Phase 6: Regulatory Action

Final Project Report

Total Maximum Daily Load for Nutrients and Dissolved Oxygen in Chorro Creek, San Luis Obispo County, California

July 2006

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

CONTENTS

Contents 2
Figures 3
Tables 3
1 INTRODUCTION 5
1.1 303(d) Listings and Project Area 5
1.2 Watershed Description 5
2 BENEFICIAL USES, WATER QUALITY OBJECTIVES, AND IMPAIRMENT 7
2.5 Beneficial Uses 7
2.6 Water Quality Objectives and Standards 8
2.6.1 Interpreting Basin Plan Water Quality Objectives 8
2.7 Impairment 9
3 NUMERIC TARGETS 11
4 SOURCE ANALYSIS AND CAUSES OF IMPAIRMENTS 12
4.1 Dissolved Oxygen and Biostimulatory Substances: Sources and Exceedences 12
4.1.1 Dissolved Oxygen Discussion 12
4.1.2 Oxygen Input in Chorro Creek 13
4.1.3 Oxygen Demand in Chorro Creek 14
4.2 Biostimulatory Substances 22
4.2.1 Nutrient Availability and Benthic Algae Cover 23
4.2.2 Relative Contributions of Nitrate-N and Orthophosphorus-P 28
4.2.3 Days of Accrual and Benthic Algae Cover 29
4.2.4 Light Availability and Benthic Algae Cover 30
4.3 Conclusions 31
5 LINKAGE ANALYSIS, SEASONALITY, CRITICAL CONDITIONS, AND MARGIN OF SAFETY 33
5.1 Linkage Analysis 33
5.2 Seasonality, Critical Conditions, and Margin of Safety 33
6 TMDLs , ALLOCATIONS, AND MARGIN OF SAFETY 34
6.1 TMDLs for Dissolved Oxygen and Benthic Algae 34
6.2 Allocations and Management Measures to Achieve TMDLs 34
6.2.1 Allocations to Achieve the Dissolved Oxygen TMDL 34
6.2.2 Allocations to Achieve the Biostimulatory Substances TMDL 35
6.3 Margin of Safety 36
7 IMPLEMENTATION, MONITORING, EXISTING EFFORTS 37
7.1 Implementation 37
7.1.1 Implementation to Achieve TMDLs for Nitrate-N, Sodium, Total Dissolved Solids, and Temperature 37
7.1.2 Implementation to Achieve the Orthophosphorus-P TMDL 37
7.1.3 Implementation to Achieve Shading TMDL 38
7.1.4 Projects Helpful, but not Required to Achieve TMDL 40
7.2 Tracking and Monitoring 44
7.2.1 Tracking: Triennial Reviews 44
7.2.2 Monitoring 45
8 TIMELINE AND MILESTONES 46

9 REFERENCES 47

FIGURES

Figure 1.1 The Chorro Creek Watershed. 6
Figure 4.1 Site TWB, illustrating lack of re-aeration due to absence of turbulence..................... 13
Figure 4.2 Conceptual model of dissolved oxygen concentration as a function of flow............. 14
Figure 4.3 Median sodium concentration in Chorro Creek and effluent in 2003........................ 16
Figure 4.4 Receiving water temperature downstream and upstream of CMC discharge 17
Figure 4.5 Twenty-four hour stream temperature at site TWB. 17
Figure 4.6 Forty Hour Dissolved Oxygen Concentration in Chorro Creek 21
Figure 4.7 Twenty-four hour pH levels at site TWB. 22
Figure 4.8 Benthic algae cover at reference site CHD in Chorro Creek...................................... 24
Figure 4.9 High algal cover in waters with background nutrient levels. Stenner Creek. 24
Figure 4.10 Monitoring Site Locations 26
Figure 4.11 Median and Maximum orthophosphorus and nitrate-N concentration at main stem sites of Chorro Creek 26
Figure 4.12 The D_a affect: Benthic algae cover in San Luis Obispo Creek as a function of number of days since January 1. 29
Figure 4.13 Benthic algae cover in San Luis Obispo Creek with varying canopy cover. 30
Figure 4.14 Benthic algae cover in Chorro Creek with varying canopy cover............................. 31
Figure 7.1 Photo of Chorro Flats in 1998. 39
Figure 7.2 Photo of Chorro Flats in 2006. 39
Figure 7.3 Instream rock and log structure. 40
Figure 7.4 Chorro Creek Ecological Reserve. 41
Figure 7.5 Entrance of gap-fence area along Dairy Creek.. 42
Figure 7.6 Gap and fenced area of Dairy Creek. 42
Figure 7.7 Walters Creek fencing and revegetation project. 43
Figure 7.8 Installed rock structure in Walters Creek. 44

TABLES

Table 1.1 Land use categories within the Chorro Creek watershed (acres/% total) 6
Table 2.1 Beneficial uses for Chorro Creek and tributaries to Chorro Creek................................ 7
Table 2.2 Exceedences of Water Quality Objectives in Chorro Creek.. 9
Table 4.1 Total Dissolved Solids in CMC effluent and receiving waters in 2003. 15
Table 4.2 Sodium concentration in CMC effluent and receiving waters in 2003......................... 16
Table 4.3 Total Ammonia concentration in Chorro Creek in 2004. 18
Table 4.4 BOD in effluent from CMC plant in 2004.. 19
Table 4.5 Suspended chlorophyll-a concentration in Chorro Creek in 2003................................ 19
Table 4.6 Number of dissolved oxygen violations at four sites on Chorro Creek 21

Table 4.7 Monthly nitrate and phosphorus concentrations of CMC effluent and receiving waters. 25
Table 4.8 Nitrate-N and orthophosphorus-P summary of tributaries to Chorro Creek 28

1 INTRODUCTION

The Clean Water Act (CWA) requires a Total Maximum Daily Load (TMDL) be developed for CWA section 303(d) listed waterbodies. Chorro Creek has been included on the CWA 303(d) list as impaired. This TMDL Project Report addresses the 303(d) listings described more fully below.

1.1 303(d) Listings and Project Area

Chorro Creek is identified as impaired for nutrients on California's 1998 303(d) list. In addition, Chorro Creek is identified as impaired on the draft 2006 303(d) list due to low dissolved oxygen. The 303(d) listings addressed in this TMDL project (Project) include:

1. Chorro Creek impairment for nutrients.
2. Chorro Creek impairment for dissolved oxygen.

1.2 Watershed Description

Chorro Creek Watershed (Watershed) is located in San Luis Obispo County on the central coast of California. The major tributaries to Chorro Creek include Dairy, Walters, Pennington, San Bernardo, and San Luisito Creeks. Figure 1.1 illustrates the Watershed, including Chorro Creek and major tributaries.

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.

The Chorro Creek watershed is dominated by rangeland with areas of woodland, cropland, and urban land use. The California Men's Colony (CMC) owns and operates a wastewater treatment plant adjacent and discharging to Chorro Creek. The CMC wastewater treatment plant is a state-owned facility. Tertiary treated wastewater from the CMC plant is discharged to Chorro Creek, as shown in Figure 1.1. Table 1.1 summarizes the land use in the Chorro Creek watershed.

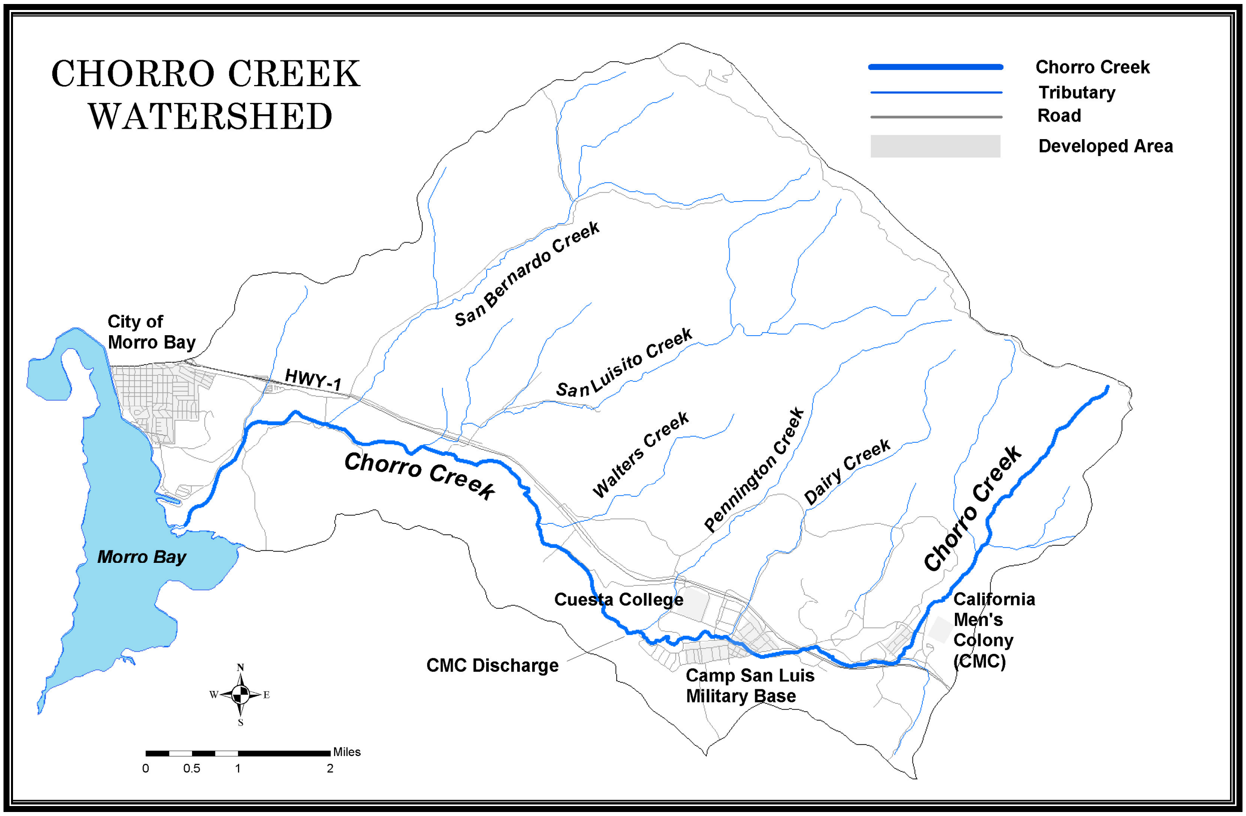


Figure 1.1 The Chorro Creek Watershed.

Table 1.1 Land use categories within the Chorro Creek watershed (acres/% total)

	Land Uses						
Subwatersheds	**Rangeland**	**Brushland**	**Woodland**	**Cropland**	**Urban**	**Other**	**Total**
Chorro Creek at Res.	561	1,241	577				**2,379**
Dairy Creek	1,206	137	76				**1,419**
Pennington Creek	819	360	192				**1,371**
San Luisito Creek	3,831	1,497	62	108			**5,498**
San Bernardo Creek	3,295	1,043	434	659			**5,431**
Walters Creek	917						**917**
Chumash Creek	421						**421**
Chorro Creek below Reservoir	4,950	518	492	57	1,455		**7,472**
Chorro Creek at Twin Bridges	1,715		607	891	73		**3,286**
Chorro Creek	17,715	4,796	2,440	1,715	1,528		**28,193**
Chorro Creek %	**62.8%**	**17.0%**	**8.7%**	**6.1%**	**5.4%**		

Source: based on UC Santa Barbara GAP data and CDF Wildlife Habitat Relationships, 1998.

2 BENEFICIAL USES, WATER QUALITY OBJECTIVES, AND IMPAIRMENT

Regional Water Quality Control Board, Central Coast Region (Central Coast Water Board) designates beneficial uses for waterbodies in the Water Quality Control Plans (Basin Plan). The Basin Plan also includes numeric and narrative objectives to protect the designated beneficial uses. The following section discusses the applicable beneficial uses and water quality objectives related to the 303(d) listings for this Project.

2.5 Beneficial Uses

Chorro Creek, along with several tributaries to Chorro Creek, have designated beneficial uses in the Basin Plan. Table 2.1 summarizes the designated beneficial uses for Chorro, Dairy, San Luisito, and San Bernardo Creeks. The Basin Plan states that surface waterbodies within the region that do not have designated beneficial uses are assigned the beneficial uses of "municipal and domestic water supply" and "protection of both recreation and aquatic life," (Basin Plan); Pennington Creek, Chumash Creek, and Walters Creek, fall into this category and are therefore designated with these beneficial uses. Table 2.1 summarizes the beneficial uses assigned to the waterbodies in Chorro Creek watershed.

