean of Pennington Creek air temperature for the study. It is used as the intercept for the regression model (see Chapter 3, Methods for further detail).

Dissolved oxygen

An increase in dissolved oxygen (ppm) was detected at DAM. Before BMP treatment, dissolved oxygen at DAM was on average 1.75 ppm lower than at PEN. Following BMP implementation, dissolved oxygen (ppm) concentrations at DAM on average increased by 0.90 ppm and were found to be statistically significant (p=<0.0001, Table 4.5).

Comparisons between DAM dissolved oxygen (ppm) concentrations and the upstream control site (DAU) yielded similar results. After BMP implementation, DAM dissolved oxygen concentrations increased on average 0.85ppm (Table 4.6).

Table 4.5. Repeated Measures linear regression results for dissolved oxygen (ppm) between DAM and PEN.

Time Period	PEN-control	DAM-treatment	P value
Pre-BMP mean	9.24*[1]	7.50	<0.0001***
Post-BMPs mean		8.40	<0.0001***

*[1]The mean of Pennington Creek air temperature for the study. It is used as the intercept for the regression model (see Chapter 3, Methods for further detail).

Table 4.6. Repeated Measures linear regression results for dissolved oxygen (ppm) between DAM and DAU.

Time Period	DAU-control	DAM-treatment	P value
Pre-BMP mean	8.46*[1]	7.28	<0.0001***
Post-BMPs mean		8.13	<0.0001***

*[1]The mean of Pennington Creek air temperature for the study. It is used as the intercept for the regression model (see Chapter 3, Methods for further detail).

Turbidity

Turbidity levels at DAM, DAU, and PEN were similar. Prior to BMP implementation, a greater frequency of turbidity samples above the threshold (10 NTUs) were found at DAM than at DAU and PEN (Table 4.10), but the number was not significant. Following BMP implementation, no statistical differences were found. Similar results were also found when a threshold of 50 NTUs. Figure 4.6 displays the turbidity results for all three sites together using 10 NTUs as the threshold values.

Table 4.10. Contingency table of the number of turbidity samples above and below the threshold for pre- and post-BMP implementation at DAM, DAU, and PEN (threshold value = 10 NTU). Also included is percentage of samples above and below the threshold, total number of samples, and p values form binary logistic regression analysis. P values for the comparison of DAM and DAU are placed in the DAU column and for DAM and PEN in the PEN column.

		DAM - treatment		DAU - control		PEN - control	
		number	%	number	%	number	%
Pre-BMPs	<10 NTU	94	89	93	88	87	92
	≥10 NTU	12	11	12	12	8	8
	Total	106	100	106	100	95	100
	P value			0.6948		0.0828	
Post-BMPs	<10 NTU	153	87	151	86	146	90
	≥10 NTU	22	13	24	14	16	10
	Total	175	100	175	100	162	100
	P value			0.8897		0.9540	

*α=0.05

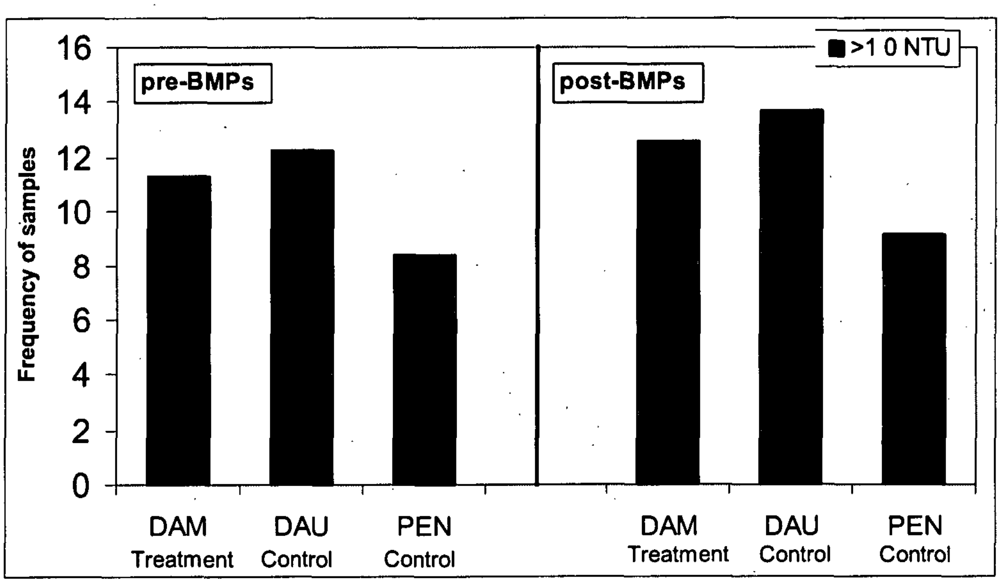


Figure 4.5 Bar chart of DAM, DAU, and PEN turbidity frequencies above the threshold of 10 NTU for pre- and post-BMPs.

Fecal Coliform Bacteria

The Regional Board's Basin Plan recreational water contact objective for fecal coliform (200MPN/100mL) was chosen as a analysis threshold. Statistical differences were found in the pre-BMP time period. Prior to BMP implementation, levels at DAM had a lower probability of exceeding the threshold (p=0.0104, Table 4.7). There was little change in the post-BMP time period (p=0.3571) and no significant differences were found. Results were similar when the fecal coliform level for non-contact recreation (2000MPN/100mL) was used as the threshold value. At either threshold, changes were not detected in fecal coliform bacteria levels at DAM.

Table 4.7. Contingency table of the binomial distribution of fecal coliform bacteria values pre- and post- BMP implementation at DAM, DAU, and PEN during ambient conditions.
(threshold value = 200 MPN/100 mL based on the Regional Board Basin Plan recreational water contact standard).
Included is number of fecal coliform bacteria samples found to be equal to or below 200 MPN/100mL and number of fecal coliform bacteria samples found to be above 200 MPN/100mL. Also included is the total number of samples, the percentage of samples in both categories, and p-values for pre- and post-BMPs time periods.

		DAM - treatment		DAU - control		PEN - control	
		number	%	number	%	number	%
Pre-BMPs	<200 MPN	65	61	49	46	43	45
	≥200 MPN	41	39	57	54	52	55
	Total	106	100	106	100	106	100
	P value			0.1553		0.0104*	
Post-BMPs	<200 MPN	104	59	103	59	71	44
	≥200 MPN	71	41	72	41	91	56
	Total	175	100	175	100	162	100
	P value			0.5834		0.9328	

The frequency of fecal coliform bacteria samples above the 200MPN/100mL threshold for DAM, DAU, and PEN is shown in Figure 4.6. Fecal coliform bacteria levels above the threshold at DAM did not change as a result of BMP implementation. Fecal coliform levels above 2000 MPN/100mL did not change significantly between sites (Table 4.6).

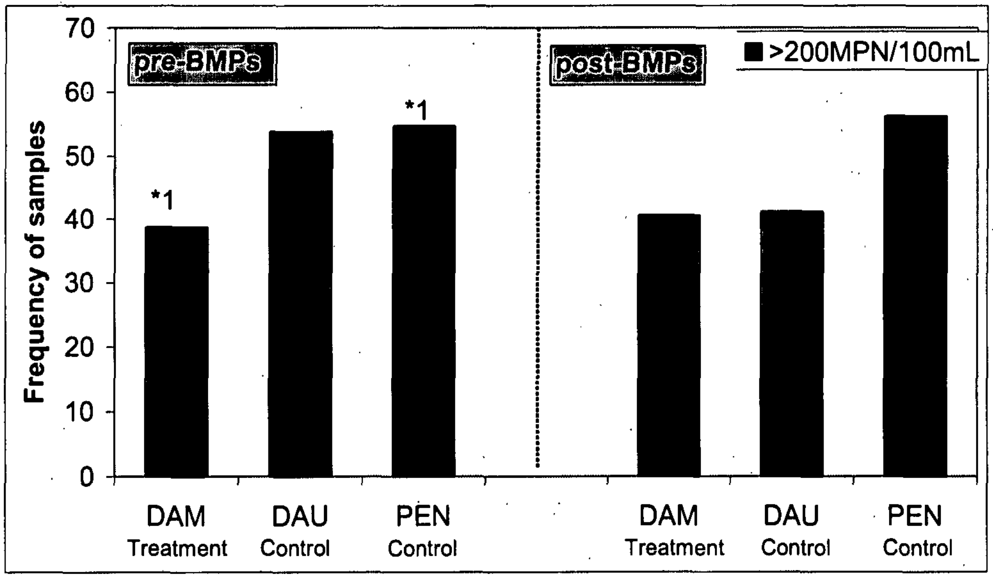


Figure 4.6. Bar chart of DAM, DAU, and PEN fecal coliform frequencies above the threshold of 200MPN/100mL for pre- and post-BMPs.
*1 indicates a significant difference between sites: $\alpha < 0.05$.

