Appendix C

Staff Report

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Changes to the Staff Report are indicated in underline/ strikethrough on the following pages:

p. 6-48 – under *Dilution credits for shallow water dischargers based on attenuation analysis*
p. 8-64 – Table 21;

in the Staff Report Appendix D, *Spatial Description of Effluent Attenuation:*

p. 2
p. 6
p. 8
p. 13
p. 19
p. 21
p. 27

All other changes are reflected in staff's Responses to Comments document (see Appendix D to the Staff Summary Report)

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STAFF REPORT ON PROPOSED SITE-SPECIFIC WATER QUALITY OBJECTIVES FOR CYANIDE FOR SAN FRANCISCO BAY

California Regional Water Quality Control Board
San Francisco Bay Region

December 4, 2006

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1 Introduction

This Staff Report supports a proposed Basin Plan amendment to replace existing marine water quality objectives for cyanide, a toxic pollutant, with site-specific objectives and proposes dilution credits for some San Francisco Bay wastewater dischargers to be used in the calculation of permit effluent limits. To implement the proposed water quality objectives, the Basin Plan amendment proposes requiring cyanide effluent limits in the permits of all San Francisco Bay municipal and industrial wastewater dischargers.

Water quality objectives for cyanide in the San Francisco Bay Region are currently based on the federal water quality standards adopted under the National Toxics Rule (NTR) in December 1992. The goal of this Basin Plan amendment effort is to incorporate into the Basin Plan, site-specific objectives for San Francisco Bay that reflect new information regarding the current understanding of cyanide toxicity. Cyanide water quality objectives that currently apply were driven by toxicity data for the eastern rock crab (*Cancer irroratus),* a species not found on the West Coast. The new cyanide water quality objectives will reflect the most recent toxicity data for several species of crabs common to San Francisco Bay. Adoption of these site-specific objectives is important to NPDES wastewater dischargers that discharge to San Francisco Bay, as it is currently infeasible for many of these dischargers to meet water-quality based effluent limits based on the NTR criteria.

The proposed action is consistent with state and federal law and regulations for adoption of water quality objectives. Site-specific objectives adjust water quality objectives to account for their over- and under-protectiveness using EPA published procedures. One of those procedures is the Recalculation Procedure. The goal of the Recalculation Procedure is to recalculate water quality objectives using data that is representative of the sensitivities of species found in the waterbody. Recalculation of the U.S. EPA cyanide criteria, incorporating recent, peer-reviewed toxicity data, suggests that the cyanide criteria should be made less stringent. This recalculation was recently used to adopt modified water quality objectives for cyanide by the State of Washington for Puget Sound, which the U.S. EPA approved, and the same approach is proposed for San Francisco Bay.

Evidence exists that beneficial uses are currently protected with respect to cyanide, in that ambient concentrations of cyanide in the main body of San Francisco Bay do not exceed the existing more stringent chronic water quality objective. Cyanide is a pollutant that chemically degrades to harmless by-products in natural waters over time, as opposed to pollutants like elemental metals. This is supported by observations that have been made of a relatively rapid decline in cyanide concentrations in the Bay away from points of discharge, due to the effects of tidal mixing, dilution and degradation (this decline is termed “attenuation” in this Report). These observations support the adoption of less stringent site-specific objectives for cyanide. The source of cyanide in municipal wastewater discharges is in part due to the fact that small amounts of cyanide are formed in municipal wastewater treatment plants as a by-product of disinfection processes, such as chlorination. Disinfection occurs at the end of the treatment process, prior to discharge to the Bay. Some of the potential compliance issues for wastewater dischargers are related to the need for disinfection.

This Staff Report demonstrates why the site-specific objectives are necessary and protective of the most sensitive beneficial uses of San Francisco Bay. Section 2 of the Staff Report presents the project's description. Sections 3 and 4 provide the background and basis of the proposed Basin Plan amendment. Cyanide sources and pretreatment programs are described in Section 5.

The scientific basis for establishing dilution credits is discussed in Section 6. The Basin Plan prohibits wastewater discharges into non-tidal water, dead-end slough or at any point that wastewater does not receive dilution of at least 10:1. The Water Board can and has granted exceptions to the Basin Plan. Those wastewater dischargers that the Water Board has currently granted an exception to are hereinafter referred to as "shallow water dischargers" in this Staff Report. The Water Board has rarely allowed shallow water dischargers to apply dilution credits in the calculation of water-quality based effluent limits. This Basin Plan amendment proposes dilution credits for shallow water dischargers based on the available information regarding the attenuation, i.e., tidal mixing, dilution and degradation of cyanide from the point of discharge. The granting of dilution credits in the calculation of cyanide effluent limits does not authorize discharges into shallow waters; each shallow water discharger must continue to satisfy all requirements for an exception to Basin Plan Prohibition 1.

Derivation of dilution credits specific to each shallow water discharger that would be used to compute effluent limits is described in the Staff Report. Appendix J of the Staff Report specifically describes how the requirements in the Basin Plan and the State Water Board's "Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California" (the State Implementation Policy or "SIP") have been addressed in the derivation of dilution credits.

Section 7 provides a discussion of the cost of providing alternative cyanide treatment technologies and the cost of converting from chlorination as a disinfectant to ultraviolet disinfection. The implementation plan in Section 8 describes targeted surveillance and monitoring and a regional cyanide action plan that will be required to ensure that water quality and beneficial uses of the Bay are protected. Regulatory analyses are presented in Section 9 that include an overview of the Project's compliance with California Water Code (CWC) requirements; peer review requirements of Health and Safety Code §57004; California Environmental Quality Act (CEQA); and federal and state antidegradation policies. The Staff Report in its entirety serves as a substitute CEQA environmental document. Language for the proposed Basin Plan amendment is included as Appendix A.

2 Project Description

2.1 Project Necessity and Definition

The Project is a proposed Basin Plan amendment that will do the following:

1) Establish site-specific marine water quality objectives (SSOs) for cyanide in all San Francisco Bay segments;
2) Establish shallow water discharger dilution credits for cyanide;
3) Require cyanide effluent limits for all municipal and industrial wastewater dischargers to protect against degradation;
4) Define the implementation plan, maintain ambient concentrations of cyanide, and comply with state and federal antidegradation policies. The implementation plan requires development of the following:
    a) Numeric effluent limits for cyanide that are protective of water quality in San Francisco Bay now and in the future;
    b) An influent monitoring program conducted by dischargers with industrial sources of cyanide to maintain surveillance of periodic influent spikes attributable to illegal discharges;
    c) An ambient water quality monitoring program to detect changes in ambient concentrations of cyanide in San Francisco Bay; and
    d) Cyanide Action Plan, consisting of standard permit provisions for all wastewater dischargers to periodically update their source identification studies, develop and implement source reduction plans if warranted, and commit resources to fully implement the source control and reduction plan, at every permit reissuance (i.e., once per five years), and report to the Water Board.
5) Reiterate that effluent limits for copper and nickel are required in NPDES permits for municipal shallow water dischargers to South San Francisco Bay, south of Dumbarton Bridge.

This Staff Report describes why it is necessary to adopt a Basin Plan amendment to establish site-specific water quality objectives for cyanide in San Francisco Bay and to require numeric effluent limits for wastewater dischargers that provide reasonable protection of those beneficial uses involving aquatic life and reflect attenuation of cyanide in ambient waters.

The proposed Basin Plan language, included in Appendix A, describes the implementation of the cyanide SSOs in NPDES permits for industrial and municipal wastewater dischargers, the latter of which are also referred to as publicly owned treatment works (POTWs).

For consistency, effluent limit implementation for the only other SSOs adopted for this region in 2002, copper and nickel for Lower south San Francisco Bay, are clarified in the proposed Basin Plan language in Appendix A. The Basin Plan language associated with the 2002 Basin Plan amendment states that copper and nickel “effluent limits will be calculated” for the three shallow water dischargers south of Dumbarton Bridge, Palo Alto, Sunnyvale, and San Jose/Santa Clara. In the subsequent permitting process of 2003, two of the three dischargers argued that effluent limits were not necessarily "required." These dischargers' interpretation conflicts with the applicable Staff Report of the Basin Plan amendment of May 2002 which states on page 33:

> "The IP [implementation plan] for maintaining the proposed SSOs [site-specific objectives for copper and nickel] includes continuation of provisions in the dischargers' NPDES permits that ensure that the treatment facilities continue to perform at highest efficiency. These provisions must also ensure that continuing efforts are being made to control all copper and nickel sources entering the treatment facilities, and that reasonable and cost-effective opportunities to reclaim wastewater are pursued. New concentration-based effluent limits for the three Lower South SF Bay POTWs will be calculated from the proposed chronic copper and nickel SSOs *and incorporated into their NPDES permits when those permits are re-issued*" (emphasis added).

Throughout the 2002 Basin Plan amendment documents, justification for less stringent water quality objectives is predicated on both the attainability and maintenance of copper and nickel effluent limits for Palo Alto, Sunnyvale and San Jose/Santa Clara, for instance on page 34 of the Staff Report:

> "After the proposed SSOs are adopted, the Regional Board intends to incorporate the water quality-based effluent limits into the NPDES permits during the next permit reissuance for the three Lower South SF Bay POTWs. Considering current performance, it is clear that all three Lower South SF Bay POTWs are in compliance with the effluent limits calculated from the proposed SSOs."

Clarifying language for copper and nickel proposed in Appendix A is not a regulatory change. Instead, it reflects and clarifies what the Board actually adopted in 2002 and prevents future misinterpretation of the adopted amendment. Effluent limits have always been needed to hold dischargers to current levels of performance to prevent accumulation of these pollutants in the sediments and waters of the San Francisco Bay Estuary, and Appendix A includes language that reaffirms this clearly. Because effluent limits derived from the site-specific objectives for copper and nickel are attainable (see Staff Report language above), there are no economic or environmental impacts of mandatory limits. There would be a potential environmental impact of removing effluent limits for copper and nickel, since it would erode the regulatory basis for copper and nickel local limits for industries discharging to these POTWs, and would potentially compromise the dischargers' abilities to meet the Basin Plan requirements to fully commit resources to ensure there is no degradation associated with adopting site-specific objectives.

2.2 Objectives of the Project

The objectives of the project are as follows:

1) Establish SSOs for cyanide and update the Basin Plan to incorporate the best available scientific information on aquatic toxicity specific to San Francisco Bay that;
    a) Fully protect aquatic beneficial uses in the Bay;

   b) Are calculated using the best and most relevant set of data and are based on sound scientific rationale;
   c) Are no more or less stringent than necessary; and
   d) Are at a level allowing municipal and industrial wastewater dischargers to comply with water quality-based effluent limits, provided they maintain high levels of performance and carry out intensive source control and prevention programs

2) Avoid unnecessary compliance problems for municipal and industrial wastewater dischargers authorized to discharge into the Bay.

3) Determine dilution credits for shallow water dischargers and provide details of an implementation plan for achieving water quality objectives

4) Comply with the antidegradation requirements of State Board Resolution No. 68-16 and federal antidegradation regulations.

3 Background and Existing Conditions

3.1 Description of San Francisco Bay

The proposed site-specific objectives (SSOs) for cyanide would apply to marine waters of the San Francisco Bay and excludes the Pacific Ocean. Water quality objectives for the ocean are established in the California Ocean Plan. The proposed marine SSOs would apply to all segments of the San Francisco Bay:

“San Francisco Bay” - for the purposes of this Report, refers to the following water bodies, as shown in Figure 1 and Figure 2:

- A portion of the Sacramento/San Joaquin River Delta (within San Francisco Bay)
- Suisun Bay
- Carquinez Strait
- San Pablo Bay
- Central San Francisco Bay
- Lower San Francisco Bay
- South San Francisco Bay

San Francisco Bay is a natural embayment in the Central Coast of California. With an average depth of six meters, the bay is broad, shallow, and turbid, which makes sediment an important factor in the fate and transport of particulate-bound pollutants such as copper and nickel. The movement of sediment within the bay is driven by daily tides, the spring-neap tide cycle, and seasonally variable wind patterns.

The Bay is divided into two major hydrographic units, which are connected by the Central Bay to the Pacific Ocean. The northern reach is relatively well flushed because more than half of the California’s freshwater flows into the bay through the Sacramento and San Joaquin Rivers. In contrast, the southern reach receives more limited fresh water inflow from local watersheds and is less well flushed.

3.2 Project Background

A new marine site-specific objective for San Francisco Bay and an associated implementation plan are needed for two main reasons: to reflect best available scientific information regarding cyanide toxicity to aquatic organisms and to implement more appropriate NPDES effluent limits. Specifically, (1) the basis of the federal criteria can be updated by adding species which are common to San Francisco Bay and to make it consistent with the objectives already adopted by the State of Washington in Puget Sound; and (2) effluent limits for cyanide based on the currently applicable federal criteria, developed in 1985, are not attainable and will cause non-compliance for a majority of NPDES dischargers beginning in 2006. Scientifically-defensible effluent limits are proposed that will provide protection of sensitive beneficial uses in accordance with procedures contained in the Basin Plan and SIP.

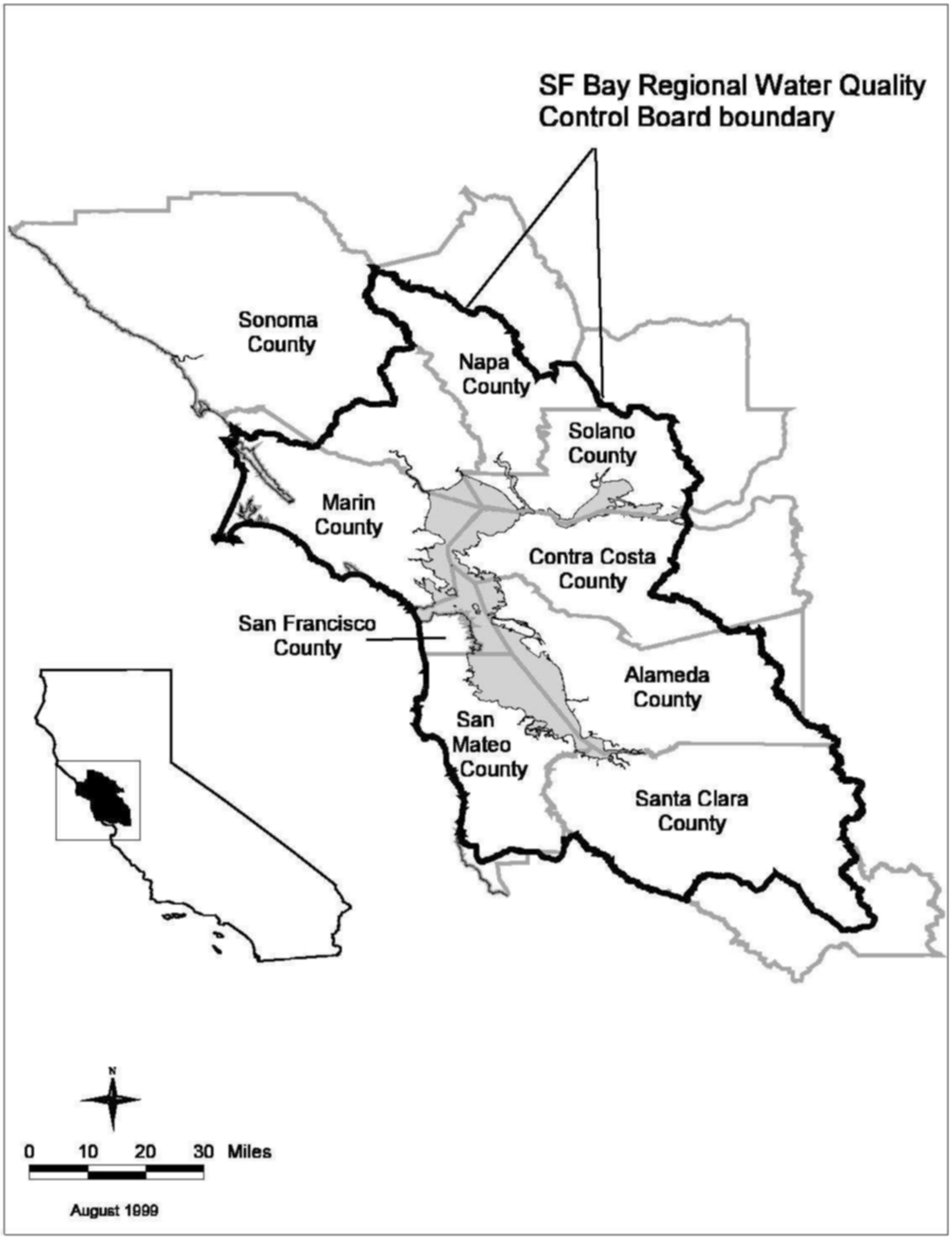

Figure 1: Map of San Francisco Bay

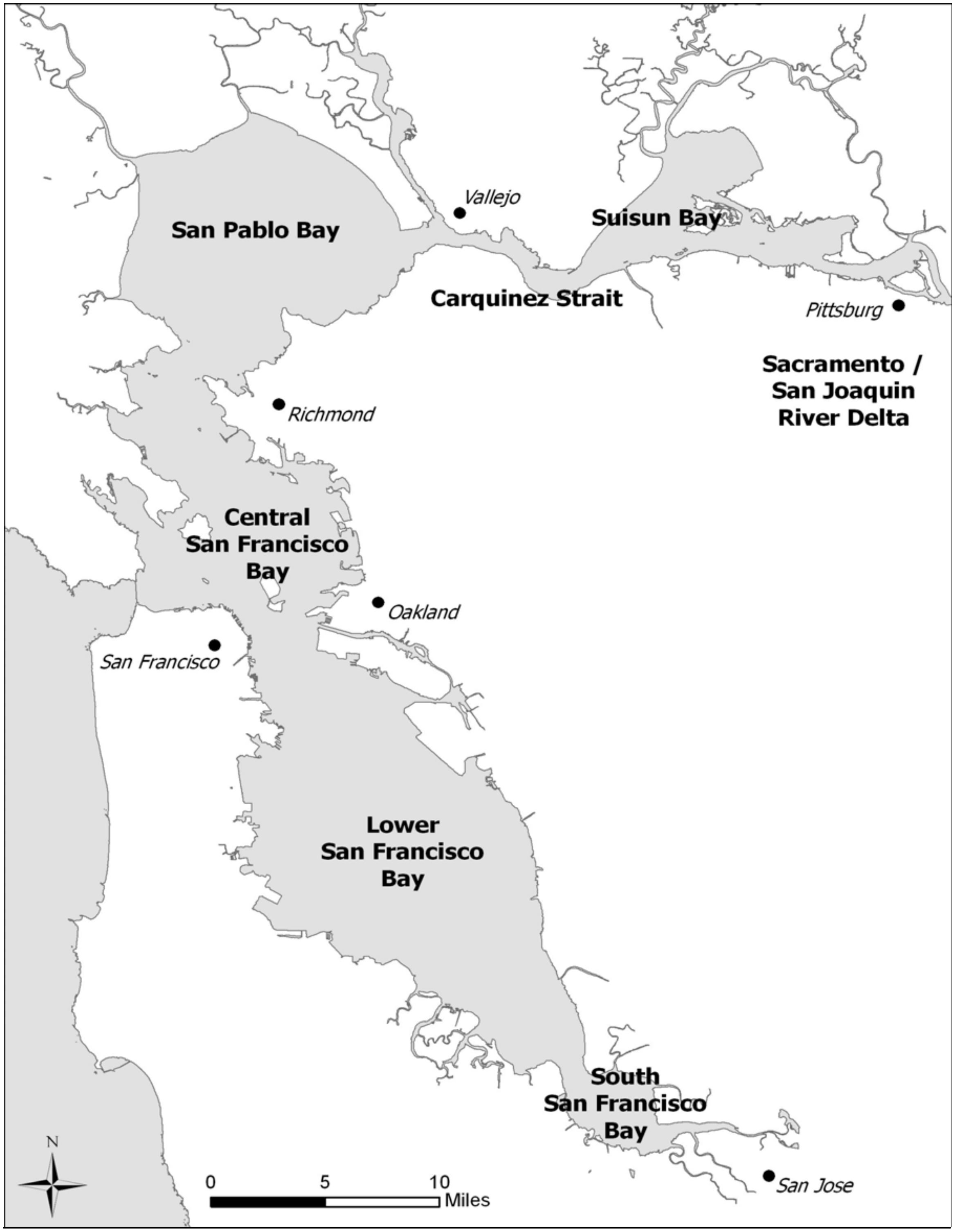

Figure 2: Segments of the San Francisco Bay

Table 1 summarizes the existing and proposed marine water quality objectives for cyanide. An objective of 1.0 µg/L (4-day average) was adopted for San Francisco Bay by U.S. EPA under the National Toxics Rule (NTR) in 1992. The NTR objective was based on the 1985 U.S. EPA ambient criterion for aquatic life protection (USEPA 1985b). It superseded the 1986 Basin Plan objective of 5.0 µg/L because it was more stringent and was based on U.S. EPA Section 304(a) criteria.

Table 1: Existing and Proposed Cyanide Objectives for Marine Waters

	Existing	**Proposed**
Acute	1 µg/L (NTR)	9.4 µg/L
Chronic	1 µg/L (NTR)	2.9 µg/L

The existing U.S. EPA cyanide marine criteria are heavily influenced by the toxicological data for one species (eastern rock crab – *Cancer irroratus*). Toxicity tests found *C. irroratus* to be six times more sensitive than the next most sensitive *Cancer* species tested. Work performed in Puget Sound using species native to San Francisco Bay made available new scientific information that provides a basis for updating the U.S. EPA criteria. Moreover the results demonstrated that the NTR objective might be unnecessarily stringent dependent on site-specific conditions. Data developed for the Puget Sound study for four other west coast crab species (*Cancer* spp.) indicate that the sensitivity of these species is 24 times less than indicated by the 1981 *C. irroratus* data (Brix et al., 2000). Like Puget Sound, these four species are known to be present in marine and estuarine waters of San Francisco Bay (Morris et al., 1980). Adding the four west coast crab species to the national data set and removing the *Cancer irroratus* data results in a recalculation of the cyanide marine chronic water quality criterion from 1 µg/L to 2.9 µg/L. Similar updated criteria have already been adopted by the State of Washington for parts of Puget Sound. The proposal is to adopt 2.9 µg/L as a 4-day average chronic objective and 9.4 µg /L as a 1-hour average acute objective, for the marine waters of San Francisco Bay

Cyanide has become a NPDES permit compliance issue for municipal and industrial wastewater dischargers to the San Francisco Bay. At each permit adoption the Water Board determines that dischargers could not comply with final effluent limits based on the NTR objective. Therefore, all San Francisco Bay wastewater NPDES permits contain interim performance-based numeric effluent limits for cyanide (see Table 22). The interim limits have prevented immediate compliance problems beginning in 2005, but those interim limits may be replaced overly stringent final limits in the next round of NPDES permits.

3.3 Cyanide Chemical Composition, Sources, and Environmental Fate

Cyanide is a chemical compound with a carbon atom triple bonded to a nitrogen atom (CN). Inorganic cyanides contain the cyanide ion (CN-) and are the salts of the acid hydrogen cyanide (HCN). These forms of cyanide, known as “free cyanide” are the most toxic to aquatic organisms. In natural waters in the pH range from 6.5 to 8.5, free cyanide is typically present in the hydrogen cyanide form (HCN).

The mechanism of cyanide toxicity occurs at the cellular level. The cyanide ion is toxic to aerobic organisms by shutting down respiration in cells, acting as an asphyxiant. Cyanide interrupts the electron transport chain in the inner membrane of the mitochondrion, thereby preventing proper combination of cytochromes with oxygen, interrupting the pathway energy is transmitted to living cells.

Cyanide compounds are typically classified as either simple or complex cyanides. Simple cyanides are those compounds that are readily converted to free cyanides (e.g. KCN, NaCN, NH_4CN). Complex cyanides are formed through the action of the cyanide ion as a ligand and its complexation with either metals (e.g. copper, iron, nickel, zinc) or with organics. Most cyanide complexes are much less toxic than cyanide, but weak acid dissociable complexes such as those of copper and zinc are relatively unstable and dissociate depending on a number of factors. Organic cyanides contain a carbon atom bonded to the CN group (also known as nitriles).

An important concern is the amount of free cyanide that is present in treated effluent, since free cyanide is the most toxic form to aquatic organisms. This is important since pollutants in treatment plant effluent are sometimes highly complexed (Bedsworth and Sedlak, 1999). Currently, best available analytical protocols and detection limits do not allow for direct measurement of free cyanide levels in treated effluent at levels that would provide answers to this question, so the Water Board exercises a conservative assumption that all measured cyanide in effluent and in ambient waters is free cyanide.

As with any toxicant, cyanide effects are dependent on the concentration and duration of exposure. Toxicological tests have been performed which establish the knowledge base regarding cyanide toxicity to sensitive aquatic species at given concentrations and exposure durations. As a rule, the toxicity tests performed to date have exposed aquatic organisms to free cyanide concentrations in clean laboratory water.

Available scientific evidence indicates that cyanide is not teratogenic (causing structural abnormalities), mutagenic (causing mutations) or carcinogenic (causing cancer) to aquatic organisms. Additionally, available information indicates that cyanide is not bioaccumulated by aquatic organisms, ostensibly due to the fact that cyanide is highly reactive and readily metabolized (Eisler 1991; USEPA 1985b; WERF 2003).

Cyanide is commonly employed as an industrial reagent due to its many uses in chemical extraction processes. Hydrogen cyanide gas (HCN) is commonly used in the manufacture of plastics, for fumigation and pesticide use, and in the synthesis of other compounds such as nitriles. Sodium and potassium cyanide are used in gold mining, metallurgy, electroplating, and animal control.

Thiocyanate (SCN^-) is one of the major constituents of wastewater from facilities that gasify coal, where various by-products are formed during the production of gas for fuel, coke, and substances for chemical industries. Cyanide is usually converted to thiocyanate by the addition reaction with sulfur since thiocyanate is less toxic than free cyanide. The resultant thiocyanate is then treated in an activated sludge process, where microbes degrade this substance.

Under normal conditions in natural surface waters, cyanide does not persist. Cyanide degrades in natural waters due to processes of microbial utilization, volatilization, and photolysis (WERF, 2003, Chapter 8). The combined effect of these processes lowers cyanide concentrations in surface waters and is often referred to as natural degradation or attenuation. In fact such attenuation is recognized as a treatment method. Cyanide solutions are placed in shallow ponds with large surface area or impoundments to maximize the rate of cyanide attenuation through volatilization and oxidation (Botz, 2001).

In receiving waters along the periphery of San Francisco Bay, cyanide discharged in wastewater effluents is also diluted through tidal mixing and turbulent diffusion in Bay waters. The combined effects of dilution and degradation lead to rapid reduction of cyanide concentrations with distance from the point of input to the Bay.

3.4 Discharger Descriptions and Performance

A total of 46 public agencies and industries discharge treated wastewater directly to San Francisco Bay and its tributaries. Each of these discharges is permitted under the federal NPDES permit program, which is administered by the Water Board under a delegation agreement with the U.S. EPA.

A summary of cyanide effluent concentration data for individual NPDES dischargers is provided in Appendix C. Implementation of the default NTR objective through the SIP would lead to unattainable effluent limits, presenting compliance problems for the majority of San Francisco Bay municipal and industrial wastewater dischargers. Resultant water quality-based effluent limits (WQBELs) would be less than 6 µg/L for deep water dischargers, and less than 1.0 µg/L for many shallow water dischargers. Neither of these limits would be consistently achieved in most effluents despite source control and treatment technologies. Table 2 and Table 3 summarize projected final effluent limits for cyanide for Bay area POTWs and industries based on effluent limitation derivation procedures contained in Section 1.4 of the SIP and the existing NTR-based water quality objectives.

For shallow water dischargers to the Bay, no dilution credit is currently granted. As a consequence, the average monthly cyanide effluent limits for a given shallow water discharger would be 1.0 µg/L or less, depending on the variability of cyanide in the effluent in question. Available data indicate that none of the thirteen shallow water dischargers examined can achieve the projected NTR-based cyanide effluent limits.

For deep water dischargers to San Francisco Bay, a dilution credit of 10:1 (the maximum allowable dilution) has been used in the calculation of estimated effluent limits. Recent ambient monitoring data collected in 2002 and 2003, relevant to deep water dischargers indicates that the maximum observed cyanide concentration at the three ambient, deep water sites tested was 0.5 µg /L total cyanide. Using the existing NTR cyanide standard of 1.0 µg/L and effluent limit derivation equations contained in Section 1.4 of the SIP, the monthly average cyanide effluent limits for a given deep water discharger would be 5.5 µg /L, or less, depending on the variability of cyanide in the effluent in question.

Table 2: Shallow Water Discharger Compliance Evaluation – Comparison of Existing Cyanide Concentrations to Projected NTR-Based Effluent Limits

NPDES Permittee	Cyanide Effluent Concentrations (µg/L)		Coefficient of Variation (CV)	Projected Final Cyanide Effluent Limits (µg/L)		Projected Compliance Problem?	Interim CN effluent limits in current permit?
	mean	***max***		***AMEL***[b]	***MDEL***[c]		
American Canyon	1.4	5.0	0.5	0.5	1.0	Yes	No [a]
Fairfield-Suisun Sewer District	3.9	28.0	1.0	0.4	1.0	Yes	Yes
Hayward Marsh	2.9	11.3	0.8	0.4	1.0	Yes	Yes
Las Gallinas Valley SD	3.0	10.0	0.8	0.4	1.0	Yes	Yes
Mt. View Sanitary District	0.5	3.0	0.6	0.5	1.0	Yes	Yes
Napa SD	2.6	20.0	1.2	0.4	1.0	Yes	Yes
Novato SD	1.8	4.4	0.7	0.5	1.0	Yes	Yes
Palo Alto, City of	3.3	4.8	0.3	0.7	1.0	Yes	Yes
Petaluma, City of	2.9	10.0	0.9	0.4	1.0	Yes	Yes
San Jose Santa Clara WPCP	2.8	5.2	0.4	0.6	1.0	Yes	No[d]
Sonoma County Water Agency	3.2	8.6	0.9	0.4	1.0	Yes	Yes
Sunnyvale, City of	4.4	29.0	0.9	0.4	1.0	Yes	Yes
USS - Posco	8.8	10.0	0.6	0.5	1.0	Yes	Yes

Note: Projected effluent limits based on existing NTR objective for cyanide = 1 µg/L (chronic).
The mean and coefficient of variation were estimated using the probability regression method

[a] No interim limits granted to a new discharge. Final limit of 5 µg/l exists.

[b] AMEL= Average Monthly Effluent Limit.. The highest allowable average of daily pollutant discharges over a calendar month, calculated as the sum of all daily discharges measured during a calendar month divided by the number of measurements.

[c] MDEL=Maximum Daily Effluent Limitation. The highest allowable daily discharge of a pollutant, over a calendar day (or 24-hour period). For pollutants with limits expressed in units of mass, the daily discharge is calculated as the total mass of the pollutant discharged over the day. For pollutants with limits expressed in other units of measurement, the daily discharge is calculated as the arithmetic mean measurement of the pollutant over the day.

[d] No permit limits in existing permit due to an artifactual finding of no reasonable potential to cause or contribute to violation of the cyanide objective, due to review of effluent data limited to a certain time period. San Jose Santa Clara had three discharge events in 2004 that caused significant violations of the cyanide objective in San Francisco Bay waters (see Figure 3 of Appendix K). This example shows why the SIP reasonable potential calculation method can be misrepresentative of actual reasonable potential, and why the SIP grants the Water Board authority to make an independent finding of reasonable potential.

Of the 25 deep water dischargers with adequate detected data, 14 (56%) will not comply with final effluent limits based on the NTR, 8 (32%) may not comply and 3 (12%) will likely comply. The eight deep water dischargers for which compliance uncertainty exists, do not have adequate detected cyanide concentration values to determine compliance based on the NTR. The data indicate that 12% of deep water dischargers can comply with projected final effluent limits, and none of the 13 shallow water dischargers can comply with NTR standard-based final effluent limits for cyanide. A summary of effluent limits and compliance dates adopted in NPDES permits in the Bay is provided in Table 22. The significance of these compliance dates is that the five-year compliance schedule allowed under the SIP will have expired resulting in immediate non-compliance for Bay area POTWs.

Table 3: Deep Water Discharger Compliance Evaluation – Comparison of Existing Cyanide Concentrations to Projected NTR-Based Effluent Limits

NPDES Permittee	Cyanide Effluent Concentrations (µg/L)		Coefficient of Variation (CV)	Projected Final Cyanide Effluent Limits (µg/L)		Projected Compliance Problem?	Interim CN Effluent Limits in Current Permit?
	mean	***max***		***AMEL***	***MDEL***		
Benicia, City of	5.6	26.0	0.9	4.1	9.9	Yes	Yes
Burlingame, City of	3.3	13.0	0.6	4.5	9	Possible	Yes
Central Contra Costa Sanitary Dist.	3.8	9.9	0.4	4.8	8	No	Yes
Central Marin Sanitation Agency	4.3	16.0	0.7	4.4	9.4	Possible	Yes
Chevron Richmond Refinery	7.3	14.9	0.5	4.7	8.6	Yes	Yes
ConocoPhillips (at Rodeo)	6.1	14.0	0.4	4.8	8	Yes	Yes
Delta Diablo Sanitation District	7.1	13.0	0.6	4.5	9	Yes	Yes
Dow Chemical Company	3.3	5.7	0.6	4.5	9	No [a]	Yes
Dublin San Ramon Services District	7.0	8.8	ND	ND	ND	ND	Yes
EBDA	5.1	68.0	1	3.4	10	Yes	Yes
EBMUD	5.7	25.0	1.6	4.2	9.7	Yes	Yes
GWF E 3rd St (Site I)	7.5	10.0	0.6	4.5	9	Yes	Yes
GWF Nichols Rd (Site V)	7.4	10.0	ND	ND	ND	ND	Yes
Livermore, City of	14.9	25.0	ND	ND	ND	ND	Yes
Marin Co SD No. 5 (Tiburon)	5.0	5.0	0.6	4.5	9	Possible [b]	Yes
Martinez Refining Company	13.2	29.0	0.4	4.8	8	Yes	Yes
Millbrae, City of	3.7	18.0	0.7	4.4	9.4	Possible	Yes
Morton	7.5	10.0	ND	ND	ND	ND	Yes
Pinole-Hercules	3.5	10.0	0.5	4.7	8.6	Possible	Yes
Rhodia Basic Chemicals	10.0	10.0	ND	ND	ND	ND	Yes
Rodeo Sanitary District	3.7	7.0	0.3	5	7.5	No [a]	Yes
S.F. Airport Water Quality Control Plant	9.8	16.5	0.6	4.5	9	Yes	Yes
S.F. Airport, Industrial	9.8	10.0	ND	ND	ND	ND	Yes
S.F. City & County Southeast, North Point & Bayside	7.8	10.0	0.5	4.7	8.6	Possible	Yes
San Mateo, City of	4.3	15.0	0.5	4.7	8.6	Possible	Yes
Sausalito-Marin Sanitary District	9.6	20.0	0.5	4.7	8.6	Yes	Yes
South Bayside System Authority	7.8	14.7	0.4	4.8	8	Yes	Yes
South San Francisco & San Bruno	18.3	430.0	2.5	2.8	9	Yes	Yes
Tesoro Golden Eagle Refinery	8.6	28.0	3.6	4.7	8.6	Yes	Yes
US Navy Treasure Island	10.0	10.0	ND	ND	ND	ND	Yes
Valero Benicia Refinery	10.0	15.0	ND	ND	ND	ND	Yes
Vallejo San. & Flood Control District	4.8	22.8	1.0	4	10	Yes	Yes
West County/Richmond	3.6	8.0	0.6	4.5	9	Possible [b]	Yes

Note: Projected effluent limits based on existing NTR objective for cyanide = 1 µg/L (chronic). The mean and coefficient of variation were estimated using the half-detection method

[a] Limited number of detected values. [b] Limited data set.

3.5 Cyanide Levels in Influent and Effluent

In almost all cases, effluent cyanide concentrations at a given treatment facility are higher than influent cyanide concentrations. This in-plant increase is attributed to disinfection processes that protect recreational users of the San Francisco Bay waters (i.e., the designated beneficial use of water - contact recreation or REC1). Figure 3 shows the relationship between plant influent, within-plant concentrations (i.e., nitrification effluent), and plant effluent at the San Jose/Santa Clara Water Pollution Control Plant (WPCP), that is typical of the relationship in the Bay area.

Consistent with the influent/effluent relationship cited above, and as shown in Table 4, effluent cyanide concentrations were above detection limits more often than influent cyanide for most of the POTWs providing data. Detection limits using U.S. EPA-approved Standard Methods for total cyanide and/or weak acid dissociable cyanide range from 3 to 10 µg/l for the POTWs).

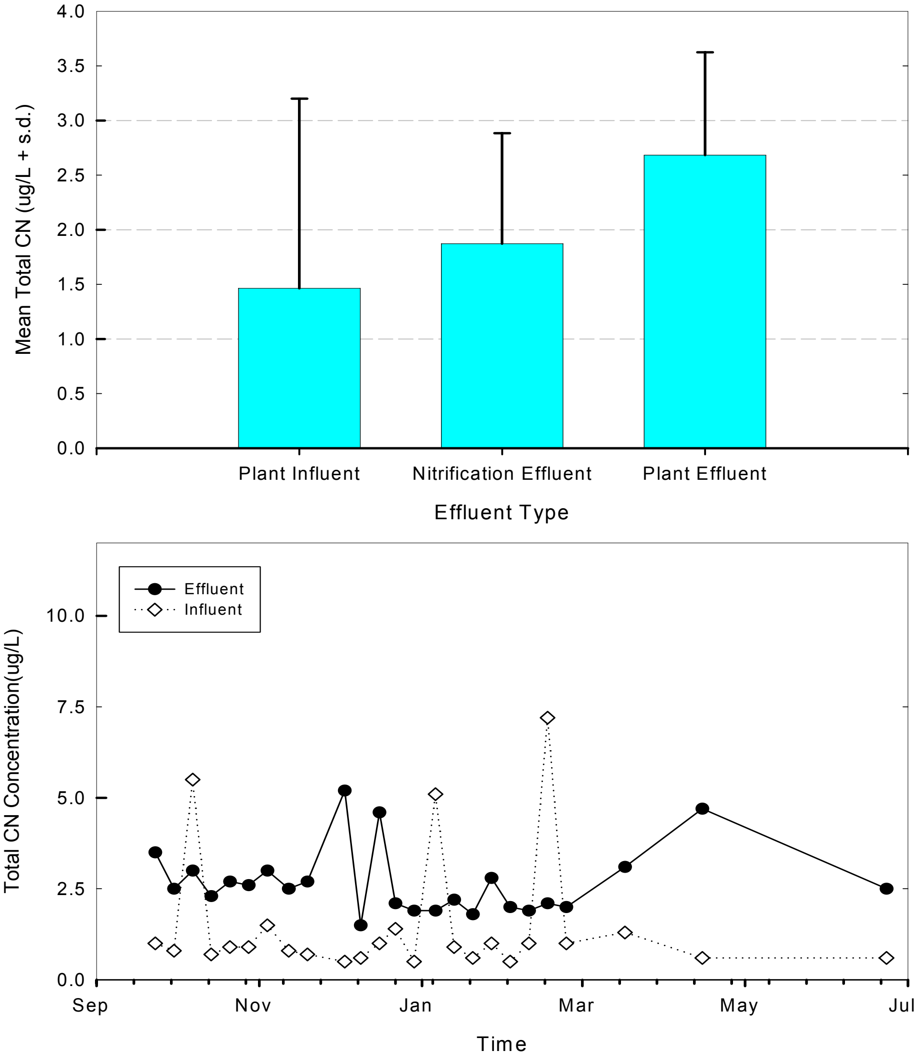

Figure 3: San Jose/Santa Clara WPCP In-Plant Cyanide Measurements (Sept. 2003 - June 2004 [1])

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[1] High cyanide episode measured in May 2004 is not included in the data above; n=25

Table 4: Effluent Cyanide Levels above Detection Limits for Bay Area POTWs[2]

Data Source	Sample Type	Data Points	Percent Detected	Maximum Detection Limit (µg/L)
American Canyon, City of	Effluent	15	46.7%	5
Benicia, City of	Influent	14	35.7%	3
	Effluent	46	89.1%	3
Delta Diablo Sanitary District (DDSD)	Influent	65	15.4%	10
	Effluent	66	16.7%	10
Fairfield-Suisun Sewer District	Influent	65	13.8%	4
	Effluent	131	66.4%	3
Millbrae, City of	Influent	31	100%	---
	Effluent	42	100%	---
Napa Sanitation District	Influent	64	28.1%	3
	Effluent	91	25.3%	3
Palo Alto RWQCP	Influent	77	32.5%	3
	Effluent	273	37.4%	3
Petaluma, City of	Influent	36	25%	3
	Effluent	38	57.9%	3
San Francisco Southeast WPCP	Influent	265	11.3%	10
	Effluent	259	23.9%	10
San Jose/Santa Clara WPCP	Influent	70	4.3%	5
	Effluent	71	5.6%	5
San Mateo WWTP	Influent	43	11.6%	5
	Effluent	79	31.6%	6.8
Sonoma Valley County Sanitation District	Influent	53	64.2%	5
	Effluent	52	34.6%	5
South Bayside System Authority (SBSA)	Influent	47	97.9%	3
	Effluent	48	100.0%	---
Sunnyvale, City of	Influent	134	1.5%	5
	Effluent	137	19.7%	5
Union Sanitary District (USD)	Influent	22	27.3%	3
	Effluent	66	31.8%	3
Vallejo Sanitation & Flood Control District	Influent	66	37.9%	3
	Effluent	66	47.0%	3

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[2] Effluent Data from 2000 - 2003

3.6 Ambient Conditions

Knowledge of the ambient levels of cyanide in the water column of San Francisco Bay is important to the understanding of potential impacts of cyanide on aquatic life beneficial uses. Available information indicates that cyanide concentrations in the main body of San Francisco Bay are typically not detectable using standard analytical methods, and that ambient concentrations are below the existing 1.0 µg/L water quality objective. Recent data collected near shallow water dischargers indicate detectable levels in the receiving waters, sometimes above the current chronic and acute NTR objective of 1.0 µg/L, which decrease with distance from the discharge points.

Open Bay Conditions

Ambient concentrations of cyanide in deep water portions of the San Francisco Bay have been measured on several occasions since 1990. S.R. Hansen and Associates made the first measurements in a study performed for several Bay area oil refineries in 1989-1990. A second set of measurements were gathered in 1993 under the first year of the Regional Monitoring Program for Trace Substances (RMP), after which cyanide monitoring was discontinued due to lack of detectable values using a detection limit of 1.0 µg/L (SFEI, 1993). The Water Board issued a Water Code Section 13267 information request to all NPDES dischargers which lead to a third set of measurements being collected as part of the Regional Monitoring Program by the San Francisco Estuary Institute (SFEI) in 2002-2003. Bay Area Clean Water Agencies (BACWA) and other Bay area NPDES dischargers funded this effort.

A description of the three cyanide ambient data sets is provided below.

Data collected by S.R. Hansen and Associates

This work was performed in 1989 and 1990. Data results are shown below in Table 5. The four monitoring stations for this work were located in San Pablo Bay (SP1) and (SP2), Carquinez Strait (CS) and Suisun Bay (SB). Each of these sampling sites is located in the deeper channels of the Bay. Samples were taken at flood tide at stations SP1 and CS and at ebb tide at stations SP2 and SB. QA/QC consisted of spikes on three occasions during the monitoring effort (January 1989, April 1989 and January 1990). Detection limits for the analytical work were 0.5 µg/L. A modification of cyanide test methods prescribed in American Society of Testing and Materials (ASTM) 1986 and American Public Health Administration (APHA) 1985 EPA were used to achieve the selected detection limits. Modifications included increasing the volume of sample distilled and decreasing the volume of NaOH scrubber solution (SR Hansen & Associates, 1990).

Table 5: Summary of Data Collected by SR Hansen and Associates (1989-1990)

Date	San Pablo Bay No. 1 (SP1)	San Pablo Bay No. 2 (SP2)	Carquinez Strait (CS)	Suisun Bay (SB)
April 1989	<0.5	<0.5	<0.5	<0.5
May 1989	<0.5	<0.5	<0.5	<0.5
June 1989	<0.5	<0.5	<0.5	<0.5
July 1989	<0.5	<0.5	<0.5	<0.5
August 1989*	8	6.5	6.8	<0.5
August 1989	<0.5	<0.5	<0.5	<0.5
September 1989	0.54	<0.5	<0.5	<0.5
October 1989	<0.5	<0.5	<0.5	<0.5
December 1989	<0.5	<0.5	<0.5	<0.5
December 1989	<0.5	<0.5	<0.5	<0.5
January 1990	<0.5	<0.5	<0.5	<0.5

Notes: The extremely elevated detected values in August 1989 stand out as anomalies in the data set and in subsequent data sets. A re-sampling one week later on August 26, 1989 indicated no detectable levels at any of the four stations. These high concentrations were not explained in the technical report. Absence of event specific QA/QC procedures precluded rigorous investigation of these results.

Data collected under the first year of the Regional Monitoring Program

This work was performed in March, May and September 1993. Results are shown below in Table 6. The sixteen monitoring stations for this work were located throughout the Bay, from the Sacramento River (BG20) and San Joaquin River (BG30) stations in the north to an extreme South Bay station (BA20) below the Dumbarton Bridge. Each of these sampling sites was located in the deeper channels of the Bay. Samples were taken at a depth of one meter at various tidal conditions. QA/QC followed protocols established for the RMP. Detection limits for the analytical work were 1.0 μg/L (SFEI online database at www.sfei.org).

Table 6: Summary of Data Collected by SFEI for RMP (March, May and September, 1993)

RMP Station No:	RMP Station Name	Cyanide Concentration - total (μg/L)	Cyanide Concentration - dissolved (μg/L)
BA20	Extreme South Bay	<1.0	<1.0
BA30	Dumbarton Bridge	<1.0	<1.0
BA40	Redwood Creek	<1.0	<1.0
BB30	Oyster Point	<1.0	<1.0
BC10	Yerba Buena Island	<1.0	<1.0
BC20	Golden Gate	<1.0	<1.0

RMP Station No:	RMP Station Name	Cyanide Concentration - total (µg/L)	Cyanide Concentration - dissolved (µg/L)
BC30	Richardson Bay	<1.0	<1.0
BC41	Point Isabel	<1.0	<1.0
BD20	San Pablo Bay	<1.0	<1.0
BD30	Pinole Point	<1.0	<1.0
BD40	Davis Point	<1.0	<1.0
BD50	Napa River	<1.0	<1.0
BF10	Pacheco Creek	<1.0	<1.0
BF20	Grizzly Bay	<1.0	<1.0
BG20	Sacramento River	<1.0	<1.0
BG30	San Joaquin River	<1.0	<1.0

Notes: Based on the above results, the decision was made to remove cyanide from the parameter list for subsequent RMP analyses.

Data collected by SFEI

This work was performed in 2002 and 2003 at three RMP monitoring stations: Sacramento River (BG20), Yerba Buena Island (BC10), and Dumbarton Bridge (BA30). Results are shown below in Table 7. The sampling sites are located in the deeper channels of the Bay. Samples were taken at a depth of one meter at various tidal conditions. Extensive QA/QC procedures were utilized during the sample collection and laboratory analysis performed, mirroring procedures employed by the RMP. Detection limits for the analytical work were 0.4 µg/L. Cyanide analyses were performed by Central Contra Costa Sanitary District's laboratory (SFEI, 2003).

Table 7: Summary of Data Collected by SFEI (2002-2003)

RMP Station Number	RMP Station Name	Dates	Cyanide Concentration - total (µg/L)
BA30	Dumbarton Bridge	January 2002	<0.4
		July 2002	<0.4
		January 2003	<0.4
BC10	Yerba Buena Island	January 2002	<0.4
		July 2002	<0.4
		January 2003	<0.4
BG20	Sacramento River	January 2002	<0.4
		July 2002	<0.4
		January 2003	0.5

Notes: These data were collected using current clean methods for sampling and analysis.

Summary tables of the available ambient cyanide data for San Francisco Bay measured in samples taken from 1989 through 2003 are presented below in Table 8. The data in Table 5 to

Table 7 show that ambient levels of cyanide at various deep water locations in the San Francisco Bay are consistently less than the existing NTR acute and chronic objectives for protection of aquatic life uses.

Table 8: Consolidated Summary of Data Collected at Overlapping Stations (1989-2003)

RMP Station No:	RMP Station Name	Mar-93	May-93	Sep-93	Jan-02	Jul -02	Jan-03
BA30	Dumbarton Bridge	<1.0	<1.0	<1.0	<0.4	<0.4	<0.4
BC10	Yerba Buena Island	<1.0	<1.0	<1.0	<0.4	<0.4	<0.4
BG20	Sacramento River	<1.0	<1.0	<1.0	<0.4	<0.4	0.5

Notes: Ambient levels are also important to the determination of effluent limits for NPDES dischargers to San Francisco Bay. Ambient levels are used in the determination of whether a specific discharge has reasonable potential to cause or contribute to a violation of a water quality objective, and thus whether an effluent limit is required to be adopted in accordance with U.S. EPA regulations (40 CFR 122.44), and Section 1.3 of the SIP. Ambient levels are also used in the calculation of water quality-based effluent limits (WQBELs) for dischargers that receive credit for dilution, according to procedures in Section 1.4 of the SIP.

Conditions near Shallow Water Discharges

Recent data for the period 2003-2005 indicate that ambient levels in the immediate vicinity of shallow water discharger outfalls are detectable at levels ranging from 0.3 µg/L to 6.7 µg/L. Figures in Appendix B show the results of ambient monitoring of cyanide concentrations at various locations along individual discharge gradients for the following shallow water dischargers: American Canyon, Fairfield-Suisun, Las Gallinas, Napa, Mountain View Sanitary District (Martinez), Petaluma, Sonoma County Water Agency, Palo Alto, Sunnyvale and San Jose/Santa Clara. These dischargers collected a total of 225 local receiving water samples between 2003 and 2005 to inform the empirical derivation of an attenuation factor (Appendices B and D; Section 6) in the proposed calculation of numeric effluent limits. The average cyanide concentration in the vicinity of shallow water discharges was 0.9 µg/L, and the 90th percentile value was 2.2 µg/L.

As shown in Appendix B and D, especially for San Jose/Santa Clara for which there are more data, the ambient data collected near shallow water discharges demonstrates a pattern of rapid decline in cyanide concentrations with distance away from the point of discharge. As described previously, this “attenuation” caused by a combination of dilution due to tidal mixing, dispersion and naturally occurring degradation processes causes ambient cyanide levels to exist at levels that are protective of aquatic life beneficial uses in the open Bay and in the Bay margins near shallow water discharges.

Ambient monitoring of cyanide levels in San Francisco Bay indicates no evidence that cyanide concentrations pose a toxicity problem to aquatic species. The monitoring done to date has measured total cyanide levels, rather than free cyanide, the toxic form. Therefore, while the ambient data set is not as robust as that for trace metals, the ambient cyanide evaluation has an inherent factor of safety, since it is likely that a portion of the cyanide present in the Bay is complexed cyanide. Such complexed forms are not toxic to aquatic organisms at the levels of the existing or proposed cyanide objectives. Additionally, a biological study of one receiving water area conducted by a shallow water discharger is described in Section 6.1.4 and Appendix M, suggests that current cyanide levels near discharge points are not adversely affecting aquatic life.

4 Derivation of Existing and Proposed Cyanide Criteria

4.1 Water Quality Standards, Criteria and Objectives

Before describing the details of the proposed cyanide water quality objective Basin Plan amendment, it is helpful to revisit the concept of a water quality standard since it is the basis of how water quality is regulated. A water quality standard defines the water quality goals of a water body by designating the beneficial uses to be made of the water, by setting the numeric or narrative criteria necessary to protect the uses, and by preventing degradation of water quality through antidegradation provisions. Under the California Water Code, the numeric or narrative criteria of the water quality standard are known as the "water quality objectives." States adopt water quality standards to protect public health or welfare, enhance the quality of water, and serve the purposes of the federal Clean Water Act. Numeric water quality criteria and objectives that are designed to protect aquatic organisms are generally of two types – the Criteria Continuous Concentration (CCC) or the Criteria Maximum Concentration (CMC).

The CCCs are the U.S. EPA national water quality criteria recommendations for the highest in-stream concentrations of a toxic pollutant to which organisms can be exposed on a long-term average basis without causing unacceptable effect (USEPA 2000). When adopted into California standards, the CCC becomes the chronic water quality objective for a given toxic pollutant. The CMCs are the U.S. EPA national water quality criteria recommendations for the highest in-stream concentrations of a toxic pollutant to which organisms can be exposed for a short-term average period of time without causing an acute effect. When adopted into California standards, the CMC becomes the acute water quality objective for a given toxic pollutant.

4.2 Existing Cyanide Water Quality Objectives

For the San Francisco Bay, existing cyanide objectives have been established through federal action under the National Toxics Rule 1992 (NTR), which superseded previous cyanide objectives from the 1986 Basin Plan, which were based on the level of detection of 5 µg/L. Existing water quality objectives for cyanide in San Francisco Bay are summarized in Table 9.

Table 9: Current Water Quality Objectives for Cyanide in San Francisco Bay

Source	Date	Description	Acute Objective	Chronic Objective
National Toxics Rule (NTR), (40 CFR 131.36)	December 22, 1992; amended May 4, 1995	**Marine water**[a] - waters with salinity greater than 10 ppt 95% of the time	1 µg/L (1-hour average)	1 µg/L (4-day average)
NTR	December 22, 1992; amended May 4, 1995	**Freshwater** - waters with salinity less than 1 ppt 95% of the time	22 µg/L (1-hour average)	5.2 µg/L (4-day average)

[a] Because marine objectives are more stringent than freshwater objectives the Basin Plan specifies that the marine objective applies for estuarine waters, where 95% of the time salinity is less than 10 ppt and greater than 1 ppt.

4.3 Proposed Cyanide Regulatory Changes

Of the above water quality objectives, Water Board staff is proposing changes to only the marine objective, based on a more complete data set for crabs of the *Cancer* genus. Only the marine objective poses significant compliance challenges for municipal and industrial NPDES dischargers to San Francisco Bay. To Water Board staff's knowledge there is no compelling scientific information available at this time that suggests the freshwater objectives should be changed.

The Water Board staff has determined through best professional judgment and consideration of the fate and transport of cyanide in San Francisco Bay, that a regional approach to implementation of cyanide objectives for shallow water discharges to the Bay is appropriate. Therefore, the Water Board staff is proposing that effluent limits which implement the proposed cyanide objectives for shallow water dischargers be based on an evaluation of cyanide attenuation in the Bay as a component of the program of implementation for San Francisco Bay cyanide objectives. The Water Board finds that attenuation, a combination of dilution, tidal mixing and natural degradation, is effectively equivalent to dilution since, in both cases, the cyanide concentration in the receiving water diminishes with distance from the discharge location. Therefore the proposed plan would grant dilution credits for individual shallow water dischargers. Section 6 describes the approach to determine the extent of dilution and degradation of cyanide in shallow incompletely mixed discharges.

4.4 Developing Site-Specific Objectives

California can choose to base state water quality objectives on the federal water quality criteria published by U.S. EPA (i.e., the basis of standards contained in the NTR and CTR) or can adopt site-specific water quality objectives provided they are based on an appropriate scientific justification.

Site-specific objectives may be developed where appropriate site-specific conditions warrant more or less stringent objectives, without compromising the beneficial uses of the receiving water. The SIP provides in Section 5.2 that a Water Board may consider site-specific objectives where an existing objective cannot be met through reasonable treatment, source control, and pollution prevention measures. The current applicable standards for cyanide are set forth in the NTR. As shown in this Report, NPDES wastewater dischargers that discharge into San Francisco Bay are unable to comply with effluent limits based on the NTR criteria.

Section 131.11(b)(ii) of the water quality standards regulation (40 CFR Part 131) provides the regulatory mechanism for states to develop site-specific criteria for use in water quality standards. There are several U.S. EPA-approved procedures (USEPA 1994) that can be used to modify national criteria so that they more accurately reflect ambient conditions and bioavailability. For this proposal, three procedures discussed below were evaluated and one was chosen as the basis for the site-specific objectives.