Table 2.1 Beneficial uses for Chorro Creek and tributaries to Chorro Creek.

Waterbody	Chorro Creek	Dairy, San Luisito, and San Bernardo Creeks	Pennington, Chumash, and Walters Creeks[1]
Municipal and Domestic Supply (MUN).	X	X	X
Agricultural Supply (AGR)	X	X	
Industrial Process Supply (PROC)			
Industrial Service Supply (IND)			
Ground Water Recharge (GWR)	X	X	
Water Contact Recreation (REC-1)	X	X	X
Non-Contact Water Recreation (REC-2)	X	X	X
Wildlife Habitat (WILD)	X	X	
Cold Fresh Water Habitat (COLD)	X	X	
Warm Fresh Water Habitat (WARM)	X		X
Migration of Aquatic Organisms (MIGR)	X	X	
Spawning, Reproduction, and/or Early Development (SPWN)	X	X	
Preservation of Biological Habitats of Special Significance (BIOL)	X		
Rare, Threatened, or Endangered Species (RARE)	X	X	
Estuarine Habitat (EST)			
Freshwater Replenishment (FRSH)	X		

Navigation (NAV)			
Hydropower Generation (POW)			
Commercial and Sport Fishing (COMM)	X	X	
Aquaculture (AQUA)			
Inland Saline Water Habitat (SAL)			
Shellfish Harvesting (SHELL)			

[1] These tributaries are not specifically listed in the Basin Plan. Therefore, two general uses (encompassing four Beneficial Uses) designated for all waterbodies in the Region apply: Municipal and Domestic Water Supply (MUN) and protection of both recreation and aquatic life (REC-1 REC-2, WARM).

2.6 Water Quality Objectives and Standards

The Basin Plan describes nutrient-related water quality objectives that must be achieved for the protection of beneficial uses. Nutrient and dissolved oxygen-related water quality objectives associated with the identified impairments include:

1. Nitrate-NO_3 water quality objective: 45 mg/L-NO_3 (equivalent to nitrate-N of 10 mg/L-N). This objective protects the MUN beneficial use.

2. Water quality objectives for dissolved oxygen protect the cold fresh water habitat (COLD) and the warm fresh water habitat (WARM). The dissolved oxygen objective protecting COLD is a minimum concentration of 7 mg/L. The dissolved oxygen objective protecting WARM is a minimum concentration of 5 mg/L. In addition, all waters not subject to a specific objective for dissolved oxygen must have a minimum dissolved oxygen concentration of 5 mg/L. For all waters, median dissolved oxygen values should not fall below 85% saturation "as a result of controllable water quality conditions." (Basin Plan). Note that since Chorro Creek is designated to support the COLD beneficial use, the more stringent dissolved oxygen objective of 7 mg/L applies.

3. The narrative water quality objective for biostimulatory substances states: "Waters shall not contain biostimulatory substances in concentrations that promote aquatic growths to the extent that such growths cause nuisance or adversely affect beneficial uses." This objective will be discussed further below.

2.6.1 Interpreting Basin Plan Water Quality Objectives

The nitrate-N and dissolved oxygen water quality objectives are numeric, and therefore easily measured against water quality data. Nitrate-N concentration exceeding 10 mg/L-N in surface waters designated to support the MUN beneficial use is an excursion of the nitrate-N objective.

Dissolved oxygen concentration falling below 7 mg/L in waters supporting the COLD beneficial use is an excursion of the dissolved oxygen objective, as are dissolved oxygen levels falling below 5 mg/L in water supporting WARM or other beneficial uses. All surface waters should maintain a median dissolved concentration of 85% as a result of controllable water quality conditions.

The water quality objective for biostimulatory substances is more difficult to measure (relative to nitrate-N) because it is a narrative objective. Staff has determined numeric indicators appropriate to measure excursion of this narrative objective. Aquatic plant growth is a typical indicator of exceedence of the biostimulatory substances objective.

Aquatic plant growths in coastal streams are most often seen in the form of attached filamentous algae. The United States Environmental Protection Agency (USEPA) compiled results of research and recommendations and found that algal biomass greater than 150 mg/m^2 presents nuisance conditions in streams. As an aerial coverage, this biomass corresponds to a range from 20%-40% cover (USEPA, 2000). Algal data for this project is presented in units of aerial cover. Therefore, staff considers aerial cover of algae exceeding 40% to be evidence of an excursion of the biostimulatory substances objective. *However, as will be discussed in subsequent sections, algal biomass exceeding the 40% threshold is not necessarily caused by loading of a "substance," but can be caused by riparian conditions and other physical parameters.*

Existing Basin Plan objectives are used as the basis for the numeric target development for this TMDL. The numeric targets used to develop the TMDL are described in Section Three, the Numeric Target section, of this report.

The anti-degradation policy states that if the existing quality of water is better than the water quality described through water quality objectives, then the existing water quality must be maintained. Therefore, the numeric targets and TMDLs established in this Project Report do not allow any reduction in water quality.

2.7 Impairment

Staff compiled data associated with the impairments being addressed. Summary data outlining the exceedences of water quality objectives discussed above is presented in Table 2.2. Data sources and a more complete dataset are presented in Section 3.1 of the Source Analysis.

Table 2.2 Exceedences of Water Quality Objectives in Chorro Creek.

Water Quality Objective (Indicator)	# of samples	Exceedences / #of Data (% exceeding)		
		All Data	Summer only (May-Sept.)	Summer 2004/2005
Nitrate-N (≥ 10 mg/L-N)	681	4/681 (0.6%)	2/194 (4%)	1/24 (1%)
Dissolved Oxygen (≤ 7 mg/L)	160	46/160	46/160 (29%)	No data
Biostimulatory Substances (Algal cover ≥ 40%)	21	12/21	12/21 (57%)	No data

The data presented is compiled from monitoring reports of the California Men's Colony (CMC) wastewater treatment plant and Central Coast Ambient Monitoring, excepting the algae cover data, which is from staff and volunteer monitoring efforts.

Nitrate-N concentration in Chorro Creek is supportive of the MUN beneficial use. Thus, Chorro Creek is not impaired for nitrate-N, but nitrate-N concentrations are contributing to exceedences of the biostimulatory objective, which in turn contributes to exceedences of the dissolved oxygen objective. A more detailed analysis of nitrate-N and sources is provided in the Source Analysis Section. However, the following discussion summarizes staff's conclusion regarding protection of the MUN use.

The nitrate-N water quality objective was exceeded in 4 of the total 681 data. This constitutes exceedence of 0.6% of the total data. Exceedence of the nitrate-N objective during the summer occurred 2 out of 194 data, constituting 4% exceedence on a seasonal basis. Finally, there was 1 in 24 data exceeding the nitrate-N objective in the last two summers, constituting a 1% exceedence in the last two years during the dry season. A ten percent frequency of exceedence is used as the basis impairment (see State Water Resources Control Board Resolution No. 2004-0063). However, the frequency of exceedences does not reach ten percent whether considering all the available data, seasonal analysis, or most recent data. Staff conducted several analyses of the nitrate-N data, and in all analyses the frequency of exceedence is less than ten percent. In addition, as will be seen in the Source Analysis section, the summer months represent the season of the highest probability of exceeding the nitrate-N objective, due to a lack of dilution from natural flow, yet exceedence did not reach the 10% threshold.

Although the nitrate-N concentration in Chorro Creek is protective of the MUN beneficial use, current nitrate loading in the system is *a contributor* to the exceedence of the biostimulatory substances narrative objective, which in turn is contributing to exceedences of the dissolved oxygen objectives. This will be discussed further in the Source Analysis Section.

Algal cover is used to indicate the biostimulatory substances objective. Chorro Creek exceeds the 40% algal cover threshold in 57% of the data considered, marking exceedence of the biostimulatory substances water quality objective. *Therefore, Chorro Creek is impaired due to exceedence of the biostimulatory substances water quality objective.*

Dissolved oxygen concentration in Chorro Creek is below the water quality objective in 29% of the data considered. *Therefore, Chorro Creek is impaired due to low dissolved oxygen.* As will be seen in the Source Analysis section, excursion of the dissolved oxygen objective occurs in the lower reaches of Chorro Creek, and is associated with impairment due to biostimulatory substances.

The following impairments are confirmed by staff, and are associated with the 303(d) listing for nutrients and dissolved oxygen in Chorro Creek:

1. Biostimulatory substances
2. Dissolved oxygen.

3 NUMERIC TARGETS

The numeric target used to develop the TMDL for dissolved oxygen is a concentration of 7 mg/L, measured as an instantaneous daily minimum. The numeric target for dissolved oxygen expressed as saturation is 85%, measured as a daily median. These targets are based on the most stringent water quality objectives protecting established beneficial uses in the Project area. Achieving the numeric target for dissolved oxygen concentration means that dissolved oxygen concentration will not fall below 7 mg/L. Achieving the numeric target for dissolved oxygen saturation means that the daily median dissolved oxygen saturation will not fall below 85%.

The numeric target for biostimulatory substances is a combination of the numeric target for dissolved oxygen and a numeric target for benthic algae. The numeric target for benthic algae is an aerial cover of 40%, expressed as a monthly median from May through September, and measured at mid-channel in reaches with continuous (non intermittent) flow. Achieving the numeric target for biostimulatory substances while at the same time and location achieving the dissolved oxygen numeric target means that the numeric target for biostimulatory substances is being met. The target for algae is based on USEPA's recommendation for algal cover (USEPA, 2000).

4 SOURCE ANALYSIS AND CAUSES OF IMPAIRMENTS

This section discusses the causes of impairments in Chorro Creek. The identified causes are then used as the basis for recommended implementation actions outlined in the Implementation section of this document.

The causes of impairment due to biostimulatory substances and low dissolved oxygen levels are the result of complex physical and chemical relationships occurring in riparian and aquatic systems. The following discussion aims to simultaneously identify these key relationships as well as the sources of chemicals helping to drive the relationships.

4.1 Dissolved Oxygen and Biostimulatory Substances: Sources and Exceedences

The narrative objective for biostimulatory substances is indicated by algae cover. Excessive algal growth can impact dissolved oxygen concentration. Dissolved oxygen and algal cover are discussed together, since they are related.

4.1.1 Dissolved Oxygen Discussion

The amount of dissolved oxygen in water is a result of oxygen input and removal. Oxygen is imparted into water through aeration occurring at the water surface and air interface. Turbulence increases the surface area of water exposed to air as well as results in turnover of water from below to the surface. The result is re-aeration of oxygen into water. Conversely, slow-moving, stagnant, and pooled water has little opportunity for aeration, resulting in declining dissolved oxygen if removal exceeds input. Oxygen input into the water column also results from photosynthesis of aquatic plants.

Oxygen removal is the result of oxygen demand. Oxygen demand results from the sum of biological, chemical, and physical removal of oxygen in water. Biological removal of oxygen occurs when aquatic plants respirate, primarily during evening and early morning hours. Oxygen is removed from the water column during respiration by plants for cell production. Microbes remove oxygen from the water column during decomposition of organic material. Chemical removal of oxygen from the water column occurs through many processes. For example, ammonia is oxidized to nitrite, and eventually nitrate, thereby removing available oxygen from the water column. Ammonia can be loaded into aquatic systems anthropogenically. Ammonia is also a product of decomposition of organic matter. Physical removal of oxygen occurs between the atmosphere and the water column. The saturation of oxygen in water is a function of temperature and salinity; water with lower temperature and salinity retains more dissolved oxygen, relative to higher temperature and salinity.

The Basin Plan requires that Chorro Creek carry a dissolved oxygen concentration of 7 mg/L and should carry a median saturation of 85% or greater. The 85% objective applies to controllable water quality conditions. To achieve this level of dissolved oxygen (DO), oxygen demand cannot exceed oxygen input. In addition, water temperature, salinity, and hydraulics need to be in balance with oxygen demand to a point where the dissolved oxygen objectives are sustained.