Table 4.8. Contingency table of the binomial distribution of fecal coliform bacteria values pre- and post- BMP implementation at DAM, DAU, and PEN during ambient conditions (threshold value = 2000 MPN/100 mL based on the Regional Board Basin Plan non-contact water recreation standard).
Included is number of fecal coliform bacteria samples found to be equal to or below 2000 MPN/100mL and number of fecal coliform bacteria samples found to be above 2000 MPN/100mL. Also included is the total number of samples, the percentage of samples in both categories, and p- values for pre- and post-BMPs time periods.

		DAM - treatment		DAU - control		PEN - control	
		number	%	number	%	number	%
Pre-BMPs	<2000 MPN	87	92	92	87	93	98
	≥2000 MPN	8	8	14	13	2	2
	Total	95	100	106	100	95	100
	P value			0.4159		*0.0415	
Post-BMPs	<2000 MPN	150	93	164	94	152	94
	≥2000 MPN	12	7	11	6	10	6
	Total	162	100	175	100	162	100
	P value			0.6492		0.3571	

*α=0.05

Total Coliform Bacteria

The implementation of BMPs at DAM resulted in a significantly higher number of total coliform samples exceeding the threshold of 1000 MPN/100mL. When compared to the upstream control, DAU, or the control creek, PEN, significant differences were found (Table 4.9). Although the difference between DAM and PEN was not statistically significant (α=0.05), p scores of 0.0597 and 0.0865 (Table 4.9) supported the conclusion that a significant change in total coliform bacteria at DAM. However when compared to DAU a significant change was found. This may be due to an improvement in habitat at DAM..

Table 4.9. Contingency table of the number of total coliform bacteria samples above and below the threshold for pre- and post-BMP implementation at DAM, DAU, and PEN (threshold value = 1000 MPN/100mL based on the median of the data set).
Also included is percentage of samples above and below the threshold, total number of samples, and p values form binary logistic regression analysis. P values for the comparison of DAM and DAU are placed in the DAU column and for DAM and PEN in the PEN column.

		DAM - treatment		DAU - control		PEN - control	
		number	%	number	%	number	%
Pre-BMPs	<1000 MPN	68	64	56	53	50	53
	≥1000 MPN	38	36	50	47	45	47
	Total	106	100	106	100	95	100
	P value			0.0192*		0.0597	
Post-BMPs	<1000 MPN	89	51	94	54	81	50
	≥1000 MPN	86	49	81	46	81	50
	Total	175	100	175	100	162	100
	P value			0.0159*		0.0865	

*α=0.05

The frequency of total coliform bacteria samples above and below the threshold of 1000 MPN/100mL for DAM, DAU, and PEN supports that DAM significantly changed as a result of BMP implementation (Figure 4.7). Levels at DAU And PEN remained similar between treatment periods. It is unclear why a significant increase in total coliform bacteria samples over the threshold of 1000 MPN/100mL was found.

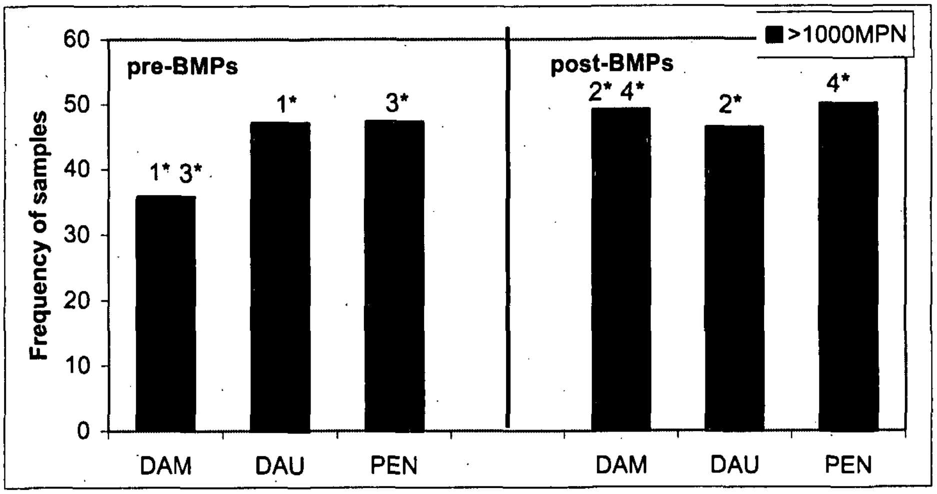


Figure 4.7. Bar chart of DAM, DAU, and PEN total coliform frequencies above and below the threshold of 200 MPN/100mL for pre- and post-BMPs. 1*, 2*, 3*, and 4* indicates a significant difference between sites: $p<0.05$.

Nitrate-nitrogen

A significantly higher percentage of nitrate samples above the thresholds were found at DAM prior to BMP implementation when compared to DAU ($p<0.0001$) and to PEN ($p=0.0008$). The frequency of nitrate-nitrogen above the threshold increased at all of the sites following BMP treatment, but these differences were not significant. (Table 4.11).

Table 4.11. Contingency table of the number of nitrate nitrogen samples above and below the threshold for pre- and post-BMP implementation at DAM, DAU, and PEN (threshold value = 0.700 mg/L).
Also included is percentage of samples above and below the threshold, total number of samples, and p values form binary logistic regression analysis. P values for the comparison of DAM and DAU are placed in the DAU column and for DAM and PEN in the PEN column.

		DAM - treatment		DAU - control		PEN - control	
		number	%	number	%	number	%
Pre-BMPs	<0.700mg/L	82	77	71	67	88	93
	≥0.700mg/L	24	23	35	33	7	7
	Total	106	100	106	100	95	100
	P value			<0.0001***		0.0008***	
Post-BMPs	<0.700mg/L	116	66	104	59	142	88
	≥0.700mg/L	59	34	71	41	20	12
	Total	175	100	175	100	162	100
	P value			0.1016		0.1498	

***$\alpha=0.001$

Figure 4.8 displays the frequencies of nitrate samples above and below the threshold (0.700 mg/L) at DAM, DAU, and PEN. The increase in nitrate at all of the sites following BMP implementation, is shown.

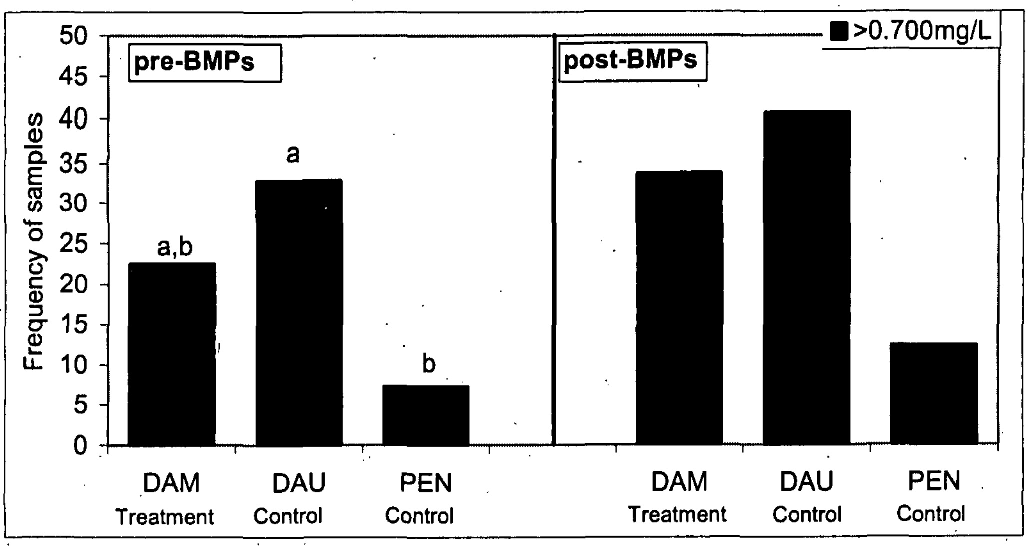


Figure 4.8. Bar chart of DAM, DAU, and PEN turbidity frequencies above and below the threshold of 10 NTU for pre- and post-BMPs. 'a' and 'b' indicates significant differences between sites: $p<0.05$.