4.4.1 Recalculation Procedure

The proposed cyanide objectives are based on the recalculation procedure. It allows for modification to the national criterion by correcting, adding or removing data from the national toxicity database. Toxicity databases are collections of laboratory-measured toxicity values for different species and form the basis of water quality criteria promulgated by U.S. EPA. The goal of the recalculation procedure is to create a data set that is appropriate for deriving a site-specific criterion by modifying the national data set in some or all of three ways:

a) Correction of data that are in the national database;
b) Addition of data to the national database; and/or
c) Deletion of data that are in the national database (e.g. elimination of data for species that are not residents).

The proposed objectives rely on (b) and (c) above. The proposal includes addition of data for four species of the *Cancer* genus and deletion of data from *Cancer irroratus*, a species that exists only on the east coast of the United States.

4.4.2 Indicator Species Procedure

This procedure allows for modifications to the national criterion by using a site-specific multiplier called a water effects ratio (WER). Under the WER approach, the toxic substance of interest is added to clean laboratory water (to mimic the testing approach used in development of U.S. EPA criteria) and site water samples (to reflect local conditions) and toxicity tests are performed using sensitive organisms. The WER is the numeric ratio between the toxicity value (typically lethality to 50% of the organisms [LC50] or adverse effects to 50% of the organisms [EC50]) in local site water versus the toxicity value in clean laboratory water. The WER is then used as a multiplier in the following equation to produce a site-specific objective:

U.S. EPA national criteria X WER = Site-specific water quality objective

U.S. EPA (1994) guidelines specify that WERs may be developed for either acute or chronic criteria and that the test endpoint used to derive the WER should be near to but above the criterion that it is intended to modify**.** Laboratory studies conducted by dischargers in the region could not generate a consistent WER value for cyanide, so this alternative was abandoned early in the process.

4.4.3 Resident Species Approach

This procedure is intended to account for differences in both resident species sensitivity and differences in toxicity due to local water quality characteristics. Under the Resident Species procedure, data for species which are either resident or known to be present in the Bay are assembled or developed for use in criteria calculations. The minimum data requirements for development of national criteria must be met. Data used in the resident species procedure must pass the strict quality assurance and data quality requirements required for national criteria development.

For the marine cyanide objectives there were not enough data available for resident species to meet the minimum data requirements for a national criteria, so this alternative was abandoned early in the process.

4.5 Calculation of Proposed Cyanide Site-Specific Objectives

The proposed marine site-specific objectives for cyanide were developed based on the recalculation procedure. The recalculation was performed by adding recent toxicity data for four *Cancer* species to the existing U.S. EPA data set, deleting data from an east coast *Cancer* species, and recalculating the criteria values.

The calculation of water quality criteria for cyanide using the recalculation procedures includes several steps. The first step is using LC50 (lethal concentration to 50% of test organisms) toxicity data to arrive at a final acute value (FAV), and then the FAV becomes the basis for both the chronic criterion and the acute criterion. The FAV is derived from LC50 or EC50 values and is divided by two to calculate an acute criterion. Division by two is an approximation intended to estimate a concentration that will not adversely affect organisms (i.e. as a means to estimate the LC0 or EC0 value). The FAV is divided by an acute-to-chronic ratio (ACR) to produce a chronic criterion.

These calculations can be summarized as follows:

Acute Criterion = (FAV/2)
Chronic Criterion = (FAV/ACR)

4.5.1 Basis for Current U.S. EPA Marine Criteria for Cyanide

The Section 304(a) water quality criteria for cyanide were developed by the Environmental Research Laboratory of the U.S. EPA and published as national criteria in January 1985 (USEPA 1985b). These criteria were adopted into California water quality standards through the NTR. The cyanide marine criteria were derived using the minimum data set allowed by the U.S. EPA Guidelines (acute toxicity data for eight genera, chronic toxicity data for 5 freshwater and two saltwater species). The species and associated data used in the marine acute toxicity analysis are summarized in Table 10. The species used in this analysis include 3 fish families in the phylum Chordata, 4 families in the phylum Arthropoda (one mysid shrimp, one crab, one amphipod and one copepod) and one family in the phylum Mollusca (a gastropod). This assemblage of representative genera fulfilled the *minimum* allowed by U.S. EPA criteria guidelines.

Chronic toxicity data was available for a marine mysid, *Americamysis bahia* (formerly *Mysidopsis bahia*) and a marine fish (*Cyprinodon variegatus*) and five freshwater species (three fish, an amphipod and an isopod). The chronic values for these species were used to calculate acute-to-chronic ratios for each of these species. According to the U.S. EPA (1985c) guidelines, a final chronic value may be determined by one of eight different methods, which are summarized in the U.S. EPA 1995 Saltwater Copper Addendum. The acute-to-chronic ratio values for four freshwater species were used in the derivation of the final freshwater chronic value (FCV) by dividing the FAV by the ACR (USEPA 1985b). However, Method 4 (USEPA 1995) was used to derive a marine chronic value. Method 4 assumes that the ACR is 2 (CMC=CCC) because the acute tests used to derive the FAV were from embryo larval tests with molluscs, and a limited number of other taxa (*Cancer* sp. crabs in the case of cyanide). This assumption appears to be correct since the saltwater CMC of 1.015 ppb is 8-fold lower than the lowest observed “acceptable” freshwater chronic result (*Salvelinus fontinalus*), and 36-fold lower than the lowest observed “acceptable” saltwater chronic result (*Cyprinodon variegatus*) shown in the U.S. EPA cyanide criteria document (see Table 11).

Table 10: Data Used in Calculation of Current Cyanide Marine Criterion (USEPA 1985b)*

Rank	Species	Genus Mean Acute Value (μg/L)
8	Common Atlantic slippershell, *Crepidula fornicata*	>10,000
7	Amphipod, *Ampelisca abdita*	995.9
6	Winter flounder, *Pseudopleuronectes americanus*	372
5	Sheepshead minnow, *Cyprinodon variegatus*	300
4	Mysid, *Americamysis bahia/bigelowi*	118.4
3	Atlantic silverside, *Menidia menidia*	59
2	Copepod, *Acartia clausi*	30
1	Eastern rock crab, *Cancer irroratus*	4.893

* U.S. EPA criteria calculations are based on GMAVs for organisms ranked 1 through 4. The FAV is calculated based on a regression equation using the GMAVs for the four most sensitive genera. Refer to Table 11 and Table 12 for the specific calculations used in the U.S. EPA criteria derivation.

No saltwater studies have been reported which show significant bioaccumulation or biomagnification in the aquatic food chain. Studies indicate that while cyanide may penetrate aquatic organisms, it readily metabolizes (USEPA 1985b).

Table 11: Calculations for Existing Cyanide Marine Criteria for San Francisco Bay

Rank	Genus species	Common Name	Phylum/Class/Family	GMAV	ln(GMAV)	ln(GMAV)2	P	(P)0.5	
1	Cancer irroratus	Eastern rock crab	Arthropoda/Crustacea/Cancridae	4.89	1.5872	2.5192	0.1111	0.3333	
2	Acartia clausi	Copepod	Arthropoda/Crustacea/Acartiidae	30	3.4012	11.5681	0.2222	0.4714	
3	Menidia menidia	Atlantic silverside	Chordata/Osteichthyes/Atherinidae	59	4.0775	16.6263	0.3333	0.5774	
4	Mysidopsis bahia/bigelowi	Mysid	Arthropoda/Crustacea/Mysidae	118.4	4.7741	22.7917	0.4444	0.6667	
5	Cyprinodon variegatus	Sheepshead minnow	Chordata/Osteichthyes/Cyprinodontidae	300					
6	Pseudopleuronectes americanus	Winter flounder	Chordata/Osteichthyes/Pleuronectidae	372					
7	Ampelisca abdita	Amphipod	Arthropoda/Crustacea/Ampeliscidae	995.6					
8	Credipula fornicata	Common Atlantic slippershell	Mollusca/Gastropoda/Calyptraeidae	10000					
		Count (n)	8						
		Sums			13.8400	53.5054	1.1111	2.0488	
		S2	= [Ln(GMAV)2 - Ln(GMAV)*Ln(GMAV)/4]/[P-P(0.5)*P(0.5)/4]						90.9781
		S	= SQRT (S2)						9.5382
		L	= [Ln(GMAV)-S/(P)0.05]/4						-1.4254
		A	= SQRT(0.05)*S+L						0.7074
		FAV	= Exp (A)						2.0288
		CMC	= FAV/2						1.0144
		FCV	Based on U.S. EPA judgment, FCV = CMC = CCC						1.0144

4.5.2 Basis for Current U.S. EPA Freshwater Criteria for Cyanide

The freshwater cyanide objectives are not proposed to be changed, but the basis of these objectives is discussed in this section, as they are considered in discharges to estuarine regions where freshwater and marine species overlap in occurrence. The 1985 U.S. EPA aquatic life criteria document (USEPA 1985b) describes the basis for calculation of the freshwater criteria for cyanide, which is currently a water quality objective for the San Francisco Bay Region as established under the NTR.

Data on the acute toxicity of free cyanide to 17 aquatic species of fish and invertebrates in 15 genera were used to derive the U.S. EPA freshwater acute criterion. The range in acute toxicity for the 17 species was from 44.73 μg/L to 2490 μg/L. The freshwater chronic criterion was calculated using acute and chronic data for four freshwater species. The species and associated data used in the acute and chronic freshwater criteria development are summarized in Table 13. The species used in this analysis include fish families in the phylum Chordata, families in the phylum Arthropoda and families in the phylum Mollusca. This assemblage of representative genera fulfilled the U.S. EPA criteria guidelines.

In the final freshwater criteria calculation, the species mean acute value (SMAV) for juvenile rainbow trout (previously referred to as *Salmo gairdneri,* now *Oncorhynchus mykiss)* (44.73 μg/L) derived from six separate study results performed between 1978 and 1984 was found to be more sensitive than the final acute value (FAV) calculated from the four most sensitive genera [rainbow trout and Atlantic salmon (*Salmo salar*), brook trout (*Salvelinus fontinalis*), yellow perch (*Perca flavescens*) and bluegill (*Lepomis macrochirus*), all fish families in the phylum Chordata]. In accordance with U.S. EPA water quality criteria guidance, the rainbow trout SMAV replaced the calculated FAV. The most sensitive invertebrate (*Daphnia*) was more than two-fold less sensitive than rainbow trout.

The freshwater acute criterion (CMC) of 22.4 μg/L was derived by dividing the rainbow trout SMAV-based FAV of 44.73 μg/L by 2 (to approximate a "no effect" value from the EC50 value [effects concentration affecting 50% of organisms] for rainbow trout). The freshwater chronic value (CCC) of 5.2 μg/L was derived by dividing the FAV (44.73 μg/L) by an acute to chronic ratio of 8.57 (geometric mean of values from four freshwater species). The most sensitive chronic toxicity value used in criteria derivation in 1985 was 7.85 μg/L for brook trout (*Salvelinus fontinalis*), a sensitive species to cyanide.

No freshwater studies have been reported which show significant bioaccumulation or biomagnification of cyanide in the aquatic food chain (USEPA 1985).

Table 12: Calculations for U.S. EPA Existing Cyanide Freshwater Criteria (USEPA 1985)

Rank	Genus species	Common Name	SMAV	GMAV	ln(GMAV)	ln(GMAV)2	P	(P)0.5	
1	Oncorhynchus mykiss	Rainbow trout	44.73	63.45	4.1503	17.2246	0.0625	0.2500	
	Salmo salar	Atlantic salmon	90						
2	Salmo salvelinus	Brook trout	85.8	85.8	4.4520	19.8205	0.1250	0.3536	
3	Perca flavescens	Yellow perch	92.64	92.64	4.5287	20.5093	0.1875	0.4330	
4	Lepomis macrochirus	Bluegill	99.28	99.28	4.5979	21.1411	0.2500	0.5000	
5	Pomoxis nigromaculatus	Black crappie	102	102					
6	Micropterus salmoides	Largemouth bass	102	102					
7	Daphnia magna	Cladoceran	160	123.6					
	Daphnia pulex		95.55						
8	Pimephales promelas	Fathead minnow	125.1	125.1					
9	Poecillia reticulata	Guppy	147	147					
10	Gammarus pseudolimnaeus	Amphipod	167	167					
11	Carassius auratus	Goldfish	318	318					
12	Pteronarcys dorsata	Stonefly	426	426					
13	Physa heterostropha	Snail	432	432					
14	Asellus communis	Isopod	2326	2326					
15	Tanytarsus dissimilis	Midge	2490	2490					
	Count (n)	15							
	Sum				17.7289	78.6955	0.6250	1.5366	
	S2	= [Ln(GMAV)2 - Ln(GMAV)*Ln(GMAV)/4]/[P-P(0.5)*P(0.5)/4]							3.3584
	S	= SQRT (S2)							1.8326
	L	= [Ln(GMAV)-S/(P)0.05]/4							3.7283
	A	= SQRT(0.05)*S+L							4.1380
	FAV	= Exp (A)							62.6798
	Calculated CMC	= FAV/2							31.3399
	Sensitive Species-based CMC (based on species mean acute value for rainbow trout)					= 44.73/2			22.3650
	FCV (based on Rainbow trout SMAV divided by ACR for four freshwater species)					=44.73/8.57			5.2194

Table 13: Data Used in U.S. EPA (1985) Cyanide Chronic Freshwater Criteria Derivation

FW[a] or SW[b]	Rank[c]	SMAV[d]	SMACR[e]	SMCV[f]	Species	Common name
SW	5	300	8.306	36.12	*Cyprinodon variegatus*	Sheepshead minnow
SW	4	113	1.621	69.71	*Americamysis bahia*[g]	Mysid
FW	14	2326	68.29	34.06	*Asellus communis*	Isopod
FW	10	167	9.111	18.33	*Gammarus pseudolimnaeus*	Amphipod
FW	8	125.1	7.633	16.39	*Pimephales promelas*	Fathead minnow
FW	4	99.28	7.316	13.57	*Lepomis macrochirus*	Bluegill
FW	2	83.14	10.59	7.849	*Salvelinus fontinalus*	Brook trout
			1.621	7.849	Minimum	
			68.29	34.06	Maximum	
			8.306		Median ACR (all)	
			9.05		Geometric Mean ACR (all)	
			8.37		Median ACR (Freshwater only minus Asellus)	
			8.57		Geometric Mean ACR (Freshwater only minus Asellus)	

[a] Fresh Water

[b] Salt Water

[c] Rank is based on sensitivity to cyanide, with the most sensitive genus ranked no. 1

[d] SMAV= species mean acute value

[e] SMACR = species mean acute to chronic ratio

[f] SMCV= species mean chronic value

[g] formerly Mysidopsis bahia

4.5.3 Proposed Cyanide Marine Site-Specific Objectives for San Francisco Bay

The SIP requires that site-specific water quality objectives "be developed in a manner consistent with State and federal law and regulations." In accordance with the State's Porter-Cologne Water Quality Control Act (Division 7 of the Water Code), objectives must provide for the reasonable protection of beneficial uses based on consideration of the factors listed in Water Code Section 13241. In accordance with federal law (CWA) and regulations (40 CFR 131.11, revised as of July 1, 1997), the objectives must be "based on sound scientific rationale and protect the designated beneficial uses of the receiving water." The SIP further requires that the "RWQCB shall use scientifically defensible methods appropriate to the situation to derive the objectives. Such methods may include U.S. EPA-approved methods (e.g. Water Effects Ratio (WER) procedure, recalculation procedure, a combination of recalculation and WER procedures, Resident Species Procedure), and/or other methods…"

Section 6.1.5 describes the different U.S. EPA-approved methods reviewed to address the cyanide compliance issue for dischargers to San Francisco Bay.

The 1985 cyanide marine criteria values are significantly affected by the acute toxicity value (LC50) for one species (*Cancer irroratus*, the Eastern rock crab). This acute value has been scrutinized by researchers (Brix et al., 2000) and has been found to be significantly different from the acute values for other *Cancer* species.

The cyanide marine site-specific objectives are derived through application of the U.S. EPA recalculation approach by using acute toxicity test results for four crab species (*Cancer magister, Cancer productus, Cancer gracilis, and Cancer oregonensis*) to replace the existing data for *Cancer irroratus* used in the 1985 U.S. EPA cyanide criteria. A slight variation of this approach was performed and approved in the adoption of cyanide standards in Puget Sound, located in U.S. EPA Region 10. The resulting Genus Mean Acute Value (GMAV) derived from the consideration of crab data for four species is then used in the recalculation of the cyanide water quality objectives. Acute to Chronic Ratio (ACR) value of 6.46 is used in the derivation of the cyanide chronic criterion. The ACR value of 6.46 was calculated using all ACR values in the 1985 U.S. EPA criteria document except the ACR value for *Asellus communis*. The ACR value for *Asellus communis* was excluded from the 1985 U.S. EPA freshwater criteria calculations by U.S. EPA criteria experts in accordance with U.S. EPA guidance because its magnitude was significantly different from the other available ACR values.

The four additional acute toxicity values for *Cancer* spp. were developed by Parametrix, Inc. and EcoTox in 1995 using West Coast species as part of a study to derive site-specific cyanide marine objectives for Puget Sound in Washington (Parametrix, 1995; Brix et al., 2000). The four additional values are presented in Table 14, below *Cancer irroratus*. The results indicated significantly higher LC50 values for each of the *Cancer* species tested than the LC50 value stated for the Eastern rock crab (*Cancer irroratus*) in the U.S. EPA cyanide criteria document. The net effect of adding the data for these four crab species into the data set was to increase the GMAV for *Cancer* from 4.9 µg/L to 62.6 µg/L. The GMAV without the *Cancer irroratus* SMAV is 118.4 µg/l. In the recalculation for the proposed cyanide SSOs, it is proposed that the GMAV without *Cancer irroratus* be used.

Table 14: Summary of Available Acute Toxicity Saltwater Data for Five Crab Species (*Cancer* spp.)[a] After Brix et al., 2000)

Species	Species Mean Acute Value (μg/L)	Genus Mean Acute Value (μg/L)
Cancer irroratus[b]	4.9	
Cancer magister	68.5	
Cancer productus	153.1	
Cancer gracilis	143.7	
Cancer oregonesis	130.7	
Cancer spp (with *Cancer irroratus)*		62.6
Cancer spp (without *Cancer irroratus)*		118.4

[a] Three additional West Coast Cancer species are known to exist in San Francisco Bay (C. anthonyi, C. antennarius, and C. jordani). No data are available for these species to assess sensitivity to cyanide.

[b] This species (Eastern rock crab) is not present in San Francisco Bay.

The recalculated site-specific objectives are based on the revised Cancer GMAV and the ACR value. See Table 15 for the values used to derive the recalculated cyanide marine criteria. See Table 1 for the existing and proposed site-specific objectives for cyanide.

U.S. EPA criteria documents and the Technical Support Document for Water Quality-Based Toxics Control (USEPA 1991, Appendix D) state that beneficial uses will be protected if the 304(a) criteria values are not exceeded more than one time in three years, particularly acute criteria. The same allowable exceedance frequency is presumed to apply to these recalculated cyanide objectives.

4.6 Justification of the Site-Specific Objectives Required by SIP

Significant compliance problems will occur throughout the San Francisco Bay for the majority of NPDES dischargers if effluent limits based on the existing water quality NTR standard of 1.0 μg/L are adopted in NPDES permits. This is despite the fact that evidence exists that current ambient concentrations of cyanide are not impacting beneficial uses in the waters of San Francisco Bay. NPDES permittees are currently subject to interim limits, which are scheduled to sunset in 2010. This proposed Basin Plan amendment presents site-specific marine objectives for cyanide for San Francisco Bay, using procedures detailed in the SIP for recalculation of a water quality objective based on utilizing data from resident aquatic species. The site-specific objectives are justified under the SIP as dischargers cannot comply with the NTR-based limits even though they have implemented and will continue to do so, all reasonable treatment, source control and pollution prevention activities. Beneficial uses will continue to be protected after the adoption of the site-specific objectives.

Table 15: Calculations for Proposed Cyanide Marine Site-Specific Objectives for San Francisco Bay

	Rank	**Genus**	**Common Name**	**GMAV**	**ln(GMAV)**	**ln(GMAV)2**	**P**	**(P)0.5**	
	1	*Acartia clausi*	*Copepod*	30	3.4012	11.5681	0.1111	0.3333	
	2	*Menidia menidia*	*Atlantic silverside*	59	4.0775	16.6263	0.2222	0.4714	
	3	*Cancer spp*	*Crabs* (excludes *Cancer irroratus* at 4.89 µg/l*)*	118.4	4.7741	22.7917	0.3333	0.5774	
	4	*Mysidopsis bahia/bigelowi*	*Mysid*	118.4	4.7741	22.7917	0.4444	0.6667	
	5	*Cyprinodon variegatus*	*Sheepshead minnow*	300					
	6	*Pseudopleuronectes americanus*	*Winter flounder*	372					
	7	*Ampelisca abdita*	*Amphipod*	995.6					
	8	*Credipula fornicata*	*Common Atlantic slippershell*	10000					
Count (n)									8
Sum					17.0269	73.7779	1.1111	2.0488	
S2									21.0376
S									4.5867
L									1.9075
A									2.9331
FAV									18.7855
CMC									**9.3928**
ACR									6.4600
FCV **CCC**									**2.9080**

5 Cyanide Source Characterization

Cyanide sources are limited to municipal and industrial wastewater dischargers. Several Bay area POTWs have completed cyanide source identification studies, some as a condition of having interim effluent limits, to determine the origins of the cyanide in their effluent. Results show that the predominant source of effluent cyanide is typically generated in-plant through municipal and industrial wastewater treatment processes (disinfection or biosolids incineration). In some cases, cyanide that enters municipal treatment plants from industrial, commercial and residential sources may influence effluent concentrations of cyanide (see Appendix K).

5.1 Cyanide in Municipal Influent

Available data from POTW facilities show that influent concentrations of cyanide are often not detected, or are present at levels below effluent cyanide concentrations. Recent and historic (over ten years old) data both indicate that higher influent values are an episodic occurrence, sometimes traceable to illicit discharges in the collection system.

Where observed in municipal wastewater influent, cyanide may originate from industrial activities, such as metal plating, steel production, mining operations, or photographic finishing facilities (WERF 2003). Other commercial or industrial operations that may utilize or discharge cyanide include metal finishing, electroplating, hospitals, manufacturing, chemical laboratories, and chemical manufacturing facilities. In several Bay area studies completed to date, these sources have been considered insignificant based on mass balance calculations that demonstrate their relative contributions to wastewater treatment plant influent. A study performed for Sacramento Regional County Sanitation District detected cyanide in 5% of residential wastewater samples taken, suggesting that residential wastewater is a minor source of cyanide loading (Malcolm Pirnie 2003). Formation of cyanide in the collection system as a result of chemical treatments or maintenance activities is also a possible source of cyanide in influent.

Thiocyanate (SCN^-) in influent is a potential precursor of cyanide in effluent. Little is currently known about the amount of thiocyanate in POTW influent, as it is currently an unmonitored and unregulated constituent. There is a question as to whether thiocyanate may be a significant and controllable precursor for cyanide formation in wastewater treatment. WERF (2003) researchers have found that chlorination of thiocyanate seems to be an important mechanism for the formation of cyanide in wastewater treatment. In 2005 Los Angeles County Sanitation District (LACSD) tested thiocyanate levels at various points in the wastewater treatment process and found that elevated levels of thiocyanate in raw wastewater and primary effluent were reduced significantly in the secondary (biological) process, indicating that thiocyanate is biodegradable. This result is generally consistent with the WERF findings. However, the LACSD investigators found that use of an ion chromatography analytical method, that avoided interferences inherent in the colorimetric methods used in the WERF study, yielded much lower thiocyanate measurements in effluent. This result raises doubt whether levels of thiocyanate in effluent are capable of causing cyanide formation at previously reported levels. Since thiocyanate is not measured in the total cyanide test, a question exists whether influent levels of thiocyanate may explain observed cyanide levels in effluent. A more detailed discussion of thiocyanate is presented in Section 5.2.1.

5.2 Cyanide Formation in Wastewater Treatment

Cyanide, cyanide precursors, and cyanide complexes can undergo various transformations during the wastewater treatment process for municipal and industrial dischargers. Chlorination, UV disinfection, and incinerator scrubber return flows have been implicated as sources of cyanide formation during wastewater treatment and sources of cyanide detected in effluent (Zheng et al., 2004a; Zheng et al., 2004b; Malcolm Pirnie 2003). In-plant cyanide formation is not limited to POTWs; any discharger that disinfects or incinerates may produce cyanide in their effluent.

Investigations of cyanide formation in wastewater treatment can be confounded by the presence of interferences that produce false negatives or false positives introduced as a result of sample handling, preservation or analytical methods. Additionally, limitations on the detection levels of total cyanide, free cyanide and thiocyanate have hampered our understanding of cyanide formation (see Section 5). As also described in Section 5, other compounds that can affect the formation or measurement of cyanide in wastewater effluent include nitrate, nitrite, sulfide, aldehydes, and uncharacterized organic matter.

5.2.1 Chlorination

Chlorination was the first process to be identified as causing formation of cyanide within treatment plants. Oxidative decomposition of thiocyanate using chlorine can produce free cyanide. Thiocyanate is known to be used or generated in various industrial processes, including photofinishing, coke gasification, herbicide and insecticide production, ore mining process, and dyeing and electroplating (Zheng et al., 2004a; WERF 2003). Zheng et al., 2004a and 2004c showed cyanide formation from thiocyanate to be dependant on chlorination levels. Treatment plant influent from two plants was used in the study. None of the treatment plant influent samples had detectable levels of thiocyanate. When spiked with thiocyanate, approximately 1-6% of the thiocyanate was converted to cyanide during chlorination of the effluent. The cyanide was formed as a result of non-stoichiometric amounts of chlorine being applied.

The above case study can be applied to a hypothetical example, which suggests that thiocyanate probably does not explain the majority of cyanide formed in chlorination processes in treatment plants. Extrapolating the study results above, if an industrial facility discharges 10,000 gal/day containing 5 mg/L thiocyanate to the collection system of a 10 MGD plant, the approximate thiocyanate concentration in the POTW influent would be 0.005 mg/L. If 6% of the thiocyanate were converted to cyanide, it would add approximately 0.3 μg/L of cyanide to the effluent, which is below the levels of concern (i.e., 1 to 3 μg/L). Therefore, unless an industry is identified that discharges large amounts of thiocyanate, influent thiocyanate levels are unlikely to significantly impact cyanide levels in POTW effluents.

Thiocyanate concentrations measured in POTW influent have been observed to decrease in secondary influent by 60% (WERF 2003; Zheng et al., 2004b), suggesting significant removal in primary treatment. However, a positive correlation between thiocyanate decrease and cyanide increase could not be established, suggesting multiple factors contributing to the cyanide formation.

Other organocyanide compounds also have the potential to elevate cyanide concentrations in post-chlorinated effluent, although these effects are not well understood. Compounds studied include acetonitrile, D-Amygdalin, 2-acetoxy-3-butenenitrile, and cyanobalamin.

5.2.2 UV Disinfection

Available information on cyanide formation by UV disinfection is very limited at this time. The information hints that switching from chlorination to UV could reduce cyanide effluent levels, but much more investigation and full scale evaluation using very low detection limits would be needed to verify this preliminary hypothesis.

One study has shown that UV irradiation has the capability to decompose thiocyanate and create cyanide. Zheng et al. (2004a) conducted studies with thiocyanate-spiked wastewater treatment plant effluents and confirmed that cyanide does have the potential to form (12.3% conversion for irradiation time of 10 min at pH 6.9) when precursors are present. Emerging information indicates that UV disinfection may not create cyanide at the same concentrations created by chlorine disinfection.

While the above research has indicated that exposure to high intensity ultraviolet light creates cyanide in wastewater effluent, recent pilot study work using collimated beam tests performed by the Los Angeles County Sanitation District on secondary effluents indicates that, at lower design intensities used in newer UV installations (e.g. 500 millilJoules per square centimeter), effluent cyanide concentrations may be relatively low (i.e. less than an analytical reporting limit of 5 µg/l). Full scale testing of UV disinfection to further assess cyanide formation is scheduled to occur at the Whittier Narrows Water Reclamation Plant in 2006.

Limited full scale data from two advanced San Francisco Bay secondary plants that utilize UV disinfection (Mountain View Sanitary District of Martinez [MVSD] and American Canyon) tend to support the finding that effluent cyanide concentrations less than 5 µg/l can be produced by plants utilizing UV disinfection. Mean and maximum total cyanide effluent concentrations from these facilities ranged from 0.5 to 1.4 µg/l and 3.0 to 5.0 µg/l, respectively (see Table 16). These results indicate that MVSD and American Canyon, both shallow water dischargers, could not comply with effluent limits derived from the NTR marine objectives of 1.0 µg/l (see Table 2), and may marginally comply with the effluent limits derived from the proposed saltwater site specific objectives of 2.9 µg/l chronic and 9.4 µg/l acute, without consideration for cyanide attenuation.

The above results suggest that a conversion from chlorination disinfection to UV disinfection provides a treatment technology option to reduce cyanide concentrations in effluent. However, the ability to provide reliable projections of effluent cyanide concentrations from UV disinfection is still uncertain, given the lack of full scale operating experience over a range of treatment facilities. Given the effluent quality observed for American Canyon and MVSD, the viability of this option to comply with effluent limits in the range from 2 to 4 µg/l for a broad spectrum of treatment facilities is uncertain.

5.2.3 Biosolids Incineration Operations

The practice of biosolids incineration is practiced in the San Francisco Bay Region by Central Contra Costa Sanitary District and the Palo Alto Regional Water Quality Control Plant. It has been determined that cyanide compounds are formed as a byproduct during the combustion of biosolids. These cyanide compounds have been shown to accumulate in scrubber water. When this water is discharged to the headworks of the treatment plant, an increase in influent cyanide is possible. Optimization of hearth furnace operations, specifically furnace oxygen levels and hearth exit temperatures have been shown to be able to reduce cyanide concentrations in scrubber water (Schmidt et al., 2000).

5.2.4 Nitrosation

Nitrosation of organic compounds, which involves the reaction with nitrite, NO_2^-, has been shown to produce CN^- under some conditions. The protonated form, HNO_2, has been shown to be the primary reactive species, with NO_2^- being almost non-reactive. This suggests that the potential for nitrosation to form cyanide in neutral to high pH wastewater effluent is negligible.

While nitrosation may not occur in the treatment process due to pH, the most commonly used total cyanide analytical method utilizes strong acidic conditions and high temperature, which greatly favors the nitrosation process. Procedures specified in the 20th edition of *Standard Methods* accounts for this potential through the addition of sulfamic acid in the sample preparation to remove nitrite. (Zheng et al., 2004d). Reaction of nitrite species with organics to form cyanide may also occur during the distillation step of cyanide analyses. Sample pretreatment with sulfamic acid at the time of sampling, not at the time of analysis, has been recommended by Zheng et al. (2004d).

5.2.5 Nitrification

Incomplete nitrification (conversion of ammonia to nitrate) can result in excess nitrite in the wastewater effluent, leaving the potential for nitrosation to occur. It has been observed that cyanide formation occurs the most during the summer months when a plant is fully nitrifying (Zheng et al., 2004b). Nitrate can also act as an oxidizing agent on thiocyanate, forming free cyanide.

5.2.6 Other Potential Mechanisms of Cyanide Formation

There is a possibility that ozonation can convert thiocyanate to cyanide under some conditions. Ozonation is not practiced by Bay area POTWs for disinfection of treated effluent.

5.3 Cyanide Analytical Methods

Cyanide measurements for San Francisco Bay NPDES wastewater permit compliance are based on either total cyanide or weak acid-dissociable (WAD) cyanide measurements using Standard Methods 4500-CN or USEPA Method 335. The total cyanide analytical method attempts to measure all cyanide species that may dissociate in the environment over time due to varying conditions of heat, light, hardness and pH. These species include the toxic free cyanide species (CN- and HCN), weak and moderately strong metal-cyanide complexes of silver, cadmium, copper, mercury, nickel and zinc, and the strong metal-cyanide complexes of iron. The WAD method attempts to measure theoretically "available cyanide" (i.e. cyanide that dissociates in the presence of acid), again seeking to measure either free cyanide or the weak or moderately strong metal-cyanide complexes that may become free over time in the environment. Free cyanide test methods (ASTM D4282-02) measure free cyanide in water and wastewater by microdiffusion. Neither total cyanide nor WAD analytical methods provide specific information regarding the cyanide forms (e.g. free cyanide or metal-cyanide complexes) present in a sample. Both methods therefore overestimate, to an unknown degree, the toxic forms of cyanide by including relatively non-toxic iron-cyanide complexes and other less toxic metal-cyanide complexes.

For the purpose of the compliance analyses described in this Report, reported data from NPDES dischargers for the period 2000 to 2004 has been utilized. This data has been developed using Standard Methods 4500-CN, typically with reporting limits in the 3 to 5 µg/l range. It is appropriate to use this data for the compliance analysis since NPDES dischargers must use analytical methods approved by U.S. EPA under 40 CFR Part 136 in monitoring for compliance with effluent limits. Future monitoring for cyanide will continue to use these methods unless U.S. EPA approval for another method is granted.

The City of San Jose developed a modified version of Standard Method 4500-CN to obtain reduced detection limits for cyanide in effluent and receiving waters. The analytical method developed by San Jose was used in the analysis of effluent and receiving water data collected by shallow water dischargers that is summarized in Appendices B and D. A brief description of the modified method developed and used by San Jose is included in Appendix L.

Use of the San Jose analytical method provided improved insight into the actual levels of cyanide in effluents and in ambient waters near shallow water discharges and was essential in the determination and evaluation of cyanide attenuation in the immediate vicinity of these discharges. The reporting limits for the San Jose analytical method were 1.0 µg/l in effluent and 0.3 µg/l in ambient waters. The use of these research methods for characterizing ambient concentrations and evaluating options for determining effluent limits is appropriate. However, a distinction must be made regarding the use of this data in the NPDES permit compliance assessments. In that case, data resulting from U.S. EPA-approved analytical methods must be used to reflect future compliance capabilities. Therefore, effluent data from the special effluent and receiving water studies performed by the City of San Jose and other shallow water dischargers were not used in the compliance assessments described in this Report.

Some uncertainties have been identified regarding interferences that may affect the cyanide concentration data that is generated by NPDES dischargers using Standard Methods. In its special study, the City of San Jose reported that the addition of NaOH as a preservative to bring de-chlorinated tertiary effluent samples up to pH 12 prior to cyanide analysis (in accordance with Standard Method 4500-CN-E) resulted in increased total cyanide measurements. In a controlled experiment by San Jose where flasks were sealed to prevent the loss of cyanide, samples with NaOH preservative added to pH 12 exhibited a 75 percent increase in measured cyanide concentration (2.1 µg/l versus 1.2 µg/l) as compared to unpreserved samples (City of San Jose, 2004). Similar results were observed by the County Sanitation Districts of Los Angeles County (Khoury et al, 2005), who found that unpreserved sample concentrations were less than a reporting limit of 5 µg/l in all samples, whereas samples preserved to pH 12 were above 5 µg/l in 18 percent of the samples where thiosulfate was used as a de-chlorinating agent and in 97 percent of the samples where arsenite was used to as the de-chlorinating agent. Others have found that use of ascorbic acid as a dechlorination compound has caused an upward bias in cyanide measurements. WERF researchers (Zheng et al, 2004) have found that (a) thiocyanate in combination with nitrate and (b) nitrite in combination with specific trace organic compounds (aromatics such as phenol and benzoic acid) can produce cyanide during total cyanide analysis that biases cyanide measurements upward. These researchers recommended sufficient addition of sulfamic acid at the time of sampling to avoid upward-biased cyanide results due to nitrite/organics reactions (known as nitrosation).

Various compounds are also known to interfere with cyanide measurements, as follows:

- Oxidizing Agents – Presence of residual oxidizing agents in samples, such as free chlorine, can negatively bias results due to decomposition.
- Sulfide – Sulfides are known interferents of cyanide measurement as they can distill over with cyanide when performing an analysis and interfere with colorimetric measurements or react with cyanide to form thiocyanate.
- Aldehydes – Aldehydes can convert cyanide into cyanohydrin, thus negatively biasing results.

The above findings indicate that consideration of refinements to U.S. EPA approved sampling and analytical methods should be made to ensure that cyanide measurements reported for NPDES compliance are accurate.

The uncertainties associated with varying methodologies, the potential for interference introduced during sample handling or analysis, and the fact that many reported historical results are at or near the reporting limit, all combine to make it difficult to confidently compare influent/effluent data from different treatment plants across the country. Historically POTWs have measured total cyanide, which, as described above, includes free cyanide, weak metal-cyanide complexes, and strong metal-cyanide complexes. Furthermore, detection limits have historically been at or above 5 µg/L, in the range of typical effluent values, and above ambient levels. Adoption of uniform methods for sampling and analysis of total cyanide in Bay area effluents will be evaluated as part of the Cyanide Action Plan.

5.4 Cyanide Pretreatment and Pollution Prevention Activities in San Francisco Bay

According to the Basin Plan, site-specific objectives may be appropriate for pollutants of concern on a case-by-case basis, after it has been demonstrated that all other reasonable treatment, source control and pollution prevention measures have been exhausted. It also requires that NPDES permits for shallow water dischargers “shall include provisions requiring continuing efforts at source control, targeting the substances to which the exceptions apply.” This section of the Staff Report describes efforts at source identification and control that shall continue as part of the Cyanide Action Plan that accompanies the adoption of the site-specific marine water quality objectives for cyanide in San Francisco Bay.

Bay Area POTWs, particularly shallow water dischargers, have conducted cyanide source identification and control efforts, some as a condition of having interim effluent limits. These activities have included source identification studies, industrial discharge assessments and evaluation of POTW treatment processes.

Source identification studies are conducted through collection system monitoring and business inspections. Sonoma County Water Agency (SCWA) provided an exemplary effort to identify cyanide influent sources. As required by its current NPDES permit for the Sonoma Valley County POTW, SCWA conducted a cyanide source identification study (SCWA 2002). Commercial and residential collection system sites were monitored over a 6-month period in 1999. During that study, cyanide was never detected in the collection system above detection limits (i.e., 5 μg/L). Additional monitoring of residential collection system sites in 2001 also resulted in no detected values of cyanide. With no sources being identified through collection system monitoring, SCWA conducted a review of businesses to determine if there were any potential discharges of cyanide. As a result, four businesses were identified with cyanide levels above detection limits (a winery, two spas and a hospital). While none of these were determined to have significant mass discharges of cyanide, source control actions were implemented as appropriate. Specifically, the hospital was using a 1% cyanide solution in its laboratory that was being discharged to the sewer. SCWA staff worked with the hospital to identify a suitable non-cyanide replacement solution. The spas and winery each use chlorine for disinfection but, because of public health codes, there were no suitable replacement disinfectants.

Novato Sanitary District also conducted a Cyanide Source Reduction Study that included source identification and investigation of potential control strategies. Collection system monitoring and review of District records for industrial and commercial dischargers did not reveal any cyanide sources. Novato's service area is comprised entirely of residential and commercial users. Because no cyanide sources were identified, no source control actions were taken (Selfridge 2002).

Cyanide discharges to sanitary sewer systems have been regulated at industrial facilities, primarily metal finishers, through Pretreatment Programs. Activities in San Jose and Palo Alto provide examples of industrial cyanide source control. In the late 1990s, the San Jose/Santa Clara Water Pollution Control Plant reduced its local discharge limit for cyanide. A fact sheet was developed and distributed to metal finishers and electroplaters in an effort to assist them with meeting the local limit. (San Jose 1999). The Palo Alto Regional Water Quality Control Plant's Pretreatment Program regularly monitors electroplaters that utilize cyanide-containing plating baths. Palo Alto has worked with its industries to modify their processes to reduce discharges of both metals and cyanide to the sanitary sewer. This effort has included encouraging industries to install cyanide destruction treatment units, modification of rinse operations, and/or collection of concentrated cyanide wastes for offsite treatment (Palo Alto 1996a; Palo Alto 1996b). The cyanide destruction units use a two-stage alkaline chlorination treatment process. The first stage of treatment uses sodium hypochlorite to oxidize cyanide to cyanate, and the second stage further oxidizes the resulting cyanate to carbon dioxide and nitrogen (Cushnie 1994). Palo Alto also identified a cyanide discharge from a solvent recycler and hazardous waste management facility. The facility had been accepting, processing and discharging a waste containing cyanide strongly complexed with iron (ferrocyanide). The discharge had led to violations of Palo Alto's cyanide effluent limits. Palo Alto worked with the facility to modify its procedures to prevent a recurrence of the discharge (Palo Alto 1997).

Central Contra Costa Sanitary District (CCCSD), a deep water discharger, did not identify influent sources of cyanide but reviewed its treatment processes and determined that cyanide was being discharged in scrubber water from its sludge incineration process. CCCSD modified the air inlet configuration to reduce cyanide formation and evaluated redirecting the scrubber water. (CCCSD 2002).

All shallow water dischargers have been issued interim cyanide effluent limits and compliance schedules were established in their permits. Under the SIP requirements, before a compliance schedule is authorized, the dischargers are required to document that diligent efforts are undertaken to quantify pollutant levels in the discharge and to control pollutant sources. In addition, a plan to implement measures to control future sources and to minimize pollutant levels is also required. Therefore, in advance of this proposed Basin Plan amendment, shallow water dischargers with interim limits in their permits were required to conduct source identification studies and to develop and implement specific source reduction plans.

They also committed resources to implement the source control and reduction plans. These efforts have been successful at identifying and reducing cyanide sources in the collection system and within the treatment plant processes. Continuation of these programs under the proposed Cyanide Action Plan will effectively minimize cyanide discharges to receiving waters.

6 Cyanide Effluent Limits for Shallow Water Discharges

6.1 Need for Dilution Credits

Analysis of effluent data for the past several years indicates that shallow water dischargers will not be assured of achieving water quality-based effluent limits through reasonable treatment, source control and pollution prevention measures (Table 2) without dilution credits. The locations of these discharges are shown in Figure 4. The resulting permit non-compliance would lead to a presumption that aquatic life uses are being impacted by the existing shallow water discharges. In fact, available toxicity and biological information indicates that aquatic uses are not adversely affected by these discharges (see discussion below and Appendix M). This information and the fact that cyanide undergoes natural degradation in the receiving waters create the need for considering dilution credits for cyanide in shallow water discharges, described below.

Unlike metals and selenium, cyanide does not persist and ambient water quality data from the RMP indicate it does not accumulate to levels of concern in the waters and sediment of the Bay. Cyanide attenuates in the receiving waters due to degradation as well as dilution. Wastewater discharges are the only significant source of cyanide to the Bay; urban runoff is not known to contain detectable levels of cyanide.

Before this project, limited data existed in shallow water receiving waters (i.e., where discharges receive less than 10:1 dilution) relative to ambient levels of cyanide. In the last three years, information was collected by shallow water dischargers to better define dilution and degradation of cyanide in areas near their discharges and analyzed using a modified analytical method that lowered the detection limit. A body of low-level detection limit cyanide data was developed that exists nowhere else in the world. This information was used to determine dilution credits, as authorized by the SIP, for shallow water dischargers that reflect attenuation of cyanide (dilution and degradation) in receiving waters.

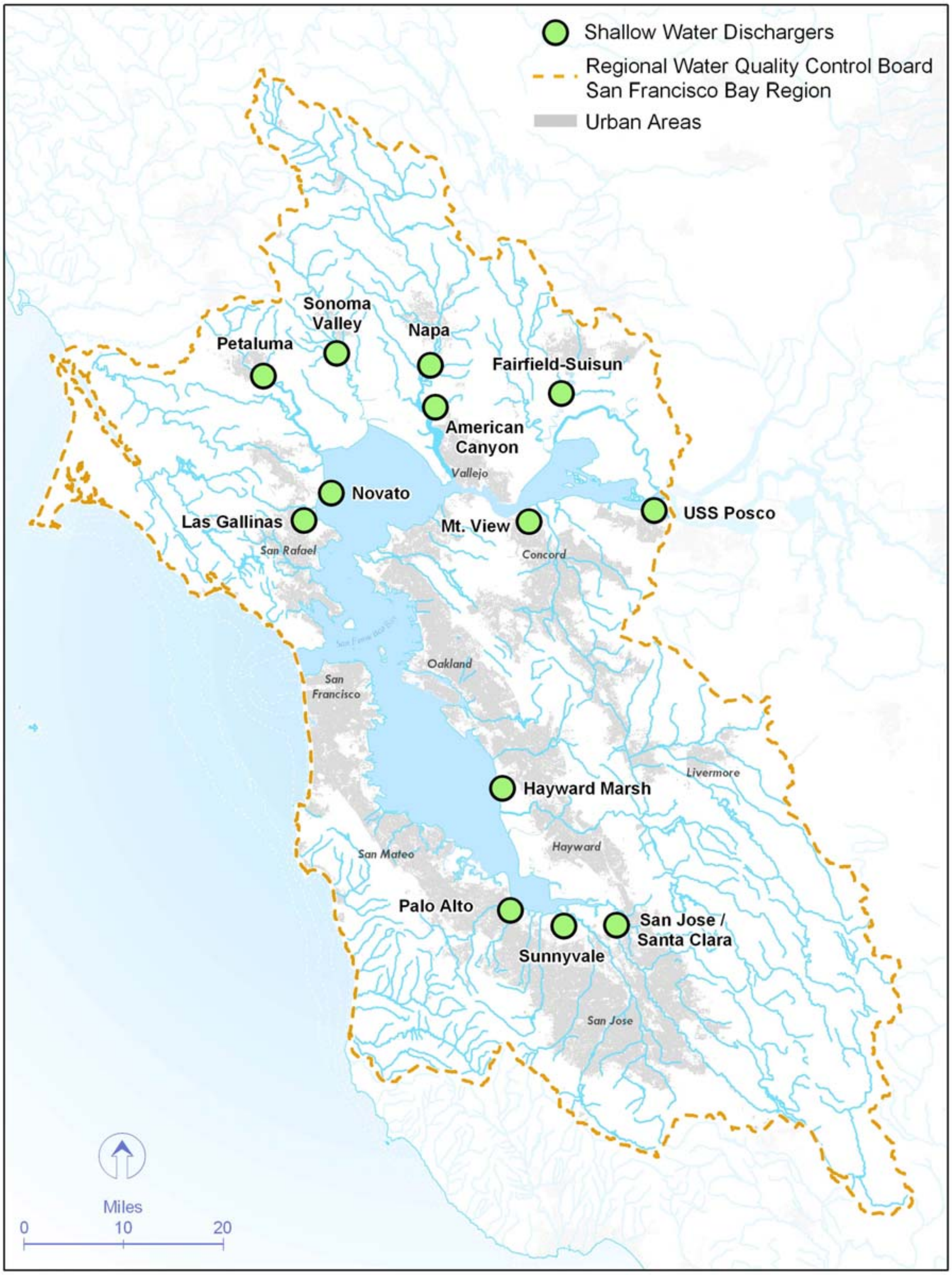

Figure 4: Location of Shallow Water Dischargers

6.1.1 Methodology for Selection of Dilution Credits and Derivation of Effluent Limits

The methodology employed to determine dilution credits from attenuation studies is summarized below and is detailed in Appendix K. For incompletely mixed discharges the SIP provides an option to establish dilution credits and mixing zones by a number of methods including, for example, dye studies, modeling studies and monitoring upstream and downstream of the discharge. If the latter approach is used, it would not be known what caused the concentrations to diminish and in the case of cyanide, the observed reduction would be partly attributed to dilution and partly to natural degradation. Similarly, in the approach applied in this Project, cyanide concentrations were measured in receiving waters to determine attenuation that results from combination of dilution and degradation.

In 2003, City of San Jose initiated a study to determine the rate of cyanide attenuation in the receiving waters (City of San Jose 2004). Cyanide concentrations were measured upstream and downstream of the effluent discharge and along the discharge gradients from the San Jose/Santa Clara Water Pollution Control Plant. This was done to evaluate cyanide degradation in addition to dilution and to test selection of alternative, protective attenuation levels that would aid NPDES permit compliance while minimizing the areal extent of mixing zones associated with varying cyanide concentrations. The potential for acute toxicity to passing organisms within mixing zones was also evaluated.

A number of shallow water dischargers have performed water quality modeling studies to assess the patterns and time scales of dilution of treated effluent in the San Francisco Bay Estuary. These studies have typically been calibrated using dyes or tracers. Information derived from those modeling studies provides important insight for estimation of cyanide attenuation near a given discharge. A summary of these modeling studies is provided in Appendix E. Other shallow water dischargers performed monitoring of cyanide levels along a gradient from the discharge location to determine dilution. Low detection limit analytical methods tested by the City of San Jose were used to measure cyanide concentrations in the effluent and receiving waters. A brief description of the modified Standard Method 4500-CN developed and used by the City of San Jose is included in Appendix L.

The use of measured concentrations in the Bay provides information for direct calculation of attenuation, and thereafter water quality-based effluent limits. Using ambient data, attenuation is calculated as the reciprocal of the total cyanide observed at a given sampling station measured as a fraction of the total cyanide discharged by a treatment facility at the upper end of a discharge gradient. Available modeling results can be used to give a conservative estimate of attenuation at a given location, based on the dilution of effluent at that location without account for natural degradation of total cyanide in the Bay. The conceptual formula for attenuation is as follows:

***Attenuation* = [*(Degradation in ambient waters)* + *(Effluent Dilution)*]**

When using empirical cyanide data, the calculation of an attenuation factor inherently takes both degradation and dilution into account. Given the log normal distribution of such empirical data, median values are used in this calculation. The attenuation factor (AF) derived from empirical cyanide data is calculated as follows:

***AF* = [*1/ (Ratio of total cyanide at a given location to the total cyanide in the effluent discharge)*]**

When using modeling results that provide information on the percent of effluent at given locations, the calculation of an attenuation factor does not take degradation into account. The attenuation factor derived from modeling results is calculated as follows and reflects dilution only:

***AF* = [*1/ (Percent effluent at a given location)*]**

Assessment of empirical data along discharge gradients and available mathematical modeling

One year of monthly data collected by the City of San Jose along its discharge gradient in Artesian Slough and Coyote Creek were first used to indicate that cyanide dissipated rapidly in the vicinity of shallow water discharges. Empirical data and mathematical modeling results from other shallow water discharges were used to confirm that the attenuation of cyanide observed by the City of San Jose was exhibited in other situations around the Bay. Based on the combination of empirical measurements and modeling data the attenuation curves were developed for all 13 shallow water discharges to determine attenuation levels and the associated locations along each gradient where those levels are likely to occur (see Appendix D).

Initially the empirically determined attenuation levels of 2.25 and 4.5, corresponding to successive receiving water monitoring locations along the San Jose gradient at Drawbridge and the mouth of Alviso Slough, were selected as upper and lower boundaries for further evaluation. These stations were selected because no exceedances of the proposed water quality objectives occurred in this portion of the receiving waters during the year-long study, therefore these values were considered protective. In addition, these attenuation thresholds were indicative of dilution ratios that, when implemented, would likely lead to effluent limits that could be complied with by municipal dischargers, based on effluent values attributable to disinfection processes.

Cyanide thresholds of concern in shallow water discharges; mixing zone issues

Not all available effluent data from 2000-2003 are considered to be acceptably protective. Effluent values above the U.S. EPA freshwater CMC (22 μg /L), equivalent to the LC0 for rainbow trout, and the marine site-specific final acute value (18.8 μg /L) derived from toxicity information for a copepod species, were considered too high to be reasonably in compliance or attributable to only disinfection. The analysis for attainability did not use compliance of all shallow water discharger data from 2000-2003 as the only criterion, but considered the freshwater CMC and recalculated marine site-specific FAV as well to prevent acute toxicity in the receiving waters of shallow water dischargers. Use of these values is considered appropriate because shallow water discharges are known to stratify in tidal sloughs for some periods of the day, and not mix immediately because of difference in salinity (1 part per thousand in effluent) from receiving waters (anywhere from 0 to 34 ppt). Also, many shallow water discharges comprise most of the waters in certain sloughs at lower low tide and receive limited dilution over a short timescale exceeding one hour. This might occur at, for example, Novato discharge on the San Pablo Bay mudflat and Palo Alto discharge in a constructed dead-end slough and South San Francisco Bay mudflat.

Analysis of projected NPDES permits compliance for alternative attenuation levels

Effluent concentration data collected between 2000 and 2003 were used to conduct an iterative evaluation of potential dilution credits corresponding to attenuation levels established from empirical and modeling studies to evaluate the preferred dilution credits. These evaluations included attenuation values of 2.25, 3.0, 3.5, and 4.5.

The selected attenuation values were evaluated to determine the projected compliance of each shallow water discharger with final cyanide effluent limits derived from the proposed cyanide marine SSOs for San Francisco Bay, based on the procedure described above and in Appendix F. The results of this analysis are summarized in Table 16. At an attenuation value of 2.25, Fairfield Suisun, Hayward Marsh, Las Gallinas Valley SD, Napa, Petaluma, Sonoma County Water Agency and Sunnyvale would be anticipated to have compliance difficulties with projected effluent limits. At an attenuation value of 4.5, no shallow water dischargers would have attainability issues. Fairfield-Suisun and Sunnyvale detected concentrations of cyanide above potential effluent limits based on an attenuation value of 4.5, but those effluent values exceed the freshwater CMC and marine FAV and therefore would not be protective of receiving waters in a shallow water discharge situation where stratification of effluent may occur. Attenuation values of 3.0 and 3.5 were also investigated for potential compliance difficulties. Aside from Fairfield-Suisun and Sunnyvale, Napa, Petaluma, and Sonoma could all have some compliance difficulties with a value of 3.0, however, this value could provide attainable effluent limits for cyanide concentrations in discharges attributable to in-plant formation of cyanide.

Analysis of the areal extent of mixing zones associated with different attenuation levels

Using the attenuation curves developed in the first step, the distance from the point of discharge was determined for each discharge for the two boundary attenuation values (2.25 and 4.5). Subsequently, areal estimates of the surface water between the point of discharge and the point where a given attenuation value would occur were determined. These distances and areal estimates are summarized in Appendices D and L.

Evaluation of potential for acute toxicity in mixing zones

A review of available toxicity data for sensitive aquatic organisms was performed to evaluate whether acutely toxic conditions to mobile organisms would occur within either of the mixing zones within the boundaries defined by the selected attenuation thresholds of 2.25 and 4.5. The review indicated that acute toxicity would not significantly impact the determination of dilution credits within that range. A detailed discussion is provided below in Sections 6.1.3 and 6.1.4.