4.1.2 Oxygen Input in Chorro Creek

The input of oxygen occurs through aeration and as a product of photosynthesis by plants. As discussed above, oxygen is imparted into the water column through contact of the water surface and the atmosphere. Turbulent water increases the surface area of the waters' surface, thereby increasing dissolved oxygen in the water column. Turbulence can occur through complexities within the wetted channel. Flow magnitude and velocity, woody debris, geologic features, slope, stream substrate, sinuosity, etc., all play a role in creating turbulence.

Chorro Creek is effluent dominated during the summer and late fall downstream of the California Men's Colony (CMC) discharge. Flow is minimal during summer and early fall at sites upstream of the CMC discharge, relative to downstream of the discharge. The median flow upstream of the CMC discharge in July-September of 1998 is 0.38 ft^3/second, whereas downstream flow median value is 1.62 ft^3/second. The increased flow downstream of the discharge results in greater opportunity for aeration due to increased water surface area and turbulence, relative to upstream.

Reduced slope in lower reaches also plays a role in minimizing re-aeration, and could counteract the increased flow. Reduced slope, and therefore reduced turbulence, is apparent at monitoring sites TWB and CCR. Figure 4.1 is a photograph of site TWB. Note the smooth water surface and absence of turbulence. Re-aeration of oxygen at this site and site CCR is minimal. *We will discuss, in a subsequent section, the resulting dissolved oxygen level at site TWB.*

Figure 4.1 Site TWB, illustrating lack of re-aeration due to absence of turbulence.

Some reaches in Chorro Creek, as well as tributaries to Chorro Creek, cease flowing altogether during some months. As such, low dissolved oxygen in these areas is inevitable. Consider the conceptual model of dissolved oxygen levels under varying flow conditions in Figure 4.2. The model assumes that all factors, excepting aeration, affecting dissolved oxygen are static.

Dissolved oxygen concentration can rise to a saturation level under high flow conditions, noted at letter "A." Conversely, dissolved oxygen concentration will be lower under decreasing flow conditions, noted by letter "B," eventually reaching zero when flow ceases completely. *It is therefore reasonable to conclude that under decreasing flow conditions, there will be some point at which dissolved oxygen will be less than the desired 7 mg/L protective of the COLD beneficial use.* As such, excursions of the dissolved oxygen water quality objectives are inevitable in streams where flow gradually diminishes to zero. Such is the case in Chorro Creek and its tributaries. Water flow is minimal in the late summer months.

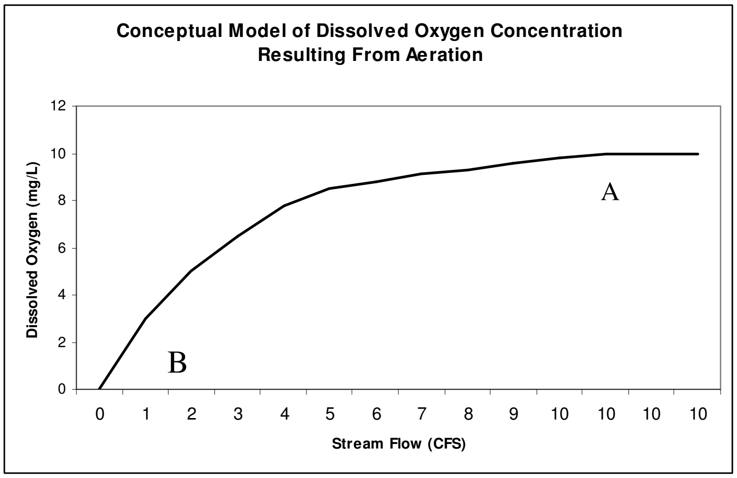


Figure 4.2 Conceptual model of dissolved oxygen concentration as a function of flow.

Oxygen input through photosynthesis also occurs in Chorro Creek. Specifically, benthic algae has been documented in the lower reaches of Chorro Creek. Oxygen concentration can rise dramatically in the presence of high-density algae colonies during daylight hours. Conversely, dissolved oxygen levels can sink during predawn hours as a result of respiration. Data illustrating this phenomenon is presented in subsequent sections.

4.1.3 Oxygen Demand in Chorro Creek

Removal of oxygen in Chorro Creek occurs through physical, biological, and chemical processes. Of particular concern are the biological and chemical processes as these processes are potentially controllable and can be used to implement measures to increase dissolved oxygen.

The physical release of oxygen into the atmosphere is a function of water temperature, salinity, and atmospheric pressure. Oxygen solubility in water is inversely proportional to water temperature. Water temperature increases with increasing solar radiation as well as from discharges with temperatures exceeding receiving water temperature. Oxygen solubility decreases exponentially with increasing salinity (Wetzel, 1975). The loading of salts will increase water column salinity thereby decreasing dissolved oxygen solubility.

Little salinity data is available in Chorro Creek. However, total dissolved solids (TDS) data is often used as a surrogate to salinity. In addition, the CMC treatment plant monitors sodium concentration in the effluent discharged to the Creek as well as the resulting sodium level in receiving waters. The Basin Plan objective for TDS in Chorro Creek is an annual mean of 500 mg/L. The Basin Plan objective for sodium in Chorro Creek is 50 mg/L.

Table 4.1 shows monthly average of TDS in 2003 in receiving waters immediately upstream of the CMC discharge (site RW1), the effluent, and immediately downstream of the discharge (site RW2). Site RW0 is approximately two miles upstream of the CMC discharge. Please see Figure 4.11 for map of monitoring locations.

Table 4.1 Total Dissolved Solids in CMC effluent and receiving waters in 2003.

Upstream →				
DATE	RW2 (TDS mg/L)	EFFLUENT (TDS mg/L)	RW1 (TDS mg/L)	RW0 (TDS mg/L)
Jan-03	540	660	500	NA
Feb-03	NA	690	NA	NA
March-03	NA	520	NA	NA
Apr-03	530	560	510	NA
May-03	550	750	520	NA
Jun-03	550	500	550	380
Jul-03	690	530	610	400
Aug-03	510	460	550	340
Sep-03	520	450	580	NA
Oct-03	550	520	610	430
Nov-03	550	540	550	380
Dec-03	550	570	540	380
Average		**562**		

Data drawn from CMC monitoring reports.
NA: data not available.

Note that the TDS from the CMC effluent caused an increase in receiving water TDS in three of the twelve months sampled. Also note that TDS values upstream of the CMC discharge are consistently above 500 mg/L. There are no known anthropogenic sources of TDS upstream of the CMC discharge. Therefore, background levels of TDS may be above the Basin Plan objective of 500 mg/L. However, TDS from the CMC effluent is over the Basin Plan objective of 500 mg/L. Therefore, during low flow conditions (Summer and early Fall), TDS loading from the CMC plant will have a higher probability of increasing receiving water TDS. In addition, effluent from the CMC discharge is adding TDS to Chorro Creek above the water quality objective. Therefore, staff concludes that natural TDS concentration in Chorro Creek may exceed the Basin Plan objective, but *loading from the CMC discharge is exacerbating the TDS concentration in Chorro Creek.*

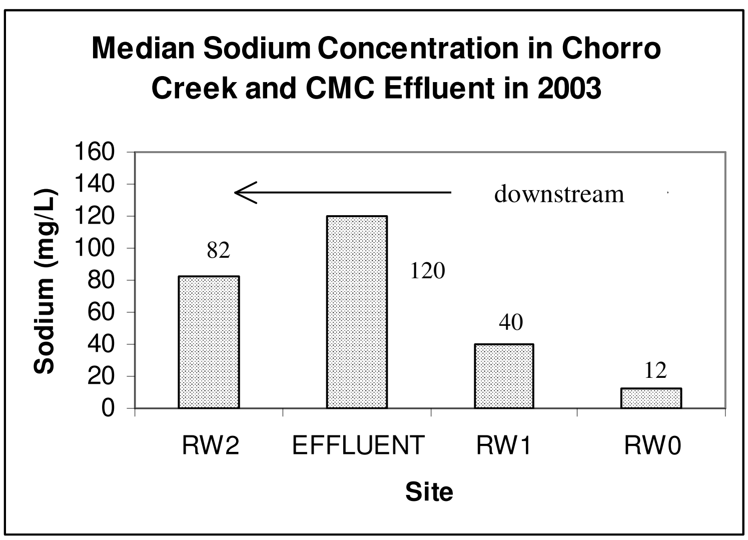
Table 4.2 shows sodium concentration of the CMC effluent as well as in Chorro Creek. Figure 4.3 illustrates the data graphically.

Note that sodium concentration below the reservoir, at RW0, is less than at RW1, located 100 feet upstream of the CMC outfall. Also note that the sodium level of the effluent is significantly greater than RW1, creating an increase in sodium concentration 100 feet downstream of the outfall at RW2. In addition, sodium concentration in the CMC effluent remains consistent throughout the year, even into the summer months. It is during the summer months that stream flow is minimal (relative to winter), and biologic removal of oxygen is greatest. Consequently, the effect of chemical removal of oxygen will be more pronounced during the summer. Finally, note that the Basin Plan objective for sodium is not being met downstream of the CMC outfall. *This increase in sodium concentration from the CMC discharge reduces oxygen solubility in Chorro Creek.*

Table 4.2 Sodium concentration in CMC effluent and receiving waters in 2003.

Upstream →				
DATE	RW2 (Na mg/L)	EFFLUENT (Na mg/L)	RW1 (Na mg/L)	RW0 (Na mg/L)
Apr-03	41	120	31	NA
May-03	53	170	34	NA
Jun-03	82	100	36	NA
Jul-03	140	140	42	11
Aug-03	64	100	42	11
Sep-03	77	110	44	NA
Oct-03	90	120	43	12
Nov-03	110	130	40	12
Dec-03	86	130	38	12
Mean	83	124	39	12
Median	82	120	40	12

Data drawn from CMC monitoring reports.
NA: data not available.



Developed from 2003 CMC monitoring reports.
Figure 4.3 Median sodium concentration in Chorro Creek and effluent in 2003.

Receiving water temperature, like sodium, is affected by the CMC discharge. The CMC discharge increases receiving water temperature. Figure 4.4 illustrates the increase in temperature downstream of the CMC outfall.

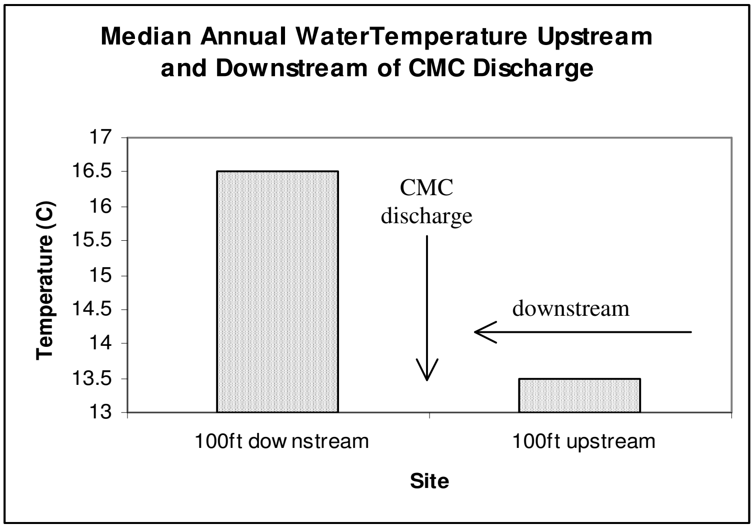


Figure 4.4 Receiving water temperature downstream and upstream of CMC discharge

The increase in temperature resulting from the CMC outfall reduces oxygen solubility in downstream waters.

Discharge from the CMC is not the only source of temperature increase in Chorro Creek (Creek). Some sites along the Creek have minimal or absent overhead canopy. Solar radiation on the Creek is not interrupted, thereby causing stream temperatures to rise during peak solar hours. Figure 4.5 illustrates 24-hour stream temperature at site TWB. Please see in Figure 4.1 that site TWB receives direct solar radiation on the water surface and stream bottom at this site.