Ortho-Phosphate

Table 4.12 shows ortho-phosphate levels before and after BMP implementation. Following BMP implementation, the exceedances at DAM declined, however, this decline was also found at the control (DAU).

Table 4.12 Contingency table of the number of ortho-phosphate samples above and below the threshold for pre- and post-BMP implementation at DAM, DAU, and PEN (threshold value = 0.150 mg/L).
Also included is percentage of samples above and below the threshold, total number of samples, and p values form binary logistic regression analysis. P values for the comparison of DAM and DAU are placed in the DAU column and for DAM and PEN in the PEN column.

		DAM - treatment		DAU - control		PEN - control	
		number	%	number	%	number	%
Pre-BMPs	<0.150mg/L	19	20	20	19	83	87
	≥0.150mg/L	76	80	86	81	12	13
	Total	95	100	106	100	95	100
	P value					<0.0001***	
Post-BMPs	<0.150mg/L	74	46	99	51	156	96
	≥0.150mg/L	88	54	85	49	6	4
	Total	162	100	175	100	162	100
	P value					0.0002***	

*p<.05, ***p<0.001

Even-Interval Water Quality Conclusions

Water temperature improved at Dairy Creek (DAM). This result is most likely due to shading from riparian vegetation that was planted as part of BMP implementation. Dissolved oxygen levels also significantly improved at DAM. Dairy Creek, although degraded in some localized areas, had a relatively mature riparian plant community at the beginning of the study. In contrast, Chumash Creek (Chapter 4) is still in the early stages of plant succession and although riparian vegetation was planted and water temperature did significantly decrease, the riparian corridor is still relatively undeveloped. This perhaps explains why Chumash Creek had a decrease in dissolved oxygen levels following BMP implementation, while levels increased at Dairy Creek.

Fecal coliform levels at DAM and PEN remained the same before and after BMP implementation, however, fecal coliform bacteria levels at one of the control sites (DAU) improved. The water gaps within the cattle exclusion fencing to allow cattle access to the creek for watering, may contribute to a higher frequency of fecal coliform bacteria levels found above the thresholds. In contrast, fecal coliform levels at Upper Chorro Creek (Chapter 6) declined significantly following BMP implementation. This is most likely due to the 'total cattle exclusion' at this BMP site. For reasons unknown, total coliform bacteria levels increased at DAM.

Turbidity, nitrate-nitrogen, and orthophosphate did not significantly change as a result of BMP implementation at DAM. It is recommended that water troughs be installed at Dairy Creek to prevent Cattle from watering in the creek.

4.3.2 Rapid Bioassessment

Results

As indicated previously, DAM is the treatment site and DAU and PEN are control sites. Both comparisons are used to evaluate the effectiveness of BMPs at DAM.

NMP project staff used an Index of Biological Integrity calculated as part of the Central Coast Regional Monitoring Program. Figure 4.8 shows Index of Biological Integrity (IBI) scores at Dairy and Pennington Creeks. As shown, results were variable at both creeks. During the pre-BMP time period, the Highway 41 Fire burned portions of the Dairy Creek, subwatersheds in August 1994. The adverse effects of the fire on benthic macro-intertebrate assemblages are apparent in 1995. Recovery from the event is also apparent in 1996. The IBI score at the treatment site was higher than at the two control sites in 1996, although additional data is needed to determine effectiveness. Overall IBI scores found throughout the Morro Bay watershed are shown in Chapter 8.

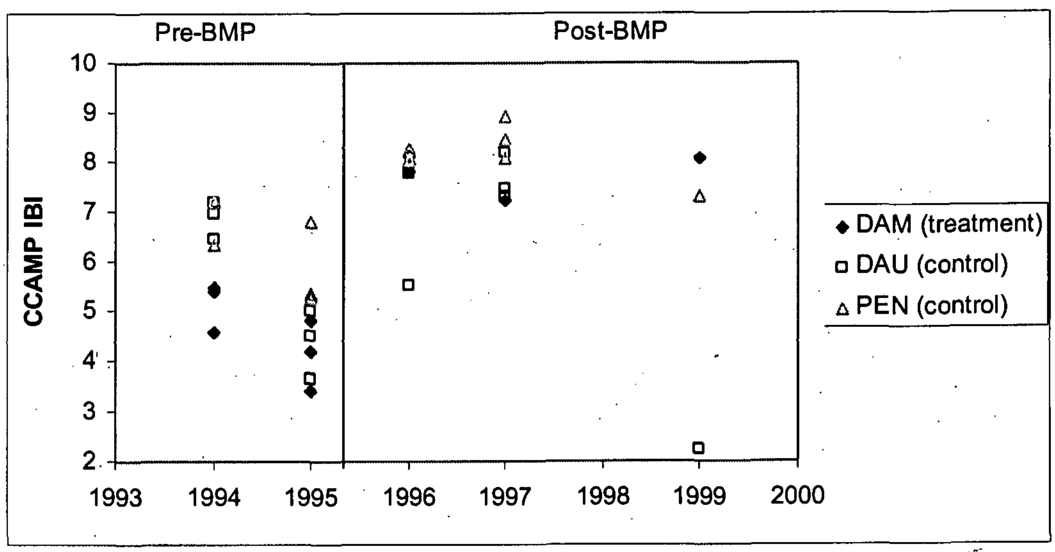


Figure 4.9. Index of Biological Integrity (IBI) scores at Dairy and Pennington Creeks.

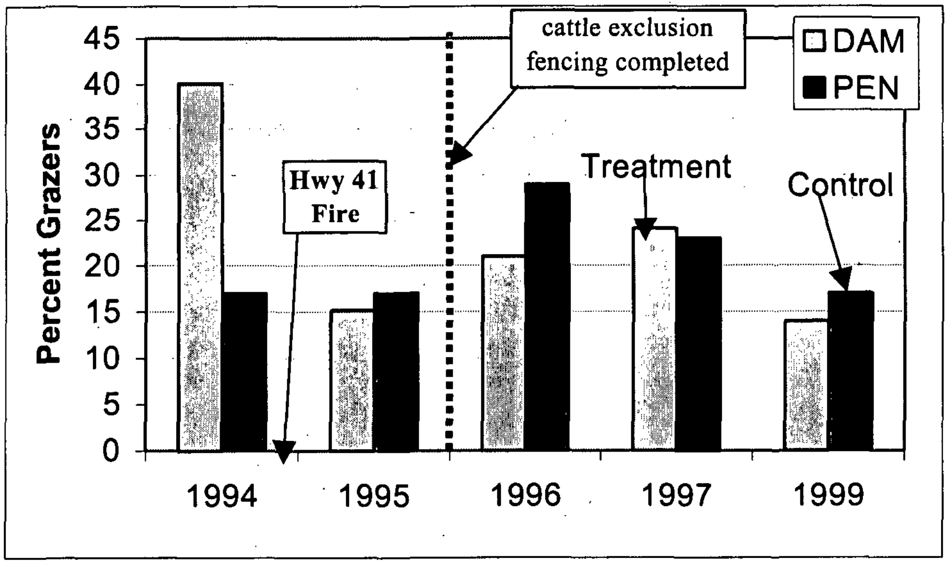
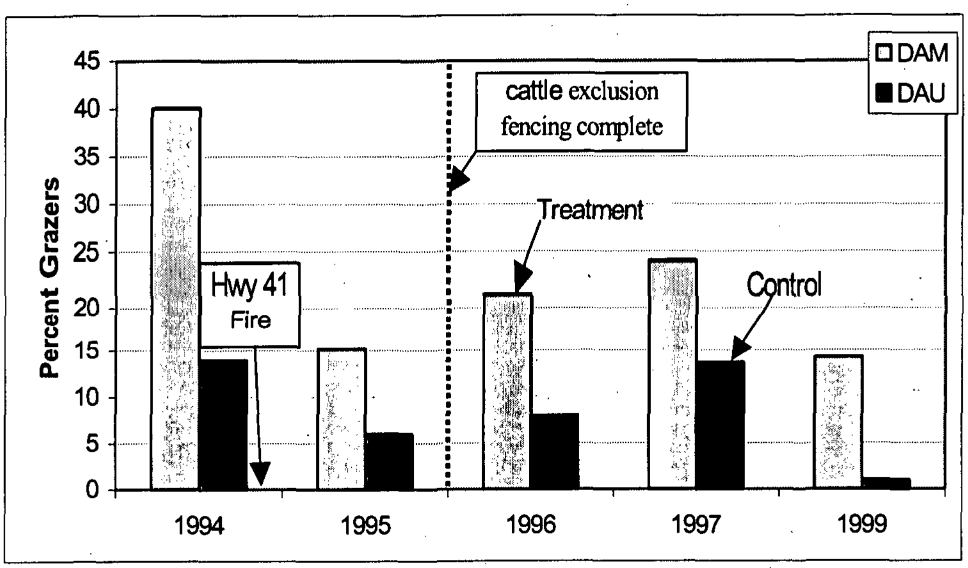


Figure 4.10. The percent of the benthic macro-invertebrate feeding strategy.