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Table 16: Attainability Analysis of Cyanide Attenuation

		1	2	3	4	5	6	7	8	9	10	11	12	13
Discharger		**American Canyon**	**Fairfield-Suisun**	**Hayward Marsh Effluent**	**Las Gallinas**	**Mt. View**	**Napa**	**Novato**	**Palo Alto**	**Petaluma**	**San Jose/ Santa Clara**	**Sonoma**	**Sunnyvale**	**USS Posco**
Coefficient of Variation (CV)	**CV-regression**	1.216	1.002	0.794	0.776	0.600	1.227	0.665	0.300	0.868	1.190	0.858	0.944	0.600
	CV-half detection limit	0.600	0.979	0.764	0.730	0.600	1.095	0.568	0.564	0.731	1.190	0.822	0.903	0.600
Summary Statistics	**MEC**	2.9	28	11.3	10	1.6	20	4.43	5	10	5.2	13	29	4.6
	Mean	1.4	3.9	2.9	3.0	0.5	2.6	1.8	3.3	2.9	2.8	3.2	4.4	4.4
	95th	2.5	11.7	7.3	7.8	1.3	8.3	4.6	5.1	9.1	5.0	8.7	12.3	NA
	99th	3.4	21.1	11.8	12.9	2.2	16.4	7.6	6.3	17.1	6.6	14.9	21.4	NA
	99.87th	4.6	38.0	19.1	21.3	3.7	32.3	12.3	7.6	32.1	8.6	25.4	37.1	NA
No Dilution	LTA	1.1	1.3	0.8	1.4	1.5	1.0	1.6	1.6	1.4	0.9	1.3	1.2	1.5
	AMEL	2.4	2.1	2.3	2.3	2.4	2.0	2.4	2.4	2.3	2.0	2.2	2.2	2.4
	MDEL	4.8	5.3	5.1	5.0	4.8	5.3	4.7	4.7	5.0	5.4	5.1	5.2	4.8
	Compliance	**No** Mean>LTA 95th>AMEL	**No** Mean>LTA 95th>AMEL 99th>MDEL	**No** Mean>LTA 95th>AMEL 99th>MDEL	**No** Mean>LTA 95th>AMEL 99th>MDEL	**Yes**	**No** Mean>LTA 95th>AMEL 99th>MDEL	**No** Mean>LTA 95th>AMEL 99th>MDEL	**No** Mean>LTA 95th>AMEL 99th>MDEL	**No** Mean>LTA 95th>AMEL 99th>MDEL	**No** Mean>LTA 95th>AMEL 99th>MDEL	**No** Mean>LTA 95th>AMEL 99th>MDEL	**No** Mean>LTA 95th>AMEL 99th>MDEL	**No** MEC> AMEL
Attenuation =2.25	LTA	5.2	3.2	3.8	3.8	4.5	2.8	4.2	6.3	3.5	5.5	3.6	3.4	4.4
	AMEL	7.6	6.2	6.6	6.6	7.0	6.1	6.8	7.9	6.4	7.6	6.4	6.4	6.8
	MDEL	13.9	15.6	15.0	14.9	14.0	16.6	14.4	11.9	15.3	13.0	15.2	15.9	13.6
	Compliance	**Yes**	**No** Mean>LTA 95th>AMEL 99th>MDEL	**No** Mean>LTA	**No** 95th>AMEL	**Yes**	**No** 95th>AMEL	**Yes**	**Yes**	**No** 95th>AMEL, 99th>MDEL	**Yes**	**No** 95th>AMEL	**No** Mean>LTA 95th>AMEL 99th>MDEL	**Yes**
Attenuation =3.0	LTA	6.4	3.9	4.6	4.7	5.5	3.5	5.2	7.6	4.3	6.7	4.4	4.2	5.3
	AMEL	9.3	7.5	8.0	8.1	8.5	7.5	8.3	9.7	7.8	9.3	7.9	7.9	8.3
	MDEL	17.0	19.0	18.3	18.2	17.1	20.3	17.6	14.5	18.6	15.9	18.6	19.4	16.6
	Compliance	**Yes**	**No** 95th>AMEL 99th>MDEL	**Yes**	**Yes**	**Yes**	**No** 95th>AMEL	**Yes**	**Yes**	**No** 95th>AMEL	**Yes**	**No** 95th>AMEL	**No** Mean>LTA 95th>AMEL 99th>MDEL	**Yes**

Discharger		**American Canyon**	**Fairfield-Suisun**	**Hayward Marsh Effluent**	**Las Gallinas**	**Mt. View**	**Napa**	**Novato**	**Palo Alto**	**Petaluma**	**San Jose/ Santa Clara**	**Sonoma**	**Sunnyvale**	**USS Posco**
Attenuation =3.5	LTA	7.2	4.3	5.1	5.2	6.1	3.9	5.8	8.6	4.8	7.5	4.9	4.7	6.0
	AMEL	10.4	8.4	9.0	9.0	9.5	8.4	9.3	10.8	8.8	10.4	8.8	8.8	9.3
	MDEL	19.1	21.3	20.5	20.4	19.1	22.8	19.7	16.3	20.9	17.8	20.8	21.8	18.6
	Compliance	**Yes**	**No** 95th>AMEL	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**No** 95th>AMEL	**Yes**	**Yes**	**No** 95th>AMEL	**Yes**
Attenuation =4.5	LTA	8.8	5.3	6.3	6.4	7.5	4.7	7.0	10.4	5.9	9.2	5.9	5.7	7.2
	AMEL	12.7	10.3	10.9	11.0	11.6	10.2	11.3	13.2	10.7	12.7	10.7	10.8	11.2
	MDEL	23.3	25.9	24.9	24.8	23.2	27.8	23.9	19.8	25.3	21.7	25.3	26.5	22.5
	Compliance	**Yes**	**No** 95th>AMEL	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**No** 95th>AMEL	**Yes**
Note:	LTA :long term average limitation MEC: maximum effluent concentration AMEL: monthly average effluent limitation MDEL: daily maximum effluent limition Coefficient of variation (CV) were calculated using both half detection limit method and probability regression method, and are listed in the first two rows of the table for comparison. The AMELs and MDELs were calculated using the CVs from the probability regression method. In general, the higher the CV, the higher the MDEL, but the lower the AMEL.													

Dilution credits for shallow water discharges based on attenuation analysis

The conclusions from the above multi-step analysis were used as a basis for selection of attenuation values reflecting dilution and natural degradation of cyanide in proximity to shallow water effluent discharges. Attenuation and modeling studies conducted for the purpose of this analysis helped determine the extent of cyanide reduction due to mixing with waters of the Bay. Therefore they could be used to establish dilution credits for individual dischargers following the procedures set in the SIP for incompletely mixed discharges. The proposed attenuation values between 2.0~~25~~ and 3.0 correspond to dilution credits of 3.0~~25~~:1 and 4.0:1 respectively.

They were selected to ensure that the extent of the mixing zone associated with each effluent outfall is minimized and that the computed compliance thresholds such as Maximum Daily Effluent Limit (MDEL) and Average Monthly Effluent Limit (AMEL) are protective of aquatic life. The maximum computed MDEL for all 13 dischargers will only slightly exceed 19.0 µg/L expressed as total cyanide, which is significantly lower than the conservative estimate of LC0 for rainbow trout of 22.4 µg/L expressed as free cyanide. The maximum computed AMEL will not exceed 8.4 µg total cyanide /L, well below the LC0 for saltwater copepod of 15 µg free cyanide/L. This ensures that no lethality to aquatic organisms would result from temporary passage through the mixing zone. Selection of the above values and the implementation of the resulting effluent limits would not have a significant impact on the ambient cyanide concentrations in the Bay, which currently comply with the proposed cyanide SSOs.

6.1.2 Spatial Extent of Mixing Zones

The provision of dilution credits for the determination of water quality-based effluent limits involves the establishment of a mixing zone as described in the SIP. Compliance with cyanide water quality objectives occurs at the edge of the cyanide mixing zone. In this project the extent of the mixing zone is defined as the location in the receiving water where the ratio of effluent concentrations to receiving water concentrations of cyanide equals the attenuation value.

The areal extent of the cyanide mixing zone for each shallow water discharger is site-specific and, in part, a function of the assigned dilution credit. Estimates of the distance from the point of discharge to the edge of the cyanide mixing zone and the surface area of the cyanide mixing zone for each shallow water discharger is provided in Appendix D. The upper and lower bounds of potential attenuation values of 2.25 and 4.5 are indicated to demonstrate the minimum and maximum dimensions of potential cyanide mixing zones. The edges of the zones were determined using measured cyanide concentrations along individual discharge gradients and the results from mathematical water quality modeling studies, where available. The proposed dilution credits were assigned to ensure that the surface area of the mixing zone is no larger than necessary to provide intended compliance relief as required by the SIP.

Appendix J provides an assessment of the compliance with additional Basin Plan and SIP requirements for the establishment of a mixing zone and dilution credit for shallow water dischargers to San Francisco Bay. This assessment and Section 5.4 are provided to document the fulfillment of these requirements.

6.1.3 Consideration of Acute Toxicity to Sensitive Organisms in Mixing Zone

In the establishment of mixing zones, the SIP prohibits acutely toxic conditions, i.e. lethality to mobile organisms that move or drift through the mixing zone.

Concentrations of free cyanide that have been observed to exhibit acute toxicity to sensitive saltwater and freshwater species are shown below. The values shown as LC50 are the free cyanide concentrations that were observed to be lethal to 50 percent of the most sensitive test organisms, in the freshwater and recalculated saltwater databases. The LC0 values are concentrations estimated to produce no acute toxicity to any test organisms.

Acartia clausi copepod (saltwater) LC50 = 30 µg/L (unmeasured)

LC0 = 15 µg/L (estimated)

Rainbow trout (juvenile) (freshwater) LC50 = 44.7 µg/L (measured)

LC0 = 22.4 µg/L (estimated)

Depending on the specific discharge, these or similarly sensitive species could pass through the cyanide attenuation zones of the shallow water dischargers to San Francisco Bay waters. Some of the shallow water discharges occur in dead end sloughs as described in Table 17 where occurrence of sensitive aquatic species may be scarce. Downstream movement of mobile aquatic organisms may occur in Coyote Creek, Guadalupe Slough, Sonoma Creek (connected to Schell Slough), Petaluma and Napa Rivers, and Miller Creek, regionally important steelhead-supporting streams. Exposure of organisms on the mudflat near the Novato mixing zone will be very short duration and will not produce concentrations that would produce acute toxicity to sensitive organisms.

Free cyanide concentrations in the estimated range from 15 to 22 µg/L establish the upper bound of cyanide concentrations that would cause acute toxicity within a cyanide attenuation zone. In the U.S. EPA criteria, total cyanide concentrations are used as a conservative estimate of free cyanide levels. Therefore, maximum daily total cyanide concentrations ranging from 15 to 22 µg/L would ensure (with a significant margin of safety) that acute toxicity to sensitive organisms would not occur within any of the cyanide attenuation zones of shallow water dischargers.

Table 17: Effluent Discharge Areas for Shallow Water Dischargers

Shallow Water Discharger	Receiving Water	Description
City of San Jose/Santa Clara	Artesian Slough	Dead-end slough
	Coyote Creek	Major tributary
City of Sunnyvale	Moffett Channel	Modified channel
City of Palo Alto	Man-made channel	Dead-end channel
Las Gallinas	Miller Creek	Minor tributary
Mt. View SD	Peyton Slough	Dead-end slough
Novato SD	San Pablo Bay	Mud flat
Sonoma County Water Agency	Schell Slough	Dead-end slough
City of Petaluma	Petaluma River	Minor tributary
Napa SD	Napa River	Major tributary
American Canyon	North Slough	Dead-end slough
Hayward Marsh	Hayward Marsh basin	Marsh
Fairfield Suisun SD	Boynton Slough	Dead-end slough
USS Posco	New York Slough	Slough channel

6.1.4 Evaluation of Biological Community along a Representative Shallow Water Discharge Gradient

Available information suggests that cyanide concentrations in existing shallow water discharges are not measurably affecting biota in the receiving waters, and therefore the proposed effluent limits would be protective of the potentially affected beneficial uses. A case in point is the Palo Alto Regional Water Quality Control Plant (Palo Alto), which represents an arguably “worst-case” source scenario of documented industrial sources of cyanide in the influent and associated historic effluent violations, as well as in-plant sources of both biosolids incinerator scrubber water and disinfection by chlorination.

Palo Alto commissioned a biological study of its effluent discharge channel in August 1997. A November 1997 technical report summarizes the results of the study, titled *Benthos and Fisheries Assessment, Palo Alto Wastewater Treatment Plant Discharge Channel*. The study also examined biological conditions in San Francisquito Creek, an urban creek with a fairly large, undeveloped watershed located 1000 feet northwest of the discharge channel. The results of the August 1997 biological assessment of benthic community and fish in the Palo Alto effluent channel indicated that it supported a diverse assemblage of aquatic fauna. The types and abundances of organisms present in the channel were representative of typical South Bay slough species and not indicative of highly stressed benthic communities, and not degraded relative to the tidal channel of San Francisquito Creek. These conditions exist despite levels of cyanide in the Palo Alto effluent channel that are elevated, at times, in comparison to the NTR cyanide objective of 1.0 µg/l and the proposed chronic site specific objective of 2.9 µg/l. A description of the Palo Alto study and its results is presented in Appendix M.

6.1.5 Options Explored to Resolve Shallow Water Discharger Compliance Issues

Several alternatives were evaluated to seek resolution of shallow water discharger permit compliance issues for cyanide. These alternatives included the following:

- Water Effect Ratio (WER)
- Toxicity testing of effluent
- Toxicity testing of ambient waters
- Use of a "translator" approach based on measurements of free cyanide and total cyanide

The WER approach was evaluated by the City of San Jose in a pilot-testing program performed in 2002 using larvae of a sensitive fish species, *Menidia beryllina* (Inland silversides), as the test organism. The City conducted acute toxicity tests in accordance with U.S. EPA guidance for performing water effect ratio studies but found that the sensitivity of the test organism (LC50 of 87 µg/L in laboratory water) was not sufficient to derive a WER value that was (a) applicable to the cyanide concentrations measured in effluent (typically in the range from 1 to 10 µg/L) and (b) a value significantly different from 1.0 (observed WER was 0.92)(City of San Jose 2002). Therefore, the WER approach was determined not to be a useful approach to address the shallow water discharger compliance issues.

Direct measurement of cyanide toxicity in effluent and receiving waters was considered as a potential method to address the shallow water discharger cyanide compliance issues. Upon examination of sensitive aquatic organisms, it was determined that even the most sensitive saltwater test organism, a copepod (*Acartia clausi*), was not adequately sensitive (LC50 = 30 µg/L) to confirm or deny cyanide toxicity in either effluent (cyanide concentrations of 1 to 10 µg/L), shallow discharge receiving waters (cyanide concentrations of 0.3 µg/L in background waters to less than 3 µg/L in sloughs near outfalls). Similar evaluation of the use of the most sensitive freshwater test organism, rainbow trout (*Oncorhynchus mykiss*) with an LC50 of 44.7 µg/L produced a similar finding.

A "translator" approach was considered which would use measured concentrations of free cyanide and total cyanide in effluent and/or ambient waters to determine the ratio in each water. This approach is similar to trace metal translators in which dissolved metal measurements and total recoverable metals measurements are used to develop ratios used in the derivation of effluent limits. The challenge in the derivation of the free to total cyanide ratios is in the availability of analytical methods to measure these cyanide fractions at the levels present in effluent or ambient waters. Analytical methods for total cyanide were researched and methods were found that would lower the detection limit from the levels obtained using U.S. EPA standard methods (3 to 5 µg/L) to 0.1 to 0.3 µg/L in ambient waters and 1 µg/L in effluent (Exygen Research 2002; City of San Jose 2004). However, similar analytical methods do not exist for the determination of free cyanide concentrations (Exygen Research 2002). Therefore, the inability to measure free cyanide concentrations at levels that total cyanide is present in ambient waters (i.e. in the range from zero to 0.4 µg/L) prevents the derivation of the desired translator values and precludes the use of this approach in the derivation of effluent limits for cyanide.

The above approaches are consistent with the evaluation of permit relief options as stipulated in Step 6 of the decision tree of Appendix 5 of the SIP. Appendix 5 of the SIP outlines a decision-making approach for performance and approval of a variety of special studies by the State and Regional Boards, including the development of site-specific objectives.

6.1.6 Consideration of Critical Habitat for Listed Species

The SIP requires that mixing zones shall not adversely impact biologically sensitive or critical habitats. Analysis of the outfall location (Figure 2) for each shallow water discharger indicates that six out of thirteen dischargers currently discharge effluent to waters that have been listed as critical habitat areas for Delta smelt (*Hypomesus transpacificus*) or steelhead (*Oncorhynchus mykiss*). These dischargers include five municipal wastewater dischargers: Fairfield Suisun Sewer District (FSSD), Napa Sanitation District (Napa SD), Petaluma, Las Gallinas and Sonoma Valley SD, and one industrial discharger: USS Posco.

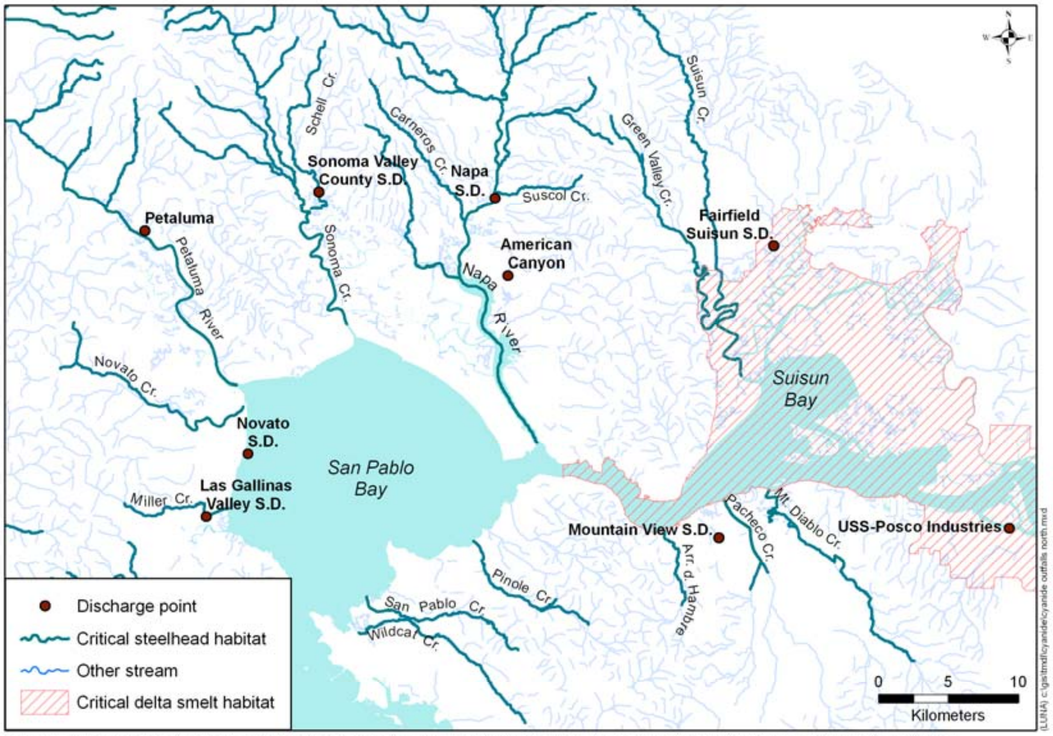
Delta Smelt

FSSD and USS Posco have their outfalls located at the northern and southern edges of the area designated as critical habitat for Delta smelt (Figure2).

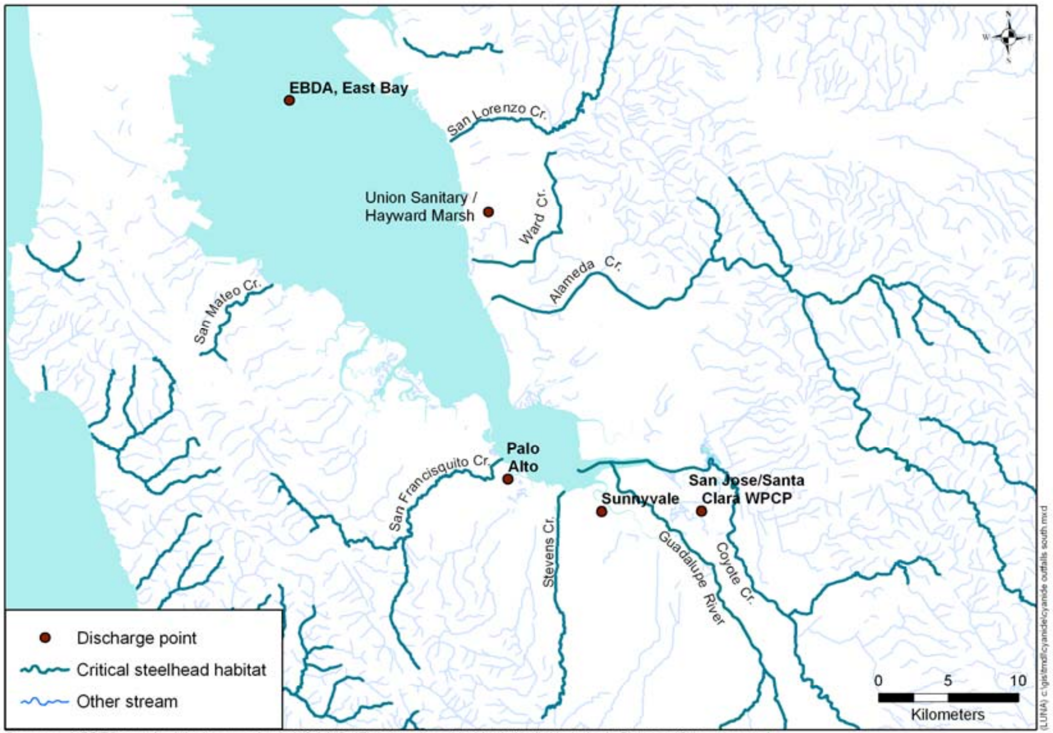
The Delta smelt (*Hypomesus transpacificus*) is a small native fish restricted to a narrow margin of low salinity habitat and spends much of its one year long life near the confluence of the Sacramento and San Joaquin rivers. In 1993, the US Fish and Wildlife Service and the California Fish and Game Commission listed the Delta smelt as threatened pursuant to the federal and state endangered species acts. Since then, the amount of new information on Delta smelt biology and ecology has increased significantly and all the recent scientific knowledge was critically reviewed and synthesized by Bennett in Critical Assessment of the Delta Smelt Population (2005). No information exists on the Delta smelt's sensitivity to cyanide.

Delta smelt spawning areas are restricted to the Delta and the freshwater reaches of the San Francisco Estuary (FWS, 2004). The extent to which Delta smelt distribution varies from year to year is not well understood. Little is known about the spawning microhabitat for Delta smelt or the actual spawning locations. The latter are usually inferred from the catches of very young larvae and fish. Fertilization and hatching success are extremely variable and most markedly constrained by water temperature. It has been observed that abundance of Delta smelt is elevated only in years when the low salinity zone is located within Suisun Bay, when a delicate balance between freshwater flows due to rainfall and water diversion is maintained. Although Delta smelt could be widely dispersed throughout Suisun Bay, it appears that northern Suisun Bay and adjoining shallows provide more favorable habitat for smelt than the deeper Ship channel to the south (Bennett, 2005).

The northernmost edges of Suisun Marsh and New York Slough, in the vicinity of FSSD and USS Posco, have not been identified as hatching habitat. The mixing zones for cyanide established for these two wastewater treatment facilities are not expected to adversely impact the Delta smelt.



Sources: NPDES permits (discharge points); NOAA/CalFish (steelhead habitat); US FWS (delta smelt habitat); Nat'l. Hydrologic Dataset (Other streams)
Date: October 22, 2006 Editor: J. Kapellas, SF Bay Regional Water Quality Control Board



Sources: NPDES permits (discharge points); NOAA/CalFish (steelhead habitat); Nat'l. Hydrologic Dataset (Other streams)
Date: November 2, 2006 Editor: J. Kapellas, SF Bay Regional Water Quality Control Board

Figure 5: Wastewater Outfalls Near Designated Critical Habitats

Steelhead Rainbow Trout

Napa River, Miller Creek, Petaluma River and Schell Creek/Schell Slough are designated as a critical habitat for steelhead (*Oncorhynchus mykiss*), listed as threatened under the Endangered Species Act. The Napa, Las Gallinas, Sonoma and Petaluma Sanitation Districts discharge treated effluent to these designated rivers and creeks (Figure 2).

Steelhead is the anadromous form of rainbow trout found in coastal drainages south and north of San Francisco. Their ecological requirements are similar to those of Pacific Salmon; however, they exhibit larger variability in terms of migration and spawning habits. Generally steelhead spend most of their lives in the ocean and return to freshwater as mature fish (CDFG, 2001). The San Francisco Estuary and its tributaries are known for so called “winter steelhead” that typically begin their spawning migration in the fall and winter and spawn within a period of weeks to months from the time they enter freshwater. The spawning requires cool, well-oxygenated waters and mostly occurs from December through April (Goals Project, 2000) in the upper reaches of small tributaries where these conditions are sustained year-round. It has been shown (CDFG, 2001) that water temperature is a critical factor for steelhead as egg mortality begins to occur at 13 ^{o}C and thermal stress is evident at temperatures approaching 18 ^{o} C. At the same time studies of population structure demonstrate that steelhead exhibit extreme adaptive capacity allowing populations to persist in varying climatic, hydrologic and limnological conditions.

Leidy, et al. (2005), investigated historical distribution and current status of steelhead in the San Francisco Estuary. They found that steelhead runs, of undetermined size, were known to exist in Miller Creek and in the upstream part of Napa River and its tributary streams with the exception of the headwaters of the river above Kimball Canyon Dam that forms a complete barrier to upstream fish migration. While Petaluma River was noted as a historical migration route and “lightly used” steelhead habitat in 1962, no steelhead or other salmonids were observed there during subsequent surveys. Schell Creek was also cited as a migratory corridor only and no steelhead were found there during more recent surveys. An extensive monitoring program of the restored and created habitat in the vicinity of Napa City (Stillwater Sciences, 2006) indicated insignificant capture rates (7 in 3 years) for steelhead in the project area. Steelhead inhabited Miller Creek historically, and were found consistently during surveys in 1981, 1993 and 1997. All these surveys were conducted upstream from Hwy. 101, above the Las Gallinas outfall, which is located approximately 1 mile west from San Pablo Bay.

All shallow water discharger outfalls are located at considerable distance from the suitable spawning and rearing areas for steelhead. Their locations are tidally influenced within the lower reaches of the water bodies, where the subsequent river systems have been highly modified due to flood management, urbanization and agricultural development. To limit any possible adverse impacts on the environment and sensitive biological species, effluent discharge is only allowed during the wet weather season, from November through May, when watershed runoff and upstream inflows provide substantial volumes of freshwater. The monitoring of receiving water quality near each of the outfalls and along the discharge gradient confirms that cyanide concentrations at these critical areas are consistently low. The concentrations measured at the outfall for all four dischargers vary from 1.5 to 2. 9 µg/L and never exceeded the proposed chronic objective for cyanide of 2.9 µg/L. This together with relatively small effluent volumes and the timing restrictions suggests that the proposed mixing zones would not cause any adverse impact on steelhead or any other sensitive biological habitats.

7 Alternative Cyanide Treatment Technologies and Costs

7.1 Cost of Treatment to Meet NTR Objective for Cyanide

In March 2002, C.L. Meyer of Shell Global Solutions, Inc. prepared a technical memorandum for the Bay area cyanide working group to evaluate available treatment technologies to assess the ability to achieve a 1 µg/L effluent limit for cyanide (Meyer 2002). The memorandum addressed the following treatment technologies: alkaline chlorination, ozone or ozone/UV, hydrogen peroxide, wet air oxidation, catalytic oxidation with GAC/PAC, ion exchange, SO_2/air oxidation, polysulfide, biological treatment, precipitation, electrolytic decomposition, reverse osmosis and air stripping.

The analysis by Meyer included (1) a description of each technology, (2) available process data, (3) available cost information, (4) applicability to the Shell refinery, and (5) a summary comment on each process. A key finding from the analysis by Meyer is that no record exists to confirm that any of the above technologies can achieve an effluent concentration of less than 10 µg/L. Many of the alternative technologies are applicable to treatment of waste streams with influents exceeding 50 to 100 µg/L. Of the technologies examined, the most likely to be able to approach or equal an effluent cyanide concentration in the range from 1 to 5 µg/L are reverse osmosis, ozonation with UV radiation and wet air oxidation. Unit cost estimates for these three treatment technologies are summarized below in Table 18. These estimates confirm that reverse osmosis would be the most economical of the three alternative technologies by a comparative percentage ranging from 73 to 465 percent.

Table 18: Cyanide Treatment Alternatives and Estimated Unit Costs

Treatment Alternative	Capital ($ million/mgd)	Annual ($ million/mgd)	Annualized Capital Annual ($ million/mgd)
Ozonation plus UV	9.2	2.0	2.8
Wet air oxidation	76		6.6
Reverse Osmosis			1.34
Reverse Osmosis plus filtration			1.58

Assumptions: ENR Construction Cost Index used to adjust costs to 2005 (ENRCCI = 8290). Capital costs for Ozonation plus UV based on 1974 estimate (ENR = 2020). Capital costs for Wet Air Oxidation based on 1987 estimate (ENR = 4406). Annual costs for Reverse Osmosis and Filtration based on 1991 costs (ENR = 4835). Interest rate = 6%. 20 year planning period. Capital recovery factor = (A/P,6%, 20) = 0.08718. Refs: Meyer 2002; NRC 1993.

Unit costs for the ozonation with UV radiation and wet air oxidation options were derived from cost information provided in Meyer, C.L., 2002, “Evaluation of the Treatment Technologies to achieve a 1 µg/L Effluent Limit for Cyanide”. Unit costs for reverse osmosis (and prerequisite filtration) were derived from cost estimates contained in 1993 National Research Council publication titled *Managing Wastewater in Coastal Urban Areas* (NRC 1993). The following annual unit costs (expressed as $ million per year per mgd) were derived from the information provided in the NRC publication and are used to estimate costs in this analysis:

- Filtration: $0.24 million per year per mgd
- Reverse osmosis (RO): $1.34 million per year per mgd
- Filtration plus RO: $1.58 million per year per mgd

These estimated costs are derived from annualized capital and annual operation and maintenance costs and are indexed to a 2005 construction cost index of 8290. The source document for these costs included costs with an estimated 1991 construction cost index of 4835 (Meyer 2002).

The estimated costs of implementing reverse osmosis (i.e. constructing and operating facilities) for the dischargers that could not comply with the projected final cyanide effluent limits derived from the NTR cyanide acute and chronic objective of 1.0 µg/l is summarized in Table 19. These costs are based on application of the unit costs for either RO or filtration plus RO at the average dry weather flow capacity for each permittee, depending on the existence of filtration at a given facility.

As shown in Table 19, the total discharge that would require reverse osmosis treatment would be approximately 601 mgd. This would require an estimated annualized capital and operational costs of $887 million. In addition, an estimated 115 mgd of concentrated brine from the reverse osmosis would be generated and would require further treatment and disposal. Costs for brine treatment and disposal are not included in the above estimated costs, but need to be acknowledged as part of potential environmental impacts of no action.

Table 19: Cost Estimate – Reverse Osmosis Treatment as Alternative to Achieve Projected Cyanide Effluent Limits

NPDES Permittee	Type of Discharge	Projected Compliance Problem with Effluent Limits derived from NTR objectives?	Design Flow Rate (mgd)	Annualized Cost ($ million)(ENR 8290)
American Canyon	Shallow	Yes	2.5	3.4
Benicia, City of	Deep	Yes	4.5	7.1
Burlingame, City of	Deep	Possible		
Central Contra Costa Sanitary District	Deep	No		
Central Marin Sanitation Agency	Deep	Possible		
Delta Diablo Sanitation District	Deep	Yes	16.5	26.1
Dow Chemical Company	Deep	No (1)		
Dublin San Ramon Services District	Deep	ND		
EBDA	Deep	Yes	97.1	153.4
EBMUD	Deep	Yes	120	189.6

NPDES Permittee	Type of Discharge	Projected Compliance Problem with Effluent Limits derived from NTR objectives?	Design Flow Rate (mgd)	Annualized Cost ($ million)(ENR 8290)
Fairfield-Suisun Sewer District	Shallow	Yes	17.5	23.5
GWF Nichols Rd (Site V)	Deep	ND		
Livermore, City of	Deep	ND		
Las Gallinas Valley SD	Shallow	Yes	2.9	4.6
Marin Co SD No. 5 (Tiburon)	Deep	Possible (2)		
Millbrae, City of	Deep	Possible		
Morton	Deep	ND		
Mt. View Sanitary District	Shallow	Yes	2.4	3.2
Napa SD	Shallow	Possible		
Novato SD	Shallow	Yes	6.5	10.3
Palo Alto, City of	Shallow	Yes	39	52.3
Petaluma, City of	Shallow	Yes	5.2	8.2
Pinole-Hercules	Deep	Possible		
Rhodia Basic Chemicals	Deep	ND		
Rodeo Sanitary District	Deep	No (1)		
S.F.Airport, Industrial	Deep	ND		
S.F.City & County Southeast, North Point & Bayside	Deep	Possible		
San Jose Santa Clara WPCP	Shallow	Yes	167	223.8
San Mateo, City of	Deep	Possible		
Sausalito-Marin Sanitary District	Deep	Yes	1.8	2.8
Sonoma County Water Agency	Shallow	Yes	3.0	4.7
South Bayside System Authority	Deep	Yes	29	45.8
South San Francisco & San Bruno	Deep	Yes	13	20.5
Sunnyvale, City of	Shallow	Yes	29.5	39.5
US Navy Treasure Island	Deep	ND		
USS - Posco	Shallow	Yes	28	44
Valero Benicia Refinery	Deep	ND		
Vallejo San & Flood Control District	Deep	Yes	15.5	24.5
West County/Richmond	Deep	Possible (2)		
			601	887

Reverse osmosis treatment facilities are energy intensive and would place a significant new energy demand on the San Francisco Bay Region. The adverse environmental and social impact of brine disposal and power demand associated operation of large reverse osmosis facilities would likely outweigh other environmental benefits of such facilities (Malcolm Pirnie 2003). Therefore, the use of such facilities to achieve cyanide final effluent limits derived from existing NTR water quality objectives would not represent a reasonable compliance option.

7.2 Costs of Conversion from Chlorination to UV Disinfection

As noted previously, a conversion from chlorination disinfection to UV disinfection provides a treatment technology alternative to reduce cyanide concentrations in effluent. However, the ability to provide reliable projections of effluent cyanide concentrations from UV disinfection is still uncertain, given the lack of full scale operating experience over a range of treatment facilities.

For evaluation purposes, as a hypothetical, it is valuable to examine the estimated costs and projected benefits of conversion to UV disinfection as a means to comply with stringent cyanide effluent limits for shallow water dischargers (i.e. limits derived without consideration for cyanide attenuation in the receiving water). The following cost analysis for the installation of UV disinfection as a replacement for chlorination facilities provides perspective on this topic.

Implementation of UV disinfection on a broad scale in the Bay area would require the following steps:

- Install either granular media filters or membrane filters ahead of UV disinfection where such facilities do not presently exist
- Remove existing chlorination equipment
- Install UV disinfection equipment, typically in new contact structures.

A breakdown showing the estimated costs for each shallow water discharger is provided in Table 20. The estimated annual costs to add facilities to provide UV disinfection for all shallow water dischargers would be $29.3 million (ENR 8290). The projected benefits of UV disinfection would include incremental reductions in the concentrations of cyanide in the effluents from eleven shallow water dischargers. The average magnitude of these reductions would be estimated to range from 1 to 4 µg/l (see Table 16). As demonstrated by the effluent quality data for American Canyon and Mt. View Sanitary District, the use of UV disinfection will reduce but not eliminate cyanide in the effluent.

The ambient water quality benefits of such reductions in effluent concentrations are limited from a spatial perspective, since such reductions would only occur in the immediate vicinity of the shallow water discharges at the upper end of each discharge gradient. As noted elsewhere in this Report, cyanide concentrations in these areas are not presently at levels that produce toxicity to sensitive aquatic organisms. Therefore, no significant benefit to aquatic life uses in these areas would be projected.

Table 20: Cost Analysis - UV Disinfection for Shallow Water Dischargers

Discharger	Existing Design ADWF	Existing Filtration	Existing UV disinfection	Annual cost filtration	Annual cost UV	Total annual cost
	(mgd)			($ million)	($ million)	($ million)
American Canyon	2.5	yes	yes	0.0	0.0	0.0
Fairfield-Suisun SD	17.5	yes	no	0.0	0.7	0.7
Las Gallinas Valley SD	2.9	no	no	0.7	0.1	0.8
Mt. View SD	2.4	yes	yes	0.0	0.0	0.0
Napa SD	15.4	yes	no	0.0	0.6	0.6
Novato SD	6.5	no	no	1.5	0.3	1.8
Palo Alto	39	yes	no	0.0	1.6	1.6
Petaluma	5.2	no	no	1.2	0.2	1.4
San Jose Santa Clara	167	yes	no	0.0	6.9	6.9
Sonoma County Water Agency	3.0	no	no	0.7	0.1	0.8
Sunnyvale	29.5	yes	no	0.0	1.2	1.2
Union SD - Hayward Marsh	20	no	no	4.7	0.8	5.5
USS Posco	28	no	no	6.7	1.1	7.8
Totals				15.5	13.8	29.3

Assumptions:

All costs in table are adjusted to ENR = 8290 (July, 2005); Annual cost recovery factor for 6%, 20 years = 0.08718. Unit costs for filtration and UV disinfection were derived from the following sources: Unit annual cost for filtration ($ million/mgd) = 0.24; Based on 1993 National Research Council publication Managing Wastewater in Coastal Urban Areas (based on ENR 4835 costs); Unit annual cost for UV disinfection ($ million/mgd) = 0.04; Based on West Yost and Associates, August 2001 report Easterly WWTP NPDES Permit Compliance Analysis (based on ENR = 6400 costs)

Conversion to UV disinfection would significantly reduce or eliminate chlorine usage for disinfection at the treatment facilities in question. Chlorine use for other in-plant purposes may continue. Electrical power consumption associated with operation of the UV process would be increased at these facilities. These costs are accounted for in the cost estimate summarized in Table 20 .

Given the lack of demonstrable benefits to aquatic life uses and the significant costs associated with implementation of UV disinfection for all shallow water dischargers in San Francisco Bay, this approach is not warranted on the basis of cyanide concentration reduction benefits alone.

8 Implementation Plan

The Basin Plan amendment implementation plan was developed to serve as a non-degradation plan to ensure that existing water quality is maintained, beneficial uses are protected, and exceedances of the site-specific water quality objectives do not occur in waters of San Francisco Bay.

8.1 Effluent Limits Justification

Mandatory effluent limits are proposed for most dischargers, to fulfill antidegradation requirements and ensure full commitment of resources from dischargers to maintain current performance and pollution prevention, as required by the Basin Plan and SIP (see Appendix J). Cyanide has been detected in effluents of most of the dischargers in the region. For some dischargers that have not detected cyanide in the effluent, the method detection limit might be too high (e.g., 10 µg/L) to make a determination that cyanide is not present. Most of the detected values are thought to be a by-product of disinfection processes, including industrial dischargers to San Francisco Bay that disinfect their effluent or sewage inputs to their wastewater. Cyanide levels in effluent appear fairly consistent region-wide, with 90% of 2,349 concentration measurements ranging from 1 to 10 µg/L. The remaining higher concentrations of cyanide detected in effluent could not be explained by the disinfection processes alone. Infrequent short-lasted spikes in cyanide levels exceeding 10 µg/L are usually attributed to dumping events in collection systems or accidental spills and other seasonal anomalies.

The SIP specifies a methodology for determining which priority pollutants require effluent limits. Step 7 of Section 1.3 of the SIP provides that Water Boards may find that numeric effluent limits are required for pollutants even if Steps 1 through 6 do not trigger the requirement for the water-quality based limits. Most dischargers monitor effluent cyanide as grab samples once per month, and are hardly able to detect every potential pulse of cyanide that could enter the collection system. Therefore, using Steps 1 through 6 of the SIP on snapshots of effluent quality data is not a sufficient means to determine the need for effluent limits. Given the episodic nature of cyanide in effluent, and the receiving waters' vulnerability to illicit discharges to the collection system, more accountability is needed to ensure that water quality standards for a pollutant such as cyanide are not violated once per three years.

Recent experience has demonstrated how any municipal discharger in the region with cyanide sources to its influent has a reasonable potential to contribute to exceedance of the water quality standard (objective), whether it is 1.0 or 2.9 µg/L. In 2004, while the City of San Jose was performing its study of cyanide attenuation in the Bay, pulses of high concentrations of cyanide were tracked through the treatment plant and into the Bay on three separate occasions (in the months of May, November and December). In the case of May 2004, concentrations of cyanide in Artesian Slough, where the standard is currently 1.0 µg/L and proposed to be 2.9 µg/L, were measured at 62 µg/L near the outfall to under 10 µg/L at Coyote Creek, almost 4 miles from the outfall (see Figure 3 of Appendix Kfor graphic description). With the LC50 for rainbow trout at 44 µg of cyanide per liter, adverse effects to aquatic life during these dumping events were likely. Eventually, San Jose source control staff identified a single industrial source of these cyanide-dumping events. This case study shows that a single entity in the collection system of a large advanced secondary treatment plant can cause serious water quality standard violations that could go undetected under the routine sampling strategy.

Before work began on this proposed Basin Plan amendment, very little was known about cyanide levels in the areas of San Francisco Bay near discharge points or in the deeper channels. It was assumed, because of non-detect data, that cyanide did not approach chronic water quality thresholds of concern. Lower detection limits, advanced by the San Jose laboratory (explained in Appendix L), have shed light on ambient cyanide characteristics, particularly near shallow outfalls. While typically protective of aquatic life, levels very close to shallow water discharge outfalls have been shown to exceed thresholds of concern, forcing the consideration of mixing zones (i.e. cyanide attenuation zones) described in Appendices B, D, and L, and in Section 6.

To help protect against degradation of waters associated with adopting a less stringent standard, and recognizing that the only areas of San Francisco Bay with ambient values approaching the proposed SSOs are those located near discharge outfalls, it is proposed that effluent limits for cyanide be required for all shallow and deep water municipal wastewater dischargers and most deep water industrial wastewater dischargers. The proposed cyanide marine site-specific objective will be implemented through required effluent limits. This is because cyanide in deep water and shallow water dischargers' effluents, attributable to disinfection processes, incineration processes, or contributions to the collection systems, have a reasonable potential to cause or contribute to an exceedance of the numeric level of 2.9 µg/L cyanide in San Francisco Bay. Levels in the main estuary have been measured at 0.5 µg/L cyanide. The 99th percentile value of effluent concentration from all the effluent data from all dischargers in this Region (from 2000-2003, n=2,349) is 26 µg/L. Discharges at this level would lead to measurable receiving water cyanide levels above 2.9 µg/L in most instances, and therefore an equitable, attainable, and enforceable effluent limits are proposed to keep all dischargers vigilant and maintaining effluent cyanide levels at current performance or better. This approach will also ensure adherence to applicable state and federal antidegradation policies.

8.2 Effluent Limits for Deep Water Dischargers

Deep Water Municipal Wastewater Dischargers

Water quality-based effluent limits for cyanide will be required for all deep water municipal wastewater dischargers. Numeric effluent limits will be derived in accordance with procedures described in Section 1.4 of the SIP.

Deep Water Industrial Wastewater Dischargers

Water quality-based effluent limits for cyanide will be required for most deep water industrial wastewater dischargers. Numeric effluent limits will be derived in accordance with procedures described in Section 1.4 of the SIP. Numeric effluent limits will not be required for those deep water industrial dischargers that do not detect cyanide in their effluent with a method detection limit of 1.0 μg/L or less, document that they do not use cyanide in their industrial processes and do not disinfect.

8.3 Effluent Limits for Shallow Water Dischargers

Possibly only one of the 13 shallow water dischargers to San Francisco Bay will be able to comply with effluent limits derived from the proposed site-specific objectives unless some recognition of the attenuation of cyanide is incorporated into the derivation of numeric effluent limits. Available effluent data, summarized in Table 2 indicate that none of these dischargers could reliably meet 2.9 μg/L as an average monthly limit.

Ambient cyanide levels near discharges meet the proposed site-specific objectives, which are considered protective of aquatic life beneficial uses. Moreover, rapid attenuation of cyanide takes place in Bay waters due to dilution and natural degradation. As such it is appropriate to consider dilution credits in the determination of cyanide effluent limits for shallow water dischargers. Table 21 shows the dilution credits assigned for each shallow water discharger that also serve as the basis for NPDES permit limit determinations. Attenuation values that formed the basis for dilution credits and a spatial extent of the mixing zone for each discharger are also provided in Table 21. An evaluation of attainability of hypothetical limits, described in Appendix F, suggests that those dilution credits are appropriate to ensure compliance attributed to disinfection-related cyanide levels, while being conservatively protective of beneficial uses. Water quality-based effluent limits will be derived for individual shallow water dischargers using dilution credits given in Table 21 and the effluent limit derivation procedures described in the SIP[1].

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[1] Cyanide is often not detected in effluent using U.S. EPA-approved methods; In evaluating attainability with respect to effluent limits, various methods are used to quantify non-detect results. The Half-Detection Method used in the SIP substitutes every non-detect value with a value that is one-half the detection limit. The probability regression method was also used to evaluate attainability with respect to effluent limits, and final values were not significantly different to that of the SIP method .

Table 21: Dilution Credits and Projected Water Quality-Based Effluent Limits for Shallow Water Dischargers

Discharger	Discharge Location	Attenuation	Dilution Credit	Mixing Zone (surface area ha)	AMEL (µg/L)	MDEL (µg/L)
American Canyon	North Slough	2.25	3.25:1	~~0.6~~0.12	7.6	13.9
Fairfield-Suisun	Boynton Slough/Suisun Slough	3.0	4.0:1	~~9.2~~1.42	7.5	19.0
Hayward Marsh	Hayward Shoreline Regional Park Marsh Basin	2.25	3.25:1	~~16.7~~2.51	6.6	15.0
Las Gallinas	Miller Creek	2.25	3.25:1	0.4	6.6	14.9
Mt. View SD	McNabney Marsh/ Peyton~~Pacheco~~ Slough	2.25	3.25:1	<0.1	7.0	14.0
Napa SD	Napa River	2.25	3.25:1	~~6.9~~0.16	6.1	16.6
Novato SD	San Pablo Bay	2.25	3.25:1	<0.1	6.8	14.4
City of Palo Alto	~~Unnamed~~ Man-made channel/ South San Francisco Bay	2.25	3.25:1	1.7	7.9	11.9
City of Petaluma	Petaluma River	2.25	3.25:1	~~0.6~~0.32	6.4	15.3
City of San Jose	Artesian Slough/Coyote Creek	2.0~~25~~	3.~~25~~0:1	~~16.2~~8.01	7.~~6~~0	12~~3~~.0
Sonoma County Water Agency	Schell Slough	2.25	3.25:1	~~11.~~0.08	6.4	15.2
City of Sunnyvale	Moffett Channel/ Guadalupe Slough	3.0	4:1	2.3	7.9	19.4
USS Posco	New York Slough	2.25	3.25:1	0.1	6.8	13.6

8.4 Cyanide Action Plan

The following describes the proposed plan for actions to ensure that current discharger performance is maintained and to ensure compliance with state and federal antidegradation policies. Additionally, continuing source control efforts targeting pollutants of concern, such as cyanide, is a key part of approving exceptions to the Basin Plan prohibition for shallow water dischargers. Because dilution credit is proposed for calculation of shallow water discharger effluent limits to be required in their NPDES permits, commitment to continuing efforts at cyanide source control by these dischargers is mandatory.

Required Effluent Limits for Cyanide

With the exception of deep water industrial dischargers that do not use cyanide in their processes, do not disinfect, and have no detectable cyanide in their effluent, all wastewater dischargers to San Francisco Bay will have water quality-based effluent limits in their permits to implement the site-specific objective. An attainability analysis, included as Appendix F, demonstrates that shallow water dischargers could comply with limits based on an attenuation of 2.25 or 3.0 corresponding to dilution ratios of 3.25:1 and 4:1 respectively, and deep water dischargers are expected to be able to comply with limits computed under derivation procedures described in the SIP. The mechanism of required effluent limits will ensure that current performance is maintained, and sources of cyanide to the influent are tracked and regulated by the dischargers.

Monitoring and Surveillance requirements

An additional element of the implementation plan supporting the proposed site-specific cyanide objectives and shallow water discharger effluent limits is a program of monitoring and surveillance to prevent unnecessary or excessive discharges of cyanide from wastewater discharges to the Bay. This program is described below:

- *Influent and Effluent*

  Monitor total cyanide monthly in influents and effluents using low detection level cyanide analytical methods. As noted in Appendix F, cyanide attainability analysis, some dischargers with higher effluent cyanide values in the past few years will likely sample effluent more than once per month for compliance purposes.

- *Service Area*

  At least once per 5-year permit cycle, assess whether potential contributors of cyanide exist in each service area. Where potential contributors exist, implement a local program aimed at the prevention of illicit discharges to the sewer system, as have occurred in 2004 in the City of San Jose (Figure 3 of Appendix K). The local program shall consist of the following elements:

  a) Identify sources of cyanide. Discuss how estimates and sources are identified in the annual Pollutant Minimization Plan report. Maintain list of potential contributors (e.g., metal plating operations, hazardous waste recycling, etc.).
  b) Monitor total cyanide monthly in influents and effluents using low detection level cyanide analytical methods.
  c) Within a year of permit adoption, perform a site inspection of each potential contributor to assess the need to include the facility in an ongoing program.
  d) For facilities in the ongoing program or those covered by the pretreatment program, follow U.S. EPA Guidance such as Industrial User Inspection and Sampling Manual for POTWs (EPA 831-B-94-01) that provides inspection and wastewater sampling procedures such as:
     i. Perform routine inspections of facilities.

   ii. Develop and distribute educational materials regarding the need to prevent illicit discharges to the sewer system.

e) Prepare an emergency monitoring and response plan to be implemented in the event that a significant cyanide discharge event occurs. The plan should include procedures to verify the delivery, use and shipment of cyanide from a facility suspected of illicit discharges. (i.e. verify that State Hazardous Waste Manifests are consistent with the facility's permit application and self-monitoring report information and comparable to other disposal practices of similar local facilities).

- *Ambient*

  Include cyanide monitoring in the ongoing ambient monitoring in San Francisco Bay. Use analytical methods with detection limits of 1 µg/L or less. Implement an ambient trigger concentration of 1.0 µg/L in the main body of the Bay as the basis for initiation of a localized review of effluent limit compliance for wastewater discharges within the vicinity of the Bay where the trigger was exceeded and require dischargers to take appropriate actions to determine and abate any identified sources of cyanide.

Model permit language to implement this action plan for cyanide control by municipal wastewater dischargers, as an NPDES permit provision, has been developed and is included as Appendix I.

9 Regulatory Analyses

This section provides the regulatory analyses required for adoption of new site-specific water quality objectives, for establishing dilution credits to be used in the calculation of numeric effluent limits for wastewater dischargers to shallow waters and the implementation plan. Subsections below include an overview of the Project's compliance with California Water Code requirements; peer review requirements of Health and Safety Code §57004; CEQA; and federal and state antidegradation policies.

9.1 California Water Code §13241

CWC Section 13241 identifies six factors that must be considered when establishing a water quality objective.

- Past, present and probable beneficial uses of water;
- Environmental characteristics of the hydrographic unit under consideration; including the quality of water available thereto;
- Water quality conditions that could reasonably be achieved through the coordinated control of all factors that affect water quality in the area;
- Economic considerations;
- The need for developing housing within the region; and
- The need to develop and use recycled water

Each of these six factors is discussed below.

Beneficial Uses

The past, present and probably beneficial uses of San Francisco Bay are commercial and sport fishing, estuarine habitat, industrial service supply, marine habitat, fish migration, navigation, industrial process supply, preservation of rare and endangered species, water contact recreation, non-contact water recreation, shellfish harvesting, fish spawning, and wildlife habitat. Beneficial uses of the Bay are currently not impaired by cyanide. The proposed new site-specific objectives are based on the latest science pertaining to the toxicity of cyanide to aquatic organisms and, by definition, are fully protective of the most sensitive beneficial uses, those relevant to aquatic life and are thus protective of all beneficial uses listed above.

Environmental Characteristics of the Hydrographic Unit

The hydrographic unit is San Francisco Bay. San Francisco Bay includes a number of water bodies that are shown in Figure 2. The environmental characteristics and existing conditions in the Bay are discussed in Sections 3.1 and 3.3 of this Report.

Water Quality Conditions that Could Reasonably be Achieved

The goals of the proposed water quality objectives are to sustain current low levels of cyanide in the Bay waters while recognizing that existing marine water quality objectives for cyanide do not reflect site-specific conditions of San Francisco Bay for protecting beneficial uses. Although the recommended SSOs are higher than the National Toxics Rule marine cyanide criteria that currently apply, they better reflect existing scientific knowledge of cyanide toxicity and its effects on aquatic organisms specific to the Bay. The new cyanide objectives are based on the most recent toxicity data for several species of crabs common to San Francisco Bay and Puget Sound, where the new criterion has already been adopted by the State of Washington. The derivation of new objectives is conducted using calculation procedures established by the U.S. EPA, which, in turn, result in scientifically-defensible objectives for cyanide. The methods used to derive existing and proposed cyanide criteria are described in Section 4 of this Report. Less stringent cyanide objectives are appropriate and still protective of water quality and all beneficial uses. However, it is important to note that maintaining ambient cyanide concentrations at current levels is further assured by imposing numeric effluent limits for all industrial and municipal wastewater dischargers with cyanide in their effluent and a rigorous control plan.

A water quality attainment strategy developed to support the SSOs (Section 8.4, Appendix H) proposes coordinated efforts to control factors that may affect water quality. The strategy includes surveillance to ensure that these efforts are being sustained and that water quality is maintained. The ambient monitoring program is in place to detect an increase in cyanide ambient concentrations. According to the implementation plan, more aggressive pollution prevention actions, beyond the current baseline activities, would be triggered when that ambient level is exceeded.

The proposed site-specific objectives relax the current applicable water quality objectives for cyanide. However, current ambient cyanide concentrations in San Francisco Bay are well below the existing and proposed water quality objectives. Cyanide degrades rapidly in receiving waters and does not accumulate in sediment or biota in the Bay. A potential increase in cyanide loading of 15 kg per day is predicted applying theoretical effluent limits calculated using the maximum allowable dilution credits. The assimilative capacity of San Francisco Bay based on the existing NTR water quality objective is 200 kg. This potential loading increase is not expected to have a measurable impact on ambient cyanide levels in the Bay.

Economic considerations

There are no economic impacts that would result from this Basin Plan amendment. The proposed site-specific water quality objectives for cyanide are currently being met in the receiving water so no additional treatment measures are necessary to achieve compliance with the proposed objectives. Also, as shown in this Report, effluent limits that are calculated using the SIP methodology, and the site-specific objectives and proposed dilution credits, are attainable by the wastewater dischargers and therefore no additional treatment is required to meet such objectives. By contrast, the '*No Action*' alternative would constitute a compliance challenge for most shallow water dischargers and require substantial expenditures to ensure compliance (Section 7).

Need for Housing

The proposed water quality objectives would not restrict the development of housing in the San Francisco Bay Region because they do not result in discharge requirements that affect housing or any economic costs related to housing development.

Need to Develop and Use Recycled Water

There are no present restrictions on recycling of water due to cyanide. The intent of the proposed water quality objectives is to sustain low cyanide levels in the Bay and to maintain good water quality. Therefore, the proposed objectives are consistent with the need to develop and use recycled water. Adopting the recommended site-specific objectives for cyanide will have no impact on the quality and no impact on the quantity of wastewater available for recycling or reclamation in the region and none of the alternatives considered would restrict the development or use of recycled water.

9.2 Peer Review

Basin Plan amendments establishing new water quality objectives and related requirements necessitate scientific peer review. Health and Safety Code, Sect. 57004 requires an external peer review for work products that constitute the scientific basis for a rule "…establishing a regulatory level, standard, or other requirement for the protection of public health or the environment." State law (SB 1320) defines "scientific basis" as "the foundations of a rule that are premised upon, or derived from empirical data or other scientific findings, conclusions, or assumptions establishing a regulatory level, standard or other requirement for the protection of public health or the environment." Under SB 1320, "rule" includes any policy adopted by the State Water Resources Control Board under the Porter-Cologne Water Quality Control Act (Division 7, commencing with Section 13000 of the Water Code) that has the effect of a regulation.

This amendment establishes new site-specific water quality objectives for cyanide that replace the existing NTR criteria in the Basin Plan. The scientific basis of the amendment was subjected to external scientific peer review.

9.3 Environmental Analysis

CEQA requires agencies to review potential for their actions to result in adverse environmental impacts. The water quality planning process is a certified regulatory program approved by the Secretary of Resources as exempt from CEQA's requirements for preparation of an environmental impact report or negative declaration. As part of the regulatory program, the State Board's regulations at 23 Cal. Code of Regs. §3720 et seq require any standard, rule, regulation or plan proposed for board approval to be accompanied by a completed Environmental Checklist and a written report containing (1) a brief description of the proposed activity; (2) reasonable alternatives to the proposed activity and (3) mitigation measures to minimize any significant environmental impacts of the proposed activity. Upon completion of the written report, the Water Board is required to provide a Notice of Filing of the report to the public.