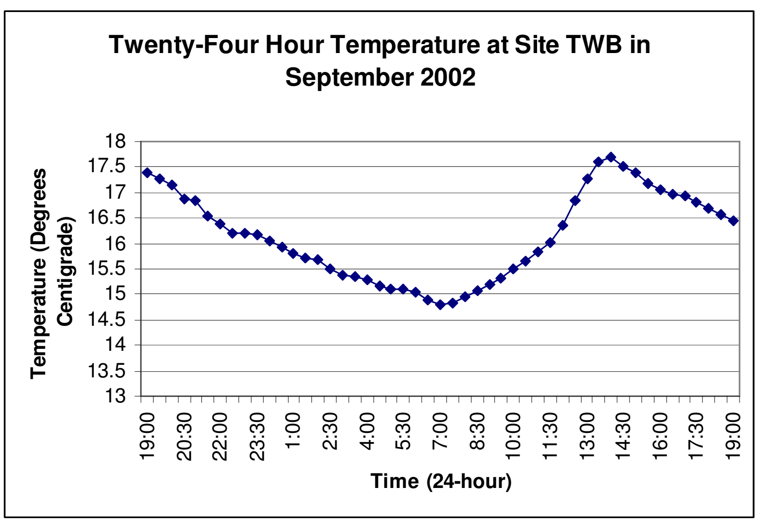


Figure 4.5 Twenty-four hour stream temperature at site TWB.

Note from the temperature graph that peak temperature occurs during mid-day hours. The data indicates that solar radiation is causing increased water column temperature. The increased temperature affects dissolved oxygen levels in the Creek by reducing oxygen solubility. In addition, as will be discussed below, the increased temperature results in increased algal cover, which is a biologic source of oxygen removal.

Chemical removal of dissolved oxygen in the water column can result from the oxidation of ammonia. Table 4.3 shows monthly averages of total ammonia concentration in receiving waters immediately upstream of the CMC outfall (RW1), the effluent, and immediately downstream of the outfall (RW2). Site RW0 is approximately two miles upstream of the CMC outfall and is immediately downstream of the Chorro Reservoir.

Table 4.3 Total Ammonia concentration in Chorro Creek in 2004.

Upstream →				
DATE	RW2 Ammonia (mg/L-N)	EFFLUENT Ammonia (mg/L-N)	RW1 Ammonia (mg/L-N)	RW0 Ammonia (mg/L-N)
Apr-03	ND	0.15	ND	0.11
May-03	ND	0.14	ND	ND
Jun-03	ND	0.12	ND	ND
Jul-03	ND	ND	ND	ND
Aug-03	ND	ND	ND	ND
Sep-03	ND	ND	ND	ND
Oct-03	ND	ND	ND	ND
Nov-03	1.8	1.9	ND	ND
Dec-03	ND	ND	ND	ND

Data drawn from CMC monitoring reports.
ND: not detectable.

The data from Table 4.3 suggests that oxygen removal through the oxidation of ammonia is not a significant problem in Chorro Creek. Only during November did the CMC effluent have a noticeable impact on ammonia levels in the Creek. Background levels are non-detectable.

Biological removal of oxygen from the water column, as discussed above, occurs through respiration of aquatic plants and as a result of decomposition. Indicators of biologic removal include the presence of algae and the measurement of biochemical oxygen demand (BOD).

BOD data is available for the effluent from the CMC plant. Receiving water data for BOD is not available. The CMC discharge permit has an effluent limit for BOD of 10 mg/L, measured as a monthly average. The monthly average mass loading cannot exceed 100 lb/day. Table 4.4 shows monthly averages of BOD in the effluent in terms of concentration and mass.

Table 4.4 BOD in effluent from CMC plant in 2004.

	BOD	
DATE	mg/L	lb/day
Jan-03	6.6	64
Feb-03	7	62
Mar-03	5.5	43.8
Apr-03	5	45
May-03	6.1	52.6
Jun-03	7.1	66.1
Jul-03	4.9	44
Aug-03	3.3	20.3
Sep-03	2.7	16.8
Oct-03	4.5	33.3
Nov-03	5.3	51.5
Dec-03	7.5	70.2

Data drawn from CMC 2003 monitoring reports.

Note that the concentration of BOD in the effluent from the CMC plant has a range of 2.7-7.5 mg/L, with no excursions of the permit limits. The mass BOD loading ranges from 16.8-70.2 lb/day, again, no excursion of the permit limits occurred in 2004. Receiving water BOD data is not available. Staff concludes that although the CMC discharge is adding BOD mass load to Chorro Creek, there is no evidence to suggest that the loading of BOD from the discharge is causing an excursion of the dissolved oxygen water quality objectives.

Biologic removal of dissolved oxygen also occurs through the respiration of living aquatic plants and the decomposition of plants and other organic matter. Of particular concern is algae, which respirate during the evening and predawn hours, and eventually die and are decomposed. Algae that are single-celled, free-living in the water column are measured in terms of the suspended chlorophyll-a concentration. Suspended chlorophyll-a levels in streams and rivers should range from 1.78-4.85 µg/L, with a specific target of 1.78 µg/L being associated with desirable dissolved oxygen levels (USEPA, 2001). Table 4.5 shows suspended chlorophyll-a concentration in Chorro Creek during 2003. Please refer to Figure 4.10 for monitoring site locations.

Table 4.5 Suspended chlorophyll-a concentration in Chorro Creek in 2003.

	Suspended Chlorophyll-a		
	Upstream →		
DATE	RW2 Chlor-a µg/L	RW1 Chlor-a µg/L	RW0[1] Chlor-a µg/L
Apr-03	4	25	6.7
May-03	2	2	3
Jun-03	ND	ND	4
Jul-03	ND	ND	ND
Aug-03	ND	ND	ND
Sep-03	ND	ND	ND
Oct-03	ND	ND	ND
Nov-03	ND	ND	ND
Dec-03	ND	ND	ND

RW0; located about 2 miles upstream of CMC outfall.
RW1; located 100 ft upstream of CMC discharge.
RW2; located 100 feet downstream of CMC discharge.
ND; not detected

Suspended chlorophyll-a concentration was above the USEPA recommended level in April. All other months were within the recommended concentration range. Note that during the summer months chlorophyll-a was not detected. This is important because the physical input of dissolved oxygen is lower during summer, relative to winter. It is during the summer that low dissolved oxygen is a potential problem. Staff concludes that suspended algae are not significantly driving dissolved oxygen levels in Chorro Creek.

Attached benthic algae are a filamentous plant that attaches to stream substrate. It is often seen in coastal streams in summer and late fall. The presence of benthic algae is often quantified as the mass of chlorophyll-a over an area, e.g. mg/m^2. Nuisance densities of benthic algae fall within the range of 100-200 mg/m^2 of chlorophyll-a (USEPA, 2000), with levels greater than 200 mg/m^2 of chlorophyll-a producing a very green stream bottom (Dodds *et al*, 2000).

Another means of quantifying benthic algal cover is in terms of the percentage of aerial cover of the stream bottom. The United States Environmental Protection Agency (USEPA) compiled results of research and recommendations and found that algal biomass greater than 150 mg/m^2 indicates nuisance conditions in streams. As an aerial coverage, this biomass corresponds to a range from 20%-40% cover (USEPA, 2000). Therefore, for the purposes of this Project, aerial cover of algae exceeding 40% cover is considered evidence of an excursion of the biostimulatory substances objective, and a potential force causing low dissolved oxygen.

Recall that the water quality objective for dissolved oxygen is 7 mg/L; dissolved oxygen concentration is not to fall below this level in order to be protective of the COLD beneficial use. Staff compiled predawn and daylight hour dissolved oxygen data. Figure 4.6 illustrates dissolved oxygen levels in Chorro Creek during a 40-hour period in September 2003. Table 4.6 shows the number of exceedences of the dissolved oxygen objective at each site during this 40-hour period.

Please refer to Figure 4.10 for an illustration of the site locations in Figure 4.3. Site TWB is near the mouth of Chorro Creek. Site CCR and TWB are downstream of the confluence with San Bernardo and San Luisito Creeks. Site CAN is upstream of these tributaries, but downstream of the CMC discharge. Site CHO is in the upper watershed, and is upstream of the CMC discharge.

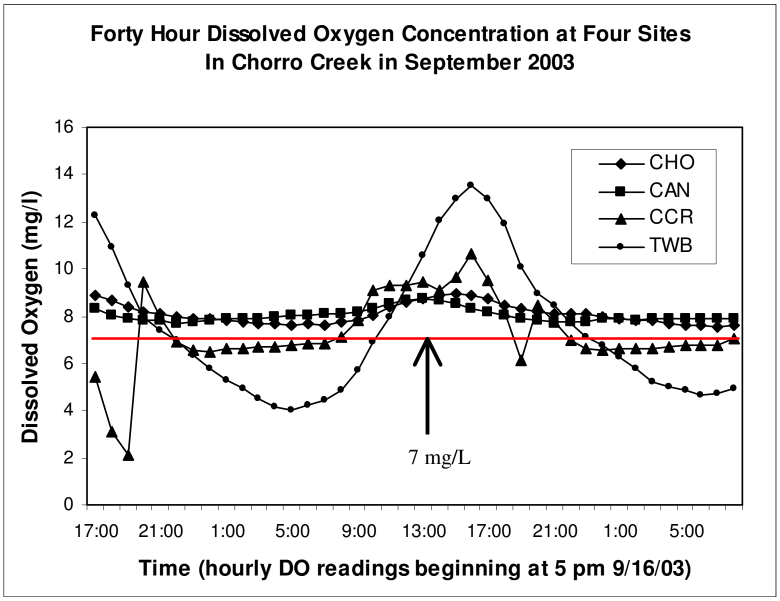


Figure 4.6 Forty Hour Dissolved Oxygen Concentration in Chorro Creek

Table 4.6 Number of dissolved oxygen violations at four sites on Chorro Creek

Site	TWB	CCR	CAN	CHO
No. of exceedences[1]	22	24	0	0
Benthic Algal Cover	≥ 99%	No data	95%	90%

[1] Number of events where dissolved oxygen concentration fell below 7 mg/L

It is clear from Figure 4.6 and Table 4.6 that the dissolved oxygen objective is not being achieved at sites TWB and CCR during the early morning hours. Site TWB, located near the mouth of Chorro Creek watershed, displays evidence of dissolved oxygen affected by the presence of algae. Note that dissolved oxygen levels fall well below the 7 mg/L threshold at this site during the evening and predawn hours, whereas afternoon levels are an order of magnitude higher, relative to predawn hours; an oxygen curve as this is typical of waters affected by photosynthesis and respiration of aquatic plants. Also note that the benthic algal cover at site TWB reaches as high as 99%. No quantified data for algal cover is available for site CCR. However, anecdotal information suggests that site CCR carries maximum algal levels similar to that of site TWB.

Respiration of aquatic plants, e.g. benthic algae, affect water column pH. Photosynthesis is accelerated during afternoon hours when peak solar radiation is present. Photosynthesis by algae uses water column carbon dioxide. The reduced carbon dioxide has a net affect of increasing pH. Therefore, accelerated respiration during daylight hours is indicated by a corresponding increasing pH during these hours. Figure 4.7 illustrates water column pH at site TWB during a 24-hour period in September 2002. Note that pH rises during mid-to-late afternoon hours, corresponding to peak solar radiation hours.

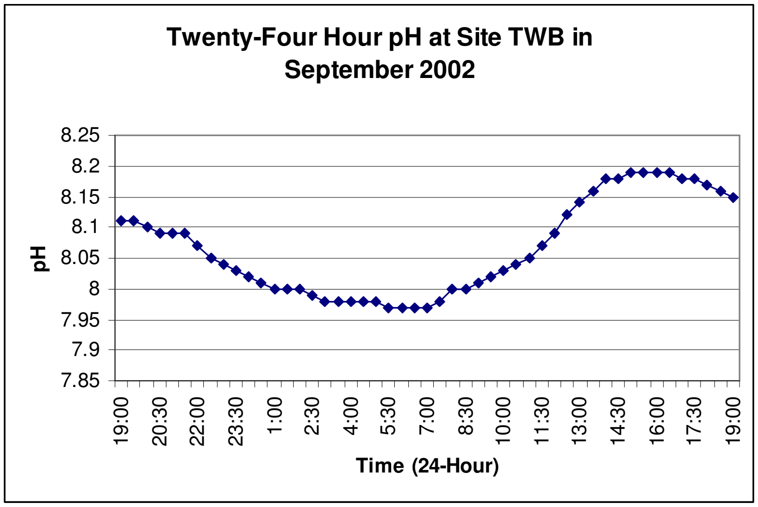


Figure 4.7 Twenty-four hour pH levels at site TWB.

The diurnal dissolved oxygen curve of Figure 4.7, in combination with the algal levels observed in the lower part of the watershed (sites TWB and CCR) and pH fluctuations at this site, indicates that low dissolved oxygen levels are, at least in part, driven by benthic algae.