Figures 4.10 and 4.11 illustrates grazers found at DAM (the treatment) and at PEN and DAU (the controls) in rapid bioassessment samples from 1994, 1995, 1996, 1997, and 1999. Percent Grazers fluctuated at all sites through the study (Figure 4.9 and 4.10). The dotted lines indicates BMP implementation at DAM, cattle exclusion fencing with gaps. 1994 and 1995 are considered pre-BMPs and 1996, 1997, and 1999 post-BMPs. The Highway 41 Fire occurred in August 1994.

Figure 4.11. The percent of the benthic macro-invertebrate feeding strategy.



Regional Board staff examined two richness metrices as indicators of water quality for DAM, DAU, and PEN - Taxonomic Richness and EPT Taxa Richness. Taxonomic Richness is the number of taxa (genera and some families in our case) present in a sample. EPT Taxa Richness is the number of taxa representing mayflies (*Ephemeroptera spp*), stoneflies (*Plecoptera spp*), and caddisflies (*Trichoptera spp*) in each sample. These taxa are sensitive and intolerant to pollutants. Their numbers are expected to decrease with disturbance to habitat and increase as water quality and/or benthic macroinvertebrate habitat improves. Taxonomic Richness at DAM and PEN were similar during the years sampled.

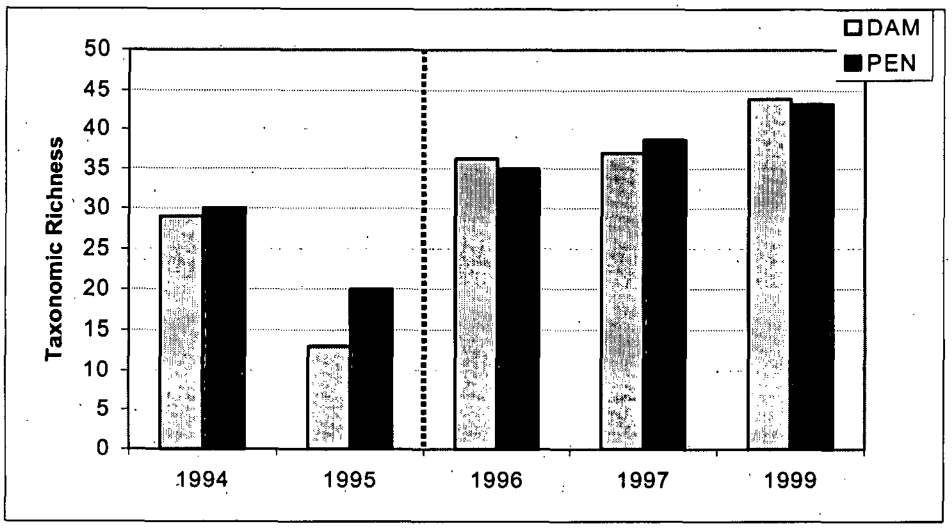


Figure 4.12. Taxonomic richness found in DAM and PEN samples for the years 1994, 1995, 1996, 1997, 1999.
The dotted line indicates BMP implementation at DAM, cattle exclusion fencing with gaps. 1994 and 1995 are considered pre-BMPs and 1996, 1997, and 1999 post-BMPs. The Highway 41 Fire occurred in August 1994.

Taxonomic Richness at DAM and DAU were also similar prior to BMP implementation. However, Following BMP implementation, Taxonomic Richness at DAUis less than at DAM. (Figure 4.12). When evaluating Taxonomic Richness as an indicator of water quality, it appears that DAM may be improving due to BMP implementation.

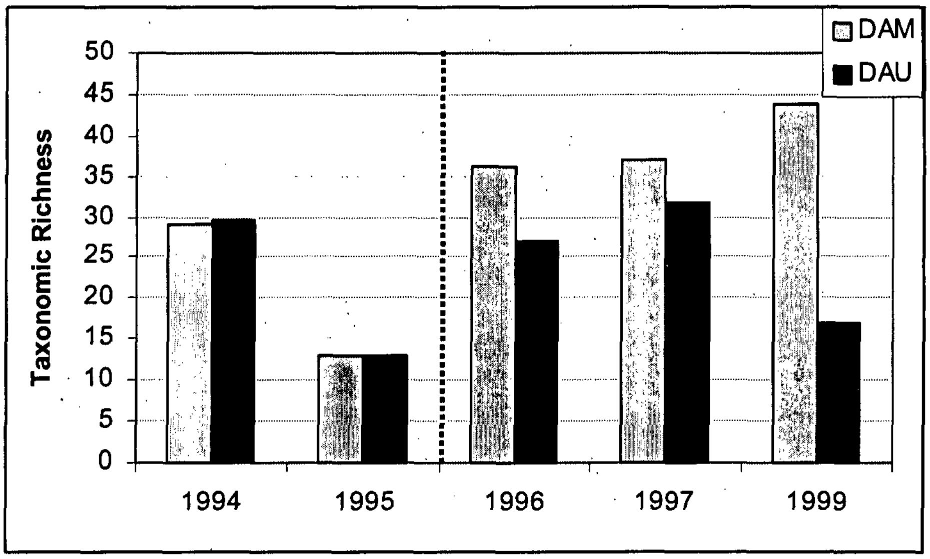


Figure 4.13. Taxonomic richness found in DAU and PEN samples for the years 1994 through 2001 (minus 1998).
The dotted line indicates BMP implementation at DAM, cattle exclusion fencing with gaps. 1994 and 1995 are considered pre-BMPs and 1996, 1997, and 1999 post-BMPs. The Highway 41 Fire occurred in August 1994.

After the Highway 41 Fire in1995 the Percent Dominant Taxon increased at DAM, while PEN remained the same as in 1994, possibly due to a greater resilience at this site. (Figure 4.13). From 1996 through 1999, Percent Dominant Taxon were variable at both DAM and PEN. When results at DAM are compared to those at PEN, it is difficult to conclude that any changes are a result of BMP implementation.

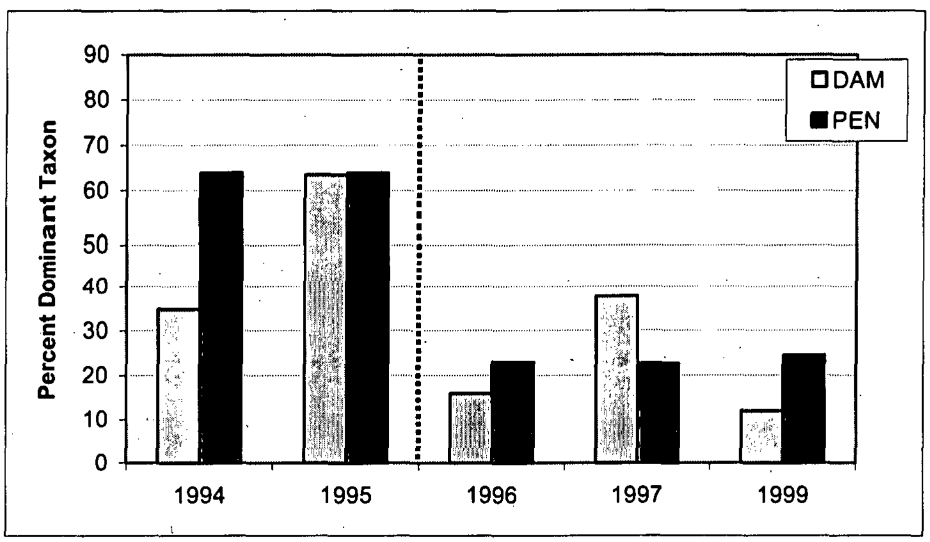


Figure 4.14. Mean Percent Dominant Taxon of DAM and PEN for 1994, 1995, 1996, 1997, and 1999.

A Percent Dominant Taxon is defined as the percent of the sample dominated by the most abundant benthic macroinvertebrate taxon (genera). A decline indicates improvement in benthic macroinvertebrate diversity for this metric. The dotted line indicates BMP implementation at DAM, cattle exclusion fencing with gaps. 1994 and 1995 are considered pre-BMPs and 1996, 1997, and 1999 post-BMPs. The Highway 41 Fire occurred in August 1994.