This Staff Report including Appendix H, Environmental Checklist, meets the requirements of CEQA for adopting Basin Plan amendments.

9.3.1 Brief Description of the Proposed Activity

The proposed Project is an amendment to the Basin Plan that establishes site-specific marine water quality objectives for cyanide in San Francisco Bay and an implementation plan to meet the objectives and sustain current good discharger performance. It also requires the imposition of effluent limits under the "Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California" (SIP) in wastewater NPDES permits and sets forth calculated dilution credits for specific dischargers, currently authorized to discharge into shallow waters, which will be used to calculate effluent limits. A detailed project description outlining the project objectives is provided in Section 2. The amendment described in Appendix A, proposes replacing the existing acute cyanide objective of 1 µg/L to 9.4 µg/L and the chronic objective of 1 µg/L to 2.9 µg/L and setting the dilution credits for individual shallow water dischargers. The proposed dilution credits will result in numeric effluent limits that provide reasonable protection for sensitive aquatic life uses in the vicinity of each discharge.

In addition to site-specific objectives for cyanide, the amendment also includes clarifying language regarding the site-specific objectives for copper and nickel for Lower South San Francisco Bay adopted by the Water Board in 2002. The record for that action clearly indicated that effluent limits for Lower South San Francisco Bay municipal wastewater dischargers would be both calculated and imposed. The language in the Water Quality Attainment Strategy portion of the Basin Plan stated only that the effluent limits would be "calculated," which some dischargers have been interpreting erroneously to mean that limits would be calculated but not included in their NPDES permits. Therefore, the clarifying language states that effluent limits for dischargers will be calculated and included in NPDES permits. This language clarification will not have economic or environmental effects, as it continues the current regulatory requirements.

Sections 2, 3, 4, 6, and 9 of this Report satisfy the foregoing analysis requirements for the proposed Basin Plan amendment. Appendix H contains the Environmental Checklist for the proposed activity. An explanation follows the Environmental Checklist and provides details concerning the environmental impact assessment. The analysis concludes that adopting the proposed amendment will not have any significant adverse environmental effects and no mitigation measures are proposed.

9.3.2 Consideration of Alternatives for the Proposed Amendment

Two alternatives to the proposed amendment are considered: (1) no Basin Plan amendment (*No Action*) and (2) Site-specific objectives only.

No Action

Under this alternative, the Water Board would not amend the Basin Plan to adopt the proposed cyanide site-specific objectives or the related implementation activities. The effluent limits based on the existing NTR objective and the SIP procedures would continue to present compliance problems for the majority of municipal and industrial wastewater discharges where compliance has thus far been determined to be infeasible. This issue would not be resolved under the '*No Action'* alternative.

The No Action alternative would not have less environmental impacts than the proposed project. Compliance issues may require wastewater dischargers to implement additional measures to reduce cyanide concentrations in their effluent that may include construction of additional treatment facilities, which, in turn, could adversely impact the environment. A '*No Action*' alternative would allow unnecessarily stringent effluent limits for San Francisco Bay wastewater dischargers, thereby possibly requiring the dischargers to consider implementing economically infeasible measures to comply as the only alternative to mandatory penalties (see Section 7). The more stringent effluent limits are not necessary to protect beneficial uses.

Site-Specific Objectives Only

Under this alternative, the Water Board would amend the Basin Plan to adopt the proposed marine cyanide site-specific objectives of 2.9 µg/L (chronic) and 9.4 µg/L (acute). No new implementation activities would be initiated and dilution credits would not be used in the calculation of effluent limits. Instead, the site-specific objectives would be implemented through NPDES permits without the additional requirements to ensure dischargers maintain their current good performance through cyanide source review, monitoring and control. This may result in missed opportunities to minimize cyanide loadings in wastewater resulting from wastewater disinfection.

Similar to the "*No Action"* alternative discussed above, compliance issues will arise that may require wastewater dischargers to implement additional measures to reduce cyanide concentrations in their effluent. This may require construction of additional treatment facilities, which, in turn, could adversely impact the environment. Dischargers could also be required to consider implementing mitigation measures that are economically infeasible. Thus, some of the objectives of the proposed Project, discussed in Section 2, will not be met if this alternative is adopted.

9.3.3 Preferred Alternative

Because the proposed Basin Plan amendment will not pose any significant adverse environmental impacts, any of the alternatives would not avoid or lessen any significant impacts. '*No Action*' would result in the moderate economic impacts of unnecessary enforcement and the significant economic impacts of capital projects to produce unnecessarily low effluent concentrations of cyanide. The analysis provided in this Report, including the ambient data collected near shallow water discharge points throughout the San Francisco Bay Estuary, show that current practices protect beneficial uses with respect to (a) discharges of cyanide and (b) current and desired cyanide concentrations at ambient levels. The proposed Basin Plan amendment is the preferred alternative.

9.3.4 Reasonably Foreseeable Methods of Compliance

CEQA additionally requires that whenever a Water Board adopts a rule that requires the installation of pollution control equipment or establishes a performance standard or treatment requirement, it must conduct an environmental analysis of reasonably foreseeable methods of compliance. This analysis must take into account a reasonable range of factors, including economics. The proposed project includes performance standards (i.e., water quality objectives) and therefore requires an environmental analysis of the reasonably foreseeable methods of compliance with these standards.

Compliance with the proposed water quality objectives will occur through the attainable and enforceable water-quality based effluent limits for the NPDES wastewater discharges. The Staff Report demonstrates that industrial and municipal wastewater dischargers will be able to comply with the effluent limits based on the proposed water quality objectives for cyanide, calculated using dilution credits. Thus, no additional measures need to be undertaken, there are no associated environmental impacts, and no mitigation measures are required.

9.4 Antidegradation

Before a water quality objective can be changed, careful consideration must be given to state and federal antidegradation requirements. The proposed Basin Plan amendment is consistent with the guidance concerning those requirements.

9.4.1 The Implementation Plan Protects Against Degradation

The assessment of consistency with anti-degradation policies include: a) analysis of the potential degradation to water quality resulting from the adoption and implementation of site-specific objectives for cyanide, and b) evaluation of the spatial extent of any potential water quality degradation.

The anti-degradation policies allow minor changes in both mass loadings and ambient concentrations, but do not allow significant adverse changes in ambient water quality. Concerns that concentrations of cyanide in San Francisco Bay may undergo significant adverse change with the adoption and implementation of cyanide site-specific objectives that are less stringent than the current cyanide objectives in the NTR is derived from the following hypotheses:

1. Effluent concentrations of cyanide from NPDES dischargers will increase as a result of less stringent effluent limits, with concentrations reaching the effluent limits,
2. Cyanide loadings to the Bay will increase as a result of increased concentrations, and
3. Increased cyanide loadings will lead to increased concentrations of cyanide in the Bay.

An evaluation of this “worst-case scenario” of the likelihood that adoption of site-specific cyanide objectives could result in increased concentrations of cyanide in the Bay is examined below.

Changes in Cyanide Effluent Limits and Concentrations

Wastewater discharges, controlled through NPDES permits, represent the major source of cyanide to the Bay. Twenty-two wastewater dischargers may receive increased effluent limits (Table 22) as a result of adoption of the new water quality objectives for cyanide and the proposed dilution credits for shallow water dischargers as compared to existing interim permit effluent limits.

However, an analysis of treatment plant operations and processes indicates that less stringent cyanide effluent limits are not expected to result in increased cyanide concentrations. Available data indicate that, for wastewater treatment plants discharging into San Francisco Bay, effluent cyanide concentrations are not a function of influent concentrations. As noted in Section 3.5, for many plants, influent cyanide concentrations are lower than effluent cyanide concentrations. For the remaining plants, no relationship exists between influent and effluent concentrations. Therefore, an argument that less stringent effluent limits would tend to encourage increased influent cyanide loadings that would result in higher effluent concentrations of cyanide is not tenable. Cyanide concentrations in effluent are not well explained, but are believed to be the complicated result of chlorination, dechlorination or UV disinfection. Operation of the physical and biological treatment processes used in wastewater treatment plants to achieve secondary treatment is required to meet technology-based federal requirements and will not be modified by plant operators. Further, no reliable information exists to suggest that changes in such operations will affect cyanide effluent concentrations. In other words, municipalities and industries have neither an incentive nor capability to “re-operate” their plants to “take advantage” of less stringent cyanide limits. For this reason, changes in cyanide concentrations resulting from changes in cyanide effluent limits are not likely. The more plausible expectation is that cyanide levels in effluent will remain at current levels, despite changes in effluent limits.

The potential for contributors to municipal facilities to take advantage of higher effluent limits through increased discharges to sanitary sewers is offset by 1) local limits derived from mandatory effluent limits and 2) a periodic review by every municipal wastewater discharger, in a permit provision, every 5 years (permit reissuance) of potential cyanide dischargers to the sanitary sewer and report to the Water Board. This higher level of cyanide surveillance will counter any potential efforts to increase discharges to sanitary sewers.

Table 22: Cyanide Effluent Limits- Existing and Projected Based on Proposed SSOs

				Existing Limits				**Projected Effluent Limits**	
Discharger	**Type**	**NPDES Permit #**	**Permit Expiration Date**	**Interim Daily Avg (µg/L)**	**Interim Daily Max (µg/L)**	**Interim Monthly Average (µg/L)**	**No Limits**	**AMEL (µg/l)**	**MDEL (µg/l)**
American Canyon, City of	POTW	CA0038768	1/19/2005	5				*7.6*[*]	*13.9*
Benicia, City of	POTW	CA0038091	7/31/2006			25		18.3[**]	44.1
Burlingame, City of	POTW	CA0037788	1/31/2007		10			20.1	40.2
Central Contra Costa Sanitary District	POTW	CA0037648	5/31/2006		18			21.4	35.9
Central Marin Sanitation Agency	POTW	CA0038628	8/31/2006		25			19.4	41.9
Delta Diablo Sanitation District	POTW	CA0038547	1/1/2009		25			20.1	40.2
Dublin San Ramon Services District	POTW	CA 0037613	8/16/2005		21			ND	ND
East Bay Dischargers Authority	POTW	CA 0037869	8/16/2005		21			15.2	44.5
East Bay Municipal Utilities District	POTW	CA0037702	5/31/2006 / 6/30/2006		10			18.8	43.2

				Existing Limits				Projected Effluent Limits	
Discharger	**Type**	**NPDES Permit #**	**Permit Expiration Date**	**Interim Daily Avg (µg/L)**	**Interim Daily Max (µg/L)**	**Interim Monthly Average (µg/L)**	**No Limits**	**AMEL (µg/l)**	**MDEL (µg/l)**
Fairfiend-Suisun Sewer District	POTW	CA0038024	9/30/2008		32			*8.0*	*18.3*
Hayward Marsh	POTW	CA0038636	5/25/2004	17.1				*6.6*	*15.0*
Las Gallinas Valley Sanitary District	POTW	CA0037851	11/30/2008		19			*6.6*	*14.9*
Livermore, City of	POTW	CA 0038008	8/16/2005		21			20.1	41.7
Marin County Sanitary District #5	POTW	CA0037753	10/31/2007	25				20.1	40.2
Millbrae, City of	POTW	CA0037532	10/31/2006			10		19.4	41.9
Mt. View Sanitary District	POTW	CA0037770	8/16/2005				No Limits	*7.0*	*17.0*
Napa Sanitation District	POTW	CA0037575	7/31/2005		25			*6.1*	*16.6*
Novato Sanitary District	POTW	CA0037958	5/25/2004		9.2			*6.8*	*14.4*
Palo Alto, City of	POTW	CA0037834	9/30/2008		32			*7.9*	*11.9*
Petaluma, City of	POTW	CA0037810	7/15/2003	14				*6.4*	*15.3*
Pinole-Hercules, Cities of	POTW	CA0037796	8/1/2006		12			20.7	38.2
Rodeo Sanitary District	POTW	CA0037826	8/31/2006		12			22.1	33.2
San Francisco International Airport	POTW	CA0038318	10/31/2006		10			20.1	40.2
San Francisco, City and County of, Southeast (Total)	POTW	CA0037664	5/31/2007				No RP	20.7	38.2
San Jose/Santa Clara WPCP	POTW	CA003784	9/30/2008				No RP	*7.6*	*13.0*
San Mateo, City of	POTW	CA0037541	5/31/2006		10			20.7	38.2
Sausalito-Marin City Sanitary District	POTW	CA0038067	7/19/2005		25			20.7	38.2
Sewerage Agency of Southern Marin	POTW	CA0037711	5/30/2006		25			15.2	45.5
Sonoma Valley County Sanitary District	POTW	CA0037800	2/28/2007			10.1		*6.4*	*15.2*
South Bayside System Authority	POTW	CA0038369	2/1/2006		18			21.4	35.9
South San Francisco /San Bruno WQCP	POTW	CA0038130	3/31/2008		10			12.7	40.3
Sunnyvale, City of	POTW	CA0037621	9/30/2008		32			*7.9*	*19.4*
Treasure Island WWTP	POTW	CA0110116	Tentative		10			20.8	41.7
Vallejo Sanitation & Flood Control District (Total)	POTW	CA0037699	4/19/2005		10			17.8	44.8
West County Agency	POTW	CA0038539	10/31/2006		25			20.1	40.2
Chevron Richmond Refinery	Refinery	CA0005134	5/31/2006					20.7	38.2
ConocoPhillips (Rodeo)	Refinery	CA0005053	3/15/2005					21.4	35.9
Martinez Refining Company	Refinery	CA0005789	10/31/2006		25			21.4	35.9
Tesoro Refinery	Refinery	CA0004961	2/16/2005		25			11.2	37.3
Valero Benicia Refinery	Refinery	CA0005550	11/30/2007		25			ND	ND
Crockett Cogeneration	Industrial	CA0029904	9/16/2003		265			20.8	41.7
Dow Chemical Company	Industrial	CA0004910	10/31/2006				No Limits	20.1	40.2

				Existing Limits				Projected Effluent Limits	
Discharger	**Type**	**NPDES Permit #**	**Permit Expiration Date**	**Interim Daily Avg (µg/L)**	**Interim Daily Max (µg/L)**	**Interim Monthly Average (µg/L)**	**No Limits**	**AMEL (µg/l)**	**MDEL (µg/l)**
General Chemical	Industrial	CA000497	5/31/2007				No Limits	12.1	39.5
GWF Power Systems (Site I)	Industrial	CA0029106	7/21/2004				No Limits	20.1	40.2
GWF Power Systems (Site V)	Industrial	CA0029122	7/21/2004				No Limits	ND	ND
Morton	Industrial	CA0005185	2/19/2002				No Limits	ND	ND
Pacific Gas & Electric (East Shell Pond)	Industrial	CA0030082	5/25/2004				No RP	ND	ND
Rhodia Basic Chemicals	Industrial	CA0006165	10/21/2003				No RP	ND	ND
S.F.Airport, Industrial (Total)	Industrial	CA0028070	2/28/2007				No RP	ND	ND
USS Posco	Industrial	CA0005002	11/29/2005		22			*6.8*	*13.6*

No RP	Reasonable Potential analysis indicated that effluent limits were not required
ND	Predominantly non-detected concentrations of cyanide and/or insufficient data to calculate effluent limits
*	For shallow water dischargers (effluent limits indicated in *italics*) AMEL and MDEL limits were calculated using the dilution credits specified in Table 21
**	For deep water dischargers a conservative dilution credit of 10:1 was used in computation of AMEL and MDEL. The site-specific dilution credit will be used in final effluent limits derivation on permit-by-permit basis.

Changes in Cyanide Loadings

In the unlikely event that effluent concentrations increase in response to less stringent effluent limits (contrary to the above analysis), cyanide loadings to the Bay would increase. Table 23 provides a summary of the maximum incremental changes in cyanide loadings to the Bay resulting from discharges at the maximum projected effluent limits reflecting the "worst-case scenario". The potential incremental increase in cyanide loadings over current loadings is less than 15 kilograms per day.

The magnitude of these incremental changes can be viewed in relation to (a) current mass of cyanide in the Bay and (b) allowable loadings of cyanide to the Bay, i.e. the assimilative capacity of the Bay for cyanide. The current mass of cyanide in the water column of the Bay is less than or equal to 2,700 kg. This is calculated based on an average cyanide concentration of less than 0.4 µg/L and modeled estimates of the estuary's mean volume of 6.66 billion cubic meters. Assimilative capacity of the Bay under the current NTR objectives and the proposed cyanide SSOs is calculated as follows:

> ***Assimilative capacity under NTR = Current cyanide chronic objective per NTR X estimated water volume of the Bay X Multiplier to convert to kg = 6,700 kg***

The total potential increase in cyanide loadings (presuming that all dischargers will increase from existing loadings to loadings allowed by new effluent limits) is estimated at less than 15 kilograms per day. This is approximately 0.6 percent of the current cyanide mass in the Bay water column, 0.2 percent of the cyanide mass allowed in the Bay under the NTR cyanide standard of 1.0 µg/L. Remembering that cyanide discharged to the Bay attenuates quickly, these minor incremental loading estimates would not be expected to have a measurable impact on ambient cyanide levels in the Bay.

Table 23: Hypothetical Cyanide Loadings at Projected Effluent Limits

NPDES Permittee	Average Annual Flow (mgd)	Projected Final Effluent Limit (AMEL) (µg/l)	Existing Mean Effluent Concentration (µg/l)	Loading at Projected AMEL (kg/day)	Existing Mean Loading (kg/day)	Hypothetical Increased Loading (kg/day)
American Canyon	1.3	10.4[a]	1.4	0.05	0.01	0.04
City of Burlingame	4.1	20.1	3.3	0.31	0.05	0.26
Central Contra Costa SD	43.1	21.4	3.8	3.50	0.61	2.88
Central Marin Sanitation Agency	7.4	19.4	4.3	0.54	0.12	0.42
Delta Diablo Sanitation District	13.1	20.1	7.1	1.00	0.35	0.65
East Bay Dischargers Authority	77.9	15.2	5.1	4.49	1.51	2.97
East Bay MUD	71.5	18.8	5.7	5.10	1.56	3.54
Las Gallinas Valley SD	1.3	9.0[a]	3.0	0.04	0.01	0.03
City of Livermore	6.3	20.1	14.9	0.48	0.36	0.12
Marin County SD No. 5	0.6	20.1	5.0	0.05	0.01	0.03
Martinez Refining Company	6.7	21.4	13.2	0.54	0.34	0.21
City of Millbrae	2.4	19.4	3.7	0.18	0.03	0.14
Novato SD	5.2	9.3[a]	1.8	0.18	0.04	0.15
City of Petaluma	3.3	8.8[a]	2.9	0.11	0.04	0.07
Cities of Pinole and Hercules	2.4	20.7	3.5	0.19	0.03	0.16
Rodeo SD	0.9	22.1	3.7	0.08	0.01	0.06
San Francisco International Airport	0.6	20.1	9.8	0.05	0.02	0.02
City of San Mateo	10	20.7	4.3	0.78	0.16	0.62
Sewerage Agency of Southern Marin	3.3	15.2	2.5	0.19	0.03	0.16
Sausalito-Marin City	1.7	20.7	9.6	0.13	0.06	0.07
South Bayside System Authority	15.5	21.4	7.8	1.26	0.46	0.80
South San Francisco/San Bruno	10.4	12.7	8.0[b]	0.50	0.32	0.19
Tesoro Golden Eagle Refinery	2.7	11.2	8.6	0.11	0.09	0.03
Treasure Island	0.4	20.8	2.6	0.03	0.00	0.03
Vallejo Sanitation and Flood Control District	11.4	17.8	4.8	0.77	0.21	0.56
West County Agency	13.1	20.1	3.6	1.00	0.18	0.82
Totals	**314**			**21.57**	**6.60**	**14.97**

Table shows loadings for discharges where projected final effluent limits exceed currently imposed interim limits.

[a] AMEL based on conservative dilution credit of 4.5:1 for shallow water dischargers; for the remaining deep water dischargers AMEL based on a dilution credit of 10:1.

[b] Median value used.

Changes in Ambient Cyanide Concentrations

In the unlikely event cyanide concentrations increase as a result of adoption of the proposed cyanide SSOs, ambient concentrations would change marginally in the vicinity of the affected shallow water discharges. Current ambient concentrations of cyanide at deep water sites in the Bay are typically less than 0.4 µg/L, while concentrations near shallow water discharges are usually less than 2.9 µg/L, sometimes as high as 4 or 6 µg/L. These ambient concentrations reflect the current source loading of cyanide to the Bay at existing effluent concentrations. Given the minor magnitude of the resulting potential increase in mass loadings as described above, significant changes in ambient cyanide concentrations would not be anticipated.

Overall Assessment

Based on the above analysis, it is not anticipated that adoption and implementation of the proposed cyanide SSOs will result in significant increased loadings or increased concentrations of cyanide in the Bay. Even if some lowering of water quality were to occur due to the relaxed SSOs, it is consistent with both state and federal antidegradation polices as discussed below.

9.4.2 State Requirements

New water quality objectives must conform to State Board Resolution 68-16, "Statement of Policy with Respect to Maintaining High Quality of Water in California." It must be demonstrated that the change in water quality owing to relaxing the water quality objective:

- Will be consistent with maximum benefits to the people of the State;
- Will not unreasonably affect present and anticipated beneficial use of such water;
- Will not result in water quality lower than that prescribed in the applicable policies; and
- Will ensure that dischargers will implement the best practicable treatment or control.

The proposed site-specific objectives for cyanide are based on the latest science pertaining to the toxicity of cyanide to aquatic organisms and are scientifically-defensible and protective of beneficial uses in San Francisco Bay. Proposing the water quality objectives is consistent with the maximum benefit to the people of the State because beneficial uses will be protected without requiring an unreasonable or unnecessary level of performance on the part of dischargers (see Section 7). Disinfection processes, identified as a contributing source of small measurable levels of cyanide in effluents, are required by the Water Board to protect beneficial uses of receiving waters for recreational users, such as swimmers, kayakers, fishers and board sailors. There is no evidence that precursors to cyanide formation contained in influents can be reasonably controlled to lower the effluent levels post-disinfection.

The original cyanide marine criterion was based on the minimum amount of data for a federal criterion and as most recent studies demonstrated, it has been overly conservative due to limited scientific information on crab species specific to San Francisco Bay. New scientific information (Brix et al., 2000) helps justify an increase in the threshold concentration of cyanide while protecting beneficial uses of the Bay. Moreover, the cities and industries are addressing potential sources of cyanide that contribute to increases in cyanide in effluents of the treatment plants (see Section 5.4). The proposed objectives are based on U.S. EPA marine cyanide criteria, which have been updated and adopted by the State of Washington. After evaluating current ambient cyanide concentrations and effects levels for the sensitive genera, impairment of beneficial uses due to current ambient concentrations of cyanide is considered unlikely.

A relaxation of the ambient water quality objectives for cyanide is unlikely to cause any increase in ambient cyanide concentrations due to increased cyanide loads if current performance by area dischargers is maintained as is expected. The analysis of adverse changes in cyanide concentrations provide strong evidence that the proposed site-specific objectives will not result in lower water quality.

The dischargers do not have the ability to manipulate their processes to adjust effluent cyanide levels, which are influenced by many factors within the disinfection process, including wastewater characteristics, and by the occasional illicit discharge into the sanitary sewer (see Section 5.4). The implementation plan in Section 8 requires effluent limits for all municipal dischargers and those industrial dischargers that have detectable levels of cyanide and/or use cyanide in their processes and describes the Cyanide Action Plan. The NPDES permit process will ensure that the sources of cyanide in the treatment plant influent and effluent are tracked and regulated by the dischargers and that the current high standard of performance is maintained. Dischargers would continue to comply with technology requirements under the Clean Water Act.

9.4.3 Federal Requirements

The federal regulations covering antidegradation (40 CFR 131.12) divide waters into three categories or tiers. Tier 1 waters[1] are those that are either not meeting the federal "fishable/swimmable" goals, or that meet "fishable/swimmable"[2] goals but lack assimilative capacity to accept any more of the specific pollutant proposed for discharge. Tier 2 waters are those where the water quality is better than the minimum necessary to maintain "fishable/swimmable" uses. Tier 3 waters are outstanding national resource waters such as National and State parks and wildlife refuges or waters of exceptional recreational or ecological significance.

Lowering of water quality (which could occur in the relaxation of a standard) may be done only after satisfying public participation requirements, and if the Water Board finds that (1) the relaxation of the standard is necessary to accommodate important economic or social development in the area in which the waters are located; (2) the revised water quality objective is fully protective of existing beneficial uses; and (3) the highest statutory and regulatory requirements will be imposed on all new and existing point sources and all cost-effective and reasonable best management practices will be required for nonpoint source control. Each of these three conditions will now be considered in turn.

1) *The relaxation of the standard is necessary to accommodate important economic or social development in the area in which the waters are located;*

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[1] According to EPA guidance, Questions and Answers on Antidegradation, 1985, Tier 1 waters are those where there is any existing use, whether it is fishable/swimmable or not.

[2] A level of water quality that provides for the protection and propagation of fish, shellfish and wildlife, and recreation in and on the water (USEPA, 1994)

Relaxing water quality objectives for cyanide is consistent with the need to accommodate important economic or social development because beneficial uses will be protected without requiring an unreasonable level of performance on the part of dischargers that are already achieving high levels of performance. In the future, it is expected that ambient concentrations of cyanide in San Francisco Bay will remain similar to current levels or continue to decrease due to the actions required by the implementation plan. In an unlikely event that loadings of cyanide in fact increase due to imposed effluent limits, the analysis in Section 9.4.1 demonstrates that it would have a minimal effect on the ambient concentrations.

The combination of the proposed site-specific objectives and implementation plan will protect water quality and accommodate current and future economic activity and population growth. These two goals can be accomplished while ensuring that little or no actual lowering of water quality will occur despite relaxing the water quality objectives for cyanide.

2) *The water quality objective is fully protective of existing beneficial uses;*

This consideration is addressed in Section 9.1 and Appendix H.

3) *The highest statutory and regulatory requirements will be imposed on all new and existing point sources and all cost-effective and reasonable best management practices will be required for nonpoint source control.*

NPDES permits will require existing wastewater dischargers to maintain their current level of performance. The intent of the actions described in Section 8 (implementation plan) of this Report is to prevent degradation of water quality due to increases in concentrations of cyanide in San Francisco Bay despite the relaxation of the cyanide water quality objectives. This includes required effluent limits for all municipal dischargers and industrial dischargers and a cyanide action plan to control sources of cyanide. Municipal dischargers would continue to comply with all technology controls under the Clean Water Act. Nonpoint sources and stormwater-associated point sources are not considered to be sources of cyanide to San Francisco Bay.

10 Conclusions

The proposed site-specific objectives (SSOs) and implementation plan are needed and warranted as a Basin Plan amendment for numerous reasons. Specific reasons for adopting the proposed Basin Plan amendment are summarized below.

Proposed site-specific objectives are protective of beneficial uses

Given the current state of analytical cyanide detection capabilities, the proposed site-specific water quality objectives have an intrinsic margin of safety. The existing analytical methods for measuring cyanide in wastewater cannot effectively discern free cyanides from the less toxic complexed cyanides. Although the total or weak acid-dissociable cyanide in wastewater from POTWs is partially free cyanides, all detected cyanide (total cyanide) is assumed to be free cyanide. The NTR criteria, as well as the proposed SSOs, were formulated using controlled laboratory concentrations of free cyanide. Therefore the proposed objectives are inherently protective since they do not account for the less-toxic metal-cyanide complexes. Consequently, any given measurement of cyanide in ambient waters or POTW effluent will over-represent the actual concentration of the harmful cyanide constituent.

Proposed site-specific objectives are recalculated using resident species data

The proposed site-specific objectives reflect the inclusion of additional species resident to San Francisco Bay and therefore are an improvement of the original dataset used to derive water quality criteria and effluent limits. The existing national criteria were calculated in 1985 using only the minimum data set required per U.S. EPA guidelines. Also, *Cancer* specimens native to the east coast of the United States were used in the data set. The east coast species yielded sensitivity values six times that of the next-sensitive *Cancer* species. The revised data set for the proposed amendment substitutes the east-coast species with four species of *Cancer* native to the San Francisco Bay. Utilizing a more robust data set with native species yields new site-specific objectives that have more scientific and regional validity. The State of Washington used the same data set and proposed the same values for the site-specific objectives for Puget Sound in 1997.

Disinfection of wastewater contributes to increase of cyanide in effluent

Cyanide formation in wastewater effluent is a by-product of the disinfection process. The disinfection process is a mandatory procedure that dischargers must implement to protect the water recreation and other beneficial uses of the Bay. There is currently no procedure available that could practicably be instituted to entirely remove or eliminate the cyanide by-product (see Section 7). Ambient cyanide concentrations throughout the Bay demonstrate that the beneficial uses of the Bay are currently protected from cyanide impacts given the status quo of POTW facility operations. If these disinfection processes were eliminated to achieve the current national criteria objective for cyanide, then the water recreation beneficial uses of the Bay would no longer be protected.

Cyanide does not persist in the aquatic environment

Cyanide does not bioaccumulate and does not persist in the aquatic environment. It is appropriate to acknowledge not only dilution, but also natural degradation of cyanide in aquatic environments when formulating effluent limits for shallow water dischargers. The attenuation (tidal mixing, dilution and degradation degradation) of cyanide in shallow water environments has been documented thoroughly in Appendices D and L, and is recommended as a basis for derivation of required cyanide effluent limits for all shallow water dischargers.

Antidegradation is ensured through individual effluent limits and Cyanide Action Plan

All individual shallow and deep water municipal wastewater dischargers to the Bay will be subject to numeric cyanide effluent limits in their NPDES permit to enforce compliance with the proposed site-specific water quality objectives. All industrial wastewater dischargers that disinfect, use cyanide or have detectable cyanide in their effluents will have effluent limits as well. The establishment of required effluent limits is a part of the Cyanide Action Plan to assure discharger accountability and compliance with State and federal antidegradation requirements. The Action Plan also requires a source control program and surveillance and monitoring that could trigger further preventive measures.

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APPENDIX A

Proposed Basin Plan Amendment

Amend the following language in Chapter 3 of the Basin Plan as follows:

Table 3-3: Marine[a] Water Quality Objectives for Toxic Pollutants for Surface Waters (all values in µg/l)

Compound	4-day Average	1-hr Average	24-hr Average
Arsenic[b, c, d]	36	69	
Cadmium[b, c, d]	9.3	42	
Chromium VI[b, c, d, e]	50	1100	
Copper[c, d, f]			
Cyanide[g]			
Lead[b, c, d]	8.1	210	
Mercury[h]	0.025	2.1	
Nickel[b, c, d]	8.2	74	
Selenium[i]			
Silver[b, c, d]		1.9	
Tributyltin[j]			
Zinc[b, c, d]	81	90	
PAHs[k]			15

Notes:

a. Marine waters are those in which the salinity is equal to or greater than 10 parts per thousand 95% of the time, as set forth in Chapter 4 of the Basin Plan. Unless a site-specific objective has been adopted, these objectives shall apply to all marine waters, except for the South Bay south of Dumbarton Bridge~~,~~ (where the California Toxics Rule (CTR) applies). For waters in which the salinity is between 1 and 10 parts per thousand, the applicable objectives are the more stringent of the freshwater (Table 3-4) or marine objectives.

b. Source: 40 CFR Part 131.38 (California Toxics Rule or CTR), May 18, 2000.

c. These objectives for metals are expressed in terms of the dissolved fraction of the metal in the water column.

d. According to the CTR, these objectives are expressed as a function of the water-effect ratio (WER), which is a measure of the toxicity of a pollutant in site water divided by the same measure of the toxicity of the same pollutant in laboratory dilution water. The 1-hr. and 4-day objectives = table value X WER. The table values assume a WER equal to one.

e. This objective may be met as total chromium.

f. Water quality objectives for copper were promulgated by the CTR and may be updated by U.S. EPA without amending the Basin Plan. Note: at the time of writing, the values are 3.1 ug/l (4-day average) and 4.8 ug/l (1-hr. average). The most recent version of the CTR should be consulted before applying these values.

g. Cyanide criteria were promulgated in the National Toxics Rule (NTR)~~. The NTR criteria specifically apply to San Francisco Bay upstream to and including Suisun Bay and Sacramento-San Joaquin Delta.~~ (Note: at the time of writing, the values are 1.0 µg/l (4-day average) and 1.0 µg/l (1-hr. average)) and apply, except when site-specific marine water quality objectives for cyanide have been adopted for San Francisco Bay as set forth in Table 3-3C.

h. Source: U.S. EPA Ambient Water Quality Criteria for Mercury (1984).

i. Selenium criteria were promulgated for all San Francisco Bay/Delta waters in the National Toxics Rule (NTR). The NTR criteria specifically apply to San Francisco Bay upstream to and including Suisun Bay and Sacramento-San Joaquin Delta. Note: at the time of writing, the values are 5.0 ug/l (4-day average) and 20 ug/l (1-hr. average).

j. Tributyltin is a compound used as an antifouling ingredient in marine paints and toxic to aquatic life in low concentrations. U.S. EPA has published draft criteria for protection of aquatic life (Federal Register: December 27, 2002, Vol. 67, No. 249, Page 79090-79091). These criteria are cited for advisory purposes. The draft criteria may be revised.

k. The 24-hour average aquatic life protection objective for total PAHs is retained from the 1995 Basin Plan. Source: U.S. EPA 1980.

Table 3-3C: Marine [a] Water Quality Objectives for Cyanide in San Francisco Bay [b] (values in µg/l)

Cyanide	Chronic Objective (4-day Average)	2.9
Cyanide	Acute Objective (1-hour Average)	9.4

Notes:

a. Marine waters are those in which the salinity is equal to or greater than 10 parts per thousand 95% of the time, as set forth in Chapter 4 of the Basin Plan. For waters in which the salinity is between 1 and 10 parts per thousand, the applicable objectives are the more stringent of the freshwater or marine objectives.

b. Objectives apply to all segments of San Francisco Bay, including Sacramento/San Joaquin River Delta (within San Francisco Bay region), Suisun Bay, Carquinez Strait, San Pablo Bay, Central San Francisco Bay, Lower San Francisco Bay, and South San Francisco Bay.

Amend the following language in Chapter 4 of the Basin Plan as follows:

SITE-SPECIFIC OBJECTIVES

In some cases, the Water Board may elect to develop and adopt site-specific water quality objectives. These objectives will ~~be based on~~ reflect site-specific conditions and comply with the Antidegradation Policy. This situation may arise when:

It is determined that promulgated water quality standards or objectives are not protective of beneficial uses; or

Site-specific conditions warrant less stringent effluent limits than those based on promulgated water quality standards or objectives, without compromising the beneficial uses of the receiving water.

In the above cases, the Water Board may consider developing and adopting site-specific water quality objectives for the constituent(s) of concern. These site-specific objectives will be developed to provide the same level of environmental protection as intended by national criteria, but will more accurately reflect local conditions. Such objectives are subject to approval by the State Board, Office of Administrative Law, and U.S. EPA.

There may be cases where the promulgated water quality standard or adopted objectives are practically not attainable in the receiving water due to existing high concentrations. In such circumstances, discharges shall not cause impairment of beneficial uses.

Site-specific objectives have been adopted by the Water Board for copper and nickel in Lower South San Francisco Bay, (Table 3-3A) and for cyanide in San Francisco Bay (Table 3-3C).

IMPLEMENTATION OF EFFLUENT LIMITATIONS

In incorporating and implementing effluent limitations in NPDES permits, the following general guidance shall apply:

(A) PERFORMANCE-BASED LIMITS

Where water quality objectives in the receiving water are being met, and an existing effluent limitation for a substance in a discharge is significantly lower than appropriate water quality-based limits, performance-based effluent limitations for that substance may be specified or the effluent limit revised. Any changes are subject to compliance with the state Antidegradation Policy. The performance-based effluent limitation may be either concentration- or mass-based, as appropriate.

(B) SITE-SPECIFIC OBJECTIVE INCORPORATION

Once the Water Board has adopted a site-specific objective for any substance, effluent limitations shall be calculated from that objective in accordance with the ~~methods described above.~~ methodology in the "Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California" (SIP).

COPPER AND NICKEL IN LOWER SOUTH SAN FRANCISCO BAY

As part of the implementation plan for copper and nickel site-specific objectives, the municipal wastewater dischargers in Lower South San Francisco Bay shall have effluent limits for copper and nickel, derived from the site-specific objectives in Table 3-3A using SIP methodology. The Water Quality Attainment Strategy for copper and nickel in Lower South San Francisco Bay that implements these site-specific objectives is included in Chapter 7.

CYANIDE

Cyanide is present in low levels in all municipal wastewater effluents and most industrial wastewater effluents. Disinfection processes contribute to in-plant formation of cyanide. Therefore, cyanide in the effluent from municipal treatment plants is a combination of cyanide in the influent and cyanide produced during disinfection. Cyanide concentration spikes in the effluent, although rare, are generally caused by accidental high concentration discharges in the collection system.

As part of the implementation plan for marine site-specific objectives for cyanide, all municipal wastewater dischargers that discharge to any segment of San Francisco Bay including Sacramento/San Joaquin River Delta (within San Francisco Bay region), Suisun Bay, Carquinez Strait, San Pablo Bay, Central San Francisco Bay, Lower San Francisco Bay, and South San Francisco Bay shall have effluent limits for cyanide derived from the marine site-specific objectives in Table 3-3C, using the methodology in the SIP. Specifically, under Step 7 of the SIP methodology, effluent limits are necessary considering the nature of cyanide, its use in the disinfection process, and to promote achievement and ensure maintenance of the marine cyanide site-specific objectives.

Industrial wastewater dischargers to San Francisco Bay shall have effluent limits for cyanide derived from the marine site-specific objectives in Table 3-3C, using the methodology in the SIP. However, effluent limits shall not be required, under Step 7 of the SIP alone, where the industrial discharger demonstrates one of the following:

- Cyanide is not detected in its effluent, using a method with a detection limit of 1.0 µg/l
- It does not disinfect any portion of its effluent
- It otherwise demonstrates that cyanide is not used in its industrial process.

Effluent limits for shallow water dischargers that have been granted an exception to Basin Plan Prohibition 1 shall be based on the dilution credits set forth in Table 4-7. Setting forth dilution credits in Table 4-7 does not authorize discharges into shallow waters. Each discharger must continue to satisfy all requirements for an exception to Basin Plan Prohibition 1.

Table 4-7: Dilution Credits for Calculation of Cyanide Water Quality-Based Effluent Limits for Shallow Water Dischargers

Discharger	**Discharge Location**	**Dilution Credit** [a]
American Canyon	North Slough	3.25:1
Fairfield-Suisun	Boynton Slough~~/Suisun Slough~~	4.0:1
Hayward Marsh	Hayward Shoreline Regional Park Marsh Basin	3.25:1
Las Gallinas	Miller Creek	3.25:1
Mt. View SD	Peyton~~checo~~ Slough	3.25:1
Napa SD	Napa River	3.25:1
Novato SD	San Pablo Bay	3.25:1
City of Palo Alto	~~Unnamed~~ channel~~/South Bay~~	3.25:1
City of Petaluma	Petaluma River	3.25:1
City of San Jose	Artesian Slough~~/Coyote Creek~~	3.0:1
Sonoma County Water Agency	Schell Slough	3.25:1
City of Sunnyvale	Moffett Channel ~~Guadalupe Slough~~	4.0:1
USS Posco	New York Slough	3.25:1

[a] The dilution credit is expressed as the ratio of total parts mixed (effluent and receiving waters) to one part of effluent

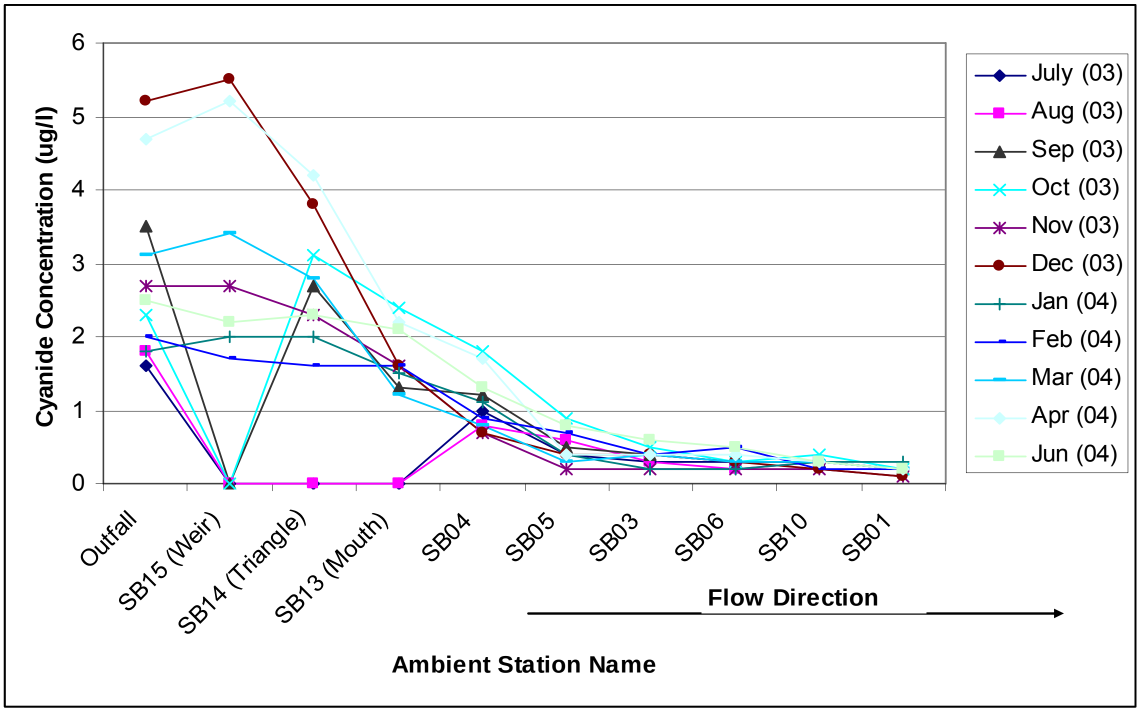
Where cyanide effluent limits are included in an NPDES permit, the discharger shall be required to implement a monitoring and surveillance program. This program shall include influent and effluent monitoring and ambient monitoring in San Francisco Bay. Each discharger shall review sources of cyanide to its influent at least once every five years. Where potential cyanide contributors exist within a discharger's service area, the discharger shall implement a local program to prevent illicit discharges to the sewer system which, at a minimum, shall include inspecting potential contributor sites, developing and distributing educational materials and preparing emergency monitoring and response plans to be implemented if a significant cyanide discharge occurs. Additionally, if ambient monitoring shows cyanide concentrations of 1.0 µg/L or higher, the discharger shall undertake actions to determine and abate identified sources of cyanide in San Francisco Bay.

APPENDIX B

Ambient Cyanide Data

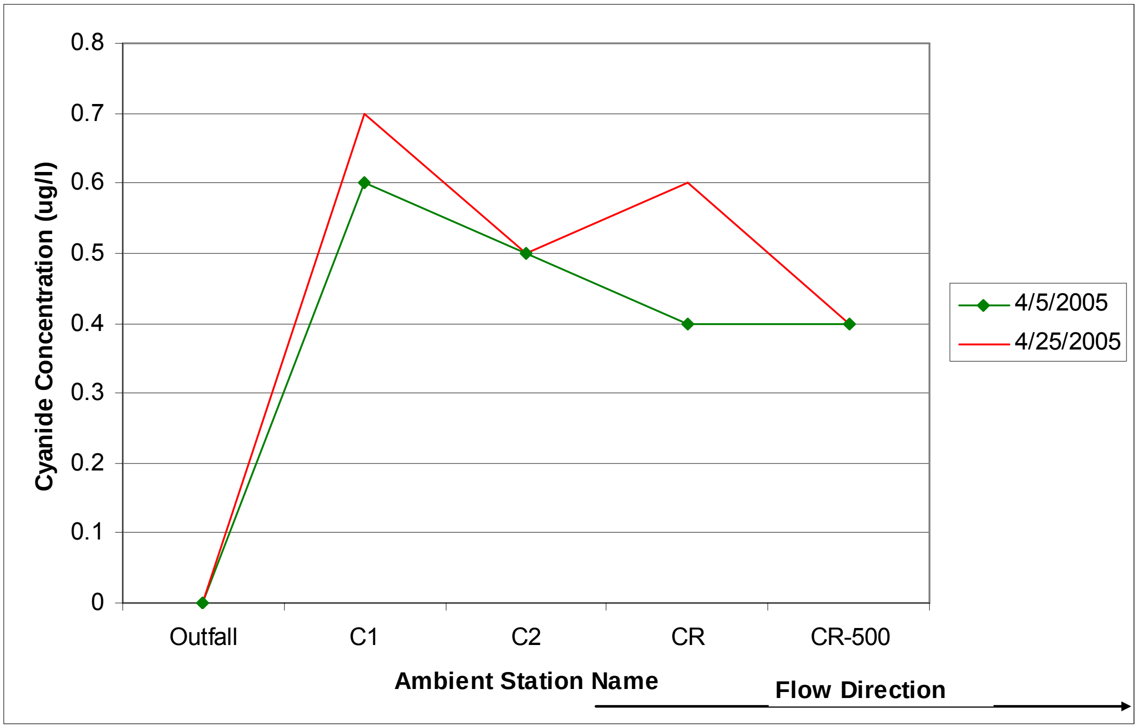
SAN JOSE-SANTA CLARA AMBIENT CYANIDE DATA (µG/L) FROM JULY 2003 TO JUNE 2004

Station	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	Jun
Outfall	1.6	1.8	3.5	2.3	2.7	5.2	1.8	2	3.1	4.7	2.5
SB15 (Weir)	NS	NS	NS	NS	2.7	5.5	2	1.7	3.4	5.2	2.2
SB14 (Triangle)	NS	NS	2.7	3.1	2.3	3.8	2	1.6	2.8	4.2	2.3
SB13 (Mouth)	NS	NS	1.3	2.4	1.6	1.6	1.5	1.6	1.2	2.2	2.1
SB04	1	0.8	1.2	1.8	0.7	0.7	1.1	0.9	0.8	1.7	1.3
SB05	0.4	0.6	0.5	0.9	0.2	0.4	0.4	0.7	0.3	0.4	0.8
SB03	0.3	0.3	0.4	0.5	0.2	0.4	0.2	0.4	0.4	0.4	0.6
SB06	0.3	0.2	0.3	0.3	0.2	0.3	0.2	0.5	0.3	0.4	0.5
SB07	0.5	0.4	0.3	0.4	0.3	0.4	0.3	0.3	0.4	0.4	0.3
SB02	0.2	0.2	0.3	0.2	0.1	0.2	0.3	0.4	0.2	0.2	0.3
SB08	0.3	0.2	0.3	0.3	0.1	0.1	0.4	0.4	0.2	0.2	0.3
SB10	0.3	0.3	0.3	0.4	0.2	0.2	0.3	0.2	0.3	0.3	0.3
SB09	0.2	0.2	0.3	0.2	0.1	0.3	0.3	0.2	0.2	0.2	0.4
SB01	0.2	0.2	0.2	0.2	0.1	0.1	0.3	0.2	0.2	0.2	0.2
SB11	0.5	0.4	0.6	0.4	0.6	0.9	0.8	0.8	1.1	0.7	0.4
SB12	0.3	0.3	0.3	0.3	0.4	0.5	0.4	0.5	NS	0.5	0.3



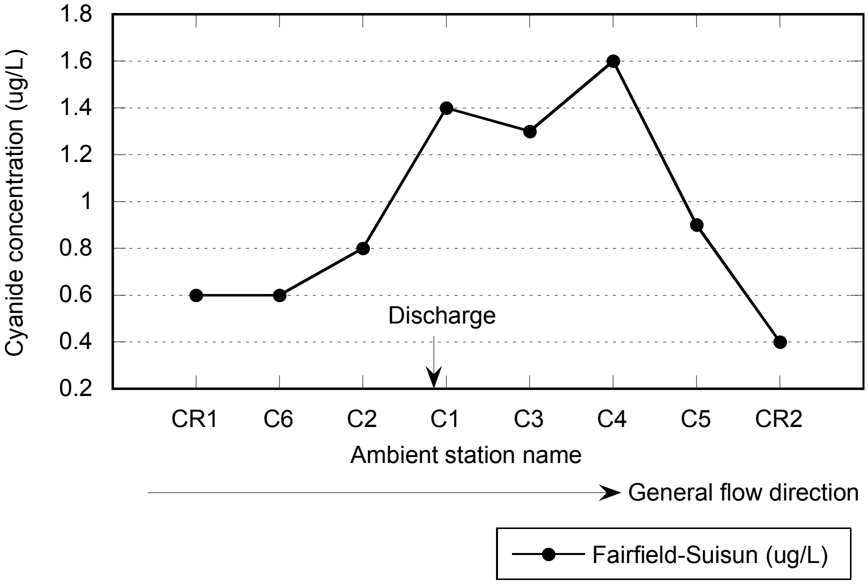
CITY OF AMERICAN CANYON AMBIENT CYANIDE DATA (µg/L)

Site	4/5/2005	4/25/2005
Outfall	<1	<1
C1	0.6	0.7
C2	0.5	0.5
CR	0.4	0.6
CR-500	0.4	0.4



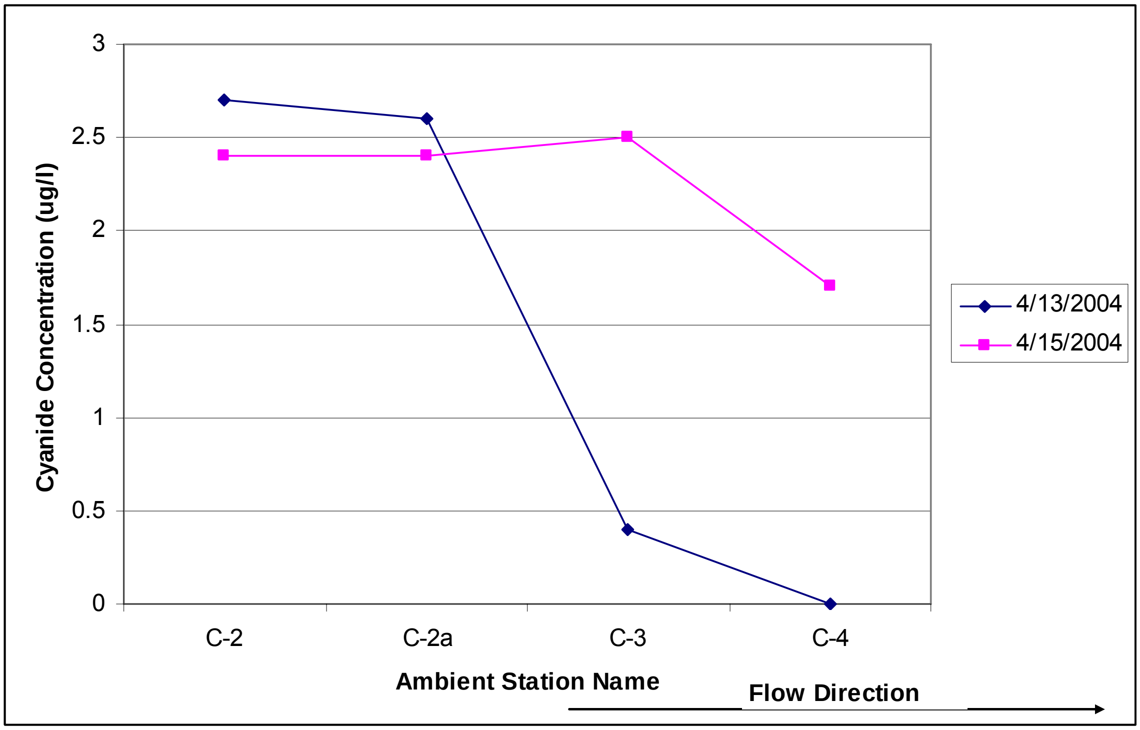
FAIRFIELD-SUISUN SEWER DISTRICT AMBIENT CYANIDE DATA (μg/L)

Station	**2/26/04**
CR1	0.6
C6	0.6
C2	0.8
C1	1.4
C3	1.3
C4	1.6
C5	0.9
CR2	0.4



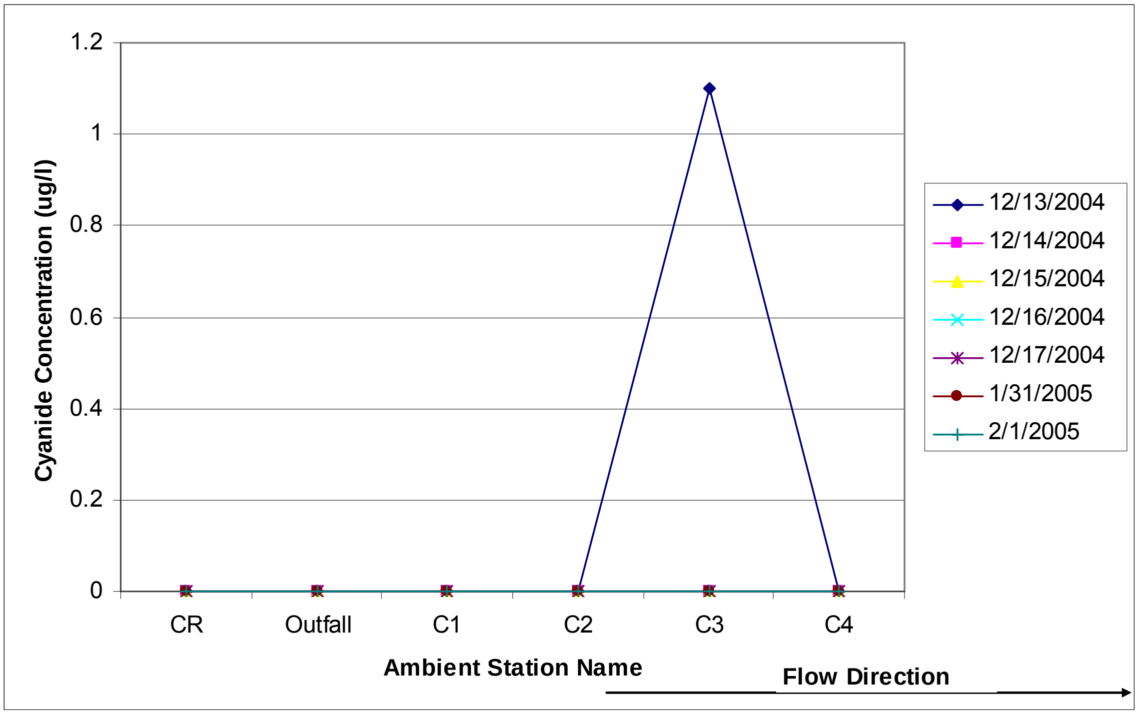
LAS GALLINAS SANITATRY DISTRICT AMBIENT CYANIDE DATA (μg/L)

Station	4/13/2004	4/15/2004	Minimum	Maximum	Average
C-2	2.7	2.4	2.4	2.7	2.55
C-2a	2.6	2.4	2.4	2.6	2.5
C-3	0.4	2.5	0.4	2.5	1.45
C-4	<0.3	1.7	0.3	1.7	1.7