Staff concludes that benthic algae is a source of biologic removal of dissolved oxygen in lower Chorro Creek during predawn hours, and is a factor causing impairment of low dissolved oxygen at sites TWB and CCR. The oxygen removal from benthic algae is not counteracted by oxygen input in the lower portion of the watershed at sites TWB and CCR, resulting in dissolved oxygen levels falling below the dissolved oxygen water quality objective, which is the proposed numeric target.

To summarize the discussion thus far, the following conditions are causing or exacerbating low dissolved oxygen levels:

1. Loading of total dissolved solids (TDS) by the CMC plant is exacerbating naturally high levels of TDS in Chorro Creek, thereby reducing oxygen solubility.
2. Loading of sodium by the CMC plant is reducing dissolved oxygen saturation.
3. Increases in water temperature are reducing oxygen saturation. Sources of temperature increase in Chorro Creek include:
    - Discharge from the CMC plant, and
    - High solar radiation due to a lack of riparian vegetation in some areas.
4. Oxygen demand due to respiration of benthic algae.

4.2 Biostimulatory Substances

Benthic algae is a natural plant in most stream systems and is a vital component of the stream food web. Under natural conditions, algal density is kept at levels that do not indicate biostimulation (and therefore do not adversely affect dissolved oxygen) through factors limiting algal growth. Factors limiting algal growth include (but not limited to):

1. nutrients

2. light
3. substrate
4. flowing water
5. temperature.

Benthic green algae require light to grow, stream substrate, e.g. gravel and/or cobble to cling to, flowing water, and as all true plants, algae require nutrients for cell development in an environment of preferred temperature. Flow can be limiting insofar as benthic algae are scoured from stream substrate under heavy flow conditions. Any one of these factors can reduce or eliminate algal growth. In addition, since algae require of suite of nutrients for cell growth, any single nutrient can be limiting. This is an important factor since managing a single nutrient (e.g. nitrate), rather than a suite of nutrients, is often more cost-effective.

Algae respond to increased water temperature with increased growth; within the temperature tolerance range of algae, the growth rate increases due to increased photosynthesis in the presence of warmer water. This phenomenon is evident in Chorro Creek watershed during the summer months when flow diminishes and water temperature increases, as does algal density. These factors are discussed below.

4.2.1 Nutrient Availability and Benthic Algae Cover

Algae require nutrients for cell production, and therefore growth. As such, nutrient management is the subject of numerous research efforts aimed at controlling benthic algae. Results of research vary. Staff reviewed existing research aimed at determining what levels of nitrogen and/or phosphorus are necessary to prevent nuisance levels of algae. Recommended nutrient levels vary by orders of magnitude, and carrying capacity of algae can occur at background nutrient levels. Recommended levels of total nitrogen-N and phosphorus-P range from 0.2-1.5 mg/L-N and 0.038-0.4 mg/L-P, respectively. The variability of recommended nutrient levels may be the result of the variability of stream systems, as well as the number of factors affecting algal growth. In addition, research suggests that the relationship between algal cover and nutrient availability, when a relationship *does* exist, exists only within a narrow range of nutrient availability; i.e., above a nutrient threshold availability, algal density does not respond (Perrin *et al*).

Figure 4.8 illustrates typical benthic algal cover at site CHD. Note that benthic algae cover rises dramatically in the summer to 80%. This algal cover occurs in the presence of background levels of nitrate-N and orthophosphate. Therefore, an increase of nutrient availability above the current level at site CHD will not be met with corresponding increase in algal cover, since algal cover is nearly 100% at background nutrient levels.

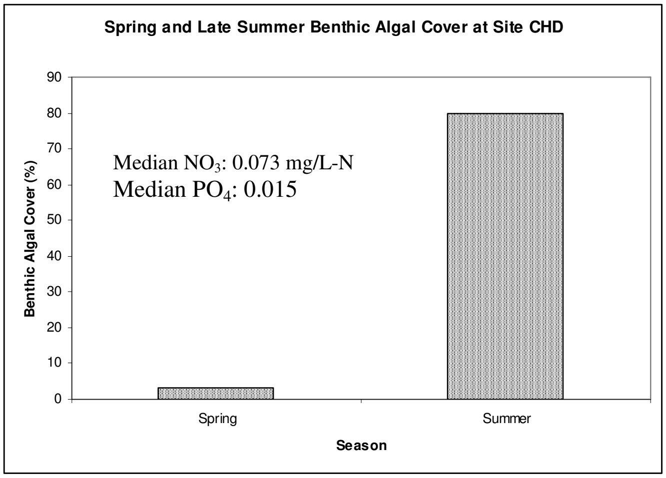


Figure 4.8 Benthic algae cover at reference site CHD in Chorro Creek

The phenomenon of high algal cover in the presence of background nutrient availability is noted not only in the Chorro Creek watershed, but also in other watersheds in the Central Coast Region. Figure 4.9 is a photograph illustrating nearly 100% algal cover in Stenner Creek Watershed, which is adjacent to the Chorro Creek watershed. The site of the photograph carries median nitrate-N levels of 0.05 mg/L-N and median orthophosphate levels of 0.03 mg/L-P. Staff observes that as flow is reduced during the summer months, water temperature rises, algal density increases, and dissolved oxygen levels are reduced.

Figure 4.9 High algal cover in waters with background nutrient levels. Stenner Creek.

The information above leads staff to conclude that nutrient loading in Chorro Creek from anthropogenic sources, including the CMC discharge, is not <u>*alone*</u> *causing nuisance levels of algal cover.*

Nutrient availability alone is not driving current algal cover in Chorro Creek. However, since nutrient availability is one of the factors limiting algae, discussion now turns to sources of nutrients in Chorro Creek watershed (watershed). Recall from the discussion at the beginning of

Section 4.2.1 that the recommended range of nitrate-N and orthophosphorus-P to control nuisance levels of algae are 0.2-1.5 mg/L-N and 0.038-0.4 mg/L-P, respectively.

Staff evaluated effluent and receiving water nitrate-N and total phosphorus data collected by the wastewater treatment plant for the California Men's Colony (CMC). Table 4.7 shows the most recent complete annual dataset. Monitoring site RW1 is immediately upstream of the discharge, and monitoring site RW3 is downstream of the discharge.

Table 4.7 Monthly nitrate and phosphorus concentrations of CMC effluent and receiving waters.

Date	Nitrate-N			Phosphorus-P		
	←Downstream			←Downstream		
	RW3	Effluent	RW1	RW3	Effluent	RW1
Jan-04	2	7.5	0	1	3.2	0
Feb-04	3.2	12	0	0.8	3	0
Mar-04	0.3	1.3	0.11	0.61	3.1	0
Apr-04	0	8.1	.55	0	5	0.58
May-04	2	7.9	0.54	0.6	1.7	0
Jun-04	2.5	7.7	0.66	0.76	2.5	0
Jul-04	2.1	5.9	0.66	0.89	2.6	0.58
Aug-04	2.7	6.8	0.72	1.4	2.8	0.63
Sep-04	2.9	5.9	0.68	1.4	2.4	0.61
Oct-04	4.1	5.9	0.86	1.2	2.6	0
Nov-04	1.5	2.5	0.72	0.97	3.2	0
Dec-04	2.9	9.3	0.63	0.91	2.4	0
Jan-05	1.4	8.8	1.1	0	1.6	0
Feb-05	2	12	1.1	0	3.3	0
Mar-05	0	5.4	1	0	3.1	0
Apr-05	1.9	11	1.1	0.41	3.8	0
May-05	2.7	13	0.84	0.41	2.1	0
Jun-05	1.8	9.5	1	0.4	2	0
Jul-05	1.7	13	0.89	0.37	1.8	0
Aug-05	1.8	9.1	1	0.53	2.7	0.072
Sep-05	2.7	7.7	1.1	0.6	2.4	0
Oct-05	5	14	1	0.95	3.5	0
Nov-05	4.6	12	0.96	1.01	3.3	0.051
Dec-05	4.8	14	0.97	1.1	3.8	0.058
Median	**2.05**	**8.45**	**0.85**	**0.685**	**2.75**	**0**
May-Sept. Median	**2.3**	**7.8**	**0.78**	**0.6**	**2.4**	**0**

It is clear from the data in Table 4.7 that the discharge from CMC increases nitrate-N and phosphorus concentration in Chorro Creek. The following observations can be made from the table:

- Dry season median nitrate-N concentration at the downstream site (RW3) is 2.3 mg/L-N, and is 1.2 mg/L-N above the range of recommended concentration to control nuisance algae.

- Dry season median total phosphorus concentration at the downstream site (RW3) is 0.6 mg/L-P, and is 0.2 mg/L-P above the range of recommended concentration to control nuisance algae. Note that because the table presents total phosphorus data, and the recommended level is in terms of orthophosphorus, that the concentration above the recommended level is actually less than 0.2 mg/L-P.

Table 4.7 shows median nitrate-N and orthophosphorus-P concentrations along the main stem of Chorro Creek (Creek) immediately upstream and downstream of the CMC discharge. Recall, however, that dissolved oxygen levels fall below the desired levels near the mouth of the Creek, i.e., at site CCR and TWB. Figure 4.11 illustrates resulting nitrate-N and orthophosphorus-P concentrations at site TWB. Refer to Figure 4.10 for site locations.

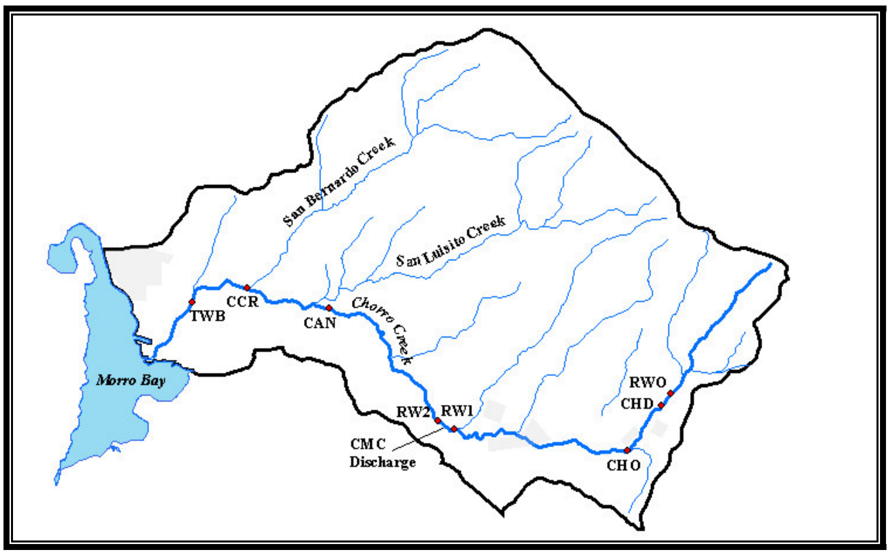


Figure 4.10 Monitoring Site Locations

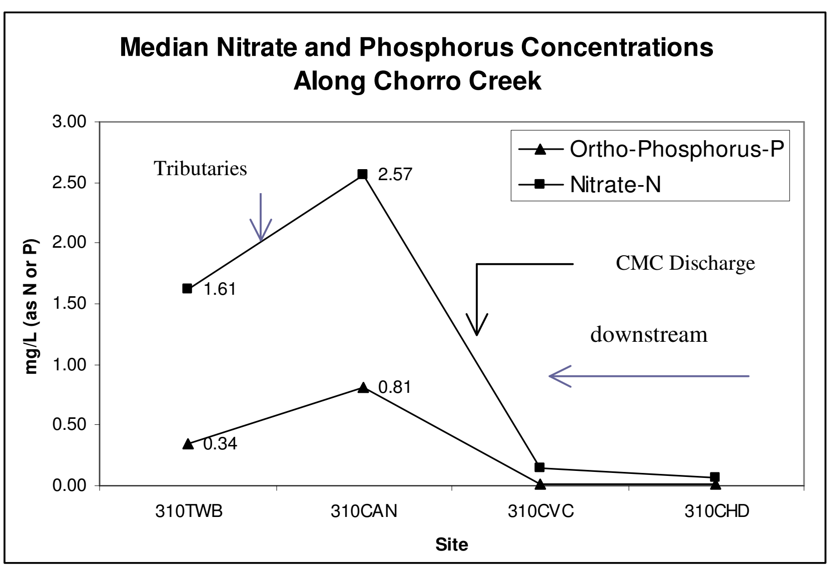


Figure 4.11 Median and Maximum orthophosphorus and nitrate-N concentration at main stem sites of Chorro Creek

Note from the figure above that nitrate-N concentration at site TWB is 1.61 mg/L, which is within 0.11 mg/L-N of upper end of the range (0.2 – 1.5 mg/L-N) suggested to protect against nuisance algal growth. This is an important fact, because recall it is site TWB that is not achieving the dissolved oxygen numeric target, which is in part driven by algal levels present here. Conversely, the orthophosphorus-P concentration at TWB (0.34 mg/L-P) is within the suggested range (.038-.4 mg/L-P). Finally, the tributaries of San Bernardo and San Luisito have a confluence upstream of site TWB. Note that both nitrate-N and orthophosphorus-P concentrations are lower downstream of these confluences, relative to site 310CAN, indicating that discharge from these tributaries are not causing a rise in nitrate-N and orthophosphate-P concentration. Discharges to Chorro Creek from these subwatersheds are discussed below.