When Percent Dominant Taxon is compared to the other control site (DAU), results suggest that DAM has improved (Figure 4.14) as a result of BMP implementation.

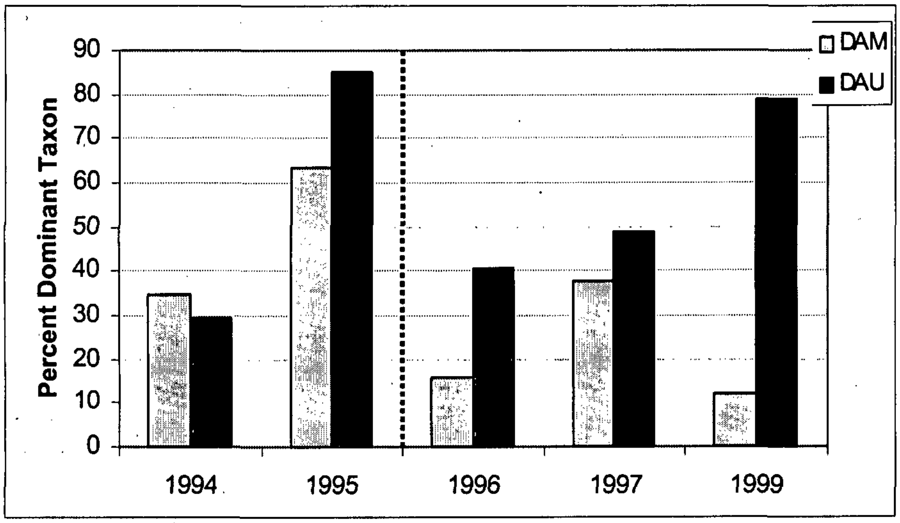


Figure 4.15. Mean Percent Dominant Taxon of DAM and DAU samples for 1994, 1995, 1996, 1997, and 1999.
A percent dominant taxon is defined as the percent of the sample dominated by the most abundant benthic macroinvertebrate taxon (genera). The dotted line indicates BMP implementation at DAM, cattle exclusion fencing with gaps. 1994 and 1995 are considered pre-BMPs and 1996, 1997, and 1999 post-BMPs. The Highway 41 Fire occurred in August 1994.

Tolerance Values at DAM and PEN were similar throughout the project (Figure 4.16). Tolerance Values at DAM were consistently higher than those at PEN. The difference between the tolerance values at DAM not change from the pre-BMP period to the post-BMP period relative to PEN. Tolerance Values at DAM were similar to those found at DAU (Figure 4.17).

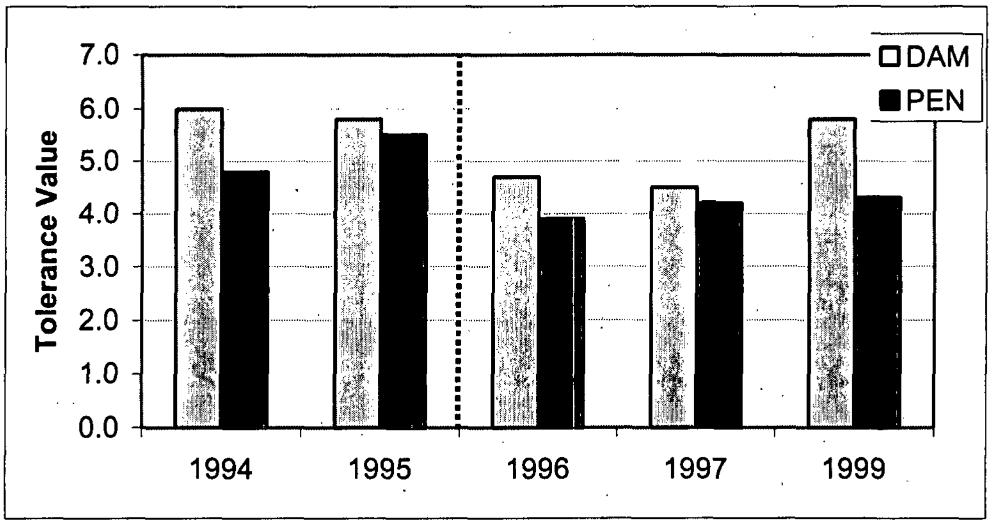


Figure 4.16. Tolerance values for DAM and PEN for 1994, 1995, 1996, 1997, and 1999. The dotted line indicates BMP implementation at DAM, cattle exclusion fencing with gaps. 1994 and 1995 are considered pre-BMPs and 1996, 1997, and 1999 post-BMPs. The Highway 41 Fire occurred in August 1994.

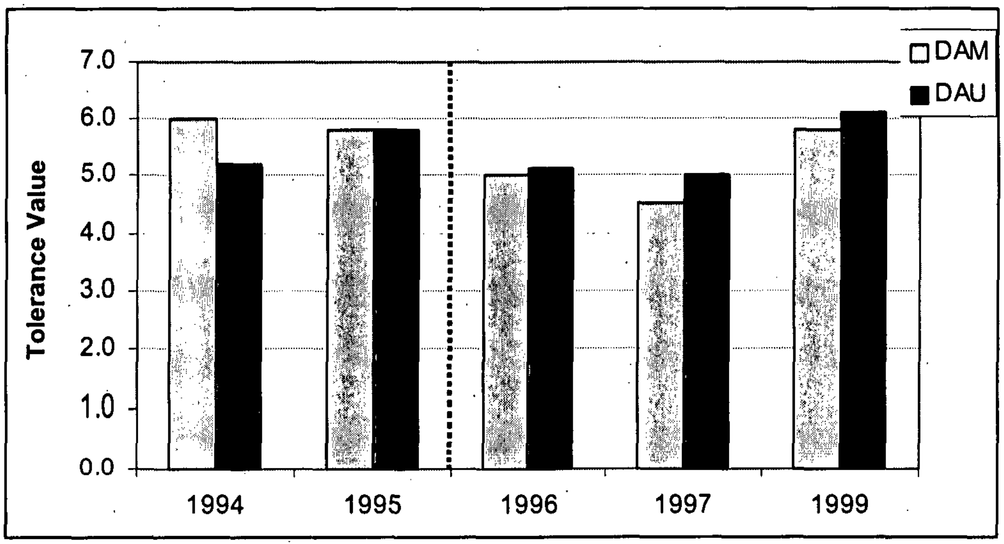


Figure 4.17. Tolerance values for PEN and DAU for 1994, 1995, 1996, 1997, and 1999. The dotted line indicates BMP implementation at DAM, cattle exclusion fencing with gaps. 1994 and 1995 are considered pre-BMPs and 1996, 1997, and 1999 post-BMPs. The Highway 41 Fire occurred in August 1994.

Average habitat assessment scores at DAM have increased implying there may be an improvement due to BMP implementation (Figure 4.17). Although due to the qualitative nature of the methods, results are not definitive. During the pre-BMP period, DAM and DAU had similar habitat assessment scores. In the post-BMP time period habitat assessment scores at DAM improved while scores at DAU decreased and scores at PEN remained about the same.

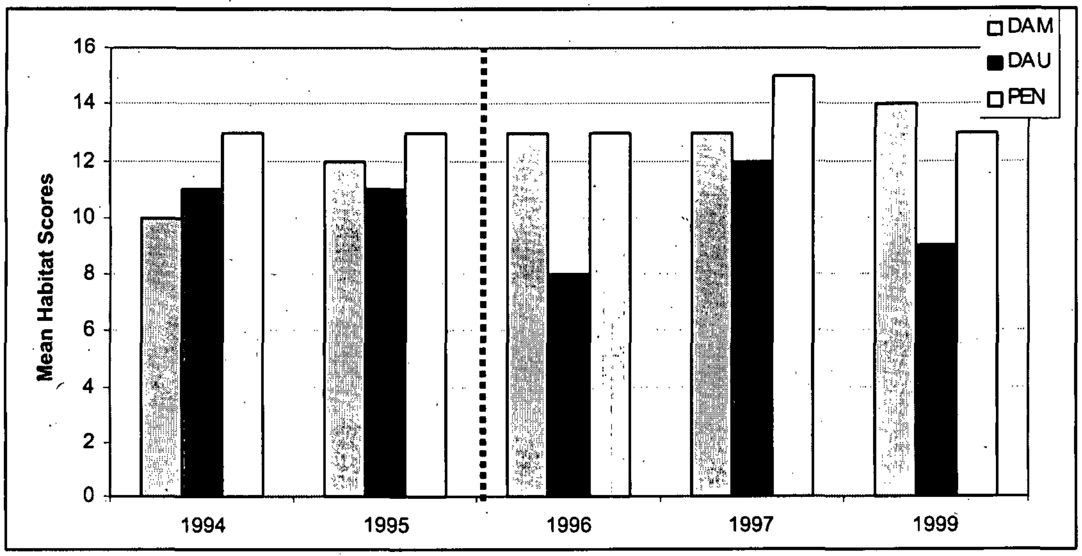


Figure 4.18. Mean Habitat assessment score for Dairy Creek sites DAM, DAU, and PEN between 1994, 1995, 1996, 1997, and 1999.
The dotted line indicates BMP implementation at DAM, cattle exclusion fencing with gaps. 1994 and 1995 are considered pre-BMPs and 1996, 1997, and 1999 post-BMPs. The Highway 41 Fire occurred in August 1994.