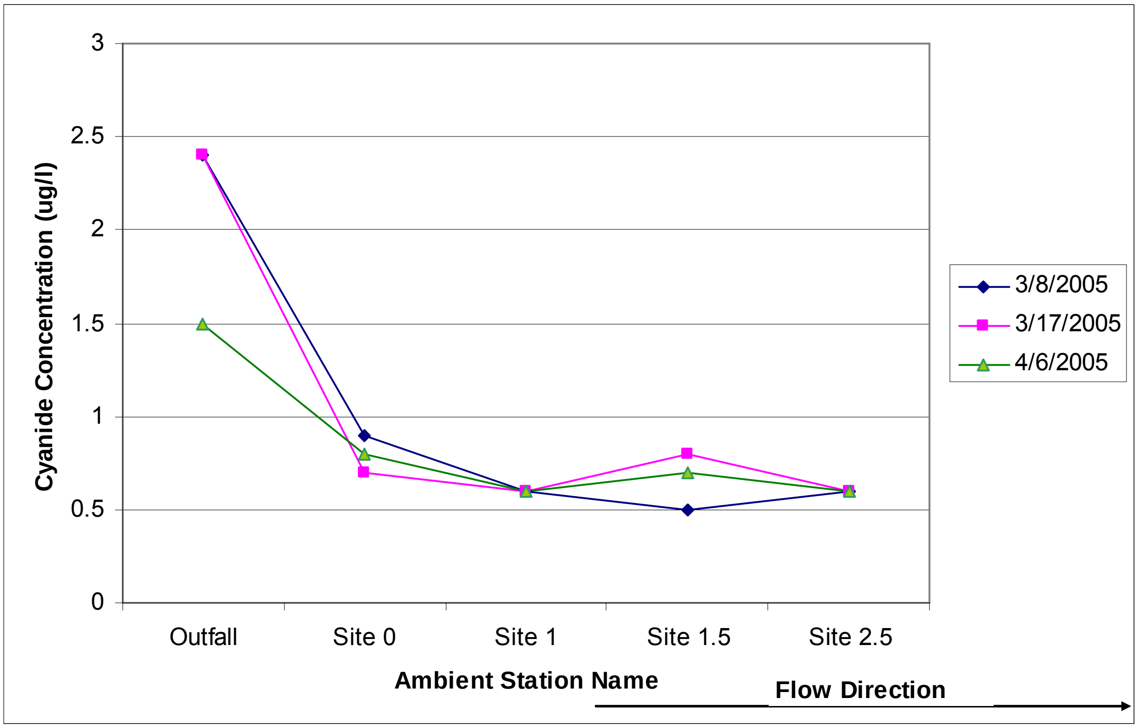
MOUNTAIN VIEW SANITARY DISTRICT AMBIENT CYANIDE DATA (µg/L)

Site	**12/13/2004**	**12/14/2004**	**12/15/2004**	**12/16/2004**	**12/17/2004**	**1/31/2005**	**2/1/2005**
Outfall	<1	<1	<1	<1	<1		
C1	<1						
C2	<1						
C3	1.1					<1	<1
C4	<1						
CR	<1						



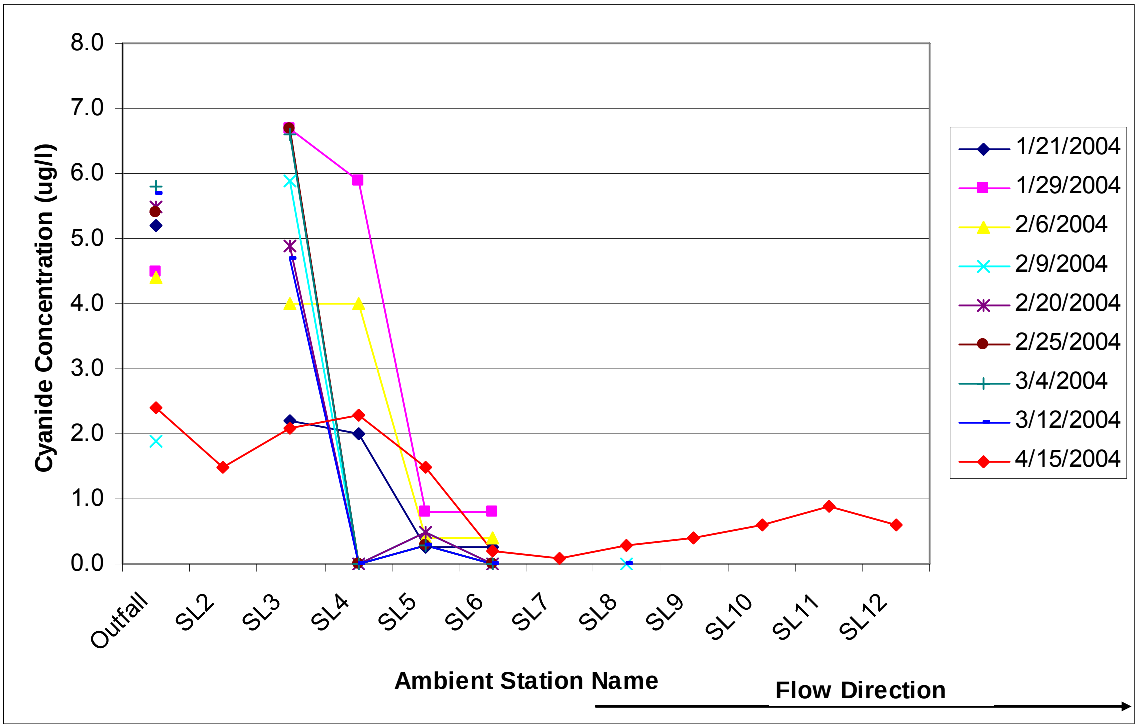
NAPA SANITATION DISTRICT AMBIENT CYANIDE DATA (µg/L)

Site	**3/8/2005**	**3/17/2005**	**4/6/2005**
Outfall	2.4	2.4	1.5
Site 0	0.9	0.7	0.8
Site 1	0.6	0.6	0.6
Site 1.5	0.5	0.8	0.7
Site 2.5	0.6	0.6	0.6



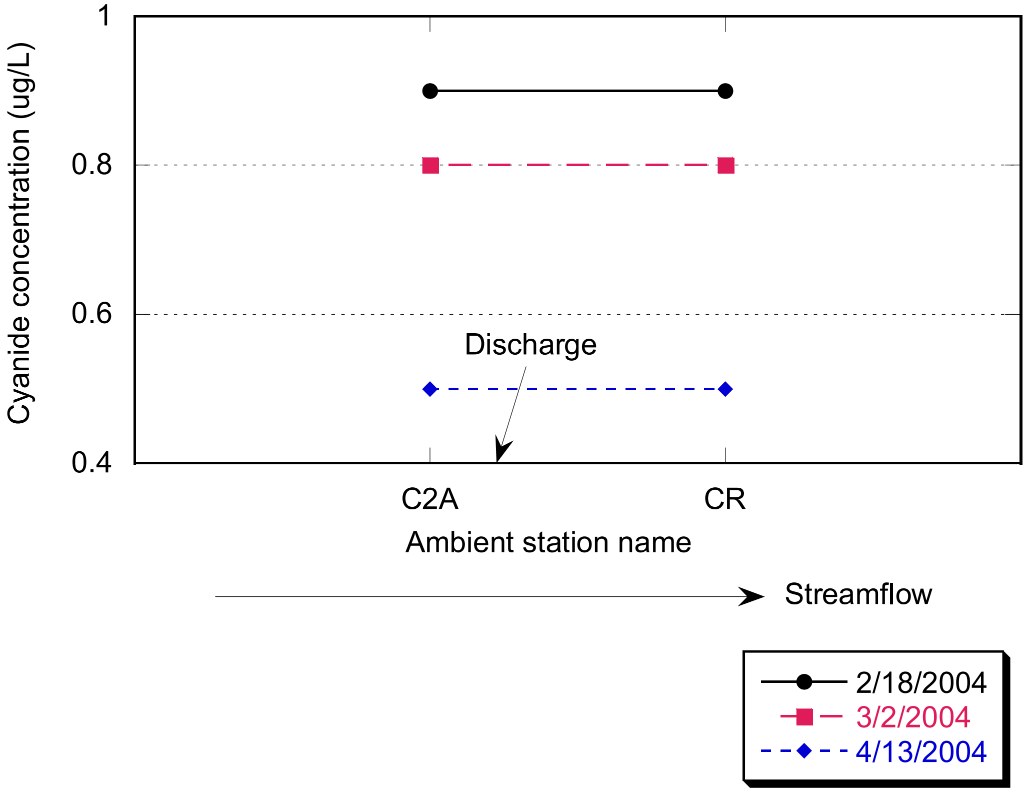
CITY OF PALO ALTO AMBIENT CYANIDE DATA (µg/L)

Site	**1/21/2004**	**1/29/2004**	**2/6/2004**	**2/9/2004**	**2/20/2004**	**2/25/2004**	**3/4/2004**	**3/12/2004**	**4/15/2004**
Outfall	5.2	4.5	4.4	1.9	5.5	5.4	5.8	5.7	2.4
SL2									1.5
SL3	2.2	6.7	4	5.9	4.9	6.7	6.6	4.7	2.1
SL4	2	5.9	4						2.3
SL5	0.26	0.8	0.4	0.5	0.5	0.3	0.3	0.3	1.5
SL6	0.26	0.8	0.4						0.2
SL7									0.1
SL8									0.3
SL9									0.4
SL10									0.6
SL11									0.9
SL12									0.6



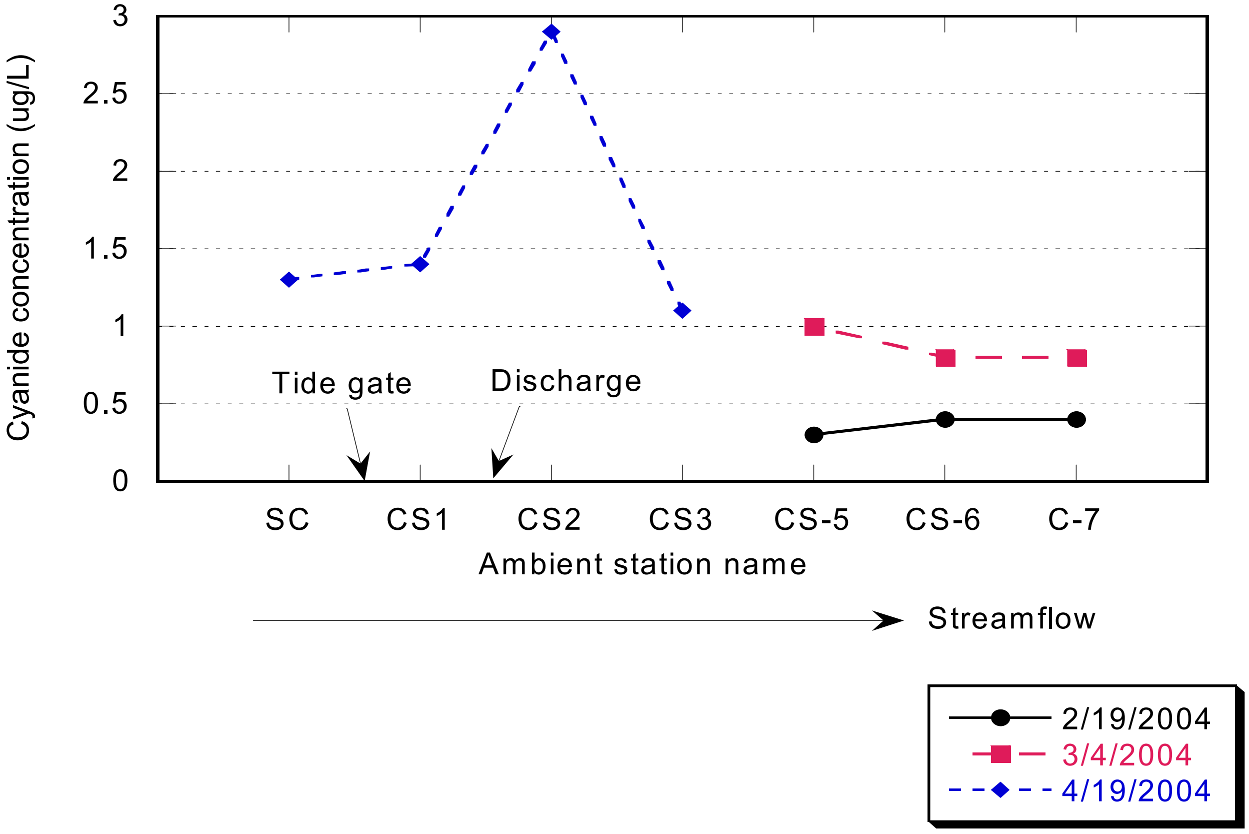
CITY OF PETALUMA AMBIENT CYANIDE DATA (µg/L)

Station	2/18/04	3/2/04	4/13/04	Minimum	Maximum	Average
C2A	0.9	0.8	0.5	0.5	0.9	0.73
CR	0.9	0.8	0.5	0.5	0.9	0.73



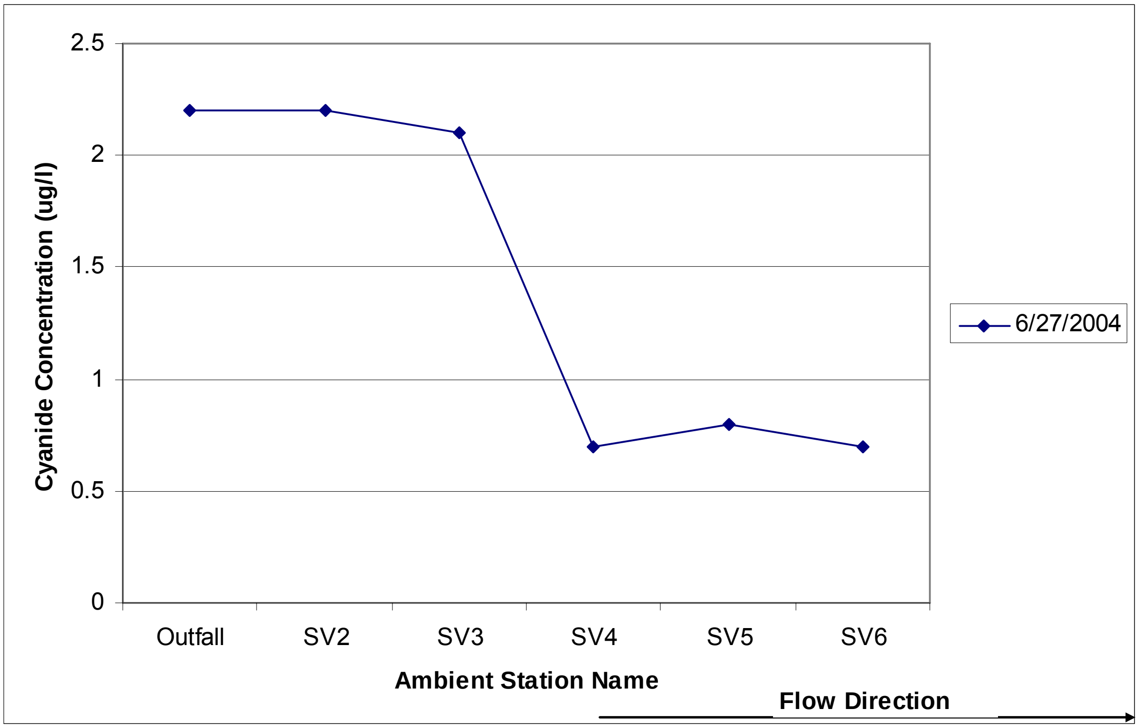
SONOMA COUNTY WATER AGENCY AMBIENT CYANIDE DATA (µg/L)

Station	2/19/04	3/4/04	4/19/04	Minimum	Maximum	Average
SC			1.3	1.3	1.3	1.30
CS1			1.4	1.4	1.4	1.40
CS2			2.9	2.9	2.9	2.90
CS3			1.1	1.1	1.1	1.10
CS-5	0.3	1		0.3	1	0.65
CS-6	0.4	0.8		0.4	0.8	0.60
C-7	0.4	0.8		0.4	0.8	0.60



CITY OF SUNNYVALE AMBIENT CYANIDE DATA (µg/L)

Site	**6/27/2004**
Outfall	2.2
SV2	2.2
SV3	2.1
SV4	0.7
SV5	0.8
SV6	0.7



APPENDIX C

Discharger Performance Summary

A summary of cyanide effluent concentration data for individual NPDES dischargers is provided below in Table 1 and 2. In Table 3, data are summarized by treatment category: (1) municipal secondary treatment facilities, (2) municipal advanced secondary facilities, and (3) industrial facilities. These tables are based on data from the period 2000 to 2004. Effluent data for deep water dischargers was accessed from the Electronic Reporting System (ERS) database, while shallow water discharger data was obtained directly form the dischargers as well as the ERS.

Table 1: Effluent Cyanide Concentrations in Deep Water NPDES Discharges (2000- 2004)[1]

Deep Water Dischargers	n	%ND[a]	min (μg/L)	max (μg/L)	median (μg/L)	mean[b] (μg/L)	stdev
Benicia, City of	48	14.6%	0.9	26.0	4.0	5.6	5.1
Burlingame, City of	58	31.0%	0.9	13.0	3.0	3.3	2.0
Central Contra Costa Sanitary District	45	44.4%	2.0	9.9	3.1	3.8	1.7
Central Marin Sanitation Agency	47	29.8%	0.6	16.0	3.0	4.3	2.9
Chevron Richmond Refinery	32	46.9%	3.0	14.9	10.0	7.3	3.7
ConocoPhillips (at Rodeo)	52	53.8%	3.0	14.0	5.0	6.1	2.4
Delta Diablo Sanitation District	45	82.2%	1.0	13.0	6.0	7.1	3.1
Dow Chemical Company	26	80.8%	0.9	5.7	3.0	3.3	1.4
Dublin San Ramon Services District	51	98.0%	7.0	8.8	7.0	7.0	0.3
EBDA	186	58.6%	3.0	68.0	3.0	5.1	8.1
EBMUD	101	18.8%	0.0	25.0	4.0	5.7	4.3
GWF E 3rd St (Site I)	17	88.2%	5.0	10.0	7.0	7.5	2.5
GWF Nichols Rd (Site V)	16	100.0%	3.0	10.0	7.5	7.4	2.8
Livermore, City of	7	100.0%	3.0	25.0	18.0	14.9	9.1
Martinez Refining Company	129	0.0%	4.0	29.0	13.0	13.2	5.7
Millbrae, City of	47	48.9%	0.6	18.0	3.0	3.7	2.6
Morton	6	100.0%	2.0	10.0	10.0	7.5	3.9
North San Mateo	15	93.3%	5.0	50.0	10.0	17.3	17.0
Pacifica Calera Creek	33	48.5%	1.0	60.0	3.0	4.8	10.0
Pinole-Hercules	28	64.3%	0.9	10.0	3.0	3.5	1.6
Rhodia Basic Chemicals	14	100.0%	10.0	10.0	10.0	10.0	0.0
Rodeo Sanitary District	20	65.0%	1.9	7.0	3.0	3.7	1.2
S.F. Airport, Water Quality Control Plant	48	89.6%	3.0	16.5	10.0	9.8	1.9
S.F.Airport, Industrial	145	98.6%	3.0	10.0	10.0	9.8	1.1
S.F.City & County Southeast, North Point & Bayside	113	75.2%	0.2	10.0	10.0	7.8	3.6
Sewer Authority Mid-Coastside	4	100.0%	5.0	10.0	10.0	8.8	2.5
San Francisco Oceanside	33	100.0%	10.0	10.0	10.0	10.0	0.0
San Mateo, City of	42	66.7%	3.0	15.0	3.0	4.3	2.2
Sausalito-Marin Sanitary District	41	4.9%	1.6	20.0	9.0	9.6	4.7
South Bayside System Authority	101	48.5%	1.1	14.7	10.0	7.8	3.0
South San Francisco & San Bruno	105	32.4%	3.0	430.0	8.0	18.3	45.1
Tiburon Treatment Plant	9	88.9%	5.0	5.0	5.0	5.0	0.0
Tesoro Golden Eagle Refinery	173	54.9%	3.0	28.0	10.0	8.8	4.1
US Navy Treasure Island	11	100.0%	10.0	10.0	10.0	10.0	0.0
Valero Benicia Refinery	166	97.6%	10.0	15.0	10.0	10.0	0.4
Vallejo San & Flood Control District	36	72.2%	3.0	22.8	3.0	4.8	5.0
West County/Richmond	12	8.3%	0.9	8.0	3.5	3.6	2.0

[1] Data used to compile this summary were taken from discharger-recorded data between the time period of January 2000 – April 2004. The summary represents available data from this time period rather than a continuous summary of that time period.

[a] When sample was reported as "not detected", summary statistics were performed assuming the concentration = detection limit.

[b] Averages were calculated using the probability regression method

Table 2: Effluent Cyanide Concentrations in Shallow Water NPDES Discharges (2000-2004)

Shallow Water Dischargers[a]	n	%ND[a]	min (μg/L)	max (μg/L)	median (μg/L)	mean[b] (μg/L)	stdev
American Canyon	15	53.3%	<3	2.9	<3	1.4	0.5
Fairfield-Suisun Sewer District	101	37.6%	<0.9	28	3.0	3.9	0.8
Hayward Marsh	33	54.5%	<3	11.3	<3	2.9	0.7
USD discharge into Hayward Marsh	48	66.7%	<3	24	<3	2.4	1.1
Las Gallinas Valley SD	20	55.0%	<3	10	<3	3.0	0.7
Mt. View Sanitary District	22	81.8%	<3	1.6	<3	0.5	0.6
Napa Sanitation District	54	72.2%	<0.3	20	<3	2.6	1.0
Novato Sanitation District	24	50.0%	<0.9	4.4	1.6	1.8	0.6
Palo Alto, City of	50	58.0%	<1.6	5	<3	3.3	1.0
Petaluma, City of	27	44.4%	<3	10	1.6	2.9	0.8
San Jose Santa Clara WPCP[1]	11	0%	1.6	5.2	2.5	5.1	0.4
Sonoma Valley County Water Agency	44	77.3%	<3	13	<5	3.2	0.7
Sunnyvale, City of	80	70.0%	<5	29	<5	4.4	0.8
USS-Posco	36	100.0%	5.0	10.0	10.0	8.8	2.2

[1] 2003 – 2004 data values were used for this summary. All other discharger summaries use data from 2000-2003.

[a] Non-detects (NDs) are considered smaller than those detected values when determining the minimum and median

[b] Averages were calculated using the probability regression method

Table 3: Effluent Cyanide Concentrations by Facility Category

	Advanced Secondary	Secondary	Industrial
n	440	1182	869
min (μg/L)	0.3	0.003	0.9
max (μg/L)	29	430	29
median (μg/L)	5	4.75	10
mean (μg/L)	5.6	7.1	9.3
stdev	3.4	14.8	3.9

Cyanide effluent data are shown graphically in Figures 1 through 5. Figures 1 through 3 portray effluent data for individual facilities in “box and whisker” plots. These plots show the full data set for each facility (10th percentile, 25th percentile, 50th percentile, 75th percentile and 90th percentile) and are grouped by facility category. Figure 4 shows the pooled results for all facilities in the three treatment categories. Figure 5 depicts the pooled probability plots for each of the three treatment categories. Frequency distribution of cyanide concentrations in effluent discharged to shallow waters is presented in Figure 6 indicating that only a small proportion of cyanide samples currently exceeds low toxicity threshold of 5 μg/L.

Figure 1: Maximum Daily Effluent Cyanide: Secondary Dischargers (2000 - 2004)

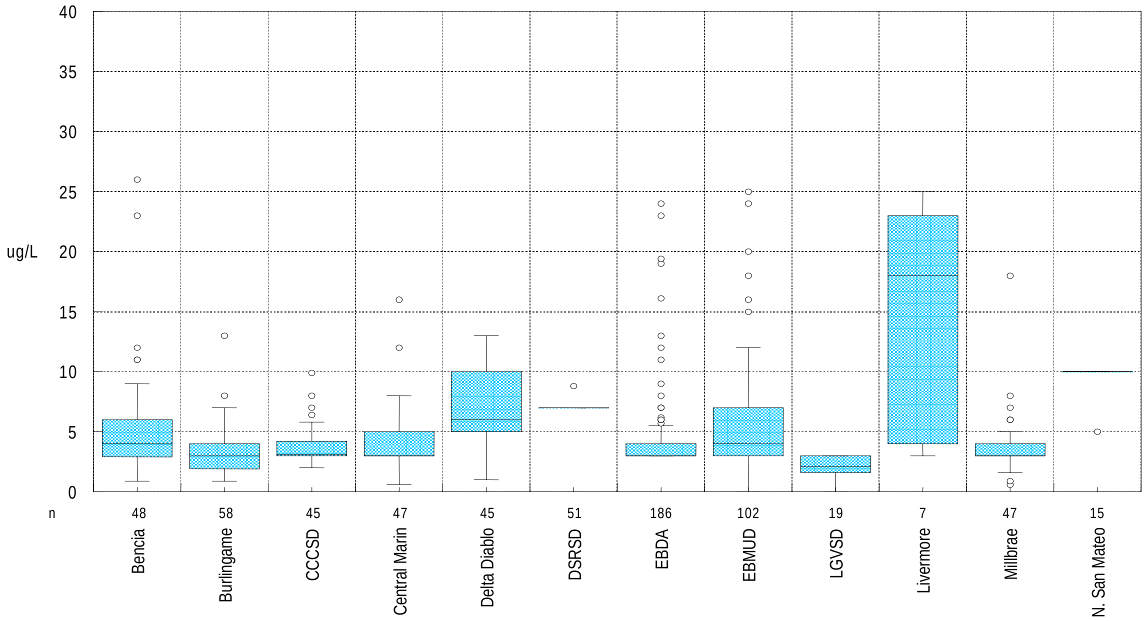


Figure 1, continued: Maximum Daily Effluent Cyanide: Secondary Dischargers (2000 - 2004)

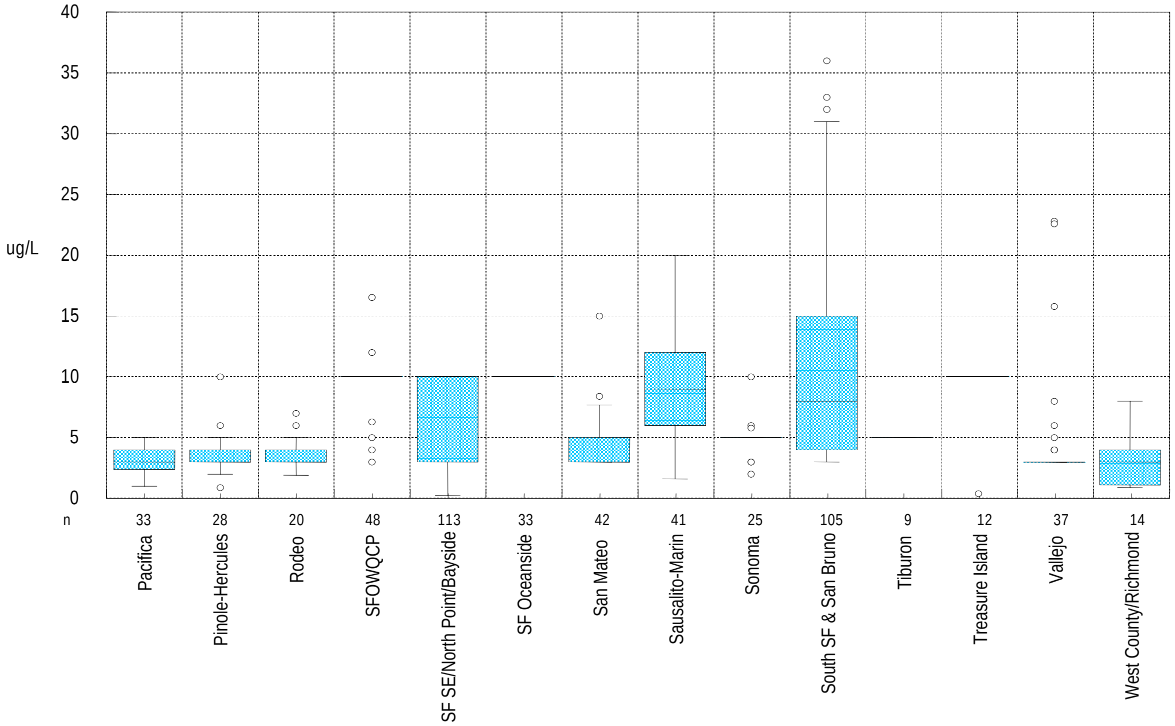


Figure 2: Maximum Daily Effluent Cyanide: Advanced Secondary Dischargers (2000 - 2004)

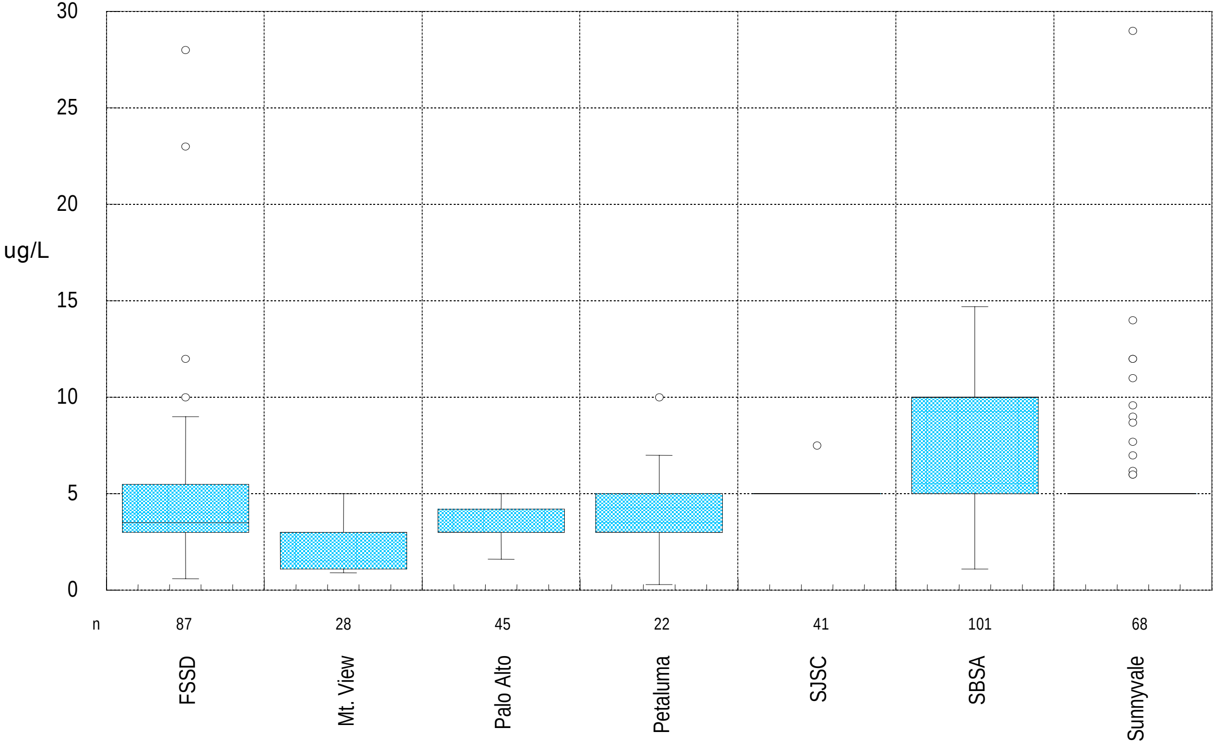


Figure 3: Maximum Daily Effluent Cyanide; Industrial Dischargers (2000 - 2004)

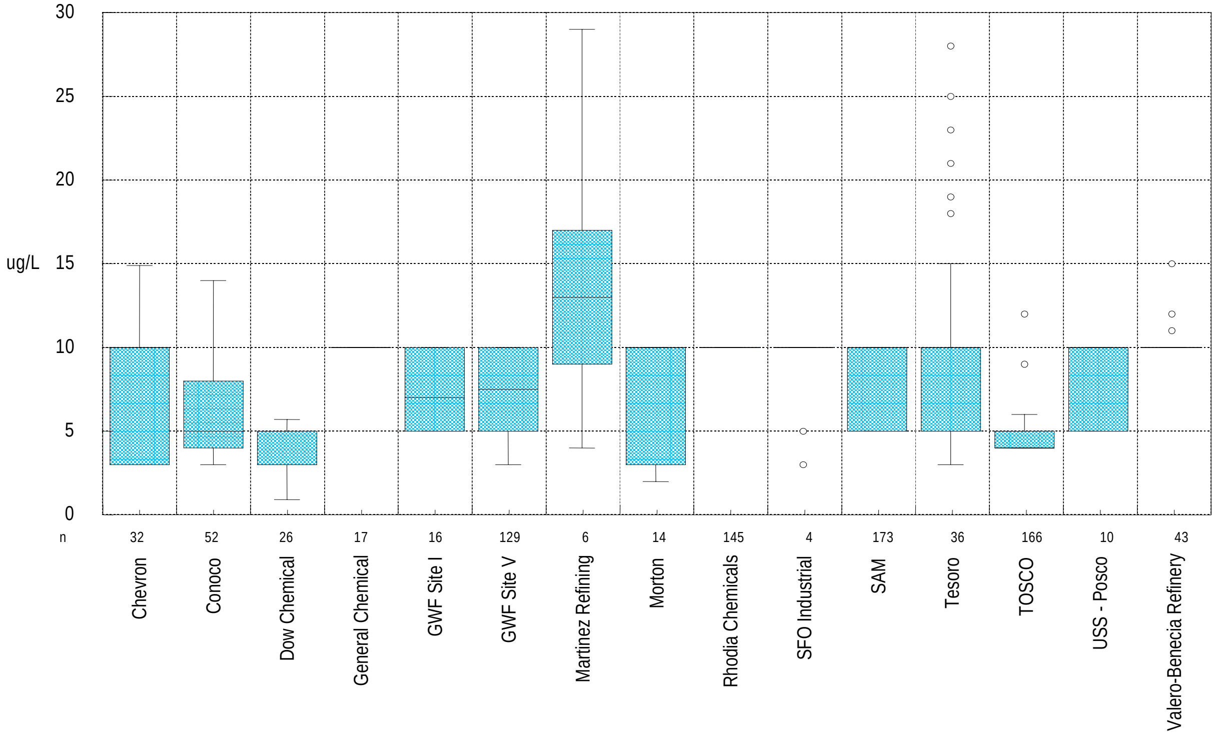
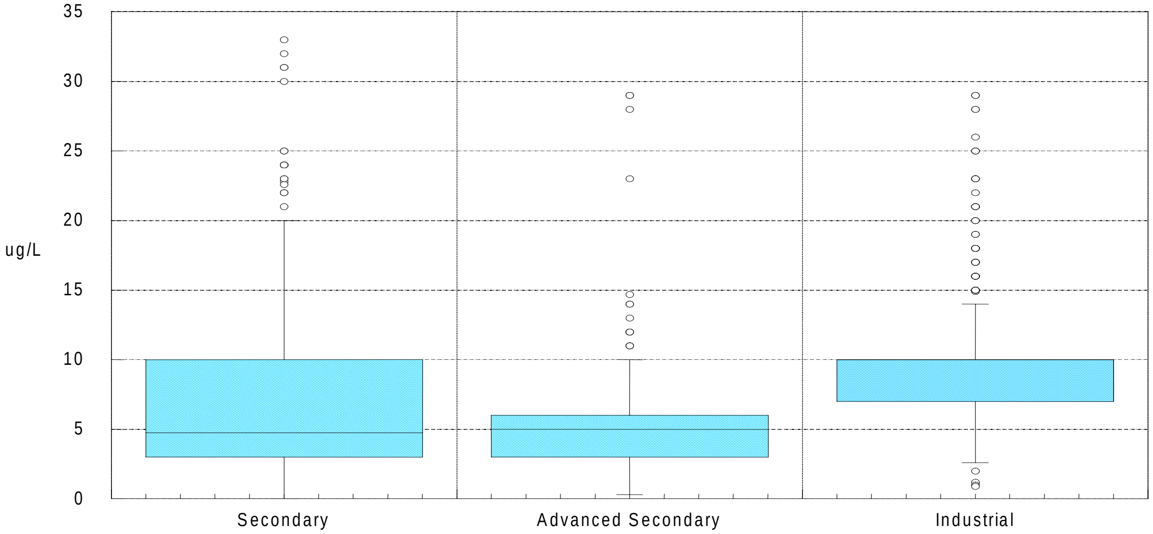


Figure 4: Effluent Cyanide Concentrations by Facility Category (2000 – 2004)



	Secondary	Advanced Secondary	Industrial
n	1182	440	869
min	0.003	0.3	0.9
max	430	29	29
median	4.75	5	10
mean	7.1	5.6	9.3
stdev	14.8	3.4	3.9

Figure 5: Maximum Daily Effluent Cyanide (2000 - 2004)

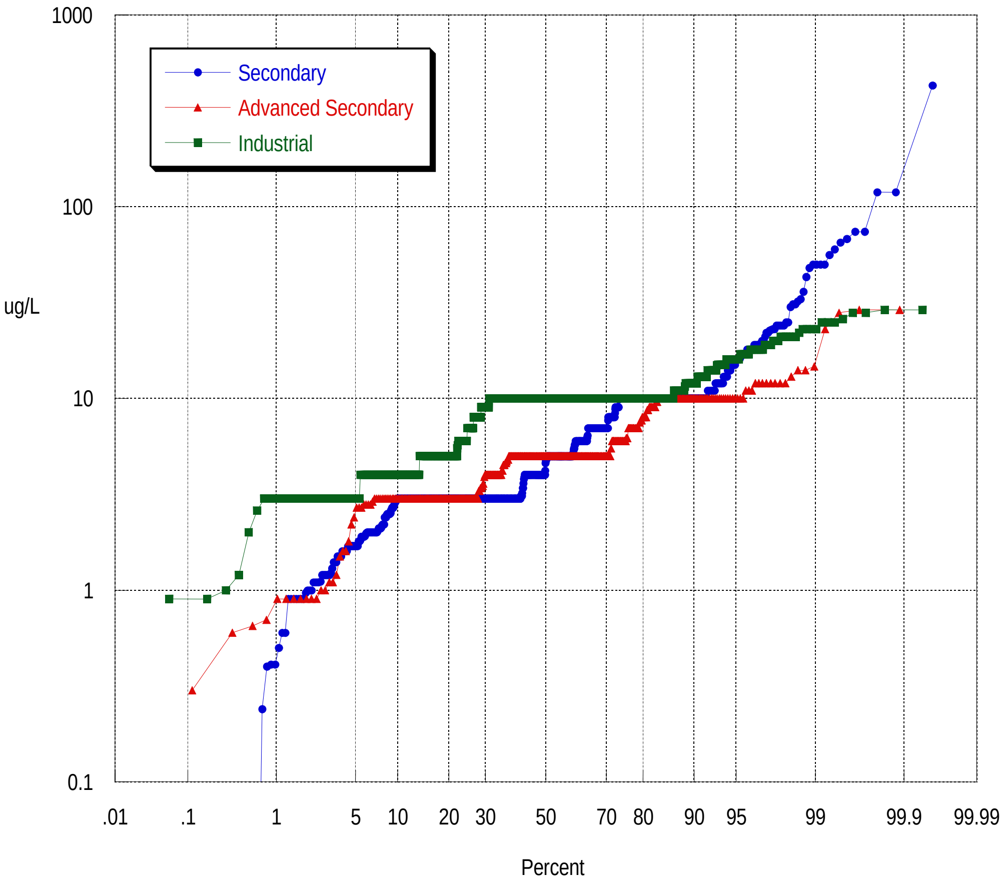
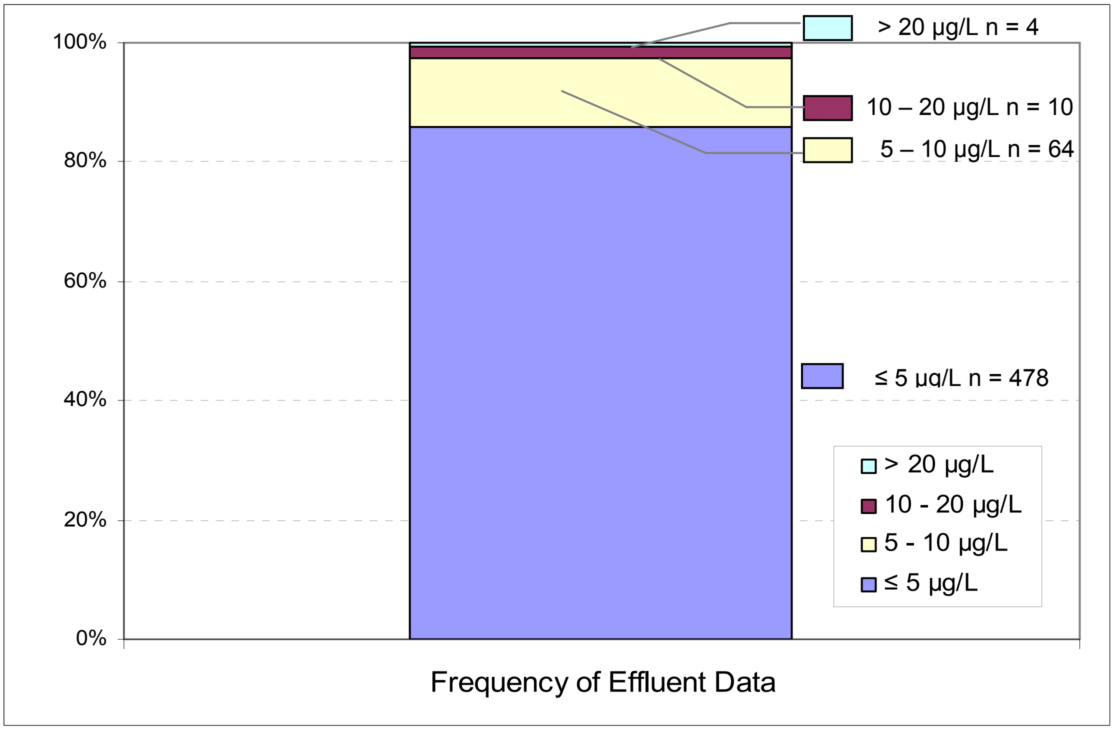


Figure 6: Frequency Distribution of Cyanide in Shallow Water NPDES Discharges (2000 - 2004)



APPENDIX D

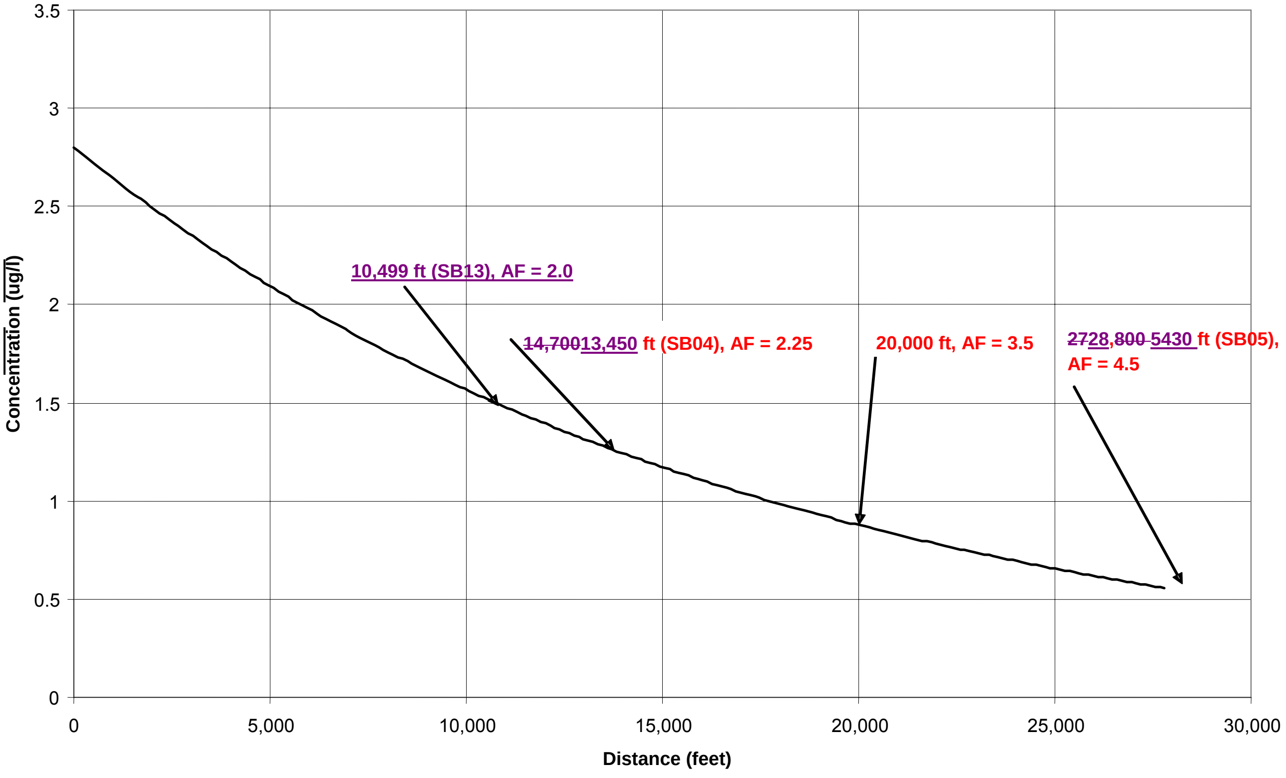
Spatial Descriptions of Effluent Attenuation

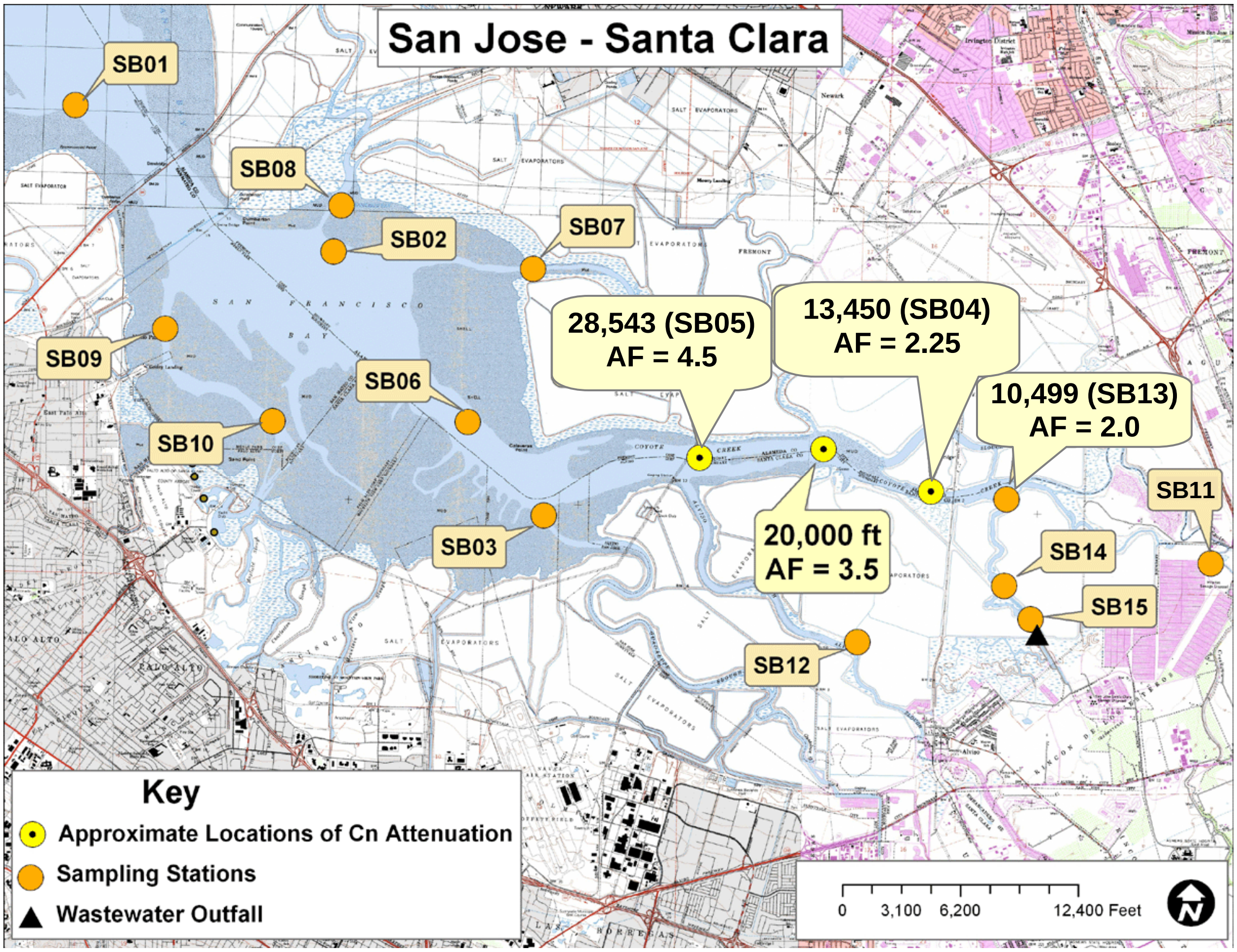
San Jose – Santa Clara

Site	Average Cyanide µg/l	No. data points	Distance from Outfall		Surface Water Area Between Sites		Median AF
			feet	kilometers	acres	sq. kilometer	
San Jose - Santa Clara							
Outfall	2.80	11	0	0	0		-
SB15 (Weir)	3.24	7	~~1,300~~0	~~0.4~~0	~~5~~0	0.0	0.9
SB14 (Triangle)	2.76	9	~~7,200~~3,281	~~2.2~~1.0	~~26~~6.2	~~0.10~~0.03	1.1
SB13 (Mouth)	1.72	9	~~13,000~~10,499	~~4.0~~3.2	~~35~~19.8	~~0.14~~0.1	1.7
SB04	1.09	11	13,450	4.1	40	0.20	**2.25**
Attenuation	-	-	20,000	6.1	~~200~~135	~~0.8~~0.5	**3.5**
SB05	0.51	11	~~27,800~~28,543	8.~~5~~7	~~500~~193	~~2.0~~0.8	**4.5**
SB12	0.38	11	28,100	8.6	288	1.1	7.2
SB03	0.37	11	36,900	11.2	1,350	5.3	7.8
SB06	0.32	11	40,100	12.2	2,750	10.9	9.0
SB07	0.36	11	48,100	14.7	6,650	26.3	7.8
SB10	0.28	11	50,100	15.3	4,500	17.8	10.0
SB02	0.24	11	52,100	15.9	8,450	33.4	11.5
SB08	0.25	11	53,600	16.3	9,400	37.2	9.0
SB09	0.24	11	57,100	17.4	6,000	23.7	11.5
SB01	0.19	11	67,100	20.5	10,100	39.9	12.5

San Jose - Santa Clara

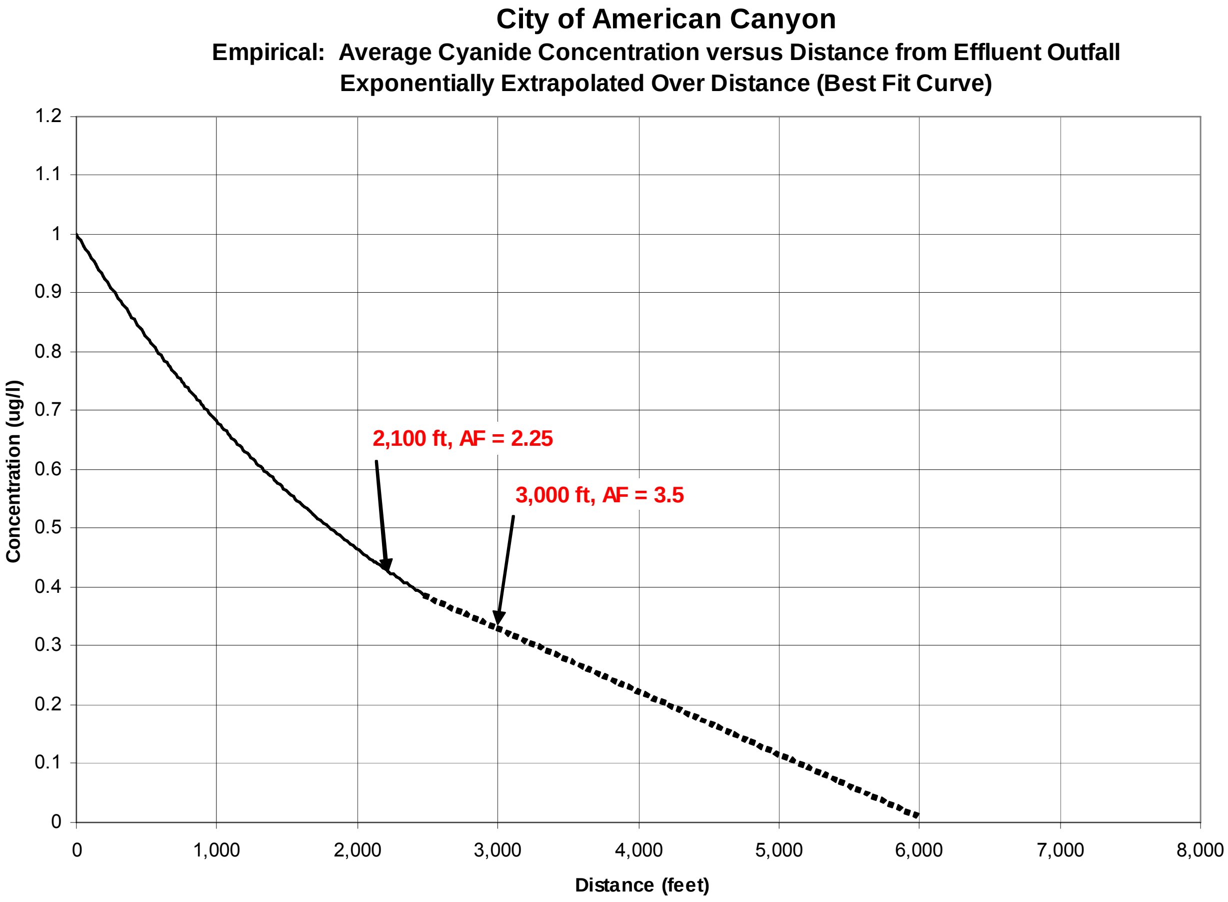
Empirical: Average Cyanide Concentration versus Distance from Effluent Outfall
Exponentially Extrapolated Over Distance (Best Fit Curve)




San Jose - Santa Clara
SB01
SB08
SB02
SB07
SB09
SB06
SB10
SB03
28,543 (SB05) AF = 4.5
13,450 (SB04) AF = 2.25
10,499 (SB13) AF = 2.0
20,000 ft AF = 3.5
SB11
SB14
SB15
SB12
Key
Approximate Locations of Cn Attenuation
Sampling Stations
Wastewater Outfall
0 3,100 6,200 12,400 Feet
N

City of American Canyon

Site	Average Cyanide µg/l	No. data points	Distance from Outfall		Surface Water Area Between Sites		Median AF
			feet	kilometers	acres	sq. kilometer	
American Canyon							
C1	0.65	2	-20	0.0	0	0	-
Outfall	1	2	0	0.0	0	0.000	-
C2	0.5	2	500	0.2	0.34	0.001	2
CR	0.5	2	2,000	0.6	1.38	0.005	2.10
Attenuation	-	-	2,100	0.6	1.45	0.006	**2.25**
CR500	0.4	2	2,500	0.8	2.87	0.011	2.5
Attenuation	-	-	3,000	0.91	3.44	0.014	**3.5**