Staff concludes from information above that the CMC is causing an increase in nitrate-N and orthophosphorus-P concentration in Chorro Creek (Creek). The increase in orthophosphate-P is attenuated in the lower reaches of the Creek to levels within the acceptable range for the control of nuisance levels of algae. *The increase in nitrate-N is attenuated in the lower reaches of the Creek to levels slightly outside the acceptable range for the control of nuisance levels of algae.*

The Dairy Creek Golf Course is located within the Dairy Creek watershed (Figure 1.1). Monitoring sites DAL and DAM are used in the analysis of this subwatershed. DAL is located downstream of the golf course and DAM is located upstream. Site DAM receives drainage from grazed lands. There are more than of 300 data points for nitrate-N and orthophosphorus gathered from 1993 to 2001 from DAL and DAM. The median nitrate concentration at both DAL and DAM is 0.45 mg/L-N, and the median orthophosphorus concentration at DAL and DAM is 0.06 mg/L-P. Both of these concentrations are within the suggested range of recommended levels to control nuisance levels of algae. Staff therefore concludes that discharges from the Dairy Creek golf course and grazed lands in the Dairy Creek watershed are not causing impairment in Chorro Creek due to biostimulatory substances and dissolved oxygen.

Cropland activity occurs in San Luisito and San Bernardo Creeks. Monitoring sites SBE and SLU are used in the analysis of this subwatershed. Over 300 data points for nitrate-N and orthophosphorus from these sites monitoring ranging from 1993 to 2001 are used. The median nitrate-N and orthophosphorus concentrations are 0.74 mg/L-N and 0.10 mg/L-P, respectively. The median values are well within the recommended levels to control nuisance levels of algae. Staff concludes that agricultural discharges in these subwatersheds are not causing impairment in Chorro Creek due to biostimulatory substances and/or dissolved oxygen.

Lands draining rangelands occur in Chumash, Walters, Dairy, and Pennington Creek watersheds. Over 750 data from four monitoring sites were collected from 1993 to 2001. The median nitrate-N and orthophosphorus concentrations are 0.12 mg/L-N and 0.05 mg/L-P, respectively. The median values are well within the recommended levels to control nuisance levels of algae. Staff concludes that grazing land uses in these subwatersheds are not causing impairment in Chorro Creek due to biostimulatory substances and/or dissolved oxygen.

Table 4.8 summarizes nitrate-N and orthophosphorus-P data for the tributaries flowing into Chorro Creek. Note that all values are within the range recommended for the control of nuisance levels of algae.

Table 4.8 Nitrate-N and orthophosphorus-P summary of tributaries to Chorro Creek

Tributary	Median NO_3-N	Median PO_4-N	Number of data	Exceedence recommended range?[1]
Dairy Cr.	.140	.06	> 330	No
Chumash Cr.	.136	.04	> 200	No
Pennington Cr.	.180	.07	> 50	No
Walters Cr.	.045	.04	>130	No
San Luisito Cr.	.182	.07	>150	No
San Bernadino Cr.	1.31	.13	>170	No

[1]Measured against the concentration range of nitrogen-N and phosphorus-P recommended to control nuisance algae.

Background nitrate-N and orthophosphorus concentrations are derived from monitoring site CHD, which is located in the headwaters of Chorro Creek watershed (watershed). A reference condition in the lower reaches of the watershed is not available; background concentrations may be different in the lower reaches, relative to the headwaters. The background concentrations for nitrate-N and orthophosphorus are 0.073 mg/L-N and 0.01 mg/L-P, respectively.

4.2.2 Relative Contributions of Nitrate-N and Orthophosphorus-P

Chorro Creek is effluent dominated by CMC discharge during the summer and early fall season. In addition, effluent from the CMC carries the highest concentration of nitrate-N and orthophosphorus-P, relative to the sources identified. Nitrate-N and orthophosphorus-P concentrations in areas draining croplands carry the second highest concentrations, although within the range of recommended concentrations to control nuisance algae. Drainages adjacent to rangelands carry lower nutrient concentrations, relative to other land uses in the watershed. However, rangelands are the largest area of land use in the watershed.

These facts lead staff to estimate that the relative mass contributions of nitrate-N and orthophosphorus-P are, in order of decreasing contribution:

1. CMC wastewater treatment plant.
2. Croplands.
3. Rangelands.
4. Dairy Creek Golf Course.
5. Natural Areas.

The CMC discharge is the only cause of elevated nitrate-N and orthophosphorus-P in excess of the recommended levels to control nuisance algal levels.

4.2.3 Days of Accrual and Benthic Algae Cover

Staff searched available methods that predict algal cover in stream systems. The highest correlation (r^2=0.741) uses days of accrual (D_a) as a predictor for algae (Biggs, 2000). D_a is the number of days since flow was three times the median flow, or more. This hydraulic factor is well correlated to algal density because benthic algae is scoured from stream substrate during high flow velocity. Once the algae is removed from the stream bottom through water flow, the algae begins to grow back through propagules left behind on stream substrate. The longer the elapsed time since stream flow was D_a, the longer the opportunity for the algae to grow, and consequently the more dense the algae.

Days of accrual is an apparent factor in benthic algae presence in central coast streams. Staff compiled monitoring data associated from a watershed adjacent to Chorro Creek watershed that confirms the D_a factor of algal growth. Figure 4.12 illustrates algal cover as a function of the number of days since January 1st.

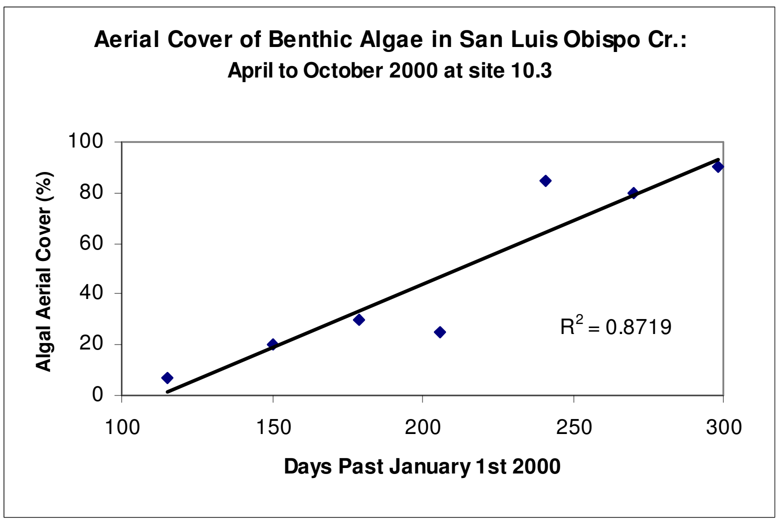


Figure 4.12 The D_a affect: Benthic algae cover in San Luis Obispo Creek as a function of number of days since January 1.

Note from Figure 4.12 that algal cover continues to increase further in time away from winter rain months. The same phenomenon occurs in Chorro Creek. A strong correlation exists between the number of days of accrual and algal cover. The Mediterranean climate of the central coast of California does not produce flows during summer months adequate to scour algae from stream substrate. Scouring does occur in isolated areas of local stream systems, such as along riffle areas where elevation gradients cause increased flow velocity. However, for many reaches in Chorro Creek, summer brings decreasing flow velocity and corresponding increasing algal cover.

Site TWB, illustrated in Figure 4.1, and the dissolved oxygen curve illustrate in Figure 4.6, experiences nearly stagnant flow in the summer months. As such, flow velocity is insufficient to scour algae from stream substrate, or even limit algal growth.

This information leads staff to conclude the natural flow conditions in the lower reaches of Chorro Creek are not limiting to algal growth during summer months.

4.2.4 Light Availability and Benthic Algae Cover

Benthic filamentous green algae is a true plant. As such, it requires light for photosynthesis and therefore growth. Like other plants, algae will respond to increased light with increased growth. Conversely, algae will have slower growth with reduced light. Light is affected in the stream through shading, e.g. by vegetative overhead canopy.

Overhead stream canopy can be used as a measurement of shading. As canopy increases, shading increases proportionally. Shading is created from trees, shrubs, buildings, or any physical object intercepting overhead light. Shading of 100% implies that the stream is completely shaded from direct sunlight.

Figure 4.13 illustrates how algal cover responds to varying shading through canopy cover at adjacent sites in San Luis Obispo Creek, a watershed adjacent to Chorro Creek watershed. All other factors are held equal between the sites, i.e., the stream substrate, nutrient regime, temperature, hydraulics, etc. are equal at the sites. Only canopy cover is variable at these sites.

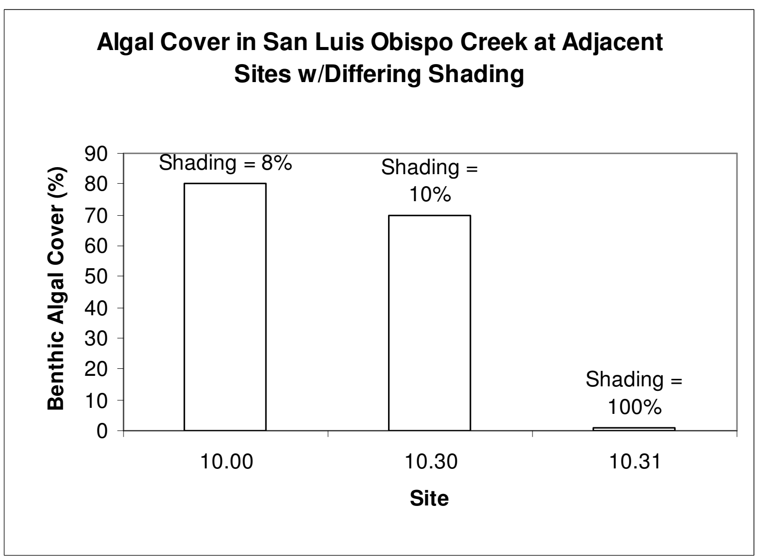


Figure 4.13 Benthic algae cover in San Luis Obispo Creek with varying canopy cover.

Note the dramatic decline in algal cover when overhead canopy is 100%. The same phenomenon occurs in Chorro Creek, as illustrated in Figure 4.14.

Figure 4.14 suggests that an inverse relationship between algal cover and shading exists in Chorro Creek; areas with higher shading carry lower algal cover. This relationship is consistent with the strong correlation between algal cover and days of accrual because as days of accrual increases, so does water temperature. Similarly, as overhead canopy decreases, water temperature increases, and algal cover increases.

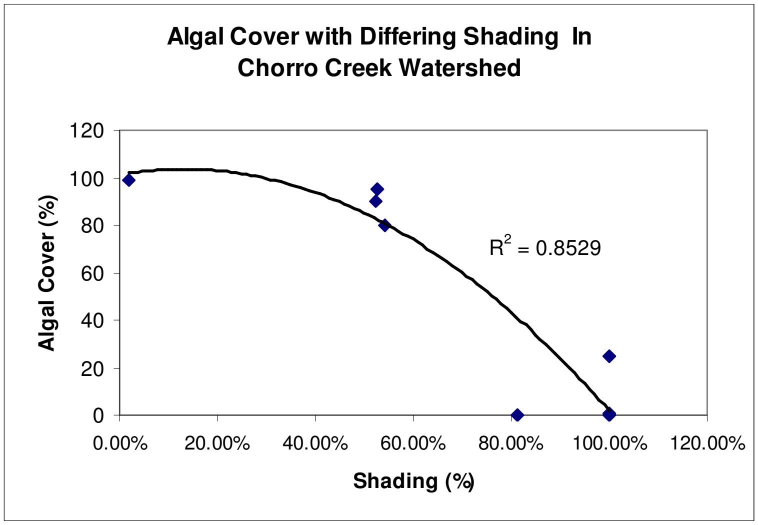


Figure 4.14 Benthic algae cover in Chorro Creek with varying canopy cover.