Rapid Bioassessment Conclusions

While some assessment trends are present, more data is needed to provide a more accurate picture of benthic macro-invertebrate community health at Dairy and Pennington Creeks. Rapid Bioassessment monitoring continue by the Morro Bay Volunteer Monitoring Program in future years and may aid in this effort.

4.3.3 Stream profiles

NMP project staff compared stream profiles at Dairy Creek and Pennington Creek. It does not appear that BMPs have effected stream morphology. Over time, the stream profiles should provide a tool to evaluate long-term trends in stream bank characteristics. Substrate analysis, riparian vegetation survey, stream classifications, photo documentation, and maps of steam profile locations are included in Chapter 8, Watershed-wide Characterization. Figures 4.12-4.16 are representative stream profiles from Dairy Creek and Pennington Creek. Each figure includes selected profiles from between 1993 through 2000.

Figure 4.19 displays Pennington Creek stream profile #2. No significant change has occurred from 1993 to 2000. Streambank erosion in Pennington Creek is shown in Figure 4.19. After the Highway 41 Fire, significant erosion of the left bank occurred.

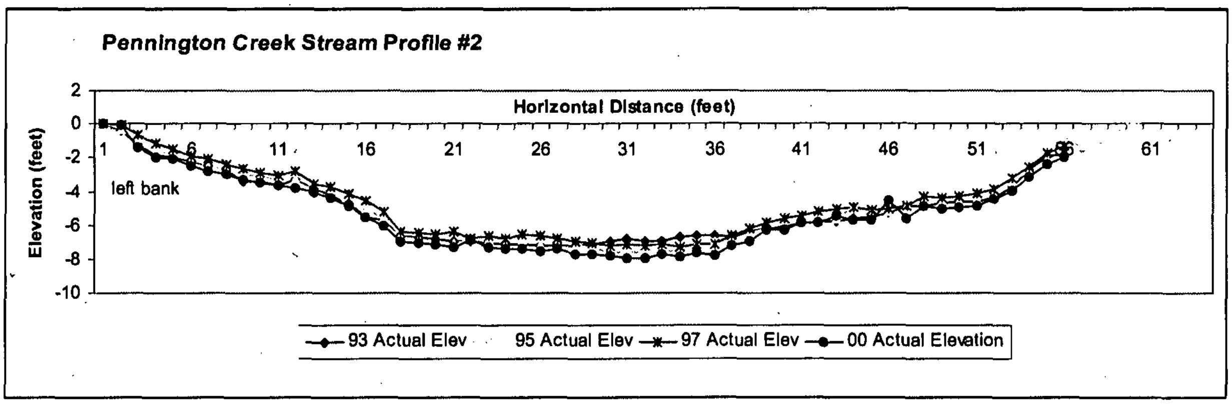


Figure 4.19. Cross sectional profile of Pennington Creek. Profile extends from left bank to right bank and is sampled at 1-foot increments.
The profile samples of 1993, 1995, 1997, and 2000 are shown (other years are left out for easy viewing).

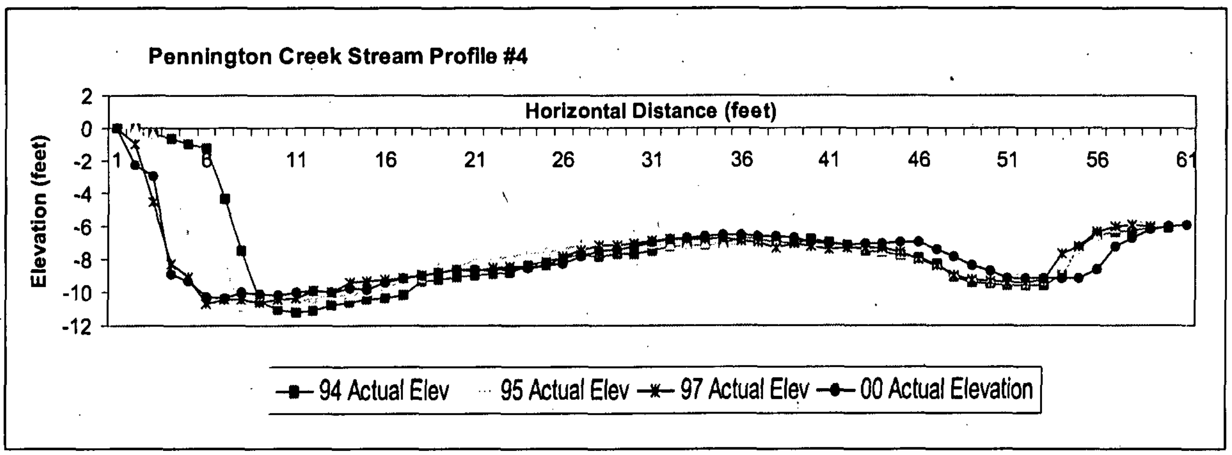


Figure 4.20 Cross sectional profile of Pennington Creek.
Profile extends from left bank to right bank and is sampled at 1-foot increments.

The profile samples of 1993, 1996, and 2000 are provided (other years are left out for easy viewing). This is profile #4 of 5. Three stream profiles along Dairy Creek are shown (Figures 4.20, 4.21, and 4.22). The Highway 41 Fire and heavy rains in the winter of 1994/1995 are responsible for changes in channel shape. Heavy rains in subsequent years also resulted in additional channel modifications at some locations.

Figure 4.20 displays a profile located in the upper portion of Dairy Creek cattle exclusion fence. Dairy Creek at this stream profile experienced erosion in the thalwag (center) of the main channel. The remainder of the channel remained stable. Post-BMPs, no significant degradation resulted, however, rains were lighter than previous years.

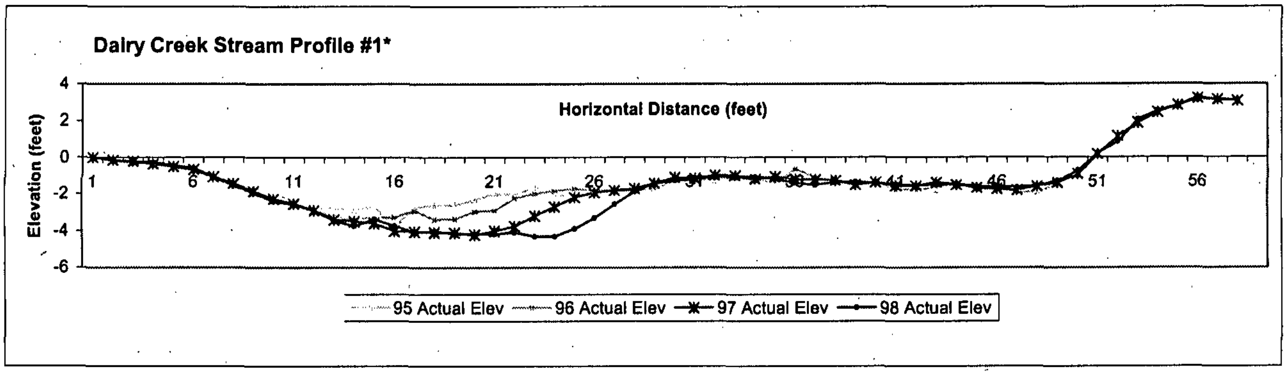


Figure 4.21 Cross sectional profile of Dairy Creek.
Profile extends from left bank to right bank and is sampled at 1foot increments. The profile samples of 1993, 1997, 1998, and 2000 are provided (other years are left out for easy viewing). This is transect #1 of 5.

Dairy Creek stream profile #3 did not experience significant change, even during heavy rain years.