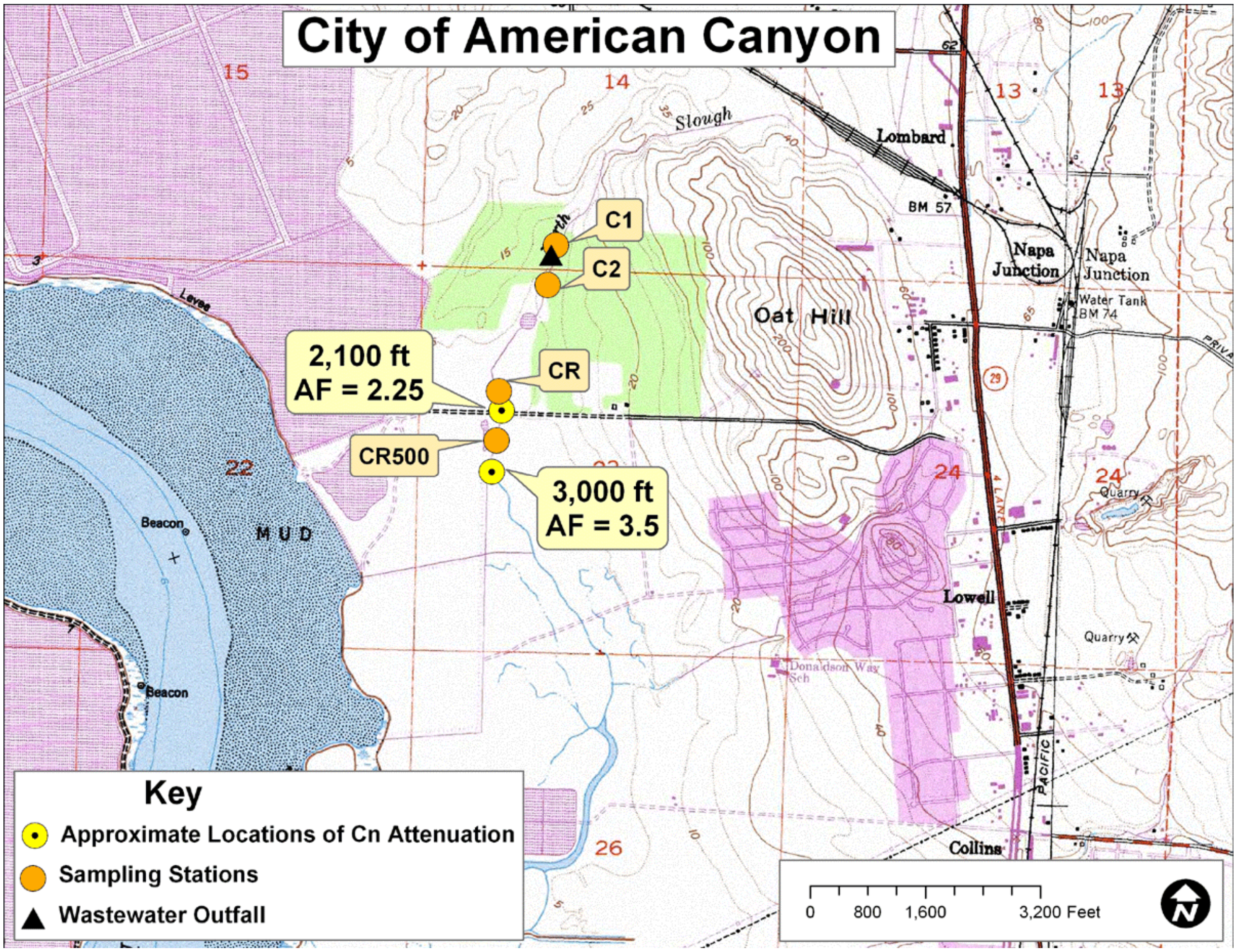


City of American Canyon

Empirical: Average Cyanide Concentration versus Distance from Effluent Outfall Exponentially Extrapolated Over Distance (Best Fit Curve)

2,100 ft, AF = 2.25

3,000 ft, AF = 3.5


City of American Canyon
C1
C2
CR
CR500
2,100 ft
AF = 2.25
3,000 ft
AF = 3.5
Key
Approximate Locations of Cn Attenuation
Sampling Stations
Wastewater Outfall
0
800
1,600
3,200 Feet
N
Slough
Levee
Lombard
BM 57
Napa Junction
Napa Junction
Water Tank
BM 74
Oat Hill
MUD
Beacon
Beacon
Lowell
Quarry
Quarry
Donaldson Way Sch
PACIFIC
Collins
15
14
13
13
22
24
24
26

Fairfield-Suisun Sewer District

Site	Cyanide µg/l	No. data points	Distance from Outfall		Surface Water Area Between Sites		AF†
			feet	kilometers	acres	sq. kilometer	
			Fairfield - Suisun				
C2	0.8	1	-100	0	0.2	0.000	-
Outfall	~~1.4~~4.1~~-~~[a]	71	0	0	0	0.000	-
C1	1.4	1	100	0	0.20	0.001	~~1~~2.9
C3	1.3	1	1,800	0.5	3.5	0.01	~~1.1~~3.2
C4	1.6	1	10,000	3.0	4.3	0.02	~~0.9~~2.6
Attenuation	-	-	15,000	4.6	5.8	0.02	**2.25**
C5	0.9	1	21,000	6.4	24.5	0.10	~~1.6~~4.6
C6	0.6	1	29,500	9.0	32.0	0.13	~~2.3~~6.8
CR1	0.6	1	32,200	9.8	34.4	0.14	~~2.3~~6.8
Attenuation			19,500	5.91	22.8	0.09	**3.0**
Attenuation	-	-	24,000	7.32	28.0	0.11	**3.5**
Attenuation	-	-	27,000	8.23	32.1	0.13	**4.5**
CR2	0.4	1	45,000	13.72	48.0	0.19	~~3.5~~10.3

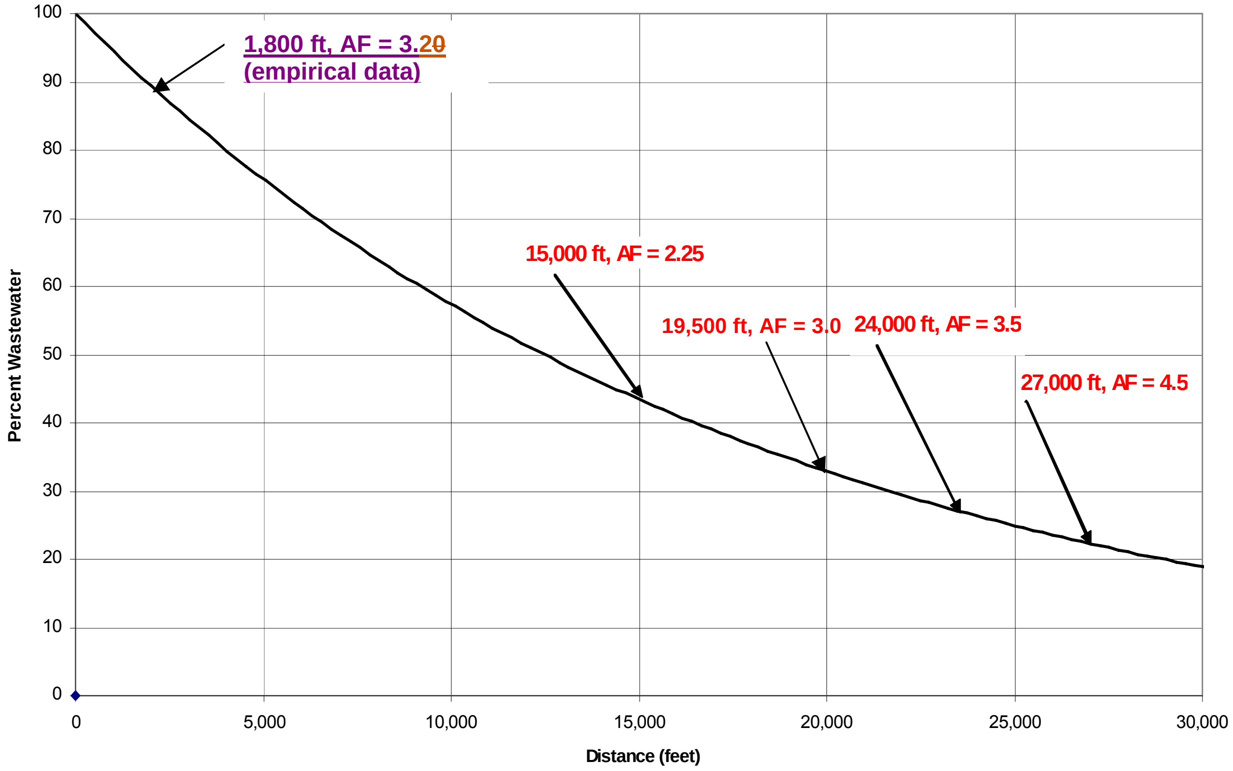
[a] 2003-2006 effluent data average. Non-detect data adjusted to one-half reporting limit

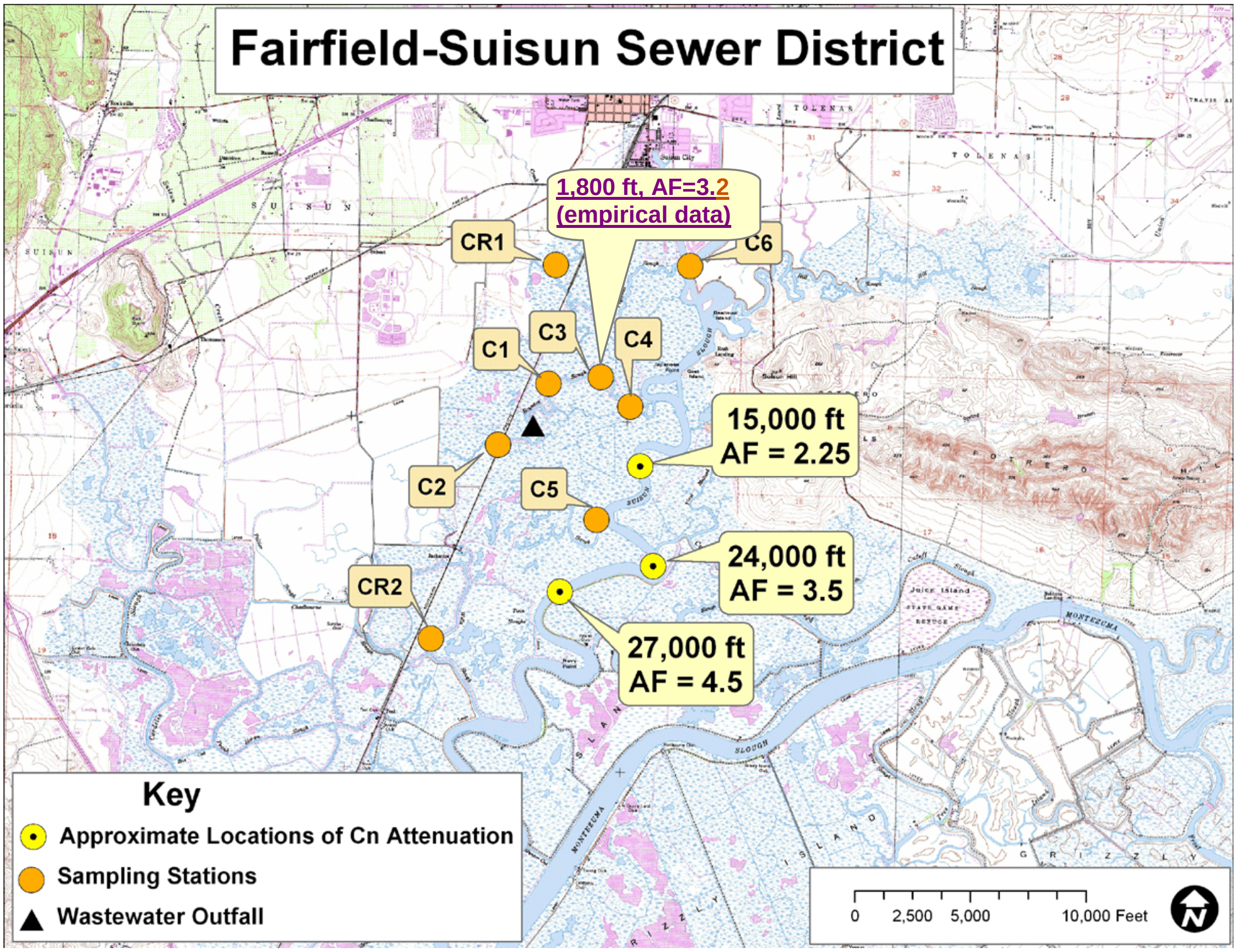
† Attenuation Factors in bold were derived from modeled percent wastewater, AF numbers not in bold are the median AF derived using empirical data.

Fairfield - Suisun SD

Modeled Percent Wastewater versus Distance from Effluent Outfall

Exponentially Extrapolated Over Distance (Best Fit Curve)

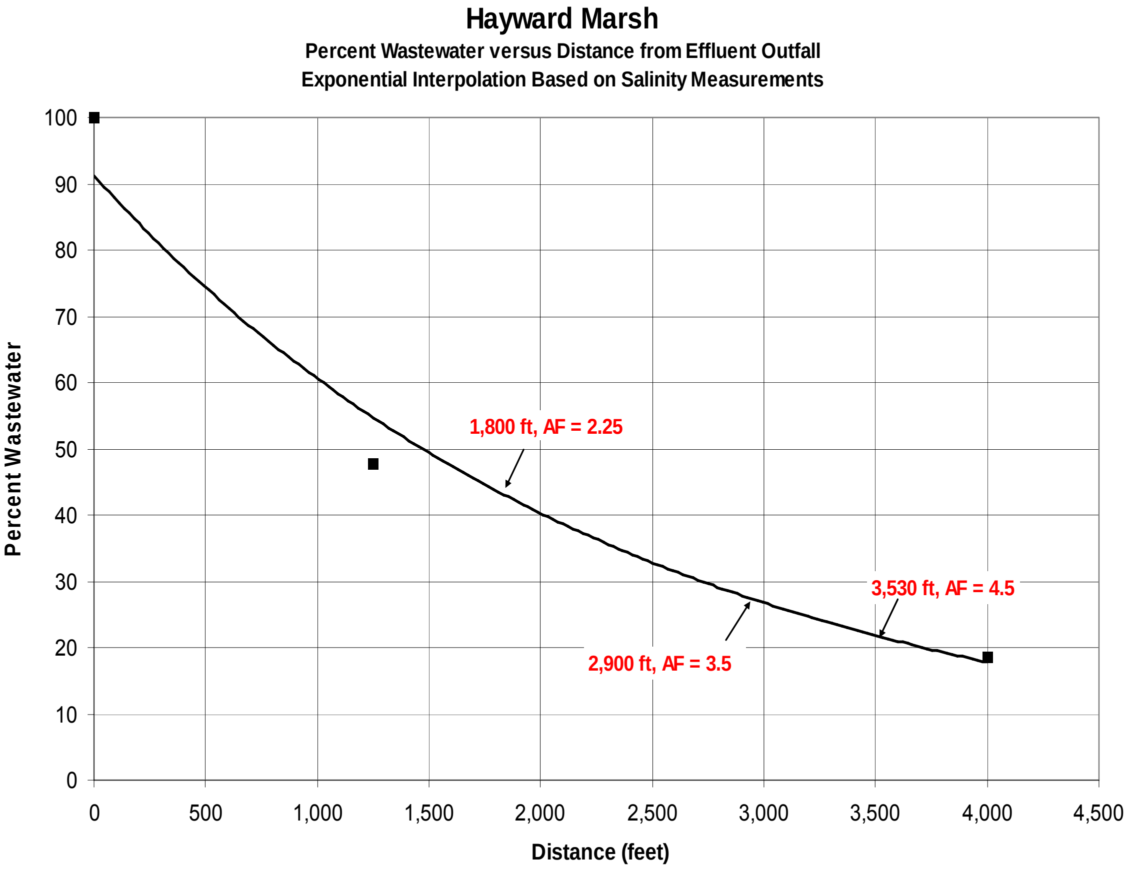


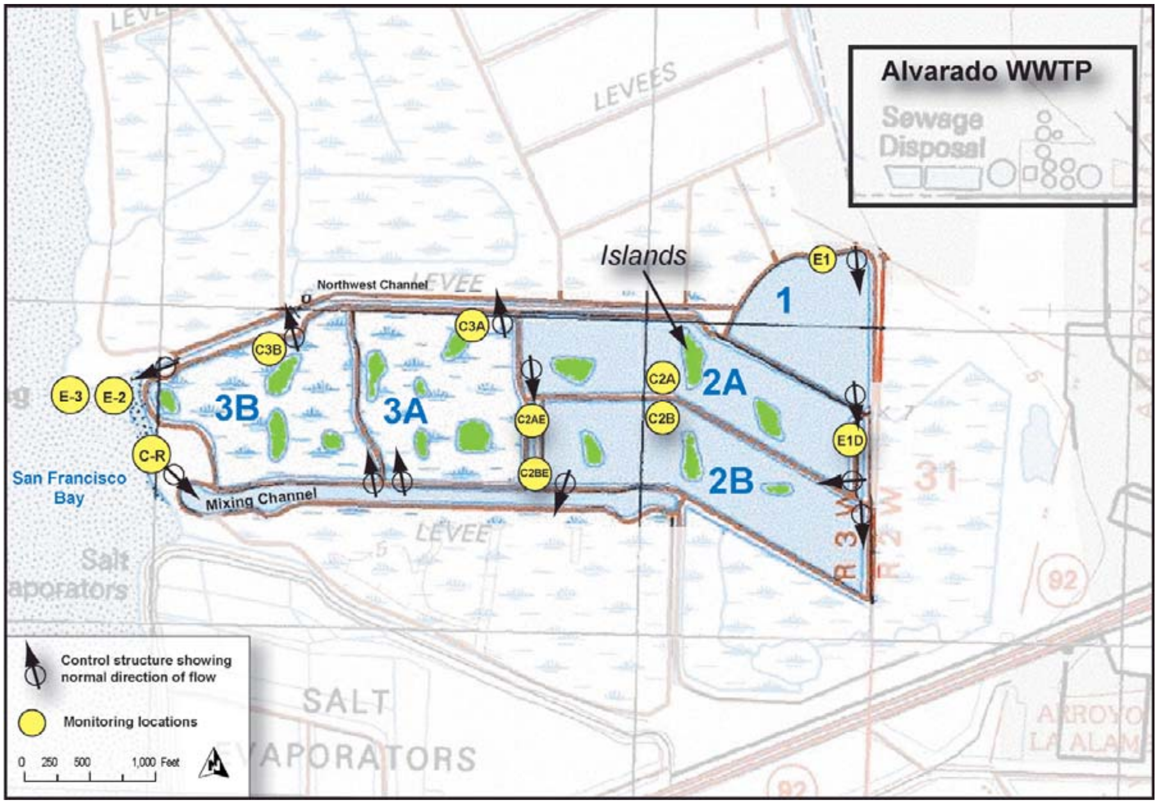

Fairfield-Suisun Sewer District
1,800 ft, AF=3.2
(empirical data)
CR1
C6
C3
C1
C4
15,000 ft
AF = 2.25
C2
C5
24,000 ft
AF = 3.5
CR2
27,000 ft
AF = 4.5
Key
⊙ Approximate Locations of Cn Attenuation
● Sampling Stations
▲ Wastewater Outfall
0
2,500
5,000
10,000 Feet
N

Hayward Marsh

Site	Average Cyanide µg/l	No. data points	Distance from Outfall		Surface Water Area Between Sites		Median Dilution/Attenuation
			feet	kilometers	acres	sq. kilometer	
Hayward Marsh							
Basin 2	3.6	23	0	0	0	0.000	
Dilution	-	-	1,800	0.5	6.2[a]	0.167	**2.25**
Dilution	-	-	2,900	0.9	66.6	0.269	**3.5**
Dilution	-	-	3,530	1.1	81.0	0.328	**4.5**

[a] 6.2 acre area is the estimated surface area of the mixing channels in Marsh Basins 3A and 3B.





Monitoring Station Locations in Hayward Marsh

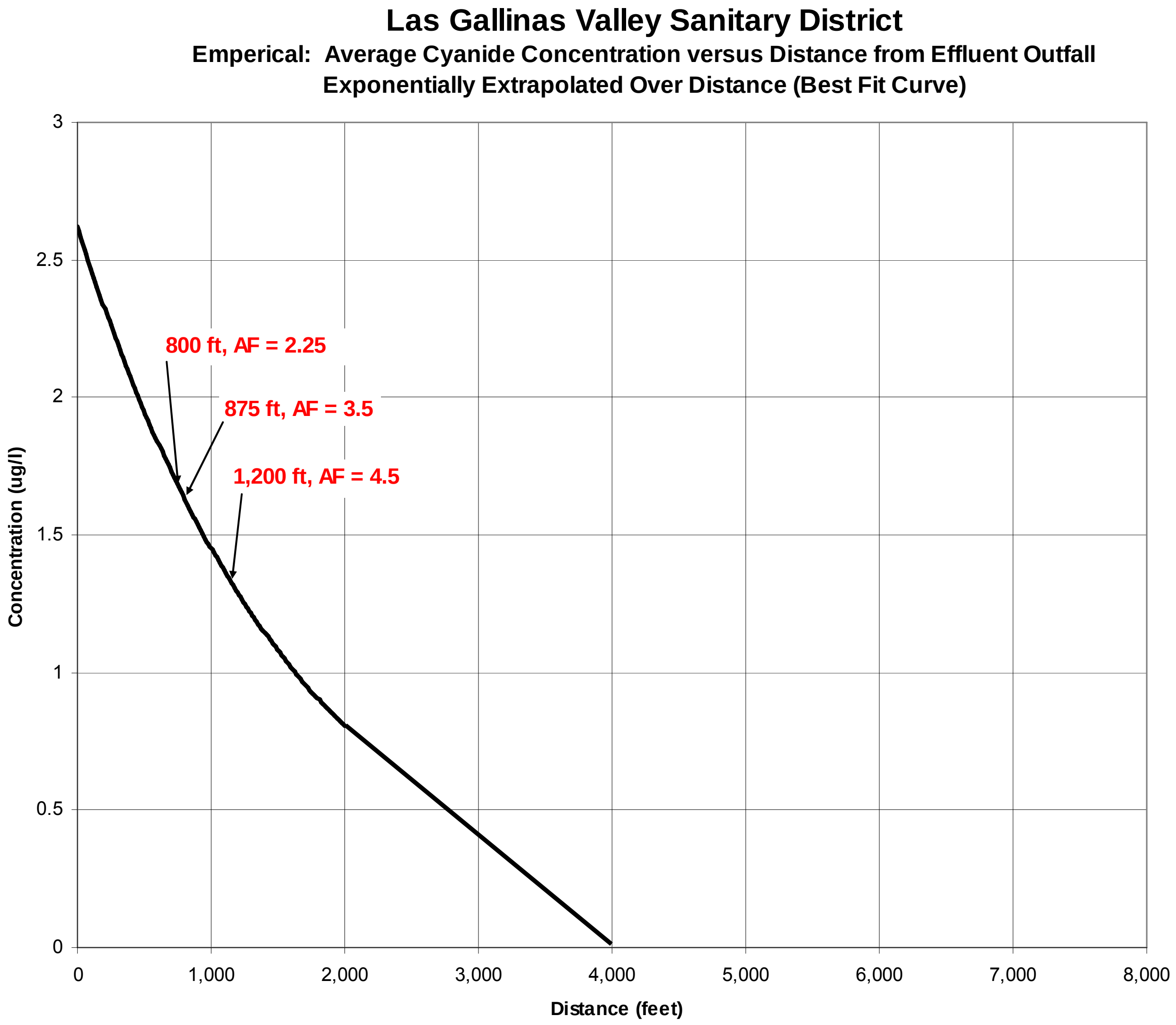
The following stations are used in calculations:

- C-2AE, C-2BE: Parallel discharge points from basins 2A and 2B, representing the permit compliance point for cyanide (averaged for each sample date) Basins 2A and 2B are freshwater marshes which are part of the treatment system.
- C-3A, C-3B: Parallel discharge points from basins 3A and 3B, 1,250 feet from basin 2A (averaged for each sample date)
- E-3: Lower San Francisco Bay, 4,000 feet from basin 2A

Las Gallinas Valley Sanitary District

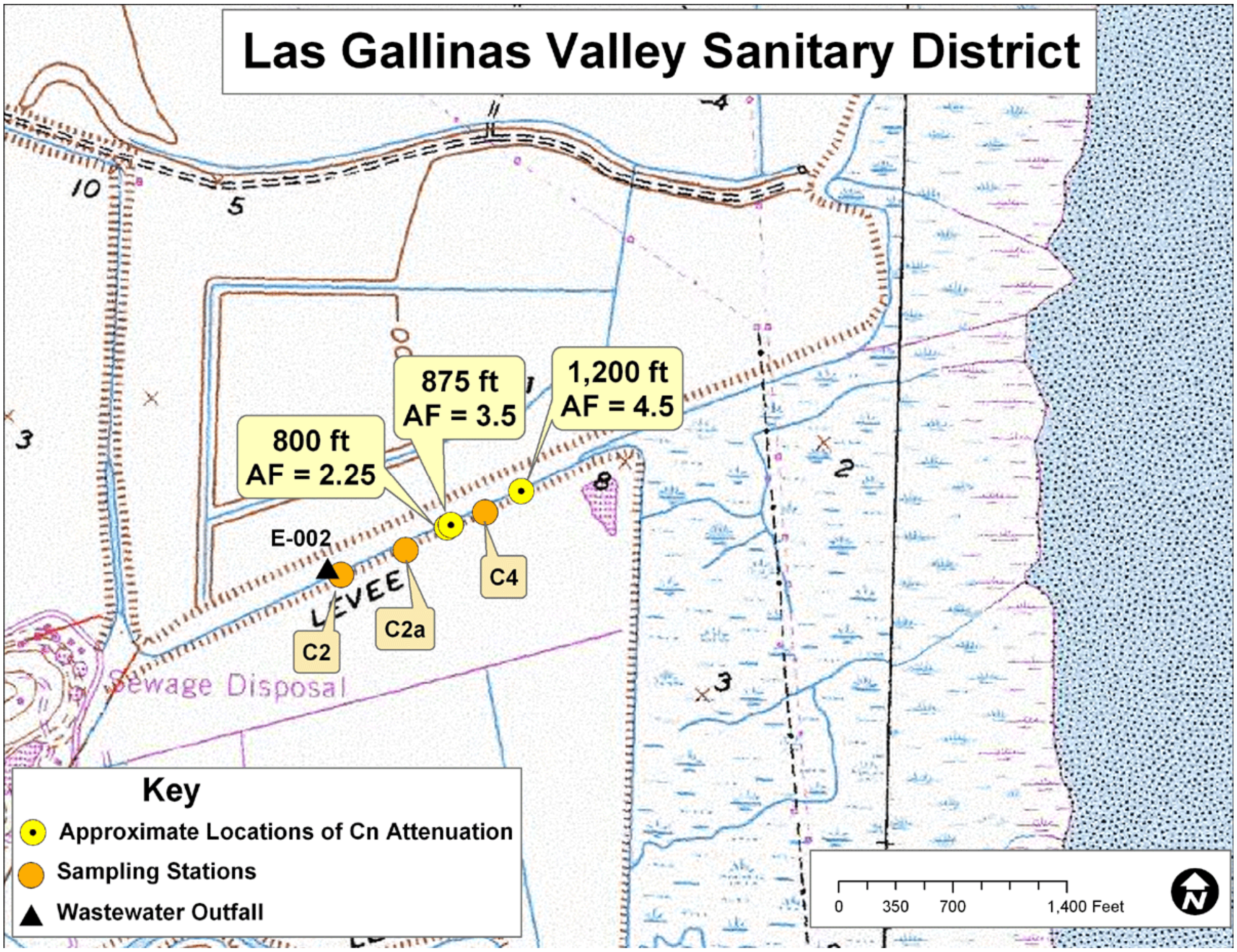
Site	Average Cyanide µg/l	No. data points	Distance from Outfall		Surface Water Area Between Sites		Median AF†
			feet	kilometers	acres	sq. kilometer	
Las Gallinas							
Outfall	0.6	2	0	0	0	0.000	-
C2	2.625	2	20	0.0	0.0	0.000	0
C2a	2.1	2	50	0.0	0.0	0.000	1.3
Attenuation	-	-	800	0.2	1.0	0.004	**2.25**
Attenuation	-	-	875	0.27	1.1	0.004	**3.5**
Attenuation	-	-	1,200	0.37	2.8	0.004	**4.5**
C4	1.025	2	2000	0.61	4.4	0.011	5.2

†Average Cyanide concentration at station C2 was used as outfall to calculate Attenuation Factors



Las Gallinas Valley Sanitary District

Emperical: Average Cyanide Concentration versus Distance from Effluent Outfall
Exponentially Extrapolated Over Distance (Best Fit Curve)

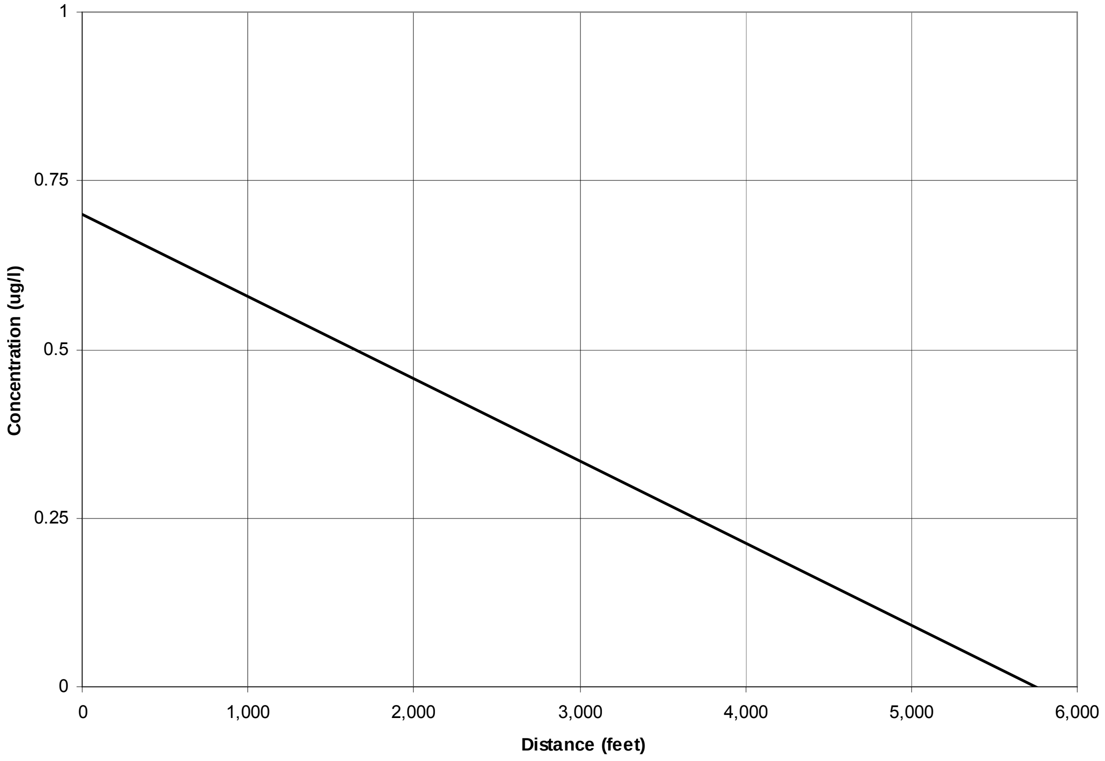

Las Gallinas Valley Sanitary District
800 ft
AF = 2.25
875 ft
AF = 3.5
1,200 ft
AF = 4.5
E-002
C2
C2a
C4
LEVEE
Sewage Disposal
Key
Approximate Locations of Cn Attenuation
Sampling Stations
Wastewater Outfall
0
350
700
1,400 Feet
N

Mt. View Sanitary District

Site	Average Cyanide µg/l	No. data points	Distance from Outfall		Surface Water Area Between Sites		Median AF
			feet	kilometers	acres	sq. kilometer	
Mt. View Sanitary District							
CR	<1	1	-800	0	0.1	0.00	0
Outfall	<1	5	0	0	0	0.00	0
C1	<1	1	10	0.0	0	0.00	0
C2	<1	1	600	0.2	0.1	0.00	0
C3	0.7	3	1,800	0.5	0.8	0.00	0
C4	<1	1	6,000	1.8	2	0.01	0

Mt. View Sanitary District

Empirical: Average Cyanide Concentration versus Distance from Effluent Outfall
Exponentially Extrapolated Over Distance (Best Fit Curve)

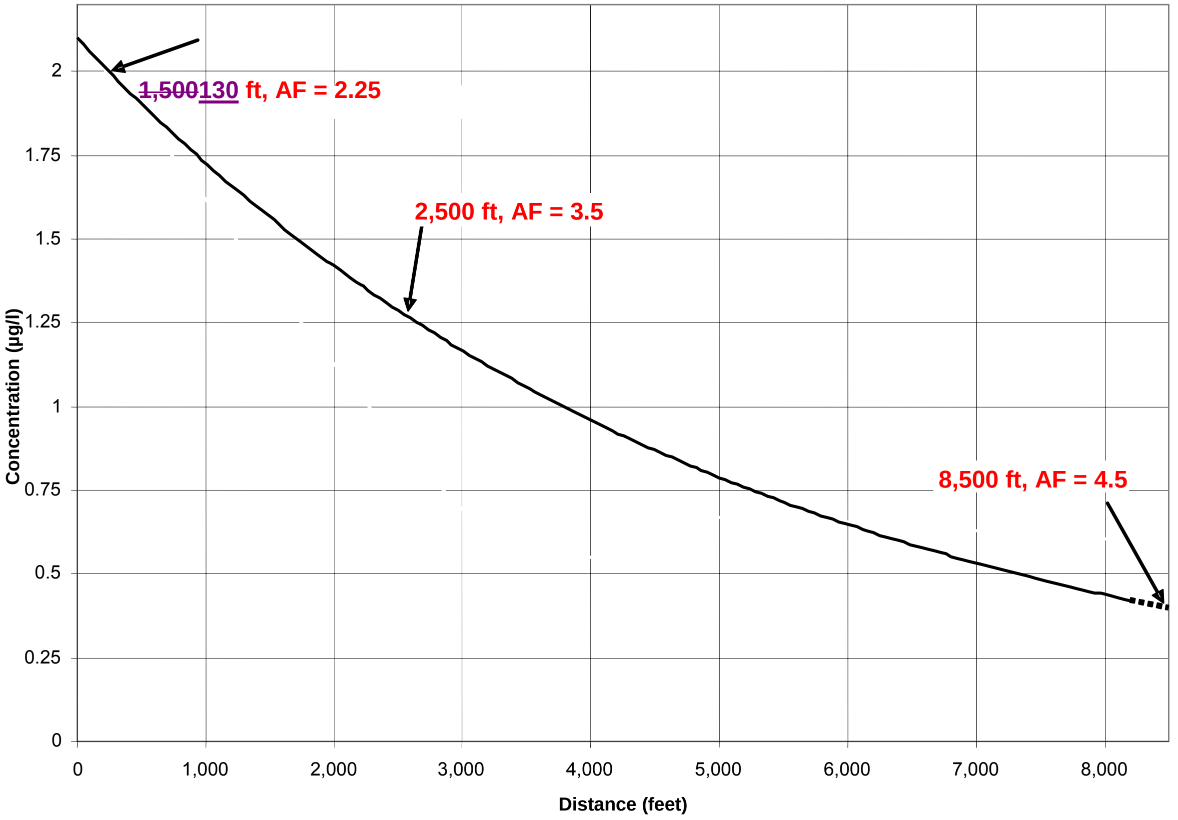


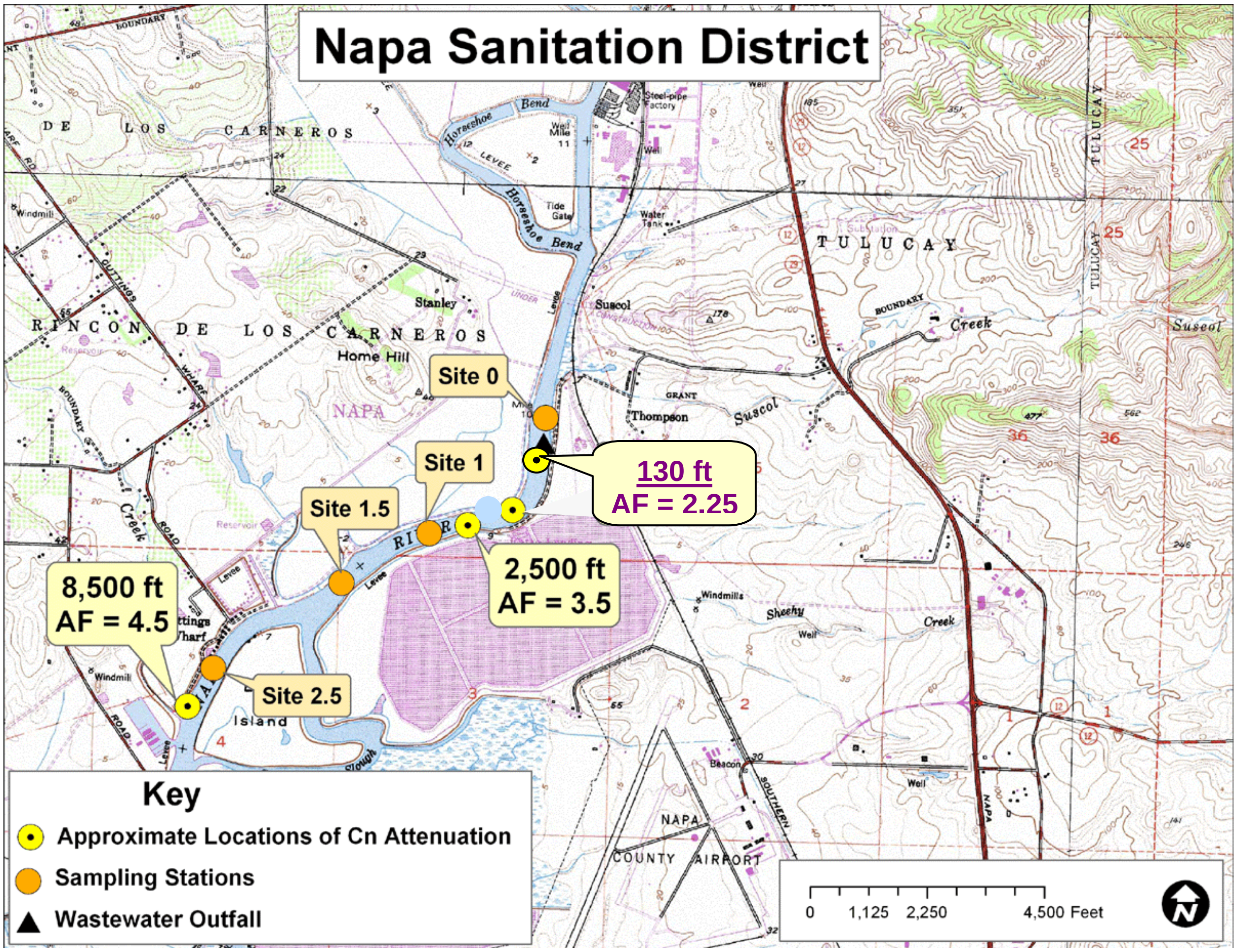
Napa Sanitation District

Site	Average Cyanide µg/l	No. data points	Distance from Outfall		Surface Water Area Between Sites		Median AF
			feet	kilometers	acres	sq. kilometer	
Napa Sanitation District							
Site 0	0.8	3	-20	0	0	0.00	-
Outfall	2.1	3	0	0	0	0.00	-
Attenuation	-	-	~~1,500~~50[a]	~~0.5~~0.01	~~17~~0.4	~~0.07~~0	**2.25**
Attenuation	-	-	2,500	0.8	29	0.11	**3.5**
Site 1	0.6	3	3,279	1.0	37	0.15	4.0
Site 1.5	0.66	3	4,918	1.5	56	0.22	3.0
Site 2.5	0.6	3	8,197	2.5	94	0.37	4.0
Attenuation	-	-	8,500	2.6	95	0.38	**4.5**

[a] The extent of the mixing zone is estimated based on a Mixing Zone Study Report submitted to the Water Board (Limno-Tech, Inc 2006).

Napa Sanitation District
Empirical: Average Cyanide Concentration versus Distance from Effluent Outfall Exponentially Extrapolated Over Distance (Best Fit Curve)

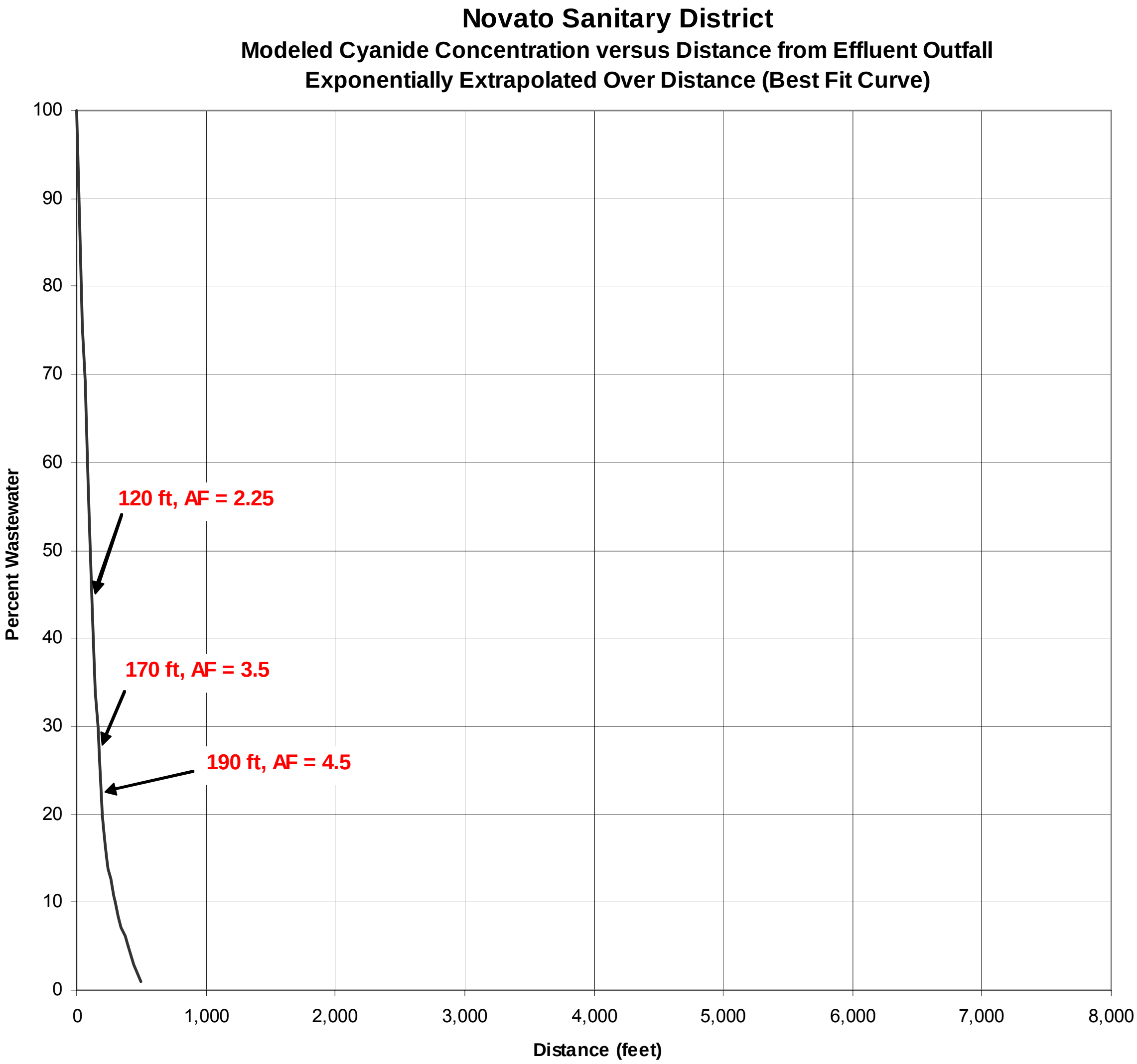


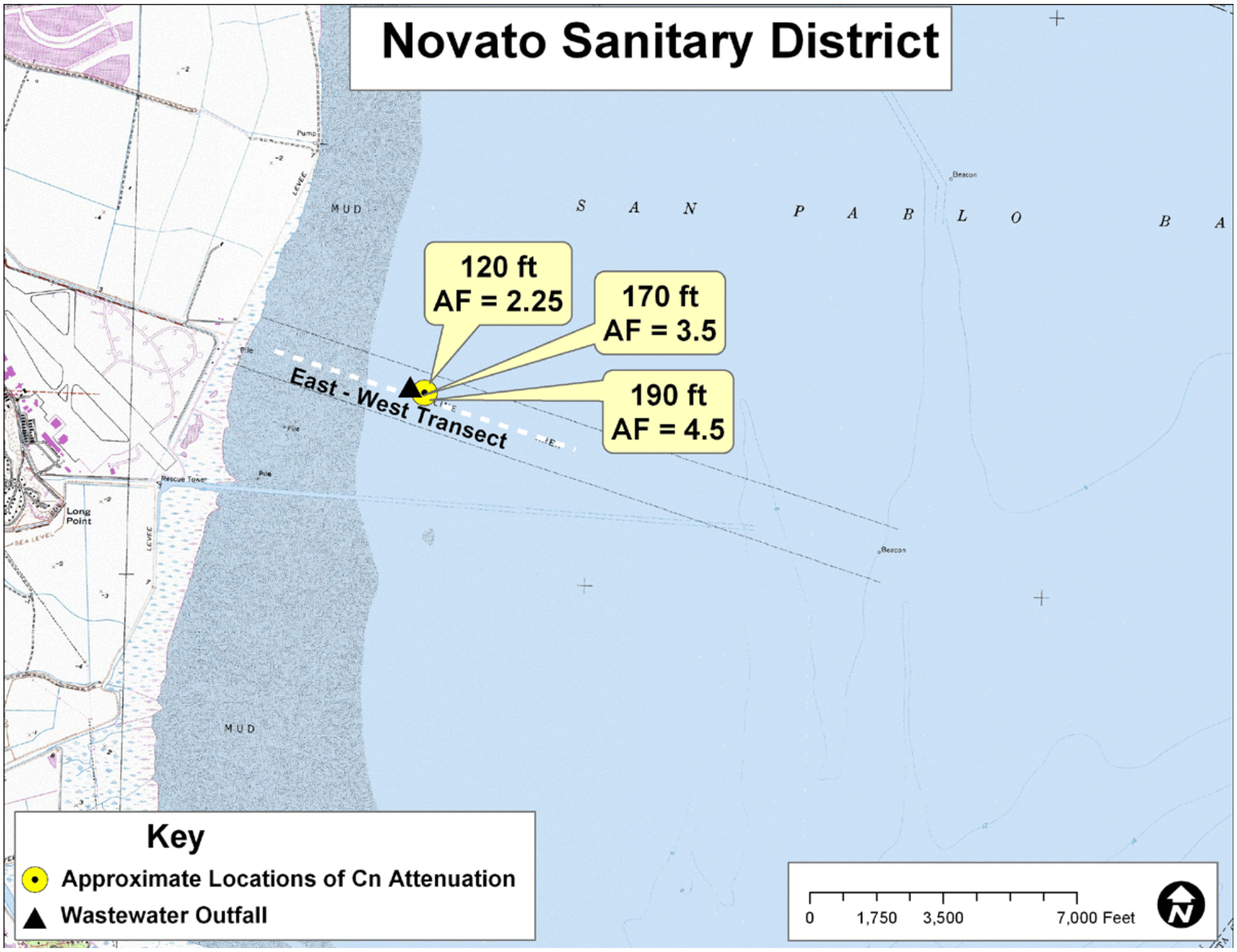

Napa Sanitation District
Site 0
130 ft
AF = 2.25
Site 1
Site 1.5
2,500 ft
AF = 3.5
8,500 ft
AF = 4.5
Site 2.5
Key
● Approximate Locations of Cn Attenuation
● Sampling Stations
▲ Wastewater Outfall
0
1,125
2,250
4,500 Feet
N
RINCON DE LOS CARNEROS
TULUCAY
Home Hill
NAPA
Horseshoe Bend
Stanley
Suscol
Thompson
Island
NAPA COUNTY AIRPORT

Novato Sanitary District

Site	Cyanide µg/l	No. data points	Distance from Outfall		Surface Water Area Between Sites		AF†
			feet	kilometers	acres	sq. kilometer	
Novato Sanitary District							
Outfall	NA	-	0	0	0.00	0.0000	-
Attenuation	-	-	120	0.0	0.14	0.0006	**2.25**
Attenuation	-	-	170	0.1	0.19	0.0008	**3.5**
Attenuation	-	-	190	0.1	0.25	0.0010	**4.5**

† Attenuation Factors in bold were derived from modeled percent wastewater.




Novato Sanitary District
S A N P A B L O B A
MUD
120 ft
AF = 2.25
170 ft
AF = 3.5
190 ft
AF = 4.5
East - West Transect
Pump
LEVEE
Pile
Rescue Tower
Long Point
Beacon
MUD
Key
Approximate Locations of Cn Attenuation
Wastewater Outfall
0
1,750
3,500
7,000 Feet
N

City of Palo Alto

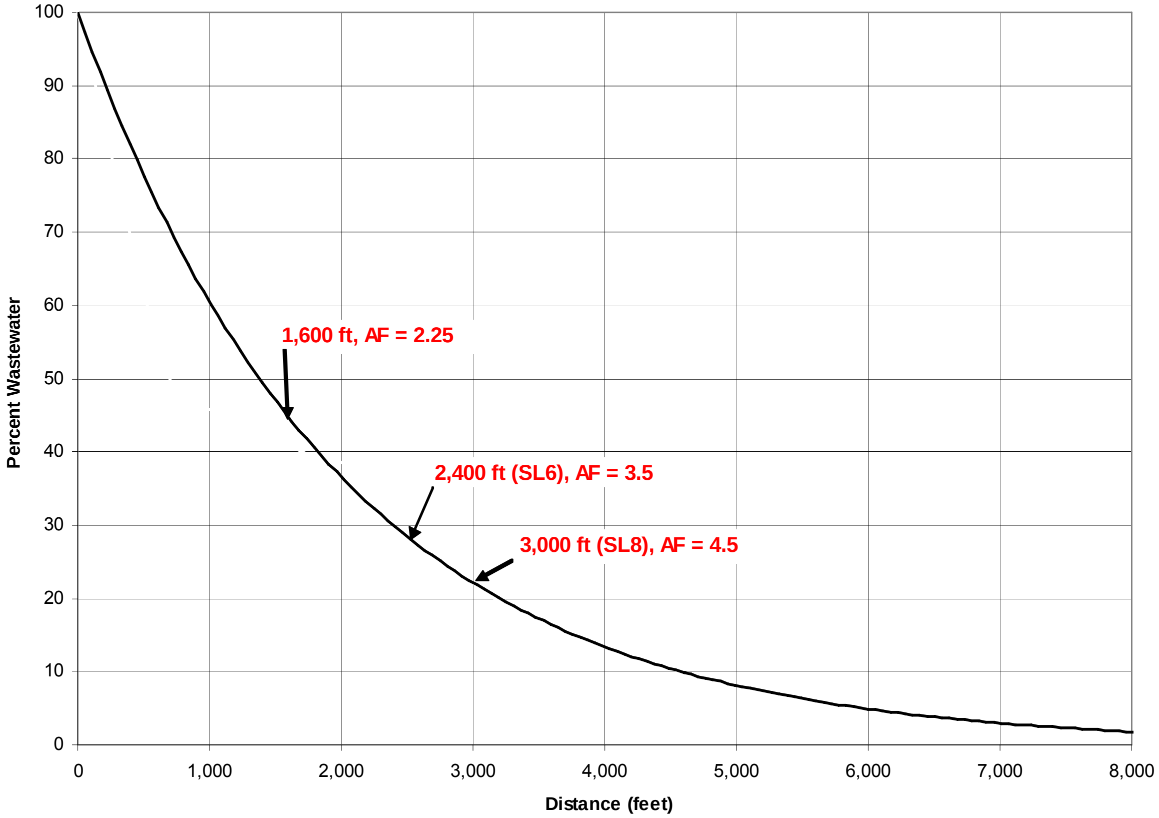
Site	Cyanide µg/l	No. data points	Distance from Outfall		Surface Water Area Between Sites		AF†
			feet	kilometers	acres	sq. kilometer	
Palo Alto							
Outfall	4.5	9	0	0	0	0.000	-
SL2	1.5	1	20	0.0	0	0.000	1.6
SL3	4.87	9	500	0.2	1	0.004	1.1
SL4	3.55	4	1,200	0.4	2	0.009	1.1
Attenuation	-	-	1,600	0.5	4.2	0.017	**2.25**
SL5	0.54	9	2,000	0.6	5.0	0.020	11
Attenuation (SL6)	0.42	4	2,400	0.7	7	0.028	**3.5** (11.5)
SL7	0.1	1	2,650	0.8	14	0.055	24
Attenuation (SL8)	0.3	1	3,000	0.9	32	0.017	**4.5** (8)
SL9	0.4	1	3,520	1.1	80	0.020	6.0
SL10	0.6	1	4,000	1.2	400	0.028	4.0
SL11	0.9	1	4,500	1.4	900	0.055	2.7
SL12	0.6	1	5,000	1.5	2,500	0.126	4.0

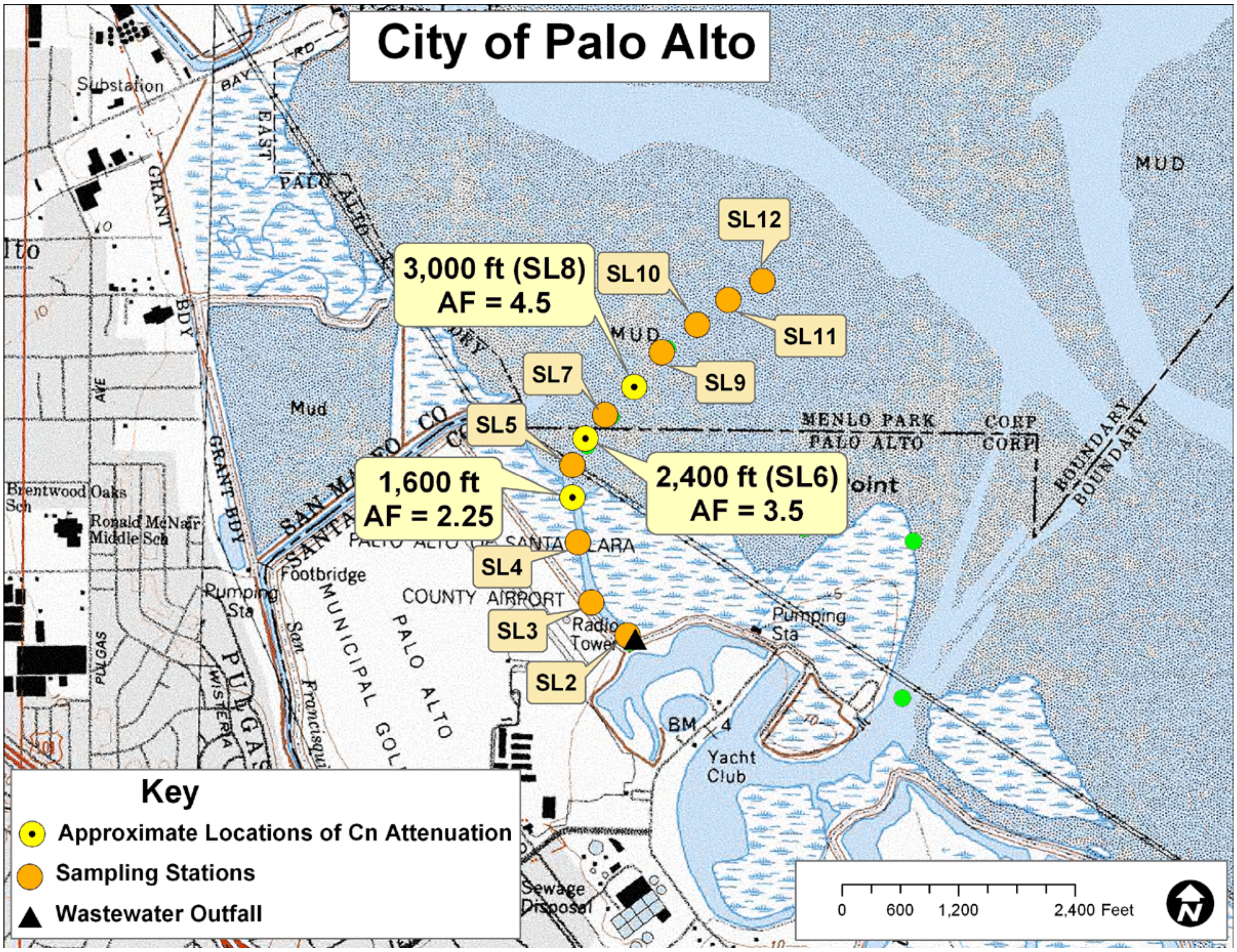
† Attenuation Factors in bold were derived from modeled percent wastewater, AF numbers not in bold are the median AF derived using empirical data.