Note in Figure 4.14 that algal cover in excess of the desired 40% (see Chapter 3) cover occurs when shading is about 70% or less. Recall from Table 4.6 that dissolved oxygen concentrations fall below water quality objectives at monitoring sites TWB and CCR. The canopy cover and corresponding algal cover at site TWB during late summer is:

Canopy Cover: 2%
Benthic algae cover: 99%

Staff concludes that the algal cover at site TWB is, in part, driven by excessive solar radiation, evidenced by a lack of shading from stream canopy.

4.3 Conclusions

The causes and sources of low dissolved oxygen in the lower reaches of Chorro Creek are related to the imbalance between oxygen input and oxygen demand. These causes are:

1. Lack of complicated and turbulent flow pattern thereby minimizing oxygen re-aeration into the water column.
2. Reduced oxygen solubility due to loading of salts (TDS and sodium) from the CMC discharge.
3. Reduced oxygen solubility due to increased stream temperature caused by:
    a. Temperature of CMC discharge.
    b. Lack of riparian shading in some reaches.
4. Increased oxygen demand due to presence of benthic algae in the lower reaches of Chorro Creek, specifically at site TWB.

Biostimulatory substances are indicated by the presence of benthic algae in excess of 40% aerial cover and low dissolved oxygen. The causes of excessive algae are:

1. Nutrient levels are not limiting to benthic algae in the lower reaches of Chorro Creek, specifically within the reach containing site TWB.
2. Climate in the project area produces a high value for days of accrual; there is a lack of scouring flows during the algal growing season.
3. Excessive light availability due to low levels of shading from a lack of riparian canopy in the lower reaches of Chorro Creek, specifically within the reach containing site TWB.
4. Increased water temperatures due to lack of riparian shading in the lower reaches of Chorro Creek, specifically within the reach containing site TWB.

Algal cover in excess of 40% occurs when shading is less than 70%.

5 LINKAGE ANALYSIS, SEASONALITY, CRITICAL CONDITIONS, AND MARGIN OF SAFETY

5.1 Linkage Analysis

An indirect linkage exists between the dissolved oxygen numeric target and sources. The numeric target is expressed in terms of dissolved oxygen. The Source Analysis section discusses the relationship between elevated levels of salinity and temperature with low dissolved oxygen (Section 4.1). The CMC discharge causes increased salinity and temperature in Chorro Creek. Therefore, a link is established between the source and numeric target. Since the CMC is the primary source of elevated salinity and temperature, staff believes that that the proposed reductions of salinity and temperature, acting in concert with other implementation actions, will result in achieving the numeric target for dissolved oxygen.

An indirect linkage exists between the numeric target for biostimulatory substances and sources. The numeric target is expressed in terms of the indicator, benthic algae cover. Benthic algae cover responds proportionally to light, and to a lesser degree, nutrient availability. The CMC discharge causes nitrate-N concentration in the lowest reach of Chorro Creek to exceed the recommended level to limit benthic algae. Therefore, a link is established between this source and the numeric target. The other source, light, is from solar radiation. This source is controlled through management of stream vegetative canopy, or shading. The Source Analysis section demonstrates a relationship between shading and resulting benthic algal cover (Figure 4.14). Therefore, a link is established between the source and the numeric target. Staff believes that the proposed reductions of light (through increased shading) will result in achieving the numeric target for biostimulatory substances.

5.2 Seasonality, Critical Conditions, and Margin of Safety

Seasonality has been accounted for insofar as the allocations are established to achieve the numeric targets during all seasons. The CMC plant will achieve its allocations through a technological upgrade that will operate throughout all seasons.

Critical conditions are accounted for insofar as the allocations are established based on the assumption of zero dilution. A critical condition occurs in late summer when little or no natural flow is present in waters upstream of the CMC discharge. The allocations to the CMC are established based on this critical condition, which does not occur throughout the year.

6 TMDLS , ALLOCATIONS, AND MARGIN OF SAFETY

The TMDLs to address impairment due to dissolved oxygen and biostimulatory substances are outlined below. Recall from the previous sections that benthic algae and low dissolved oxygen are indicators for the impairment from biostimulatory substances. Also recall that a relationship between shading and algal cover has been established; the desired 40% algal cover occurs when shading is no less than 70%. (See discussion in Section 4.2.4)

6.1 TMDLs for Dissolved Oxygen and Benthic Algae

The following TMDLs are established to achieve the dissolved oxygen water quality objective; these TMDLs will also play a role in achieving the narrative water quality objective for biostimulatory substances:

Discharges shall not cause sodium concentration to exceed 50 mg/L in Chorro Creek or its tributaries.

Discharges shall not cause total dissolved solids concentration to exceed 500 mg/L in Chorro Creek or its tributaries.

Discharges shall not cause receiving water temperature to increase by more than 5° F.

The following TMDLs are established to achieve the narrative water quality objective for biostimulatory substances, which will also play a role in achieving the water quality objective for dissolved oxygen.

Median nitrate-N concentration shall not exceed 1.5 mg/L-N within the half-mile reach of Chorro Creek, measured upstream from the road crossing at South Bay Boulevard. The median is measured as a rolling median from May through September.

Median orthophosphorus-P concentration shall not exceed 0.4 mg/L-P within the half-mile reach of Chorro Creek, measured upstream from the road crossing at South Bay Boulevard. The median is measured as a rolling median from May through September.

Discharges shall not cause receiving water temperature to increase by more than 5° F.

Median stream shading shall not fall below 70% along Chorro Creek downstream from Canet Road.

6.2 Allocations and Management Measures to Achieve TMDLs

6.2.1 Allocations to Achieve the Dissolved Oxygen TMDL

Dissolved oxygen concentration in the water column is the result of factors affecting oxygen solubility in water, oxygen input, and oxygen demand. Some of the factors are load-related while others are not. The following allocations are intended to maximize oxygen input and solubility while reducing oxygen demand.

Wasteload Allocations:

- The California Men's Colony (CMC) wastewater treatment plant:

Effluent discharged shall not cause sodium concentration to exceed 50 mg/L in receiving waters, measured as a monthly maximum determined from monitoring stations not more than 200 feet upstream and downstream of the discharge.

Effluent discharged shall not cause total dissolved solids to exceed 500 mg/L in receiving waters, measured as a monthly maximum determined from monitoring stations not more than 200 feet upstream and downstream of the discharge.

Effluent discharged shall not cause receiving water temperature to be increased by more than 5 °F, measured as a monthly maximum determined from monitoring stations not more than 200 feet upstream and downstream of the discharge.

6.2.2 Allocations to Achieve the Biostimulatory Substances TMDL

Wasteload Allocations:

- CMC wastewater treatment plant:

The monthly maximum nitrate-N concentration of effluent shall not exceed 10 mg/L-N.

Median orthophosphorus-P concentration of effluent from May through September shall not exceed current levels, as measured by a comparison to effluent concentration from 2004 and 2005.

Note that achieving the nitrate-N and orthophosphorus-P allocations at the point of discharge will result in achieving the TMDLs for these constituents in the lower reaches of Chorro Creek. Also note that although the nitrate-N allocation is 10 mg/L-N, the technology of the plant upgrade for the CMC facility is expected to result in single digit nitrate-N concentration in the discharge. It is also anticipated that the plant upgrade will result in reduced effluent orthophosphorus-P concentration.

Load Allocation:

Allocations for land owners along Chorro Creek downstream of Canet Road:

Median stream shading shall not fall below 70% along Chorro Creek downstream from Canet Road.

6.3 Margin of Safety

The margin of safety for this TMDL is implicitly included through the use of existing water quality objectives for the TMDLs of sodium, total dissolved solids, and temperature. These water quality objectives are established using conservative assumptions and acceptable risks associated with implementation of the water quality objectives. They were established to protect beneficial uses and selected because they provide levels protective of the beneficial uses associated with impairment addressed in this Project.

The margin of safety for the TMDLs for nitrate-N and shade is implicit. The TMDLs for nitrate-N and shade are based on a scientific approach using data local to the project area. This is in contrast to a common approach where TMDLs are established based on data outside the project area. The use of local data to establish the TMDLs yields a more conservative approach to TMDL development, and raises the probability of rectifying impairment.

Finally, the allocations are based on conservative nitrate-N and orthophosphorus-P thresholds recommended to control nuisance levels of algae.

7 IMPLEMENTATION, MONITORING, EXISTING EFFORTS

The TMDL is being implemented using an adaptive management strategy. The management strategy is to implement the measures outlined below, monitor impacts of the implemented measures, and then make adjustments to implementation measures or the TMDLs as needed during the implementation phase.

The California Men's Colony wastewater treatment plant (CMC) has designed and is currently constructing a plant upgrade. The plant upgrade will be online in 2006. The improved facility will result in compliance with the allocations designated for the CMC.

In addition to effluent changes from the CMC discharge, best management practices and restoration projects in the watershed have already been installed or implemented and new projects are being planned. No new regulatory actions are necessary to achieve the TMDL for biostimulatory substances; recent implemented restoration projects and best management practices in Chorro Creek watershed will result in achieving 70% stream shading. These activities, acting with improvements of the CMC effluent, are expected to result in achieving the TMDLs outlined in this document.

7.1 Implementation

The following implementation measures will be taken to achieve the TMDL:

7.1.1 Implementation to Achieve TMDLs for Nitrate-N, Sodium, Total Dissolved Solids, and Temperature

- The Central Coast Water Board will incorporate effluent and receiving water limits in the California Men's Colony NPDES permit consistent with the allocations assigned to the California Men's Colony in this Project Report.

7.1.2 Implementation to Achieve the Orthophosphorus-P TMDL

- To date, CMC's orthophosphorus-P levels have not caused receiving water increases above the acceptable range of orthophosphorus-P necessary to control nuisance levels of algae in the impaired lower reaches. Therefore, Central Coast Water Board expects these levels to be maintained with the upgraded treatment operations. To insure that the levels don't cause increases in the acceptable range of orthophosphorus-P, Central Coast Water Board staff will review monitoring data for orthophosphorus-P in monitoring reports submitted by the CMC.

7.1.3 Implementation to Achieve Shading TMDL

The Chorro Flats project is a riparian and wetland restoration project, implemented by the Coastal San Luis Resource Conservation District, and located along the lower reaches of Chorro Creek. *The Chorro Flats project will result in attaining the allocation for stream shading.* In addition, other implemented best management practices and restoration projects in Chorro Creek watershed will insure improved shading throughout the watershed. As such, the numeric target for biostimulatory substances will be met. The following discussion outlines the projects that have been completed, or planned and imminent.

The Morro Bay Estuary (Estuary) is the receiving water body of Chorro Creek. The Estuary is a designated national estuary, resulting in federal aid through the United States Environmental Protection Agency. The Estuary has suffered from accelerated sedimentation, largely due to historic land use practices in the adjacent watersheds, including the Chorro Creek watershed. Consequently, there are many existing and planned efforts to minimize erosion in the watershed; these efforts will also result in water quality improvement related to this TMDL project. Specifically, many management efforts in the Chorro Creek watershed have focused on the restoration of riparian areas through vegetative plantings, livestock exclusion, and installation of engineered in-stream hard structures for habitat creation. Previous tree plantings are only now, at the time of this document preparation, beginning to mature to a point where benefits to water quality, e.g. reduced water temperatures, increased stream shading, and the formation of complex flow paths, are being realized. Central Coast Water Board staff is confident that with the maturation of existing restoration efforts, along with achievement of wasteload allocations of this TMDL, that the TMDLs prescribed in this Project Report will be achieved.