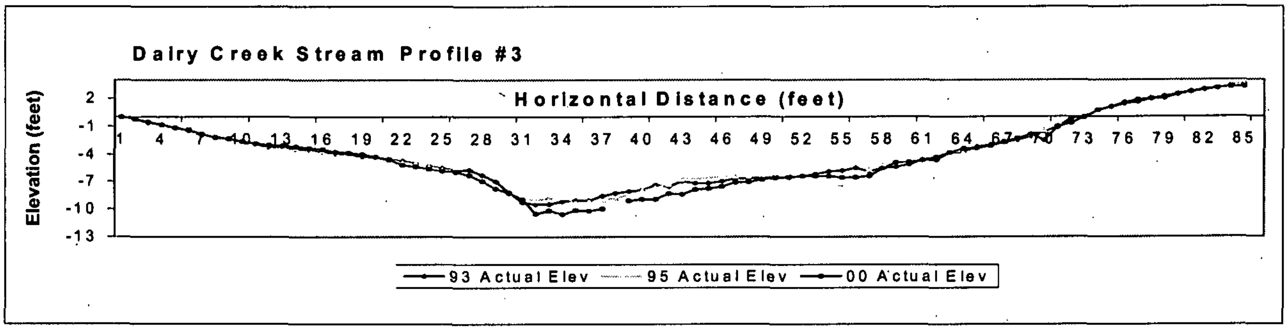


Figure 4.22 Cross sectional profile of Dairy Creek.
Profile extends from left bank to right bank and is sampled at 1foot increments. The profile samples of 1994, 1995, 1997, and 2000 are provided (other years are left out for easy viewing). This is transect #3 of 5.

Figure 4.23 displays Dairy Creek stream profile #4, located at the treatment (DAM) water quality monitoring site. Most of stream profile #4 is stable, however, the main creek channel became deeper during the study. The Highway 41 Fire and the following rains did not result in downcutting of the channel as with many other stream profiles in the Morro Bay watershed.

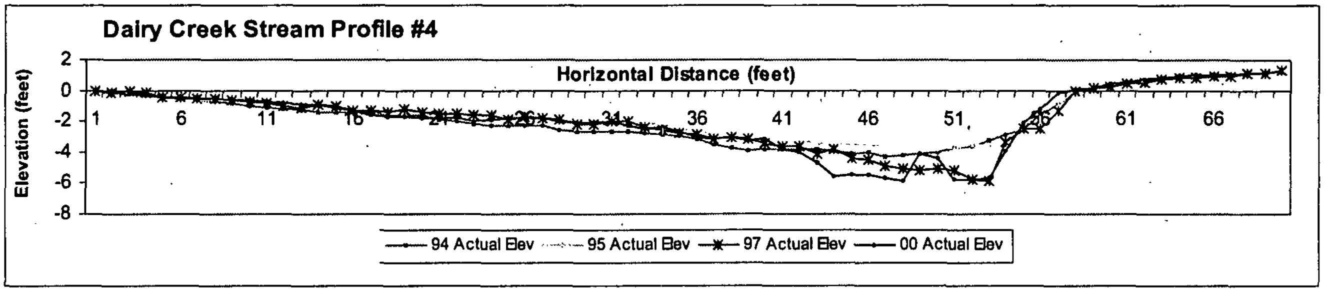


Figure 4.23 Cross sectional profile of Dairy Creek.
Profile extends from left bank to right bank and is sampled at 1foot increments. The profile samples of 1994, 1997, and 2000 are provided (other years are left out for easier viewing). This is stream profile #4 of 5.

Stream Profile Conclusions

The stream profiles did not present any pronounced changes resultant from BMP implementation, but rather provide data for long-term stream morphology. Substrate results and photo documentation are included in the appendix.

4.4 Overall Conclusions

Water temperature improved at Dairy Creek (DAM), most likely due to shading from riparian vegetation planted as part of BMP implementation. Also dissolved oxygen levels significantly improved at DAM. Turbidity, nitrate-nitrogen, and orthophosphate did not significantly change as a result of BMP implementation at DAM.

Fecal coliform levels at DAM and PEN remained the same before and after BMP implementation, however, fecal coliform bacteria levels at one of the control sites (DAU) improved. The water gaps within the cattle exclusion fencing to allow cattle access to the creek for watering, may contribute to a higher frequency of fecal coliform bacteria levels. NMP Project Staff recommend that water troughs be installed at Dairy Creek to prevent cattle from watering in the creek.

While some trends in benthic macro-invertebrate community health are present, more data is required to provide a definitive picture of the effectiveness of BMPs at Dairy Creek. The stream profiles do not appear to be affected by BMP implementation, but rather provide data for long-term stream morphology. Rapid Bioassessment monitoring will continue by the Morro Bay Volunteer Monitoring Program in future years and will aid in this effort.

STATE OF CALIFORNIA
CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
CENTRAL COAST REGION

STAFF REPORT FOR REGULAR MEETING DECEMBER 3, 2004
Prepared on November 8, 2004

ITEM: 27

SUBJECT: ADOPTING THE DAIRY CREEK TOTAL MAXIMUM DAILY LOAD FOR DISSOLVED OXYGEN AND IMPLEMENTATION PLAN

BACKGROUND

In 2002, Dairy Creek was listed on California's section 303(d) list of impaired waters for dissolved oxygen. Section 303(d) requires the Regional Water Quality Control Board (Regional Board) to adopt a Total Maximum Daily Load (TMDL) for listed waterbodies. The solution that will correct the impairment addressed by the TMDL is being implemented by a non-regulatory agency, the County of San Luis Obispo.

The Natural Resources Conservation Service, in partnership with the County of San Luis Obispo, and land managers have voluntarily implemented Management Practices along Dairy Creek. Rangeland Management Practices implemented at Dairy Creek included cattle exclusionary fencing with water gaps and riparian revegetation. Improvements to approximately one mile of Dairy Creek were completed during the summer of 1994, with an additional half-mile of the creek fenced during the summer of 1995.

Significant increases in dissolved oxygen levels have been observed as a result of Management Practice implementation, however the water quality objectives for the freshwater habitat beneficial use (COLD) are not yet being met. Management practices that address dissolved oxygen may take several years to be recognized.

The dissolved oxygen TMDL for Dairy Creek is set at 1) a minimum concentration for dissolved oxygen of 7 mg/l to protect the COLD beneficial use and 2) a <u>median</u> value equal to or greater than 85 percent saturation. The allocations, which include background levels, are also equal to the numeric targets. The County of San Luis Obispo Parks Department is given a load allocation equal to the two numeric targets. Monthly concentrations may not fall below 7 mg/l and annual median values may not fall below 85 percent saturation.

As mentioned, improvements in dissolved oxygen levels are already occurring and should continue to improve as a result of management practice implementation, and are expected to ultimately resolve the impairment and result in TMDL achievement. The County of San Luis Obispo is the owner and land manager of the land on which grazing practices resulted in removing riparian cover such that dissolved oxygen levels were likely impacted due to multiple factors (e.g. decreased canopy, increased temperature). The County of San Luis Obispo's voluntary program does not involve a discharge, and discharges to the waterbodies do not appear to be the cause of the dissolved oxygen impairment. Therefore, the State Water Resources Control Board's Policy for Implementation and Enforcement of the Nonpoint Source Pollution Control Program does not require a prohibition, waiver, or waste discharge requirements. As such, staff recommends approval of a resolution to adopt a TMDL and implementation plan that consists of existing efforts to improve dissolved oxygen in Dairy Creek.

PUBLIC INVOLVEMENT

Regional Board Staff has conducted TMDL outreach by coordinating the TMDL with agencies and individuals in the Dairy Creek watershed. In addition, public review and comment through this board hearing process provides another formal opportunity for public input for adoption of this TMDL. A public hearing notice was circulated with local newspapers and a copy of the notice was mailed to all persons requesting such notice and affected government agencies.

The Final Project Report for this proposed Board action is available at the Region 3 website at http://www.swrcb.ca.gov/rwqcb3/Board/Meetings/documents/DEC04agn.pdf. Staff did not include the entire document in the staff report in order to save paper. Paper copies are available upon request.

CALIFORNIA ENVIRONMENTAL QUALITY ACT

This Board resolution finds that an existing project makes any further regulatory action (i.e., any "project") unnecessary. Therefore, this action is not a "project" that requires compliance with the California Environmental Quality Act (California Public Resources Code §21000 et seq.). The Regional Board is not directly undertaking an activity, funding an activity or issuing a permit or other entitlement for use (Public Resources Code section 21065; 14 Cal. Code of Regs. §15378). The Regional Board is not approving any activity; it is merely finding that an ongoing activity also satisfies other legislative requirements.