Palo Alto

Modeled Percent Wastewater versus Distance from Effluent Outfall

Exponentially Extrapolated Over Distance (Best Fit Curve)




City of Palo Alto
3,000 ft (SL8)
AF = 4.5
2,400 ft (SL6)
AF = 3.5
1,600 ft
AF = 2.25
SL2
SL3
SL4
SL5
SL7
SL9
SL10
SL11
SL12
Key
Approximate Locations of Cn Attenuation
Sampling Stations
Wastewater Outfall
0
600
1,200
2,400 Feet
N
MUD
Mud
MENLO PARK
PALO ALTO
Yacht Club
Sewage Disposal
COUNTY AIRPORT
Footbridge
Pumping Sta
Radio Tower
Substation
Brentwood Oaks Sch
Ronald McNair Middle Sch

City of Petaluma

Site	Average Cyanide µg/l	No. data points	Distance from Outfall		Surface Water Area Between Sites		AF†
			feet	kilometers	acres	sq. kilometer	
City of Petaluma							
Outfall	1.067	3	0	0	0	0.000	-
Attenuation	-	-	410	0.1	~~1.5~~0.8 [a]	0.~~006~~003	**2.25**
Attenuation	-	-	410	0.1	1.5	0.006	**3.5**
C2A	0.73	3	500	0.2	1.8	0.007	-
CR	0.73	3	2,000	0.6	7.3	0.030	-
Attenuation	-	-	5,500	1.7	20.2	0.082	**4.5**

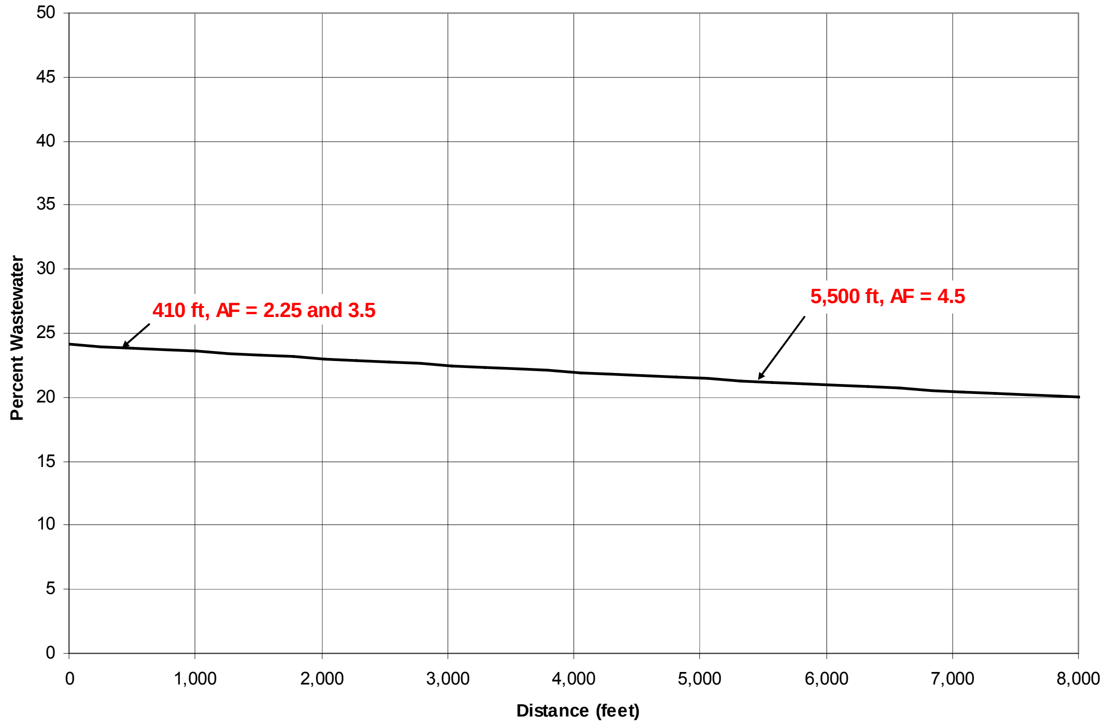
[a] The extent of the mixing zone is assumed be less than half the river width.

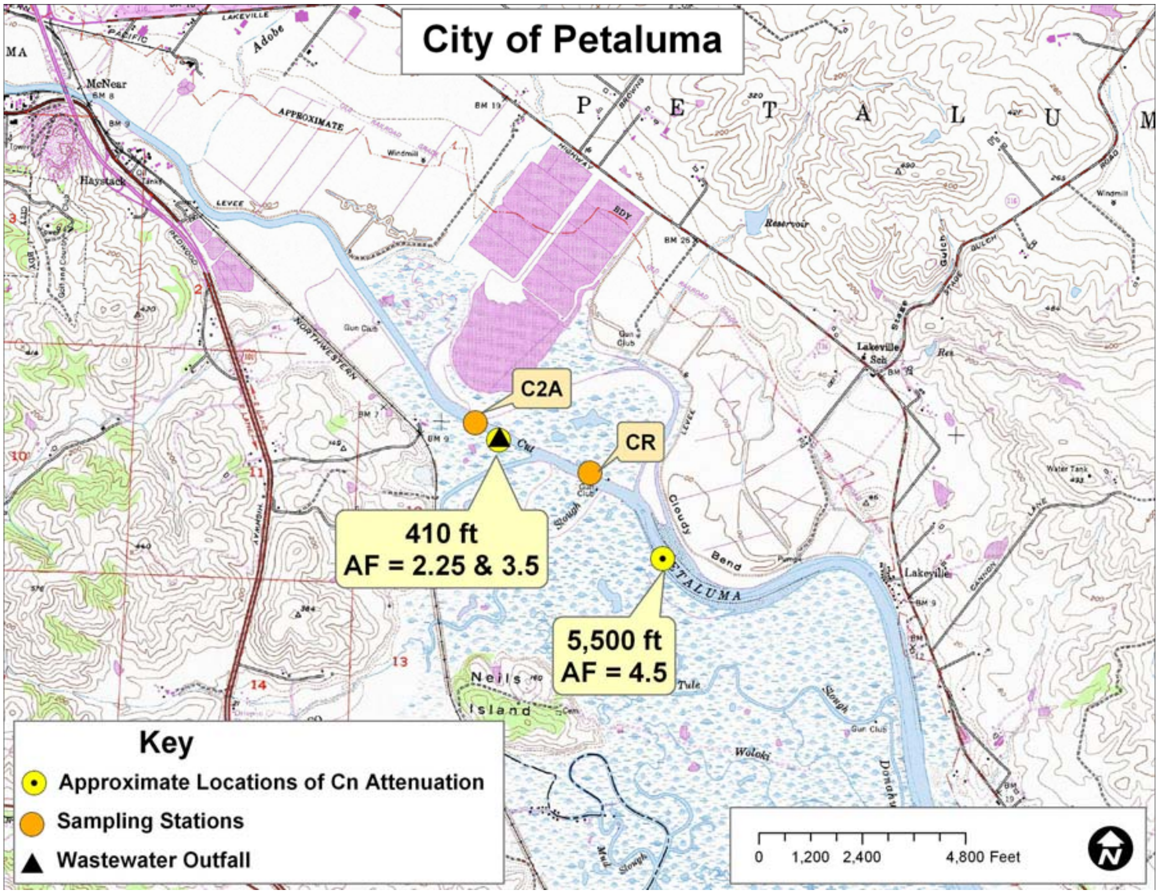
† Attenuation Factors in bold were derived from modeled percent wastewater, AF numbers not in bold are the median AF derived using empirical data.

City of Petaluma

Modeled Percent Wastewater versus Distance from Effluent Outfall

Exponentially Extrapolated Over Distance (Best Fit Curve)

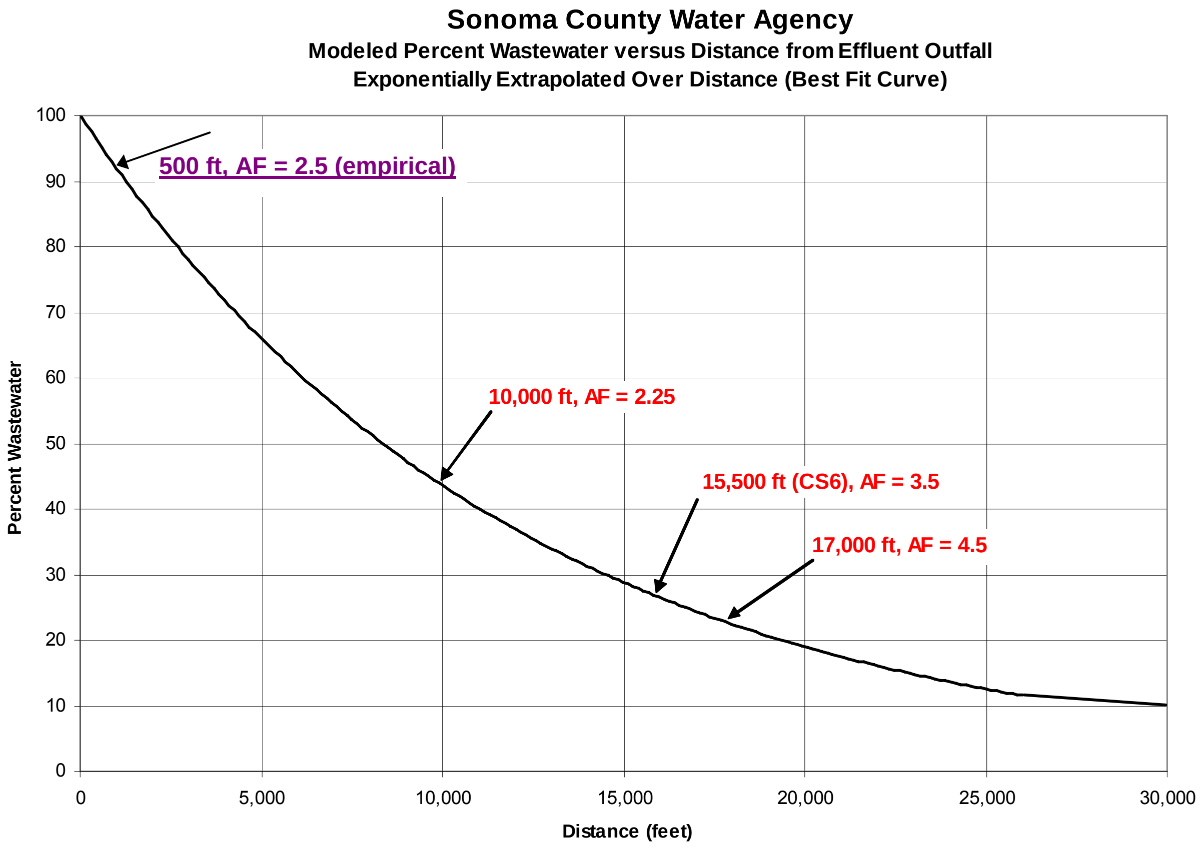



City of Petaluma
C2A
CR
410 ft
AF = 2.25 & 3.5
5,500 ft
AF = 4.5
Key
● Approximate Locations of Cn Attenuation
● Sampling Stations
▲ Wastewater Outfall
0 1,200 2,400 4,800 Feet
N

Sonoma County Water Agency

Site	Average Cyanide µg/l	No. data points	Distance from Outfall		Surface Water Area Between Sites		AF†
			feet	kilometers	acres	sq. kilometer	
Sonoma County Water Agency							
Outfall	2.9	1	0	0	0	0.000	-
CS2	2.9	1	20	0.0	0	0.000	1
CS3	1.1	1	500	0.2	0.2	0.001	2.5
CS5	0.65	2	5,600	1.7	7.7	0.030	4.3
Attenuation	-	-	10,000	3.0	29	0.115	**2.25**
CS6	0.6	2	15,500	4.7	55	0.217	**3.5**
Attenuation	-	-	17,000	5.2	62	0.245	**4.5** (4.7)

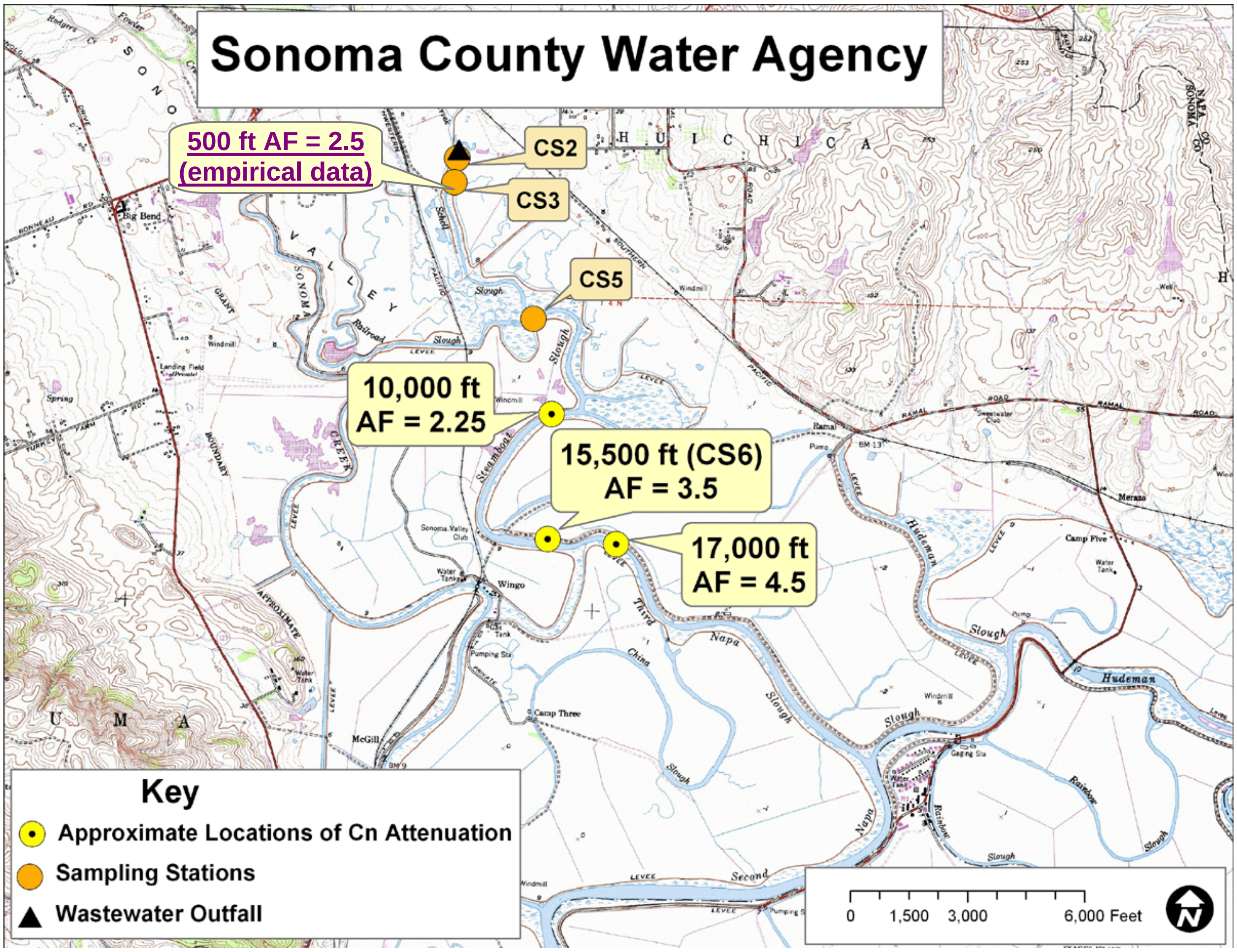
† Attenuation Factors in bold were derived from modeled percent wastewater, AF numbers not in bold are the median AF derived using empirical data.



Sonoma County Water Agency

Modeled Percent Wastewater versus Distance from Effluent Outfall

Exponentially Extrapolated Over Distance (Best Fit Curve)



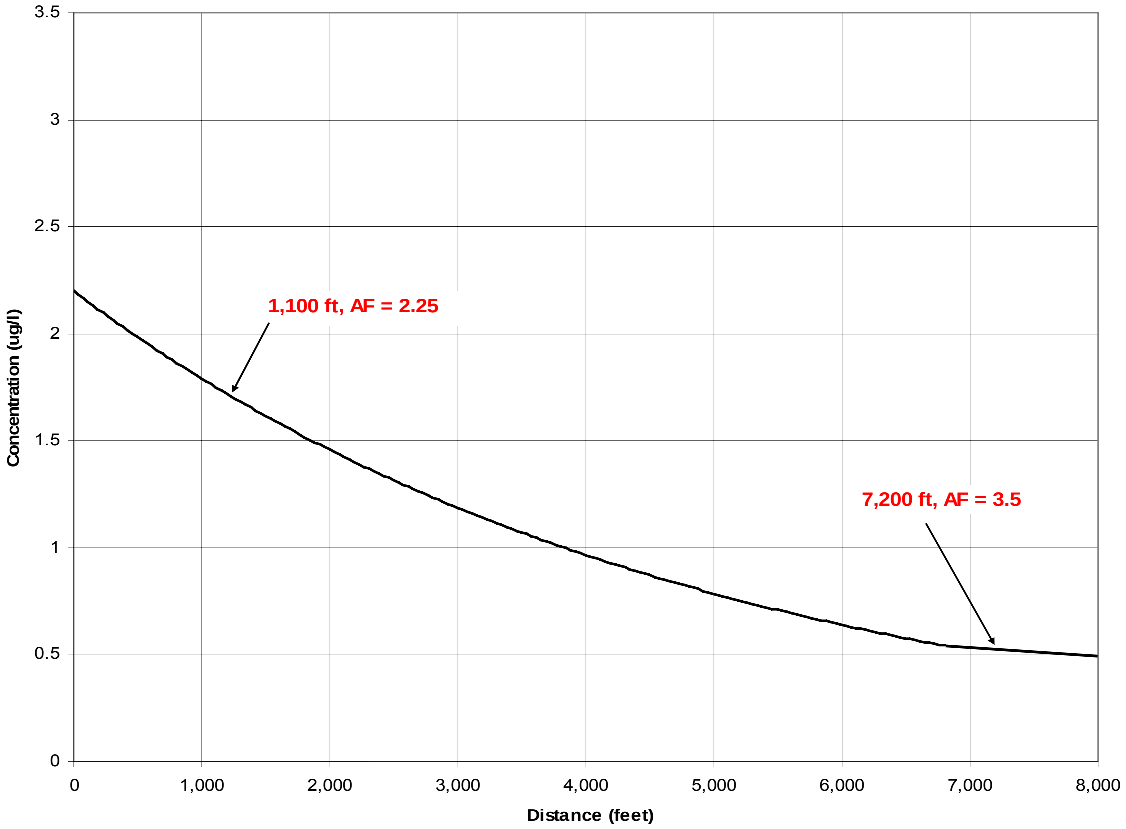
Sonoma County Water Agency
500 ft AF = 2.5
(empirical data)
CS2
CS3
CS5
10,000 ft
AF = 2.25
15,500 ft (CS6)
AF = 3.5
17,000 ft
AF = 4.5
Key
Approximate Locations of Cn Attenuation
Sampling Stations
Wastewater Outfall
0 1,500 3,000 6,000 Feet
N

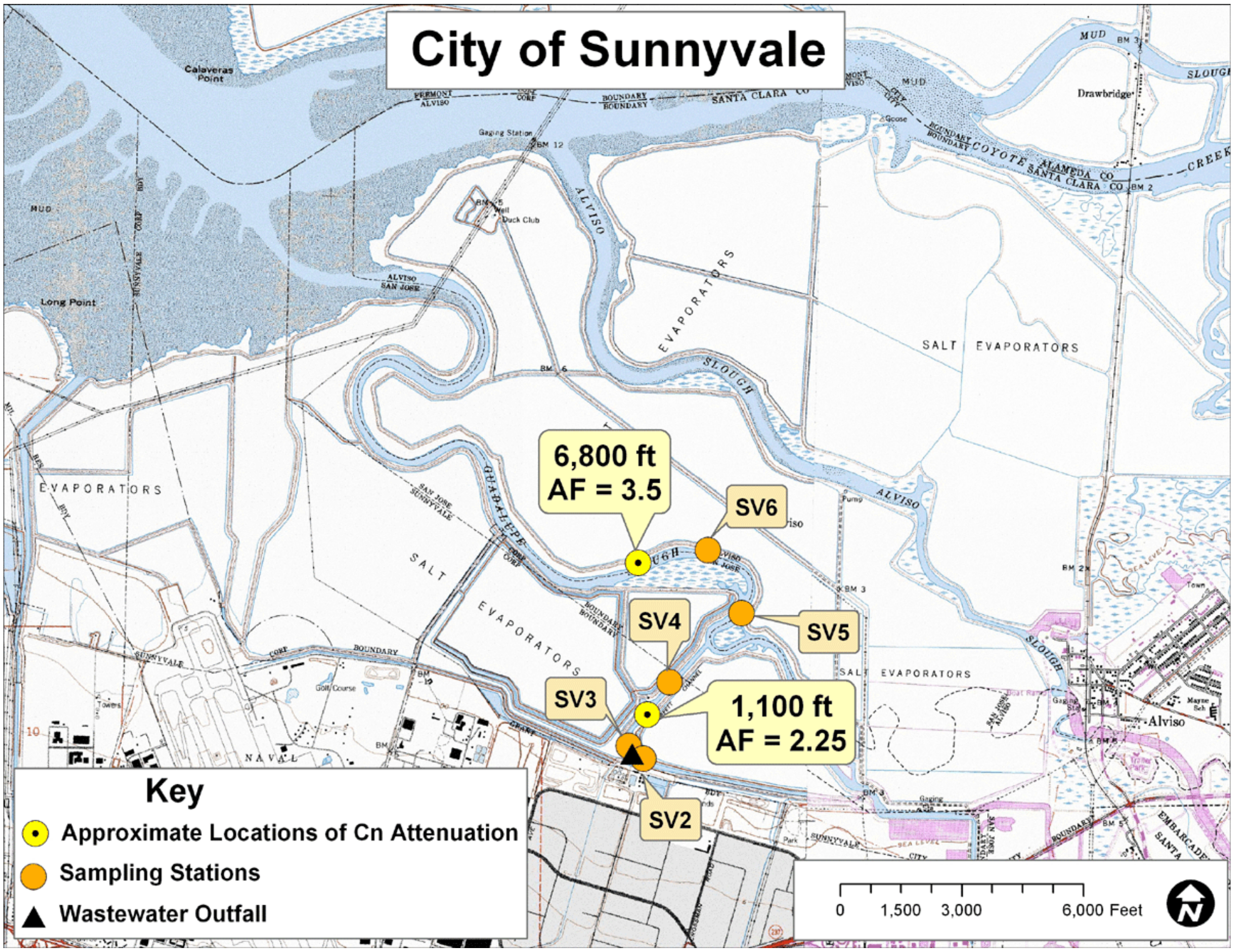
City of Sunnyvale

Site	**Average Cyanide µg/l**	**No. data points**	**Distance from Outfall**		**Surface Water Area Between Sites**		**AF**
			feet	kilometers	acres	sq. kilometer	
City of Sunnyvale							
SV2	2.2	1	-20	0	0	0.000	-
Outfall	2.2	1	0	0	0	0.000	-
SV-3	2.1	1	300	0.1	2	0.009	1
Attenuation	-	-	1,100	0.3	3	0.012	**2.25**
SV-4	0.7	1	2,300	0.7	5.8	0.023	3.1
SV-5	0.8	1	4,700	1.4	10.0	0.040	2.8
SV-6	0.7	1	6,800	2.1	11.5	0.045	3.1
Attenuation	-	-	7,200	2.2	13	0.049	**3.5**

City of Sunnyvale

Empirical: Average Cyanide Concentration versus Distance from Effluent Outfall Exponentially Extrapolated Over Distance (Best Fit Curve)

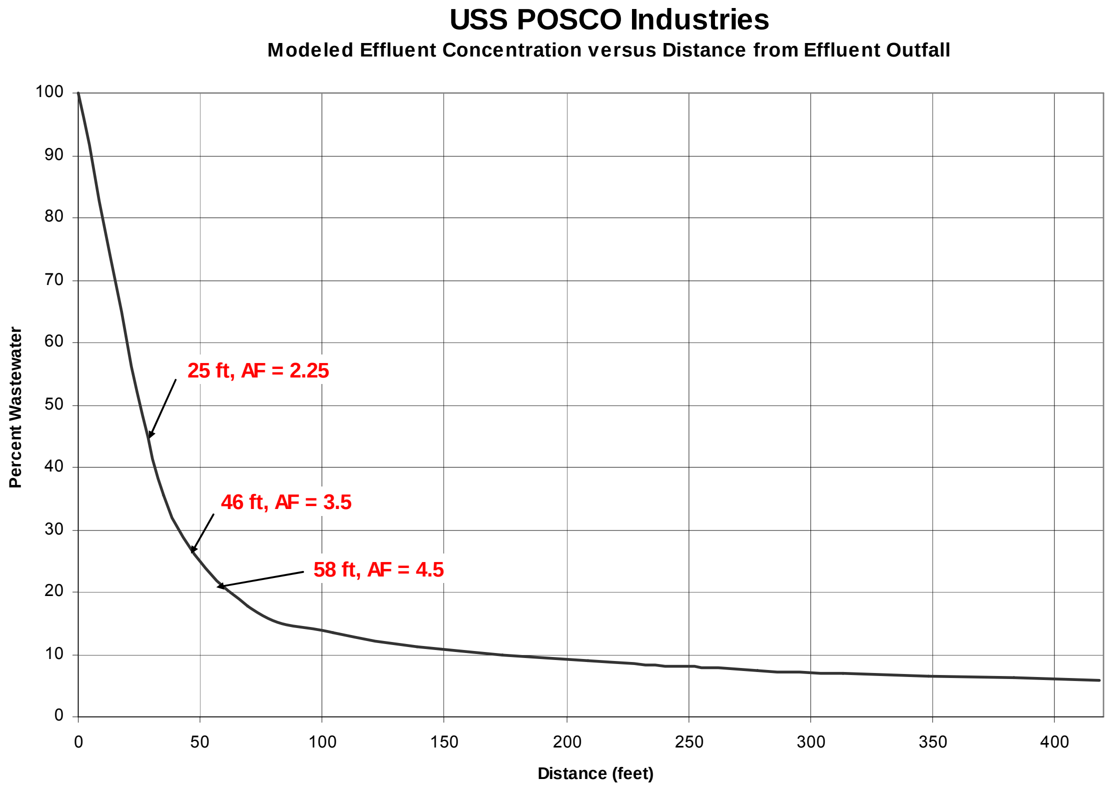


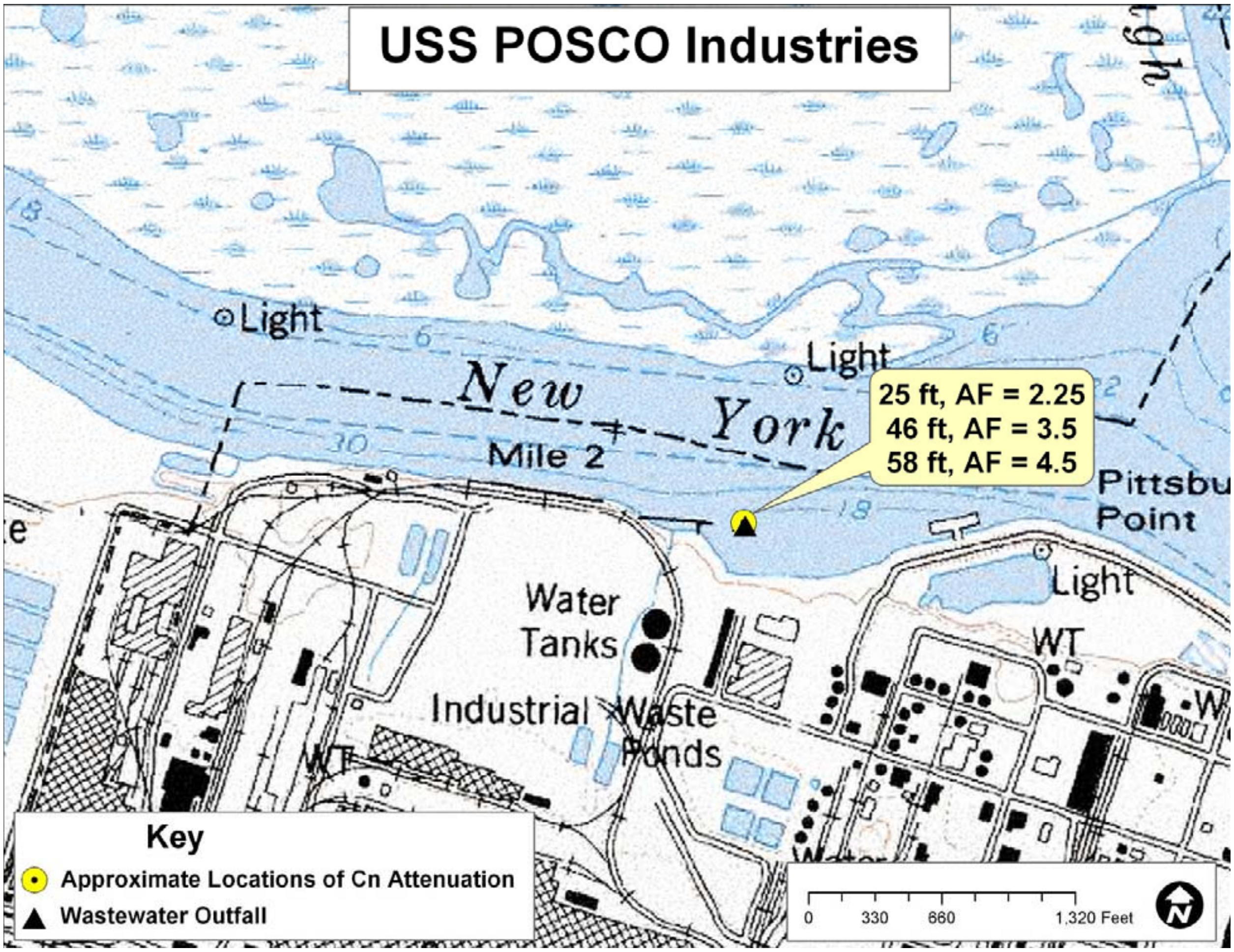

City of Sunnyvale
6,800 ft
AF = 3.5
SV6
SV4
SV5
SV3
1,100 ft
AF = 2.25
SV2
Key
Approximate Locations of Cn Attenuation
Sampling Stations
Wastewater Outfall
0
1,500
3,000
6,000 Feet
N
Alviso
SALT EVAPORATORS
ALVISO SLOUGH
GUADALUPE SLOUGH
Calaveras Point
Long Point
Drawbridge
COYOTE CREEK

U.S. Steel POSCO Industries (UPI) Plant

Site	Average Cyanide µg/l	No. data points	Distance from Outfall		Surface Water Area Between Sites		Median AF
			feet	kilometers	acres	sq. kilometer	
USS POSCO Industries							
Outfall	NA	-	0	0	0.00	0.0000	
Attenuation	-	-	25	0.01	0.14	0.0006	**2.25**
Attenuation	-	-	46	0.01	0.19	0.0008	**3.5**
Attenuation	-	-	58	0.02	0.25	0.0010	**4.5**

† Attenuation Factors in bold were derived from modeled percent wastewater.




USS POSCO Industries
Light
New York
Light
Mile 2
25 ft, AF = 2.25
46 ft, AF = 3.5
58 ft, AF = 4.5
Pittsbu
Point
Light
Water Tanks
Industrial Waste Ponds
WT
WT
Key
● Approximate Locations of Cn Attenuation
▲ Wastewater Outfall
0
330
660
1,320 Feet
N

Area Measurement Methodology and Notes

Method for Surface Water Area Calculations

Surface water areas were calculated in GIS using ESRI ArcMap 8 software and USGS hydrologic GIS data (National Hydrologic Dataset, 1999). The NHD provides line map features (rivers and stream) and polygon map features (bays, lakes, estuaries, ponds). The extent of waterbodies (including estuarine) provided by the NHD are based on the USGS 7.5 minute topographic maps. According to the USGS Topographic Mapping Standards for mapping the extent of waterbodies, strict rules apply. In the case of estuarine creeks, the shoreline is defined where 'the water is at the stage that prevails when the feature is at or near capacity'. Using the NHD data, surface water areas were mapped for selected Shallow Water Dischargers along with their respective monitoring location. The respective slough or creek polygon feature was divided into sub-sections. The dividing lines for splitting the polygon feature were the monitoring locations. For the City of San Jose/ Santa Clara, surface water areas were calculated in GIS using ESRI ArcGIS 9.1 software. The data source used was 1:12,000 scale, orthorectified, and georeferenced, 1 meter resolution, pan-sharpened color-infrared imagery from the IKONOS satellite. The IKONOS imagery was acquired, as a new collect, in June 2006 specifically for the City of San José. The surface water area was calculated based on what could be seen using this imagery. The respective slough or creek polygon feature was divided into sub-sections. The dividing lines for splitting the polygon feature were the monitoring locations. Once the slough or creek polygon feature was successfully sub-divided, area was calculated for each sub-section using the ‘calculate acres' script in ArcMap.

USGS Topographic Mapping Standards for Hydrography: *http://rockyweb.cr.usgs.gov*

Stream:

The limit of a STREAM/RIVER is the position of the shoreline when the water is at the stage that prevails when the feature is at or near capacity.

APPENDIX E

Summary of Water Quality Modeling Studies

Background

A number of shallow water dischargers have performed mathematical modeling studies of their discharges to waters of San Francisco Bay. The purpose of these studies has been to evaluate the water quality impact of individual discharges near the point of discharge and at locations in the Bay proper. Most of these modeling studies have used results from dye studies to check the results produced by the models. Dye studies provide empirical measures of plume movement over short time periods during and after the release of dye from a given outfall.

The dischargers that have performed mathematical water quality modeling studies are as follows:

- Novato SD (2004) (RMA, 2004)
- Fairfield Suisun SD (2004) (Flow Science, 2004)
- City of Petaluma (2001) (RMA, 2001)
- Sonoma County Water Agency (1997) (RMA, 1997)
- City of Palo Alto (1997) (RMA, 1997)
- City of San Jose (1989) (CH2M Hill, 1989)

Many of these studies have been prepared as part of a request to the San Francisco Regional Water Quality Control Board (Water Board) to grant a dilution credit in accordance with provisions in the San Francisco Bay Basin Plan (Basin Plan). Dating to the 1986 Basin Plan, provisions have existed for individual shallow water dischargers to request dilution credit (SFBRWQCB, 1995). These requests have included the need to demonstrate compliance with water quality objectives in near-field receiving waters.

For cyanide, the results of modeling studies performed to date are useful in the prediction of cyanide levels in the vicinity of shallow water discharges. Predictions can be made based on presumed percentages of effluent at different distances from the point of discharge.

Mathematical Modeling Methodology

The mathematical modeling that has been performed is in all cases based on the results from two linked models: (1) a hydrodynamic model that predicts the mixing of effluent in the estuarine waters of the Bay or its tributaries and (2) a water quality model that predicts the water quality conditions that will occur at various locations in the Bay due to the tidal mixing, advection and turbulent diffusion of treated wastewater effluent in the Bay. Typically, the flow, current, and stage information derived through the hydrodynamic model is used as input to the water quality model.

Descriptions of the modeling methodologies used to date are provided in the modeling reports described below.

Modeling Results

Modeling results from three dischargers are used to demonstrate the dilution characteristics in the vicinity of three different types of shallow water discharges. Those types are (1) discharge to the shallow mudflats along the periphery of the Bay (Novato Sanitary District); (2) discharge to a small dead-end channel along the periphery of the Bay (City of Palo Alto); and (3) discharge to a channelized slough remote from the Bay (Fairfield-Suisun Sewer District).

Novato Sanitary District

The Novato discharge has been modeled on two occasions by RMA, Inc. of Suisun, California. The first occasion was in 1997 as part of an application for dilution credit to the Water Board. A more recent (2004) modeling effort was performed as part of the anti-degradation analysis that the District is conducting as part of a request to increase the permitted discharge from 6.55 mgd to 7.0 mgd ADWF (RMA, 2004). Results from the modeling work will also be used in the assessment of water quality impacts of the proposed expansion project as part of an environmental impact report under CEQA.

The Novato discharge is located in the mudflat area along the western periphery of San Pablo Bay. The outfall is a pipeline that terminates approximately 300 feet from the shore. Most of the time, the discharge is submerged in the shallows of the mudflat. At low tides, for short time intervals, the outfall is exposed and effluent runs along a rivulet in the mudflat toward the deeper channel of the Bay. Flood tides over the mudflat results in significant mixing of the effluent with Bay waters.

The RMA models used to assess the water quality impacts of the Novato discharge are described in a March 2004 report for the District. In brief, the models used are finite element hydrodynamic and water quality models.

The models used in the analysis are RMA-2 and RMA-11. RMA-2 is a generalized free surface hydrodynamic model that is used to compute a continuous temporal and spatial description of fluid velocities and water depth throughout the San Francisco Bay and estuary. RMA-11 is a generalized two-dimensional water quality model that computes temporal and spatial descriptions of water quality parameters (both conservative and non-conservative) parameters. RMA-11 uses the results from RMA-2 for its description of the flow field.

The models have been calibrated against observed data in the Bay. The hydrodynamic model was calibrated against observed current velocities and stage data for San Pablo Bay generated in 1979 and 1980. The water quality model was calibrated for the same period using USGS salinity data. The water quality model was also calibrated against dye study results performed in March 1978 by E.H. Smith and Associates. Finally, predicted dissolved copper and dissolved nickel results were checked against actual RMP data at various RMP stations to further refine the modeling results.

The models are constructed in sufficient detail to represent the bathymetry of the Bay near the Novato discharge point and in the body of the Bay based on NOAA charts and data. The finite element network includes the entire Bay and Sacramento-San Joaquin Delta so that tidal currents are computed based on the tide at the Golden Gate, bay inputs and tributary stream inflows. The models are capable of simulating sheet flow over mud flats and movement of water over the deeper sections of the Bay in response to tidal activity. The models compute current velocities, water depth and the concentration of water quality parameters at 7.5-minute time steps throughout the tidal cycle. The model output can then be used to calculate hourly, 24-hour and 4-day average values of dilution and water quality concentrations at any desired point in the Bay.

The modeling performed by RMA allows for the development of effluent concentration profiles along directions parallel and perpendicular to the Novato outfall. This provides a picture of the dilution field around the Novato discharge, which approximates, in two dimensions, the three dimensional plumes that exist around deep water discharges. This distinguishes the Novato discharge from most of the other shallow water discharged to the Bay; other shallow water discharges exhibit more linear (one dimensional) dilution gradients due to their location in sloughs and channels.

Results from the Novato modeling effort are shown graphically in the March 2004 RMA report. Those results, derived for critical dry Delta outflow conditions, indicate maximum hourly average percent effluent levels of 70 percent at the point of discharge, with maximum hourly effluent percentages dropping to 10 percent at distances of 250 feet in either direction from the discharge. For maximum daily average effluent levels, the model results show a maximum of 12 percent effluent above the point of discharge dropping to less than 3 percent within 250 feet of the discharge point. The curves generated for the Novato report can be used to develop predicted cyanide concentrations in the Bay at given effluent concentrations.

City of Palo Alto

The City of Palo Alto discharges advanced secondary effluent into a short, unnamed channel along the western side of South Bay. The Palo Alto discharge was modeled by RMA, Inc, as part of a request to the Water Board for consideration of providing a dilution credit to the City for NPDES permit purposes (RMA, 1997). The models used in the Palo Alto work (RMA-2 and RMA-11) are the same models used by RMA in the above-described work for Novato Sanitary District. The inputs to the model were adjusted to reflect near-field conditions and bathymetry existing near the City of Palo Alto's discharge point.

The model was calibrated against the field observations derived from a dye study performed for the City in 1990 by Woodward Clyde Consultants. Additionally, modeling results for dissolved copper were checked against observed ambient copper concentrations in South Bay to finalize proper adjustments to the model.

Instantaneous, 24-hour average and 4-day dilution contours during critical dry season conditions were developed by RMA for the City of Palo Alto using the above-described models. These contour plots are provided as color figures in the December 1997 modeling report to the City. The information in these contour plots can be used to directly estimate ambient cyanide concentrations along the Palo Alto discharge gradient based on given effluent cyanide concentrations.

Fairfield-Suisun Sewer District

Flow Science Inc. from Pasadena, CA modeled the Fairfield-Suisun Sewer District (FSSD) discharge in 2004. Flow Science employed the Fischer Delta Model to assess the affect of the FSSD discharge of advanced secondary effluent from the point of discharge in Boynton Slough into Suisun Slough and thence to Grizzly Bay (Flow Science, 2004). The Fischer Delta Model employs a hydrodynamic model (DELFLO) and a water quality model (DELSAL) in its analytical approach.

Dilution characteristics were modeled for two water year conditions: 1991 (representative of a critical [dry] year condition with low Delta outflows in the winter and spring) and 1998 (representative of a wet year condition with elevated Delta outflows for a portion of the winter/spring period. Given the location of the FSSD discharge point in the northern region of the FSSD discharge point in the northern region of the Bay in Suisun Marsh, it was hypothesized that dilution characteristics of the FSSD discharge may vary with Delta outflow condition. In fact, the water quality modeling showed that dilution characteristics of the FSSD discharge are insensitive to water year conditions and that the effects are highly localized in Boynton Slough and the connecting reach of Suisun Slough.

The following is the typical percentage of effluent located at various points along the discharge gradient from Boynton Slough and Suisun Slough toward Grizzly Bay:

Station C1:	100 percent effluent
Station C2:	95 percent effluent
Station C4:	79 percent effluent
Station C6:	77 percent effluent
Station C5:	47 percent effluent
Station SU42:	4 percent effluent

The model was used to generate probability plots of percentage occurrence at different locations. The above percentages are 95th percentile occurrence values. A map of these stations is provided in the Flow Science modeling report.

The information derived from the modeling of effluent percentages at given locations allows the calculation of ambient concentrations of cyanide along the discharge gradient at a given value of effluent cyanide and background cyanide levels in Grizzly Bay.

Summary

The above information provides an indication of the usefulness of available dilution modeling results on the prediction of cyanide levels in ambient waters near other shallow water discharges. Available modeling information could be used to determine dilution (i.e. percentage effluent values) in the vicinity of shallow water discharges. This information could then be compared with observed cyanide levels along discharge gradients to validate the change in ambient cyanide concentrations due to dilution.

References

RMA 1997. *Dilution Analysis and Water Quality Impacts of the Palo Alto Regional Water Quality Control Plant on South San Francisco Bay.* Prepared for the City of Palo Alto. December 1997.

RMA 2001. *Water Quality Impacts of City of Petaluma Wastewater Treatment Plant Discharge in Petaluma River and San Pablo Bay.* Draft report prepared for City of Petaluma under subcontract to Larry Walker Associates. June 2001.

RMA 2004. *Water Quality Modeling for Novato Sanitary District Anti-Degradation and EIR Water Quality Analysis*. Draft report prepared for Larry Walker Associates. March 2004.

RMA 1997. Water Quality Modeling for Sonoma County Water Agency.

Flow Science, Inc. 2004. Results of Fischer Delta Model simulations, Fairfield-Suisun Sewer District. Draft Technical Memorandum to ESA and LWA. April 2004.

CH2M Hill 1989. San Jose-Santa Clara WPCP Dilution Study. Prepared for City of San Jose.

APPENDIX F

Cyanide Attainability Analysis for Shallow Water Dischargers

CYANIDE ATTAINABILITY ANALYSIS FOR SHALLOW WATER DISCHARGERS

(Attenuation Factors = 2.25, 3.0, 3.5, and 4.5)

PURPOSE OF ANALYSIS

This document presents the statistical analysis results in the determination of compliance attainability with the water quality-based effluent limitats (WQBELs), specifically, the daily maximum effluent limitation (MDEL) and the monthly average effluent limitation (AMEL), calculated using four cyanide attenuation factors (AF), 2.25, 3.0, 3.5, and 4.5, for thirteen shallow water dischargers.

When calculating WQBELs using SIP procedures, an attenuation factor (AF) is applied the same way as a dilution factor (D), i.e., to replace the D in the equation with the AF.

The thirteen shallow water dischargers used in this attainability analysis include:

1. City of American Canyon
2. Fairfield Suisun Sewer District
3. Hayward Shore Marsh Effluent
4. Las Gallinas Valley Sanitary District
5. Mountain View Sanitary District
6. Napa Sanitation District
7. Novato Sanitary District
8. City of Palo Alto
9. City of Petaluma
10. San Jose/Santa Clara Valley Water Pollution Control Plant
11. Sonoma Valley County Sanitation District
12. City of Sunnyvale
13. USS Posco

STATISTICAL ANALYSIS PROCEDURES AND RESULTS

The statistical analyses performed include the following:

1. Estimate statistics from the cyanide effluent data collected during 2000-2003: Since many of the data sets are censored data sets, i.e., many measurements are below detection limits (non-detect), a probability regression method was used to estimate the mean, standard deviation, coefficient of variation, as well as the 95th and the 99th percentiles. For this analysis, lognormal distribution was used assuming that individual cyanide effluent data sets follow this distribution.

   Attachment F-1 includes the probability plots of cyanide data (most of them are censored probability plots) from the 13 dischargers. These probability plots show how well a theoretical distribution fits the effluent data, therefore, help predict how good the statistical estimates are. For bad distribution fits, large deviations of statistical estimates from the true population parameters could be expected.

2. Calculate AMELs and MDELs using different attenuation factors. **Attachments F-2 through to F-5** show the detailed calculation results.

3. To determine compliance attainability statistically, we compare the mean, the 95th, and the 99th percentiles with the LTA (long term average), AMEL, and MDEL from the WQBEL calculation, respectively. If any of the statistical estimates (the mean, the 95th, and 99th percentiles) is greater than its corresponding criteria (the LTA, AMEL, and MDEL), then statistically it indicates that a compliance problem may occur. If a meaningful statistical analysis cannot be performed due to high censoring of data, the maximum effluent concentration (MEC) will be compared with the AMEL. If the MEC is less than or equal to the AMEL, compliance is attainable. The summary of this analysis for all four attenuation factors is shown in Table 16 (section 7.3.1).

4. To visualize the actual compliance or exceedance of the effluent data with the MDEL or AMEL, time series plots of all available cyanide effluent data during 2000-2005 were generated, with the MDEL or AMEL plotted as horizontal lines on the same plot. If the effluent data points fall above any of the two lines, it indicates an exceedance. **Attachment F-6** shows the time series plots with the MDEL and AMEL lines, for all four attenuation factors.

RESULTS

The following gives a brief summary of the statistical determination of compliance attainability and the comparison results of actual effluent measurements with AMELs and MDELs.

1. City of American Canyon:

AF=2.25: Attainability = Yes.
AF=3.0: Attainability = Yes.
AF=3.5: Attainability = Yes.
AF=4.5: Attainability = Yes.

There is one effluent measurement exceeding the AMEL at AF=2.25. There is no other exceedance of either the AMELs or MDELs.

2. Fairfield Suisun:

AF=2.25: Attainability = No (Mean>LTA, 95th>AMEL, 99th>MDEL).
AF=3.0: Attainability = No (95th>AMEL, 99th>MDEL).
AF=3.5: Attainability = No (95th>AMEL).
AF=4.5: Attainability = No (95th>AMEL).

At AF=4.5, there is one cyanide effluent measurement exceeding the MDEL, and three exceeding the AMEL. There are two exceedances of the MDELs and many exceedances of the AMELs at other three attenuation factors, indicating potential compliance problem. However, since the Discharger sampled twice per month most of the time during 2000-2004, by comparing the monthly averages with the AMELs, the number of exceedances drops significantly for attenuation factors 2.25, 3.0, and 3.5: There are only two exceedances of the AMELs at AF=3.0, 3.5, and 4.5, both exceedances are caused by two high measurements, 23 and 28 μg/L.

3. Hayward Marsh Effluent

AF=2.25: Attainability = No (Mean>LTA).
AF=3.0: Attainability = Yes.
AF=3.5: Attainability = Yes.
AF=4.5: Attainability = Yes.

There is/are one or two measurement(s) exceeding the AMELs for all four attenuation factors. There is no exceedance of the MDELs. However, the distribution fit is not good enough, and the percentile estimates of the mean and percentiles are most likely inflated (overestimate).

4. Las Gallinas (LGVSD)

AF=2.25: Attainability = No (95th>AMEL).
AF=3.0: Attainability = Yes.
AF=3.5: Attainability = Yes.
AF=4.5: Attainability = Yes.

There is only one measurement exceeding the AMELs at AF=2.25, 3.0, and 3.5.

5. Mountain View SD

AF=2.25: Attainability = Yes.
AF=3.0: Attainability = Yes.
AF=3.5: Attainability = Yes.
AF=4.5: Attainability = Yes.

The cyanide data set is too limited, therefore, it is not recommended to estimate statistics using the parametric method. Time series plots show no exceedance of the AMELs or MDELs for any of the four attenuation factors, indicating no compliance issue.

6. Napa SD

AF=2.25: Attainability = No (95th>AMEL).
AF=3.0: Attainability = No (95th>AMEL).
AF=3.5: Attainability = Yes.

AF=4.5: Attainability = Yes.

These is one exceedance of the AMEL at AF=2.25. There is no exceedance of the AMELs at the any of the other three attenuation factors. There are two to six exceedances of the MDELs calculated using the four attenuation factors.

7. Novato

AF=2.25: Attainability = Yes.
AF=3.0: Attainability = Yes.
AF=3.5: Attainability = Yes.
AF=4.5: Attainability = Yes.

There is no exceedance of any of the AMELs or MDELs.

8. City of Palo Alto

AF=2.25: Attainability = Yes.
AF=3.0: Attainability = Yes.
AF=3.5: Attainability = Yes.
AF=4.5: Attainability = Yes.

There is no exceedance of any of the AMELs or MDELs.

9. Petaluma

AF=2.25: Attainability = No (95th>AMEL, 99th>MDEL).
AF=3.0: Attainability = No (95th>AMEL).
AF=3.5: Attainability = No (95th>AMEL).
AF=4.5: Attainability = Yes.

There are/is 4, 1, 1 exceedance(s) of the AMELs at AF=2.25, 3.0, and 3.5, respectively. There is no exceedance of the AMEL at AF=4.5 or any of the MDELs.

10. San Jose/Santa Clara

AF=2.25: Attainability = Yes.
AF=3.0: Attainability = Yes.
AF=3.5: Attainability = Yes.
AF=4.5: Attainability = Yes.

There is no exceedance of any of the AMELs or MDELs.

11. Sonoma Valley County SD

AF=2.25: Attainability = No (95th>AMEL).

AF=3.0: Attainability = No (95th>AMEL).
AF=3.5: Attainability = Yes.
AF=4.5: Attainability = Yes.

There are/is 5, 3, 2, and 1 exceedance(s) of the AMELs at AF=2.25, 3.0, 3.5, and 4.5, respectively. There is no exceedance of any of the MDELs.

12. City of Sunnyvale

AF=2.25: Attainability = No (Mean>LTA, 95th>AMEL, 99th>MDEL).
AF=3.0: Attainability = No (Mean>LTA, 95th>AMEL, 99th>MDEL).
AF=3.5: Attainability = No (95th>AMEL).
AF=4.5: Attainability = No (95th>AMEL).

There is only one exceedance of the MDEL at all attenuation factors, however, there are significant numbers of exceedances of the AMELs at all attenuation factors. For example, there are five measurements above the AMEL at AF=4.5. This indicates that Discharger will have compliance issues.

13. USS Posco

AF=2.25: Attainability = Yes (MEC<AMEL).
AF=3.0: Attainability = Yes (MEC<AMEL).
AF=3.5: Attainability = Yes (MEC<AMEL).
AF=4.5: Attainability = Yes (MEC<AMEL).

There are only a few detected values with the highest detected concentration of 4.6 µg/L, which is less than the AMELs calculated using all proposed attenuation factors. Detection limits are 5 and 10 µg/L respectively. Therefore, it is expected that the Discharger will be able to attain compliance with the WQBELs, even with an attenuation factor of 2.25.

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Compliance Attainability Summary

For an attenuation factor of **2.25**, only **six** dischargers will be able to achieve compliance: City of American Canyon, Mountain View, Novato, Palo Alto, and San Jose/Santa Clara, and USS Posco.

For an attenuation factor of **3.0**, in addition to the above six dischargers, two more dischargers (a total of **eight**) will be able to achieve compliance: Hayward Marsh Effluent and Las Gallinas Valley Sanitation District.

For an attenuation factor of **3.5**, only three dischargers will have compliance issues (the other **ten** will be able to achieve compliance), which are Fairfield Suisun, City of Petaluma, and City of

Sunnyvale. However, the time series plots for Petaluma cyanide effluent concentrations do not seem to indicate a compliance problem.

For an attenuation factor of **4.5**, Fairfield Suisun and Sunnyvale are the only two dischargers that will have some compliance issues, the other **eleven** will be able to achieve compliance.

More Frequent Sampling than Once Per Month Recommended

When determining compliance attainability using the statistical three-point comparison, i.e., mean versus LTA, 95th percentile versus AMEL, and 99th percentile versus MDEL, it seems that the 95th/AMEL is the trigger indicating compliance infeasibility for most cases. Since most dischargers sample only once every month, it is practically comparing a daily sample with a monthly average limit. The time series plots also show that most exceedances are against the AMELs, unless for a few very high effluent concentrations. If the dischargers will sample more than once per month, the chance of exceeding an AMEL drops significantly: This has been illustrated by the Fairfield case. Therefore, the dischargers are encouraged to sample more than once per month to level off any high daily concentrations when comparing with the AMEL.

Recommended Attenuation Factor

It is quite clear that at AF=2.25, some dischargers will have compliance issues, even with more frequent sampling.

At AF=3.0, Sunnyvale may have bigger compliance issues than the others. If Sunnyvale samples more frequently, it might be able to describe the effluent concentrations better, but may still have difficulty in achieving compliance. Fairfield may be able to achieve compliance.

If we choose AF=3.5, with more frequent sampling, Sunnyvale might be able to achieve compliance. Fairfield should be able to achieve compliance, except for the two spiked concentrations, which might be caused by dumping events.

Use of Lower Detection Limit

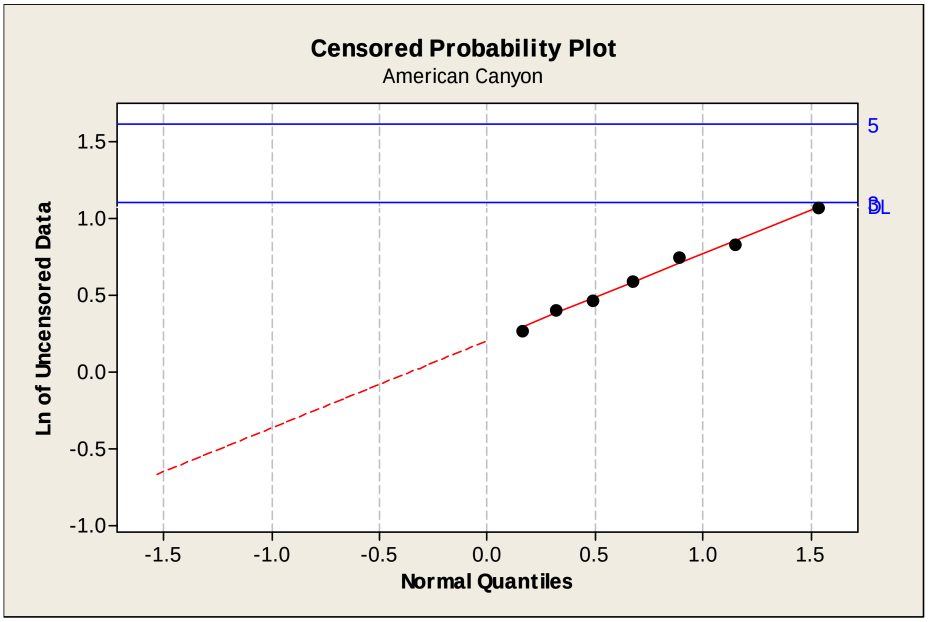
When calculating monthly average, we recommend using the method detection limit if the measurement is below the detection limit. Therefore, in addition to sampling frequency, we also encourage dischargers to use lower detection limits and report the method detection limits (instead of the reporting limits only). This will help with lowering the monthly averages when determining compliance.