7.1.3.1 Chorro Flats

The Chorro Flats project is a riparian and wetland restoration project located along the lower reaches of Chorro Creek. *The Chorro Flats project will result in attaining the allocation for stream shading.* Chorro Flats is located just upstream of monitoring site CCR and extends to the mouth of Chorro Creek near site TWB. Recall that sites TWB and CCR are the monitoring sites where data of predawn dissolved oxygen fell below water quality objectives, leading to the 303(d) listing of Chorro Creek for dissolved oxygen. Restoration began in 1998, the resulting riparian and wetland area is not yet fully mature, but is well on its way to being so.

The Chorro Flats project incorporates channel realignment to a less straight, more sinuous and complicated flow pattern. Before the realignment, Chorro Creek was forced into a straight flow pattern through a levee system in the Chorro Flats area. The realignment has resulted in a longer channel with more opportunity for turbulent flow and reaeration of oxygen into the water column. Nearly 11,000 woody plants have been planted at the Chorro Flats area. Most of the species planted are trees, including sycamore, cottonwood, oak, willow and dogwood. The maturation of the riparian forest is resulting in a shaded channel, thereby reducing water temperature, minimizing algal growth, and producing more re-aeration through turbulence. The end result will be greater dissolved oxygen input and reduced oxygen demand.

Figure 7.1 illustrates a section of Chorro Creek at Chorro Flats in 1998, before revegetation efforts. Note the hill on the left side of the photograph. Figure 7.2 illustrates the same location in January 2006, again note the hill on the left of the photograph, now behind riparian canopy. Also note in Figure 7.2 that a gravel bar has formed on the left due to reduced flow velocity brought on by greater sinuosity. The deposited gravels produce riffle areas where oxygen is aerated into the water column. Finally, note from Figure 7.2 that although the canopy has dramatically increased since 1998, the canopy area directly over the channel is not yet completely filled in. Staff is confident that the stream will be fully shaded as the riparian forest matures, thereby limiting algal growth with the net result of increasing dissolved oxygen over current levels.

Figure 7.1 Photo of Chorro Flats in 1998.

Figure 7.2 Photo of Chorro Flats in 2006.

Over thirty engineered rock and log structures were constructed in the Chorro Flats area to enhance fish habitat. The structures are creating more turbulent flow, deeper pool areas, and the deposition of gravels, all of which will create conditions for the opportunity of increased dissolved oxygen. Figure 7.3 illustrates one of the rock-log structures in Chorro Flats.

Figure 7.3 Instream rock and log structure.

7.1.4 Projects Helpful, but not Required to Achieve TMDL

The following projects are not required to achieve the TMDLs described in this report. However, it is anticipated that these projects will result in benefits to water quality, particularly with respect to dissolved oxygen and biostimulation.

7.1.4.1 Chorro Creek Ecological Reserve

The Chorro Creek Ecological Reserve is located upstream of the Chorro Flats area and below the California Men's Colony (CMC) wastewater treatment plant discharge point. The results of this project will be increased shading downstream of the CMC discharge, thereby limiting the affect of solar radiation on stream temperature as well as limiting algal production. The project includes cattle exclusion of the riparian area through 14,000 feet of fencing constructed along the riparian area of Chorro Creek. The project was completed in 2005.

The fencing has created a riparian buffer zone of approximately 50-feet on each side of the channel, creating an overall 100-foot riparian buffer along Chorro Creek. Figure 7.4 is a photograph of the newly constructed fencing.

The 100-foot riparian buffer zone will protect the riparian area downstream of the CMC outfall. Historically, cattle have been allowed into the riparian area. Breaks in the canopy are evident along this portion of the stream. It is in the canopy breaks that algae have greater opportunity for growth, which when dislocated, can be transported downstream to slower moving waters where reaeration (oxygen input) is not as prevalent, and the dislocated algae decays (oxygen demand). The fencing will result in a more vigorous and sustained canopy growth, greater stream shading, reduced algal growth, and consequently, reduced oxygen demand in downstream waters.

Figure 7.4 Chorro Creek Ecological Reserve.

7.1.4.2 Dairy Creek Gap-Fencing Project

Dairy Creek is a tributary to Chorro Creek, above the CMC discharge location, and in the upper half of the Chorro Creek Watershed. Dairy Creek watershed has a history of grazing land use with cattle access to the riparian area. Riparian vegetation has been damaged in many areas in Dairy Creek watershed. In addition, Dairy Creek is dry or carries minimal flow during the summer months of some years. The combination of minimal flow and a lack of riparian vegetation have resulted in increased solar radiation and temperature, as well as minimal water reaeration during summer months. The result is a higher probability for algal growth and low dissolved oxygen. A healthy riparian forest will help mitigate the tendency towards low dissolved oxygen during the summer through increased shading and reduced temperatures, thereby limiting algal growth, and helping to maintain base flow deeper into the summer months. The gap-fencing project has begun achieving these results.

Gap-fencing is fencing on both sides of the channel to allow the formation of a vegetative riparian buffer, but having a gap in the fencing to allow livestock intermittent (gaps) access to the creek. The result is watering areas in the gaps of the fence (located several hundred feet apart), with complete riparian protection between the gaps.

Gap-fencing was installed in 1995 along Dairy Creek for approximately one and a half miles of stream length. In addition, native willow and oak trees were planted in the riparian area of the fencing. A mature riparian forest is developing in the protected areas. Figures 7.5 and 7.6 are photographs of the gap-fence project area. Note in Figure 7.6 the clear distinction in the riparian forest between the protected fenced area and the open (gap) area. As with the Chorro Flats and Chorro Creek Ecological Reserve, the riparian forest along Dairy Creek is not yet mature, but staff is confident that given time, the riparian vegetation will limit algal growth, thereby limiting oxygen demand, while at the same time increasing oxygen input and solubility.

Benefits to Chorro Creek will be realized through decreased water temperature and reduction in algal density. Algal mats in Dairy Creek can be transported to downstream waters of Chorro Creek, where decomposition results in oxygen demand. Lower temperatures in the upstream Dairy Creek will result in lower temperatures in the receiving waters of Chorro Creek, thereby increasing oxygen solubility.

Figure 7.5 Entrance of gap-fence area along Dairy Creek.

Figure 7.6 Gap and fenced area of Dairy Creek.

7.1.4.3 Walters Creek Fencing and Revegetation Project

Walters Creek is a tributary to Chorro Creek, having a confluence with Chorro Creek downstream of the CMC discharge. Walters Creek is not a 303(d) listed waterbody, and is not causing impairment in Chorro Creek due to dissolved oxygen. However, Walters Creek is discussed here because as a tributary to Chorro Creek, conditions in Walters Creek can impact dissolved oxygen Chorro Creek. Good management practices in Walters Creek, therefore, can have a positive impact on Chorro Creek as well.

Walters Creek watershed has historically been used for grazing purposes. Much of the riparian vegetation in Walters Creek watershed is severely damaged or absent. A riparian fencing project and corresponding revegetation project was installed in 2003. Approximately 3000 lineal feet of stream has been fenced and revegetated with trees and woody plants. Rock structures were also installed to help create a complicated flow pattern and increase aeration of flowing water.

Figure 7.7 is a photograph of the fencing and revegetation project along Walters Creek. Note the blue flags along the creek bank indicating tree plantings. Figure 7.8 is an installed rock structure. When flows are present, water will plunge over the structure, thereby causing increased dissolved oxygen in flowing water.

Figure 7.7 Walters Creek fencing and revegetation project.


Figure 7.8 Installed rock structure in Walters Creek.

7.1.4.4 Four Miles of Riparian Zone Fencing

The Morro Bay National Estuary Program (MBNEP) is planning to install riparian fencing along four miles of riparian area in the Chorro Creek watershed. The project is in the planning stages at the time of this document preparation. Therefore, the location of the fencing has not been determined. Staff anticipates that the fencing will result in increased shading, reduced algal cover, decreased temperature, and corresponding increase in dissolved oxygen in Chorro Creek. It is anticipated that the project implementation will begin in 2006, and will take two years to complete.

7.2 Tracking and Monitoring

7.2.1 Tracking: Triennial Reviews

Progress toward achieving the TMDLs will be tracked by Central Coast Water Board staff during triennial reviews, as described in the following:

- Central Coast Water Board staff will conduct a review of implementation and monitoring activities every three years, beginning three years after TMDL approval by the Central Coast Water Board, unless funding is unavailable. Central Coast Water Board staff (staff) will utilize reports associated with NPDES permits, waivers, Volunteer Monitoring Programs, as well as other available information, to review water quality data and implementation efforts of implementing parties and progress being made towards achieving the allocations and the numeric targets. Staff may conclude that ongoing implementation efforts may be insufficient to ultimately achieve the allocations and numeric targets. If staff makes this determination, staff will recommend that additional reporting, monitoring, or implementation efforts be required either through approval by the Executive Officer (e.g. pursuant to CWC section 13267 or section 13383) or by the Central Coast Water Board (e.g. through revisions of existing permits and/or a Basin Plan Amendment). Staff may conclude that to date, implementation efforts are likely to result in achieving the allocations and numeric targets, in which case existing and anticipated implementation efforts will continue.

Three-year reviews will continue until the TMDL is achieved, unless funding is unavailable. The target date to achieve the TMDL is during or before the year 2016.

7.2.2 Monitoring

- The Executive Officer (EO) or the Central Coast Water Board will amend the Monitoring and Reporting Program (M&RP) of the California Men's Colony (CMC) NPDES permit to incorporate effluent and stream monitoring for nitrate-N, orthophosphorus-P, total dissolved solids, sodium, temperature, dissolved oxygen, and to require reporting of these monitoring activities.

- A collaboration of citizens, local government, non-profit organizations, and agencies are working together to restore and protect the Morro Bay Estuary, which includes efforts in the Chorro Creek watershed. The Voluntary Monitoring Program (VMP) currently monitors water quality and riparian parameters in the Chorro Creek Watershed and its receiving water body, the Morro Bay Estuary. The VMP is a monitoring program associated with the Morro Bay National Estuary, which is one of 28 estuaries in the country receiving financial assistance from the United States Environmental Protection Agency. Although the VMP relies in part on volunteer monitors, the program is funded and will continue to conduct monitoring into the implementation phase of the Project. The VMP has agreed to monitor algal cover, dissolved oxygen, and stream shading in the Chorro Creek watershed during the implementation phase of this TMDL. Monitoring will include the following:

    1. Dissolved oxygen data from four sites in Chorro from April through November.
    2. Algal cover data from four sites in Chorro Creek from April through November.
    3. Stream shading from four sites in Chorro Creek from April through November.

Central Coast Water Board staff will utilize the data collected by the VMP, as well as other information and data, for triennial reviews.

8 TIMELINE AND MILESTONES

Achieving the TMDLs for sodium, total dissolved solids, temperature, and nitrate-N is a function of the CMC achieving the allocations for these constituents. The technological upgrade under construction will be completed in 2006; these TMDLs will be achieved at that time.

The TMDLs for shading will be realized when a mature riparian canopy results from restoration projects already installed. The riparian canopy necessary to achieve the TMDL for shade, which affects impairment due to biostimulatory substances, which in turn affects dissolved oxygen, will take ten years to fully develop. This time frame is based on the anticipated growth rate of the vegetation planted.

Therefore, it is anticipated that the TMDLs associated with the impairments for biostimulatory substances and dissolved oxygen will be met by 2016.

9 REFERENCES

Biggs, Barry J. 2000. Eutrophication of streams and rivers: dissolved nutrient-chlorophyll relationships for benthic algae. North American Benthological Society, 19(1): 17-31

Perrin, C. J., Bothwell, M.L., and P. A. Slaney. 1987. Experimental enrichment of a coastal stream in British Columbia: effects of organic and inorganic additions on autotrophic periphyton production. Canadian Journal of Fisheries and Aquatic Science 44:1247-1256.

Personal Communication: Volunteer Monitoring Plan staff of the Morro Bay Estuary.

USEPA (United States Environmental Protection Agency). 2000. Nutrient Criteria Technical Guidance Manual; Rivers and Streams. EPA-822-B-00-002.

USEPA (United States Environmental Protection Agency). December 2001. Ambient water quality criteria recommendations: EPA-822-B-01-008.

USEPA (United States Environmental Protection Agency). 2000. Nutrient Criteria Technical Guidance Manual; Rivers and Streams. EPA-822-B-00-002.

Wetzel, Robert G. 1975. Limnology. W. B. Saunders Company, West Washington Square, Philadelphia, Pa 19105.