ANTI-DEGRADATION

This resolution does not allow degradation or lower water quality, and does not approve an activity that produces or may produce a waste or increased volume or concentration of waste or an activity that discharges or proposes to discharge to existing high quality waters. This resolution therefore complies with Resolution 68-16 and 40 CFR §131.12.

COMMENTS

Notice of this item being proposed to the Regional Board was distributed to a list of interested parties and agencies that have indicated interest in the Dairy Creek area.

The public comment period ends on November 22, 2004. Written comments (via mail, e-mail, and fax) concerning the proposed TMDL for Dissolved Oxygen in Dairy Creek received prior to the Regional Board meeting will be considered prior to Board approval.

RECOMMENDATION

Adopt Resolution R3-2004-0166 approving the TMDL for Dissolved Oxygen in Dairy Creek, finding the existing activities of the County will achieve the TMDL.

ATTACHMENTS:

A. Resolution R3-2004-0166
B. Final Project Report - available at the Region Three website at http://www.swrcb.ca.gov/rwqcb3/Board/Meetings/documents/DEC04agn.pdf

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CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD

CENTRAL COAST REGION

San Luis Obispo, California

new data For Dairy Ck. Add to baby - FAC dh.

RESOLUTION NO. R3-2004-0166
DECEMBER 3, 2004
ADOPTING A
TOTAL MAXIMUM DAILY LOAD AND IMPLEMENTATION PLAN
FOR DISSOLVED OXYGEN IN DAIRY CREEK

The California Regional Water Quality Control Board Central Coast Region hereby finds:

1. The California Regional Water Quality Control Board, Central Coast Region (Regional Board), adopted the Water Quality Control Plan for the Central Coastal Basin (Basin Plan), on September 8, 1994. The Basin Plan includes beneficial use designations, water quality objectives, implementation plans for point source and nonpoint source discharges, and statewide plans and policies.

2. Section 303(d) of the Clean Water Act requires states to identify and prepare a list of water bodies that do not meet water quality standards and establish TMDLs for the listed water bodies. A TMDL is the loading capacity of a pollutant that a water body can accept while protecting beneficial uses. TMDLs can be expressed in terms of either concentration, mass per time, toxicity or other appropriate measure [40 CFR §130.2(i)].

3. Dairy Creek was identified as impaired by dissolved oxygen on the 2002 Clean Water Act Section 303(d) list of impaired water bodies. Therefore, the Regional Board is required to adopt a TMDL and associated Implementation Plan (40 CFR 130.6(c)(1), 130.7, Water Code section 13242).

4. Dairy Creek is located entirely within San Luis Obispo County.

5. The Final Project Report contains a Problem Statement, Numeric Targets, Source Analysis, Total Maximum Load, Linkage Analysis, Load Allocations, Margin of Safety, an Implementation Plan, and a Monitoring Plan.

6. The Regional Board has determined that the TMDL for dissolved oxygen in Dairy Creek is set at levels necessary to attain and maintain the applicable numeric water quality objectives taking into account seasonal variations and any lack of knowledge concerning the relationship between effluent limitations and water quality (40 CFR 130.7(c)(1)).

7. The County of San Luis Obispo (County) and land managers in partnership with the Natural Resources Conservation Service voluntarily implemented Management Practices (cattle exclusion and riparian revegetation) between 1994 and 1995 along Dairy Creek. The Regional Board finds that these voluntary, non-regulatory actions will correct the impairment in Dairy Creek. Therefore, the Regional Board finds that the County's action will implement the assumptions of the TMDL in lieu of adopting a redundant program.

8. The County is the owner and land manager of the land on which grazing practices resulted in removing riparian cover such that dissolved oxygen levels were likely impacted due to multiple

factors (e.g. decreased canopy, increased temperature). The Regional Board therefore has the authority to require technical and monitoring reports from the County pursuant to Water Code section 13225(c). Currently no reporting or monitoring requirement exists. The Morro Bay Volunteer Monitoring Program (VMP) monitors dissolved oxygen levels on Dairy Creek. Regional Board staff will also conduct additional dissolved oxygen monitoring at pre-dawn hours to obtain information relative to diurnal fluctuations. Regional Board staff has requested the County submit a technical report that includes an inventory of existing Management Practices (i.e. miles of creek excluded from cattle, locations of water gaps, and inventory of riparian revegetation). Regional Board staff has requested the County to submit annual reporting on land management (i.e. any proposed changes to Management Practices that may result in impacts to dissolved oxygen levels) and VMP monitoring data to confirm that progress is made towards TMDL achievement. The technical and monitoring reports will provide adequate documentation to determine whether the TMDL is being adequately implemented. If the County or other land owners or managers are suspected of causing discharges that contribute to the dissolved oxygen impairment, the Executive Officer may require additional technical and monitoring reports or issue a formal order pursuant to Water Code section 13267. Such reports are necessary to allow the Regional Board to determine whether the existing program is adequate to achieve water quality objectives and if not, to identify additional measures to address the impairment. Any orders or requirements issued pursuant to Water Code section 13267 shall also consider whether the burden of monitoring and reporting requirements bears a reasonable relationship to the need for and benefit of the additional monitoring.

9. Regional Board staff has conducted TMDL outreach by coordinating the TMDL with the County and the VMP. In addition, public review and comment through this board hearing process provides another formal opportunity for public input for adoption of this TMDL. Notice of public hearing was given by notifying newspapers of general circulation within the Region and by mailing a copy of the notice to all persons requesting such notice and affected government agencies.

10. The Regional Board finds that an existing action makes any further regulatory action (i.e., any "project") unnecessary. Therefore, this action is not a "project" that requires compliance with the California Environmental Quality Act (California Public Resources Code §21000 et seq.). The Regional Board is not directly undertaking an activity, funding an activity or issuing a permit or other entitlement for use (Public Resources Code section 21065; 14 Cal. Code of Regs. §15378). The County is not required to obtain Regional Board "approval" to continue its remediation plan. The Regional Board is not approving any activity (14 Cal. Code of Regs. §15352); it is merely finding that an ongoing activity also satisfies other legislative requirements.

11. The TMDL and Implementation and Monitoring Plan do not allow degradation or lower water quality, and do not approve an activity that produces or may produce a waste or increased volume or concentration of waste or an activity that discharges or proposes to discharge to existing high quality waters. This resolution therefore complies with Resolution 68-16 and 40 CFR §131.12.

12. This TMDL will become effective upon approval by the Regional Board.

13. On December 3, 2004 in San Luis Obispo, California, the Regional Board held a public hearing and heard and considered all public comments and evidence in the record.

THEREFORE, BE IT RESOLVED,

1. The Regional Board, after considering the entire record, including oral testimony, adopts the Total Maximum Daily Load for Dissolved Oxygen in Dairy Creek included in the Final Project Report.

2. The Regional Board finds that the existing Management Practices voluntarily implemented in 1994 and 1995 by the County and land managers along Dairy Creek are an appropriate plan of implementation of the TMDL, will be adequate to correct the impairment and is expected to result in attainment of water quality objectives for dissolved oxygen in Dairy Creek. At this time, any further regulatory action to create another program of implementation by the Regional Board would be redundant.

3. The County is requested to submit a technical report that includes an inventory of existing Management Practices by March 15, 2005. The County is also requested to submit annual reporting on land management and VMP monitoring data by December 15, 2005 and each year thereafter. If the report is not adequate, the Executive Officer shall issue orders or requirements pursuant to Water Code section 13267 to ensure that the County provides the Regional Board with all monitoring reports necessary to evaluate progress toward attaining water quality objectives or to determine that the impairment has been resolved.

4. If the County's program does not correct the dissolved oxygen impairment by December 15, 2010, the County shall submit by March 15, 2011, a revised implementation plan for Regional Board review.

5. These findings shall remain valid as long as the COLD freshwater habitat numeric dissolved oxygen water quality objective of 7 mg/l and the general water quality objective that median values should not fall below 85 percent saturation as a result of controllable water quality conditions are attained in Dairy Creek no later than December 15, 2010.

6. The Regional Board may revoke these findings if it finds that the County's existing efforts are not adequately implemented or are no longer adequate to resolve the impairment.

7. The Regional Board's Executive Officer is directed to submit the TMDL to the U.S. Environmental Protection Agency (USEPA) for review. If during its approval process the U.S. EPA determines that minor, non-substantive corrections to the language of the TMDL are needed for clarity or consistency, the Executive Officer may make such changes, and shall inform the Regional Board of any such changes.

I, Roger W. Briggs, Executive Officer, do hereby certify the foregoing is a full, true, and correct copy of the resolution adopted by the California Regional Water Quality Control Board, Central Coastal Region, on **December 03, 2004.**

Executive Officer

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