Attachment F-1

Lognormal Probability Plots of Cyanide Effluent Concentrations

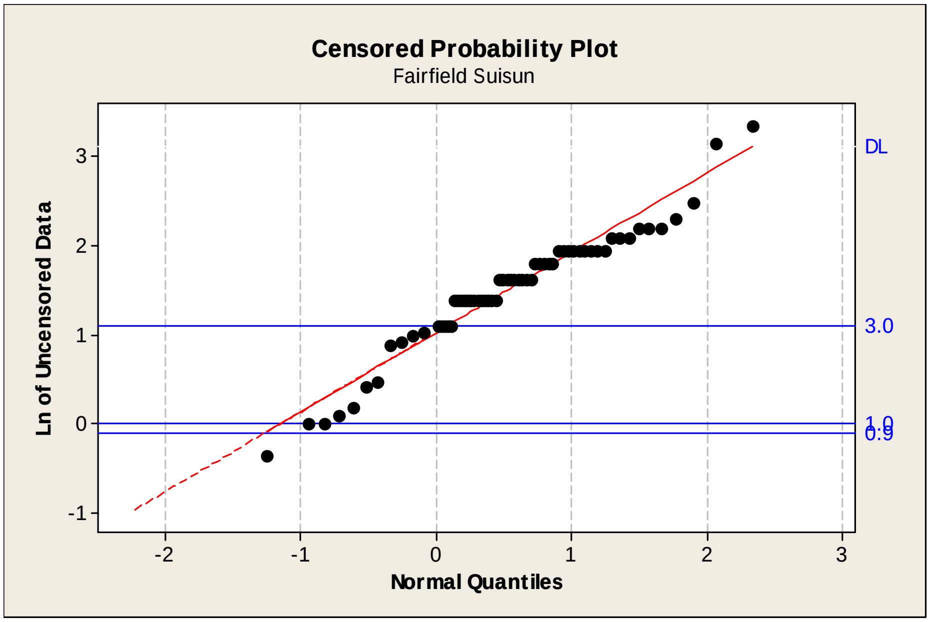
(Most Plots are Censored Probability Plots)

1. City of American Canyon



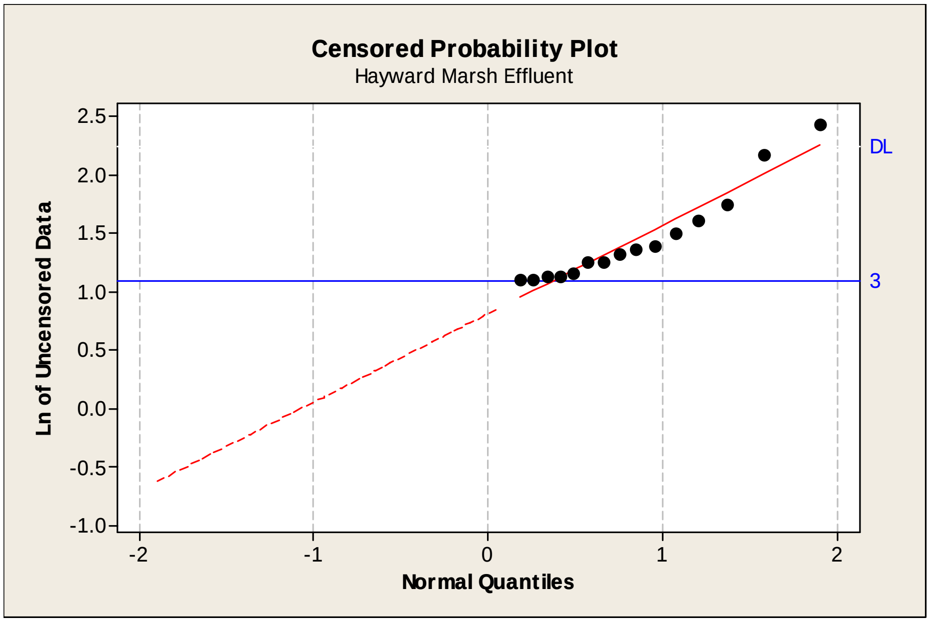
Lognormal distribution fits the data well, however, the data are too limited. There may be big deviations between the estimates and true population values.

2. Fairfield Suisun FCSD



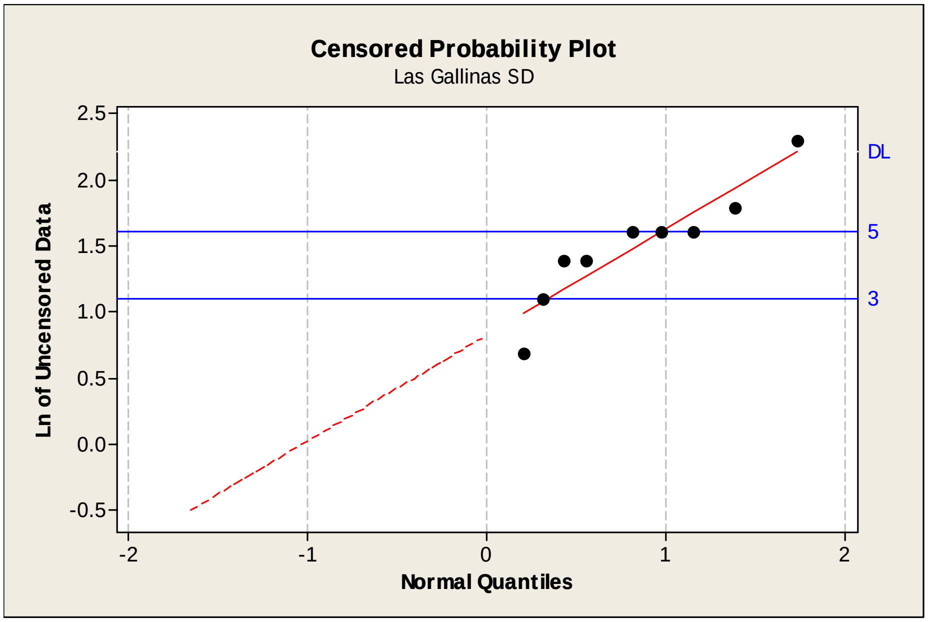
Lognormal distribution fits the data reasonably well, with small deviations. The data set is also large. Therefore, statistical estimates from this distribution fit are generally considered satisfactory.

3. Hayward Marsh Effluent



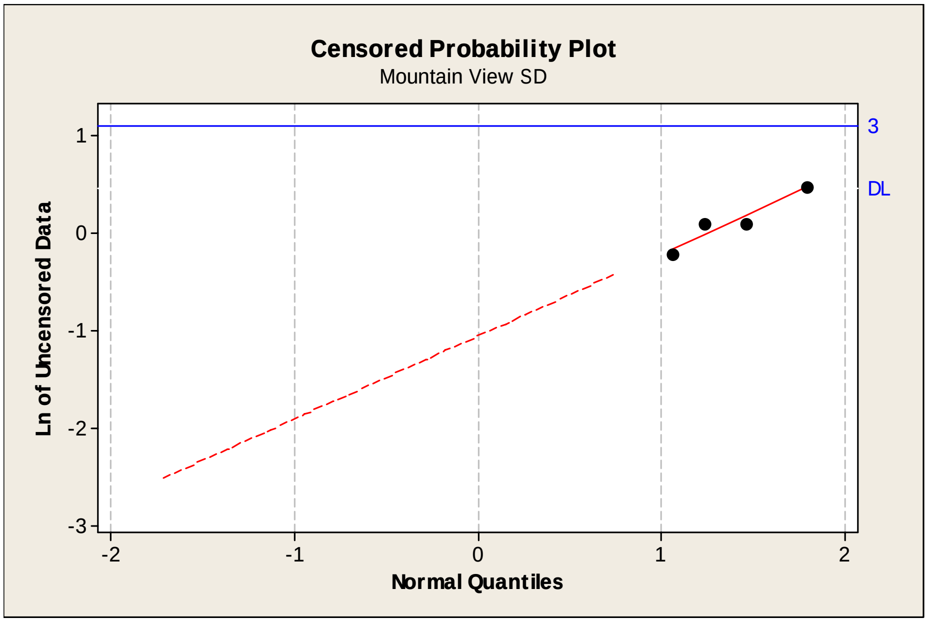
Lognormal distribution does not fit the data well. The data set is relatively small. Therefore, there will be some degrees of deviations between the statistical estimates and true population values (most likely overestimate with this method).

4. Las Gallinas Valley SD



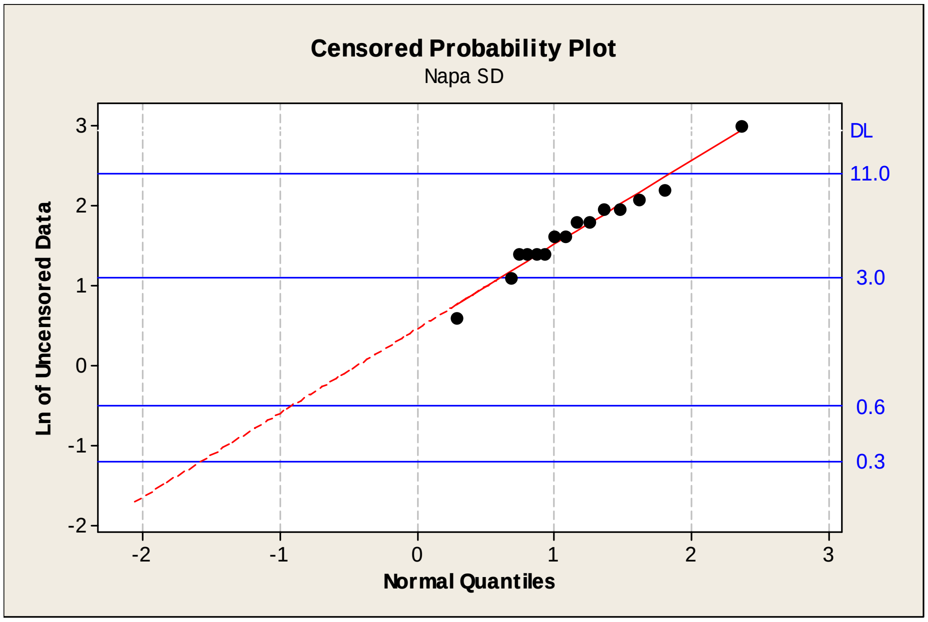
Lognormal distribution does not fit the data well. The data set is relatively small. Therefore, there will be some degrees of deviations between the statistical estimates and true population values.

5. Mountain View SD



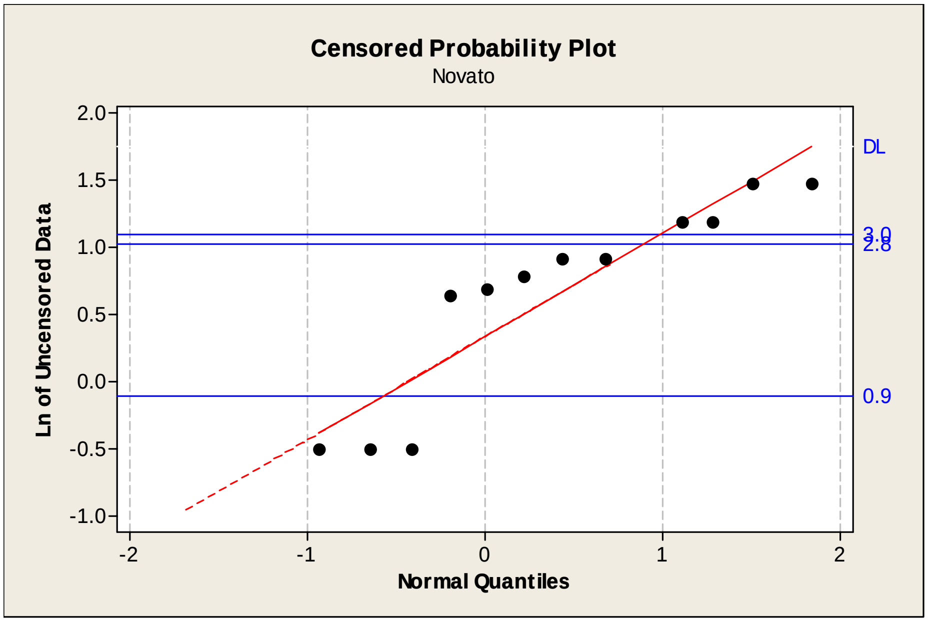
Lognormal distribution seems to fit the data well, however, the data set is too small. Therefore, it is not recommended to use this parametric method to estimate statistics.

6. Napa SD



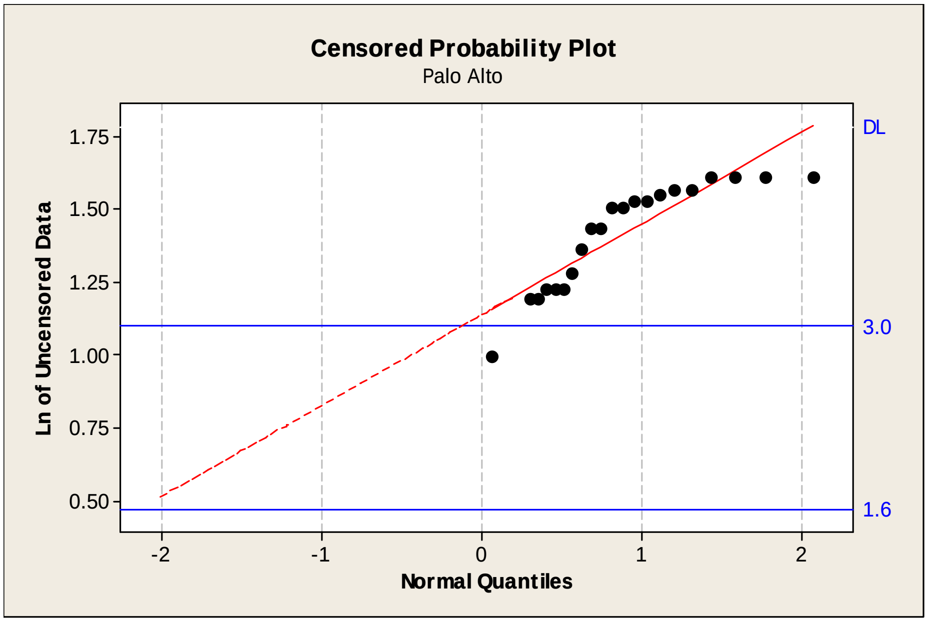
Lognormal distribution fits the data reasonably well. The data set is of medium size. Therefore, statistical estimates from this distribution fit are generally considered satisfactory.

7. Novato SD



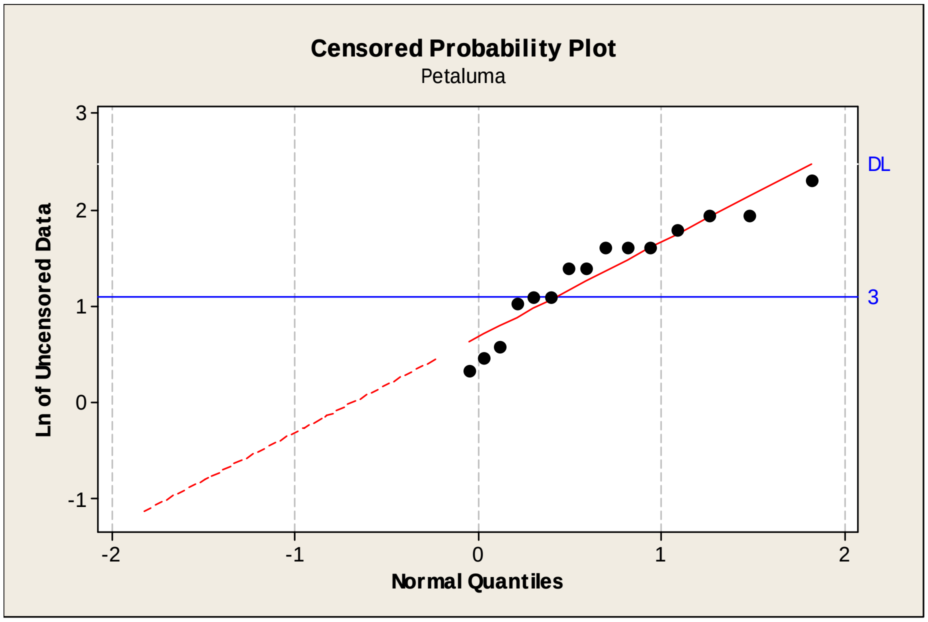
Lognormal distribution does not fit the data well. The data set is relatively small. Therefore, there will be substantial degrees of deviations between the statistical estimates and true population values.

8. Palo Alto



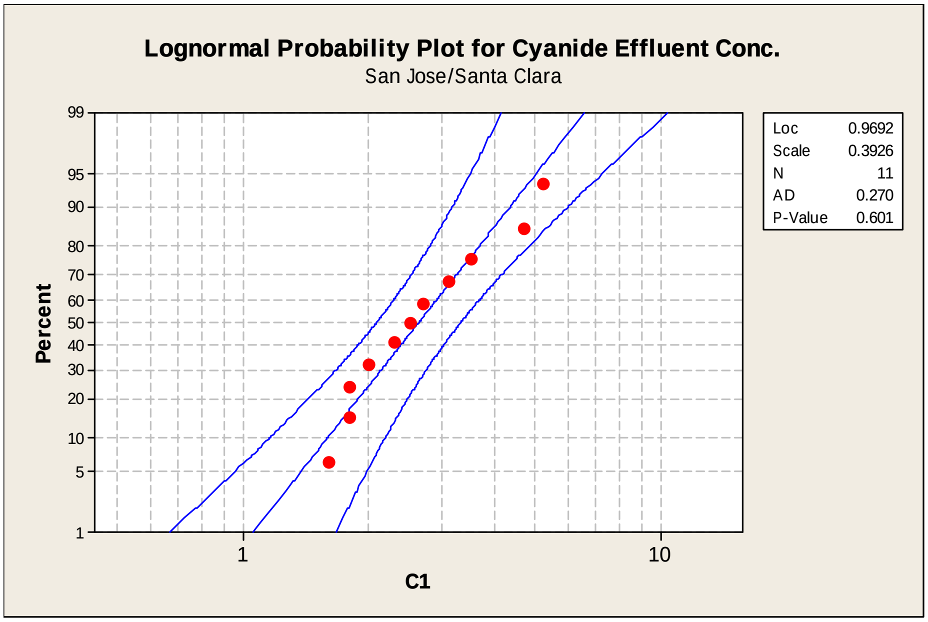
Lognormal distribution does not fit the data well. Therefore, there will be some degrees of deviations between the statistical estimates and true population values.

9. City of Petaluma



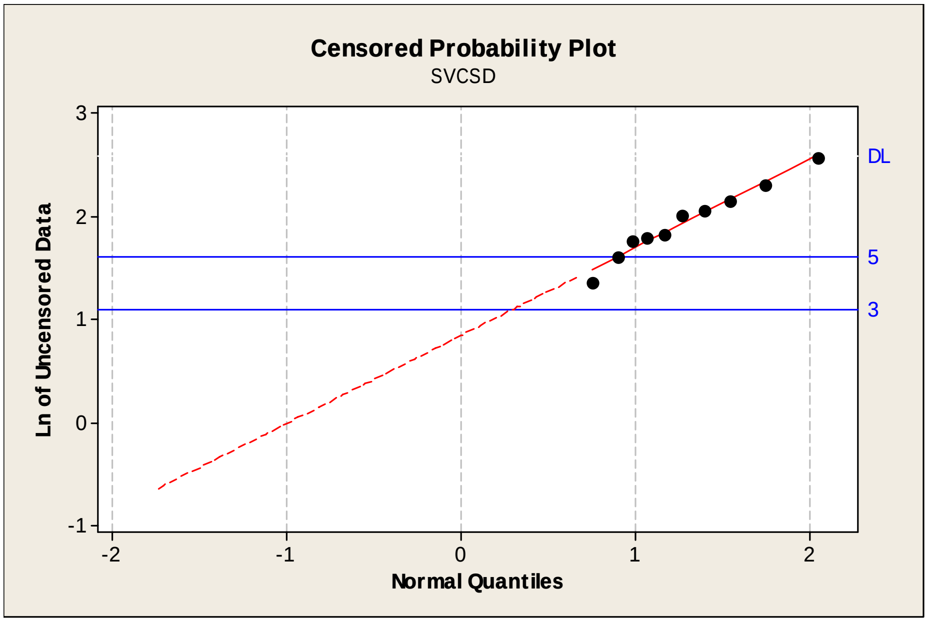
Lognormal distribution does not fit the data perfectly well, with some minor deviations. The data set is relatively small. Therefore, there will be some degrees of deviations between the statistical estimates and true population values.

10. City of San Jose/Santa Clara



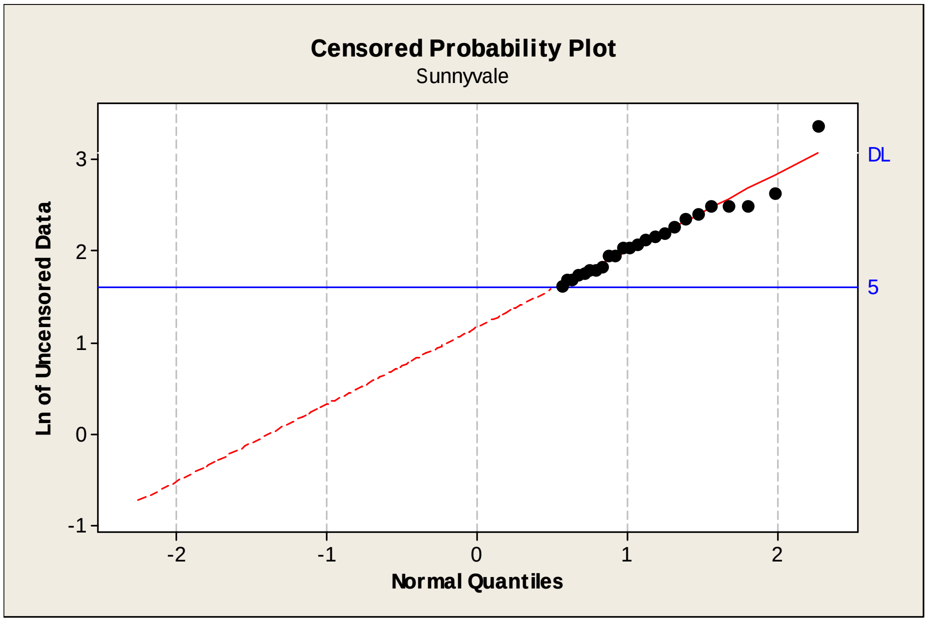
Lognormal distribution seems to fit the data well with some deviations. The data set is relatively small though. The statistical estimates are generally considered satisfactory.

11. Sonoma Valley County SD



Lognormal distribution seems to fit the data well. The data set is small though. The statistical estimates are generally considered satisfactory.

12. City of Sunnyvale



Lognormal distribution seems to fit the data well, except one extreme outlier. Therefore, there will be some degrees of deviations between the statistical estimates and true population values (the outlier will inflate the statistical estimates).

Attachment F-2

Discharger	American Canyon	Fairfield-Suisun	Hayward Marsh (Effluent)	Las Gallinas	Mt. View	Napa	Novato	Palo Alto	Petaluma	San Jose/Santa Clara	Sonoma	Sunnyvale	USS Posco
Acute Criteria	9.4	9.4	9.4	9.4	9.4	9.4	9.4	9.4	9.4	9.4	9.4	9.4	9.4
Chronic Criteria	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9
Background	0.2	0.4	0.4	0.4	0.4	0.2	0.4	0.3	0.4	0.3	0.4	0.3	0.5
Attentuation (SB04)	2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.25
ECA_{ac}	30.1	29.7	29.7	29.7	29.7	30.1	29.7	29.9	29.7	29.9	29.7	29.9	29.4
ECA_{ch}	9.0	8.5	8.5	8.5	8.5	9.0	8.5	8.8	8.5	8.8	8.5	8.8	8.3
CV	0.493	1.002	0.794	0.776	0.600	1.227	0.665	0.300	0.868	0.423	0.858	0.944	0.600
s	0.47	0.83	0.70	0.69	0.55	0.96	0.61	0.29	0.75	0.41	0.74	0.80	0.55
s^2	0.22	0.70	0.49	0.47	0.31	0.92	0.37	0.09	0.56	0.16	0.55	0.64	0.31
s_4	0.24	0.47	0.38	0.37	0.29	0.57	0.32	0.15	0.42	0.21	0.41	0.45	0.29
s_4^2	0.06	0.22	0.15	0.14	0.09	0.32	0.10	0.02	0.17	0.04	0.17	0.20	0.09
z	2.326	2.326	2.326	2.326	2.326	2.326	2.326	2.326	2.326	2.326	2.326	2.326	2.326
$ECA_{ac,m}$	0.38	0.20	0.25	0.26	0.32	0.17	0.29	0.53	0.23	0.42	0.23	0.21	0.32
$ECA_{ch,m}$	0.59	0.37	0.44	0.45	0.53	0.32	0.50	0.71	0.41	0.63	0.42	0.39	0.53
LTA_{ac}	11.33	6.04	7.45	7.60	9.52	5.12	8.71	15.76	6.87	12.62	6.94	6.42	9.45
LTA_{ch}	5.24	3.17	3.77	3.83	4.50	2.82	4.23	6.25	3.54	5.50	3.57	3.41	4.38
LTA	5.24	3.17	3.77	3.83	4.50	2.82	4.23	6.25	3.54	5.50	3.57	3.41	4.38
s_n	0.24	0.47	0.38	0.37	0.29	0.57	0.32	0.15	0.42	0.21	0.41	0.45	0.29
s_n^2	0.06	0.22	0.15	0.14	0.09	0.32	0.10	0.02	0.17	0.04	0.17	0.20	0.09
z	1.645	1.645	1.645	1.645	1.645	1.645	1.645	1.645	1.645	1.645	1.645	1.645	1.645
$AMEL_m$	1.4	1.9	1.7	1.7	1.6	2.2	1.6	1.3	1.8	1.4	1.8	1.9	1.6
s	0.47	0.83	0.70	0.69	0.55	0.96	0.61	0.29	0.75	0.41	0.74	0.80	0.55
s^2	0.22	0.70	0.49	0.47	0.31	0.92	0.37	0.09	0.56	0.16	0.55	0.64	0.31
z	2.326	2.326	2.326	2.326	2.326	2.326	2.326	2.326	2.326	2.326	2.326	2.326	2.326
$MDEL_m$	2.7	4.9	4.0	3.9	3.1	5.9	3.4	1.9	4.3	2.4	4.3	4.7	3.1
AMEL	7.6	6.2	6.6	6.6	7.0	6.1	6.8	7.9	6.4	7.6	6.4	6.4	6.8
MDEL	13.9	15.6	15.0	14.9	14.0	16.6	14.4	11.9	15.3	13.0	15.2	15.9	13.6

MEC	2.9	28	11.3	10	1.6	20	4.43	5	10	8	13	29	4.6
Mean	1.4	3.9	2.9	3.0	0.5	2.6	1.8	3.3	2.9	2.8	3.2	4.4	4.4
Logmean	0.20	1.02	0.81	0.84	-1.06	0.47	0.35	1.14	0.67		0.85	1.16	MEC is 4.6, NDs with MDL of 5 and 10
LnSD	0.44	0.87	0.71	0.74	0.785	1.00	0.72	0.30	0.93		0.79	0.82	
Mean	1.4	3.9	2.9	3.0	0.5	2.6	1.8	3.3	2.9	2.8	3.2	4.4	
95th	2.5	11.7	7.3	7.8	1.3	8.3	4.6	5.1	9.1	4.9	8.7	12.3	
99th	3.4	21.1	11.8	12.9	2.2	16.4	7.6	6.3	17.1	6.3	14.9	21.4	
99.87th	4.6	38.0	19.1	21.3	3.7	32.3	12.3	7.6	32.1	8.1	25.4	37.1	

Attachment F-3

Discharger	American Canyon	Fairfield-Suisun	Hayward Marsh (Effluent)	Las Gallinas	Mt. View	Napa	Novato	Palo Alto	Petaluma	San Jose/Santa Clara	Sonoma	Sunnyvale	USS Posco
Acute Criteria	9.4	9.4	9.4	9.4	9.4	9.4	9.4	9.4	9.4	9.4	9.4	9.4	9.4
Chronic Criteria	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9
Background	0.2	0.4	0.4	0.4	0.4	0.2	0.4	0.3	0.4	0.3	0.4	0.3	0.5
Attentuation (SB05)	3	3	3	3	3	3	3	3	3	3	3	3	3
ECA_{ac}	37.0	36.4	36.4	36.4	36.4	37.0	36.4	36.7	36.4	36.7	36.4	36.7	36.1
ECA_{ch}	11.0	10.4	10.4	10.4	10.4	11.0	10.4	10.7	10.4	10.7	10.4	10.7	10.1
CV	0.493	1.002	0.794	0.776	0.600	1.227	0.665	0.300	0.868	0.423	0.858	0.944	0.600
s	0.47	0.83	0.70	0.69	0.55	0.96	0.61	0.29	0.75	0.41	0.74	0.80	0.55
s^2	0.22	0.70	0.49	0.47	0.31	0.92	0.37	0.09	0.56	0.16	0.55	0.64	0.31
s_4	0.24	0.47	0.38	0.37	0.29	0.57	0.32	0.15	0.42	0.21	0.41	0.45	0.29
s_4^2	0.06	0.22	0.15	0.14	0.09	0.32	0.10	0.02	0.17	0.04	0.17	0.20	0.09
z	2.326	2.326	2.326	2.326	2.326	2.326	2.326	2.326	2.326	2.326	2.326	2.326	2.326
$ECA_{ac,m}$	0.38	0.20	0.25	0.26	0.32	0.17	0.29	0.53	0.23	0.42	0.23	0.21	0.32
$ECA_{ch,m}$	0.59	0.37	0.44	0.45	0.53	0.32	0.50	0.71	0.41	0.63	0.42	0.39	0.53
LTA_{ac}	13.93	7.41	9.14	9.33	11.69	6.30	10.70	19.36	8.43	15.51	8.52	7.88	11.59
LTA_{ch}	6.42	3.87	4.60	4.67	5.49	3.46	5.16	7.65	4.31	6.72	4.35	4.17	5.33
LTA	6.42	3.87	4.60	4.67	5.49	3.46	5.16	7.65	4.31	6.72	4.35	4.17	5.33
s_n	0.24	0.47	0.38	0.37	0.29	0.57	0.32	0.15	0.42	0.21	0.41	0.45	0.29
s_n^2	0.06	0.22	0.15	0.14	0.09	0.32	0.10	0.02	0.17	0.04	0.17	0.20	0.09
z	1.645	1.645	1.645	1.645	1.645	1.645	1.645	1.645	1.645	1.645	1.645	1.645	1.645
$AMEL_m$	1.4	1.9	1.7	1.7	1.6	2.2	1.6	1.3	1.8	1.4	1.8	1.9	1.6
s	0.47	0.83	0.70	0.69	0.55	0.96	0.61	0.29	0.75	0.41	0.74	0.80	0.55
s^2	0.22	0.70	0.49	0.47	0.31	0.92	0.37	0.09	0.56	0.16	0.55	0.64	0.31
z	2.326	2.326	2.326	2.326	2.326	2.326	2.326	2.326	2.326	2.326	2.326	2.326	2.326
$MDEL_m$	2.7	4.9	4.0	3.9	3.1	5.9	3.4	1.9	4.3	2.4	4.3	4.7	3.1
AMEL	9.3	7.5	8.0	8.1	8.5	7.5	8.3	9.7	7.8	9.3	7.9	7.9	8.3
MDEL	17.0	19.0	18.3	18.2	17.1	20.3	17.6	14.5	18.6	15.9	18.6	19.4	16.6

MEC	2.9	28	11.3	10	1.6	20	4.43	5	10	8	13	29	4.6
Mean	1.4	3.9	2.9	3.0	0.5	2.6	1.8	3.3	2.9	2.8	3.2	4.4	4.4
Logmean	0.20	1.02	0.81	0.84	-1.06	0.47	0.35	1.14	0.67		0.85	1.16	MEC is 4.6, NDs with MDL of 5 and 10
LnSD	0.44	0.87	0.71	0.74	0.785	1.00	0.72	0.30	0.93		0.79	0.82	
Mean	1.4	3.9	2.9	3.0	0.5	2.6	1.8	3.3	2.9	2.8	3.2	4.4	
95th	2.5	11.7	7.3	7.8	1.3	8.3	4.6	5.1	9.1	4.9	8.7	12.3	
99th	3.4	21.1	11.8	12.9	2.2	16.4	7.6	6.3	17.1	6.3	14.9	21.4	
99.87th	4.6	38.0	19.1	21.3	3.7	32.3	12.3	7.6	32.1	8.1	25.4	37.1	

Attachment F-4

Discharger	American Canyon	Fairfield-Suisun	Hayward Marsh (Effluent)	Las Gallinas	Mt. View	Napa	Novato	Palo Alto	Petaluma	San Jose/Santa Clara	Sonoma	Sunnyvale	USS Posco
Acute Criteria	9.4	9.4	9.4	9.4	9.4	9.4	9.4	9.4	9.4	9.4	9.4	9.4	9.4
Chronic Criteria	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9
Background	0.2	0.4	0.4	0.4	0.4	0.2	0.4	0.3	0.4	0.3	0.4	0.3	0.5
Attentuation (SB05)	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
ECA_{ac}	41.6	40.9	40.9	40.9	40.9	41.6	40.9	41.3	40.9	41.3	40.9	41.3	40.6
ECA_{ch}	12.3	11.7	11.7	11.7	11.7	12.3	11.7	12.0	11.7	12.0	11.7	12.0	11.3
CV	0.493	1.002	0.794	0.776	0.600	1.227	0.665	0.300	0.868	0.423	0.858	0.944	0.600
s	0.47	0.83	0.70	0.69	0.55	0.96	0.61	0.29	0.75	0.41	0.74	0.80	0.55
s^2	0.22	0.70	0.49	0.47	0.31	0.92	0.37	0.09	0.56	0.16	0.55	0.64	0.31
s_4	0.24	0.47	0.38	0.37	0.29	0.57	0.32	0.15	0.42	0.21	0.41	0.45	0.29
s_4^2	0.06	0.22	0.15	0.14	0.09	0.32	0.10	0.02	0.17	0.04	0.17	0.20	0.09
z	2.326	2.326	2.326	2.326	2.326	2.326	2.326	2.326	2.326	2.326	2.326	2.326	2.326
$ECA_{ac,m}$	0.38	0.20	0.25	0.26	0.32	0.17	0.29	0.53	0.23	0.42	0.23	0.21	0.32
$ECA_{ch,m}$	0.59	0.37	0.44	0.45	0.53	0.32	0.50	0.71	0.41	0.63	0.42	0.39	0.53
LTA_{ac}	15.66	8.33	10.27	10.48	13.13	7.08	12.02	21.76	9.48	17.43	9.58	8.86	13.02
LTA_{ch}	7.21	4.33	5.15	5.23	6.14	3.88	5.78	8.58	4.83	7.54	4.87	4.68	5.96
LTA	7.21	4.33	5.15	5.23	6.14	3.88	5.78	8.58	4.83	7.54	4.87	4.68	5.96
s_n	0.24	0.47	0.38	0.37	0.29	0.57	0.32	0.15	0.42	0.21	0.41	0.45	0.29
s_n^2	0.06	0.22	0.15	0.14	0.09	0.32	0.10	0.02	0.17	0.04	0.17	0.20	0.09
z	1.645	1.645	1.645	1.645	1.645	1.645	1.645	1.645	1.645	1.645	1.645	1.645	1.645
$AMEL_m$	1.4	1.9	1.7	1.7	1.6	2.2	1.6	1.3	1.8	1.4	1.8	1.9	1.6
s	0.47	0.83	0.70	0.69	0.55	0.96	0.61	0.29	0.75	0.41	0.74	0.80	0.55
s^2	0.22	0.70	0.49	0.47	0.31	0.92	0.37	0.09	0.56	0.16	0.55	0.64	0.31
z	2.326	2.326	2.326	2.326	2.326	2.326	2.326	2.326	2.326	2.326	2.326	2.326	2.326
$MDEL_m$	2.7	4.9	4.0	3.9	3.1	5.9	3.4	1.9	4.3	2.4	4.3	4.7	3.1
AMEL	10.4	8.4	9.0	9.0	9.5	8.4	9.3	10.8	8.8	10.4	8.8	8.8	9.3
MDEL	19.1	21.3	20.5	20.4	19.1	22.8	19.7	16.3	20.9	17.8	20.8	21.8	18.6

MEC	2.9	28	11.3	10	1.6	20	4.43	5	10	8	13	29	4.6
Mean	1.4	3.9	2.9	3.0	0.5	2.6	1.8	3.3	2.9	2.8	3.2	4.4	4.4
Logmean	0.20	1.02	0.81	0.84	-1.06	0.47	0.35	1.14	0.67		0.85	1.16	MEC is 4.6, NDs with MDL of 5 and 10
LnSD	0.44	0.87	0.71	0.74	0.785	1.00	0.72	0.30	0.93		0.79	0.82	
Mean	1.4	3.9	2.9	3.0	0.5	2.6	1.8	3.3	2.9	2.8	3.2	4.4	
95th	2.5	11.7	7.3	7.8	1.3	8.3	4.6	5.1	9.1	4.9	8.7	12.3	
99th	3.4	21.1	11.8	12.9	2.2	16.4	7.6	6.3	17.1	6.3	14.9	21.4	
99.87th	4.6	38.0	19.1	21.3	3.7	32.3	12.3	7.6	32.1	8.1	25.4	37.1	

Attachment F-5

Discharger	American Canyon	Fairfield-Suisun	Hayward Marsh (Effluent)	Las Gallinas	Mt. View	Napa	Novato	Palo Alto	Petaluma	San Jose/Santa Clara	Sonoma	Sunnyvale	USS Posco
Acute Criteria	9.4	9.4	9.4	9.4	9.4	9.4	9.4	9.4	9.4	9.4	9.4	9.4	9.4
Chronic Criteria	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9
Background	0.2	0.4	0.4	0.4	0.4	0.2	0.4	0.3	0.4	0.3	0.4	0.3	0.5
Attentuation (SB05)	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
ECA_{ac}	50.8	49.9	49.9	49.9	49.9	50.8	49.9	50.4	49.9	50.4	49.9	50.4	49.5
ECA_{ch}	15.0	14.2	14.2	14.2	14.2	15.0	14.2	14.6	14.2	14.6	14.2	14.6	13.7
CV	0.493	1.002	0.794	0.776	0.600	1.227	0.665	0.300	0.868	0.423	0.858	0.944	0.600
s	0.47	0.83	0.70	0.69	0.55	0.96	0.61	0.29	0.75	0.41	0.74	0.80	0.55
s^2	0.22	0.70	0.49	0.47	0.31	0.92	0.37	0.09	0.56	0.16	0.55	0.64	0.31
s_4	0.24	0.47	0.38	0.37	0.29	0.57	0.32	0.15	0.42	0.21	0.41	0.45	0.29
s_4^2	0.06	0.22	0.15	0.14	0.09	0.32	0.10	0.02	0.17	0.04	0.17	0.20	0.09
z	2.326	2.326	2.326	2.326	2.326	2.326	2.326	2.326	2.326	2.326	2.326	2.326	2.326
$ECA_{ac,m}$	0.38	0.20	0.25	0.26	0.32	0.17	0.29	0.53	0.23	0.42	0.23	0.21	0.32
$ECA_{ch,m}$	0.59	0.37	0.44	0.45	0.53	0.32	0.50	0.71	0.41	0.63	0.42	0.39	0.53
LTA_{ac}	19.12	10.16	12.53	12.79	16.02	8.65	14.67	26.56	11.56	21.28	11.68	10.81	15.88
LTA_{ch}	8.78	5.26	6.25	6.35	7.46	4.73	7.02	10.44	5.87	9.17	5.92	5.69	7.23
LTA	8.78	5.26	6.25	6.35	7.46	4.73	7.02	10.44	5.87	9.17	5.92	5.69	7.23
s_n	0.24	0.47	0.38	0.37	0.29	0.57	0.32	0.15	0.42	0.21	0.41	0.45	0.29
s_n^2	0.06	0.22	0.15	0.14	0.09	0.32	0.10	0.02	0.17	0.04	0.17	0.20	0.09
z	1.645	1.645	1.645	1.645	1.645	1.645	1.645	1.645	1.645	1.645	1.645	1.645	1.645
$AMEL_m$	1.4	1.9	1.7	1.7	1.6	2.2	1.6	1.3	1.8	1.4	1.8	1.9	1.6
s	0.47	0.83	0.70	0.69	0.55	0.96	0.61	0.29	0.75	0.41	0.74	0.80	0.55
s^2	0.22	0.70	0.49	0.47	0.31	0.92	0.37	0.09	0.56	0.16	0.55	0.64	0.31
z	2.326	2.326	2.326	2.326	2.326	2.326	2.326	2.326	2.326	2.326	2.326	2.326	2.326
$MDEL_m$	2.7	4.9	4.0	3.9	3.1	5.9	3.4	1.9	4.3	2.4	4.3	4.7	3.1
AMEL	12.7	10.3	10.9	11.0	11.6	10.2	11.3	13.2	10.7	12.7	10.7	10.8	11.2
MDEL	23.3	25.9	24.9	24.8	23.2	27.8	23.9	19.8	25.3	21.7	25.3	26.5	22.5

MEC	2.9	28	11.3	10	1.6	20	4.43	5	10	8	13	29	4.6
Mean	1.4	3.9	2.9	3.0	0.5	2.6	1.8	3.3	2.9	2.8	3.2	4.4	4.4
Logmean	0.20	1.02	0.81	0.84	-1.06	0.47	0.35	1.14	0.67		0.85	1.16	MEC is 4.6, NDs with MDL of 5 and 10
LnSD	0.44	0.87	0.71	0.74	0.785	1.00	0.72	0.30	0.93		0.79	0.82	
Mean	1.4	3.9	2.9	3.0	0.5	2.6	1.8	3.3	2.9	2.8	3.2	4.4	
95th	2.5	11.7	7.3	7.8	1.3	8.3	4.6	5.1	9.1	4.9	8.7	12.3	
99th	3.4	21.1	11.8	12.9	2.2	16.4	7.6	6.3	17.1	6.3	14.9	21.4	
99.87th	4.6	38.0	19.1	21.3	3.7	32.3	12.3	7.6	32.1	8.1	25.4	37.1	

Attachment F-6

Time Series Plots of Cyanide Effluent Concentrations

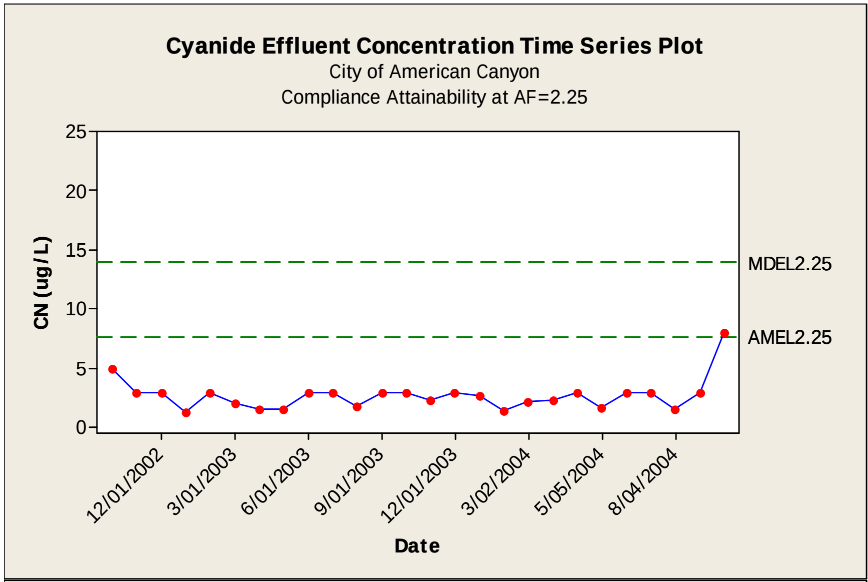
and

Average Monthly Effluent Limitation (AMEL)/

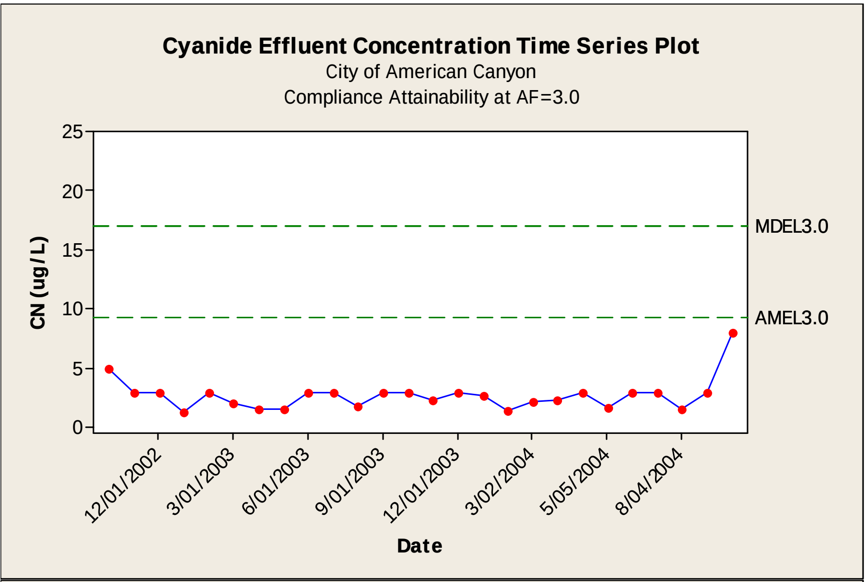
Maximum Daily Effluent Limitation (MDEL)

for Attenuation Factor (AF) = 2.25, 3.0, 3.5, and 4.5

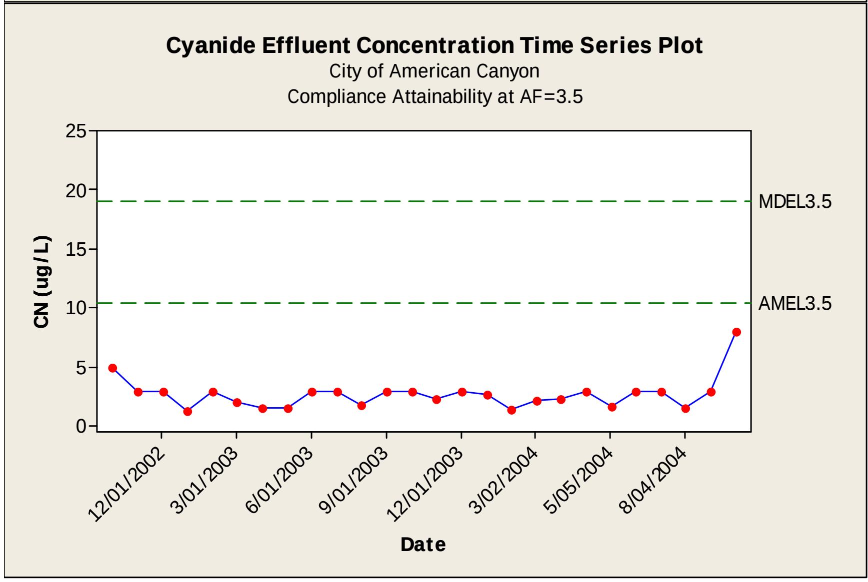
1. City of American Canyon



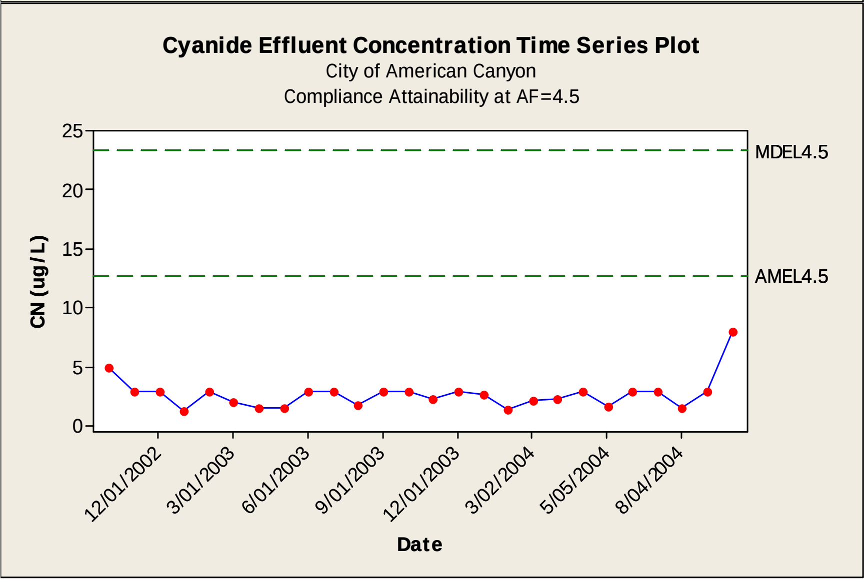
Cyanide Effluent Concentration Time Series Plot
City of American Canyon
Compliance Attainability at AF=2.25



Cyanide Effluent Concentration Time Series Plot
City of American Canyon
Compliance Attainability at AF=3.0

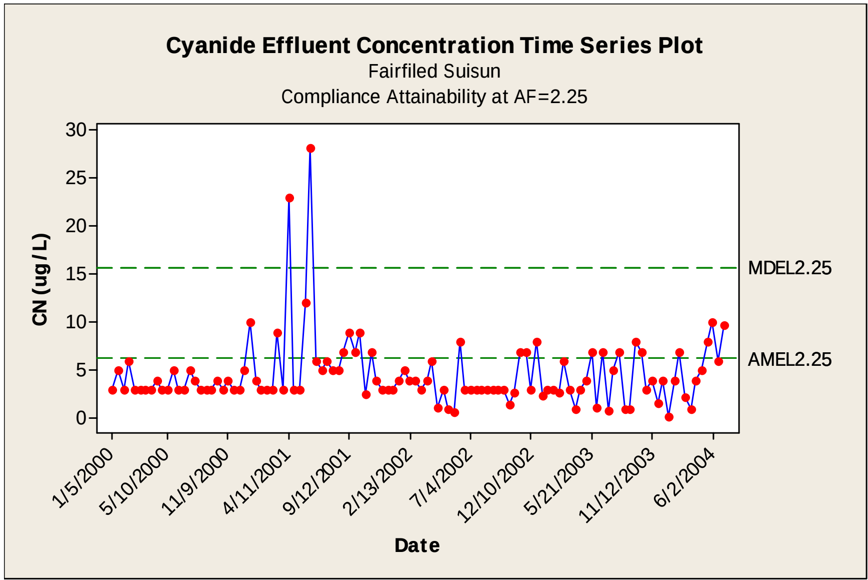


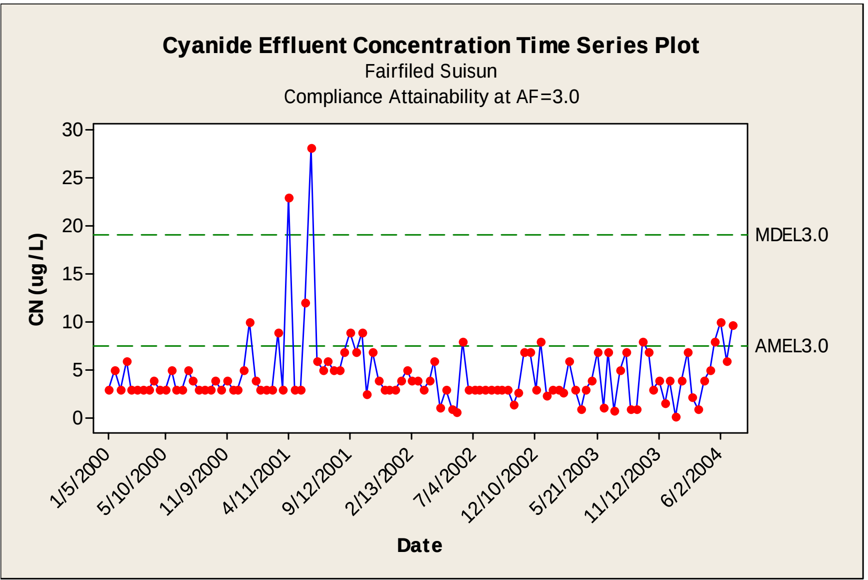
Cyanide Effluent Concentration Time Series Plot
City of American Canyon
Compliance Attainability at AF=3.5

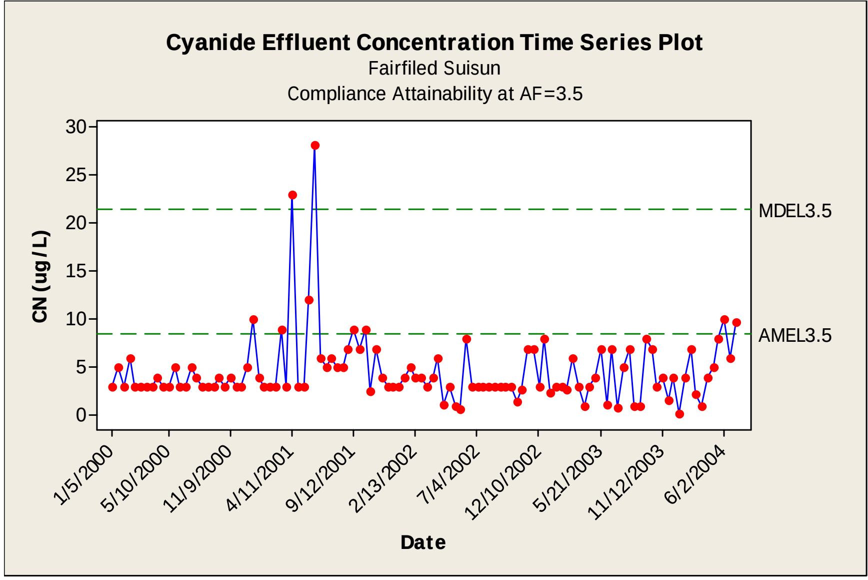


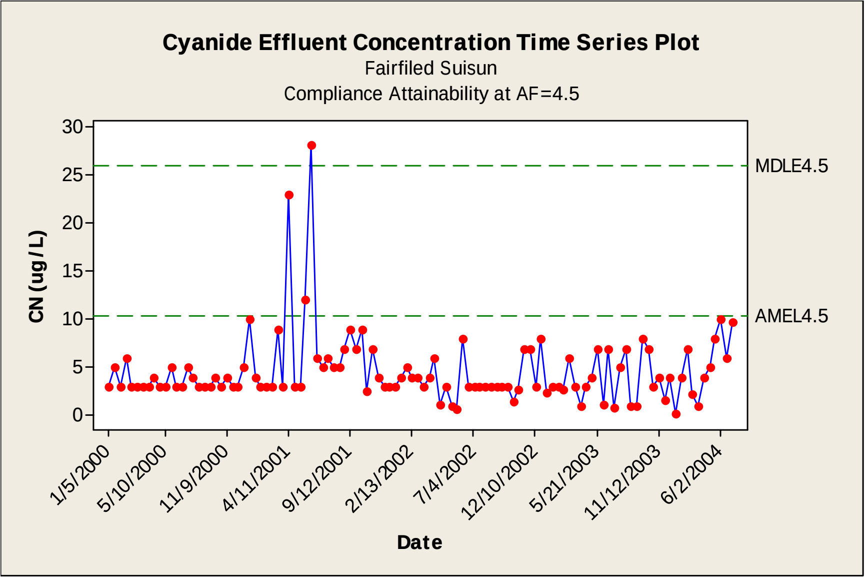
Cyanide Effluent Concentration Time Series Plot
City of American Canyon
Compliance Attainability at AF=4.5

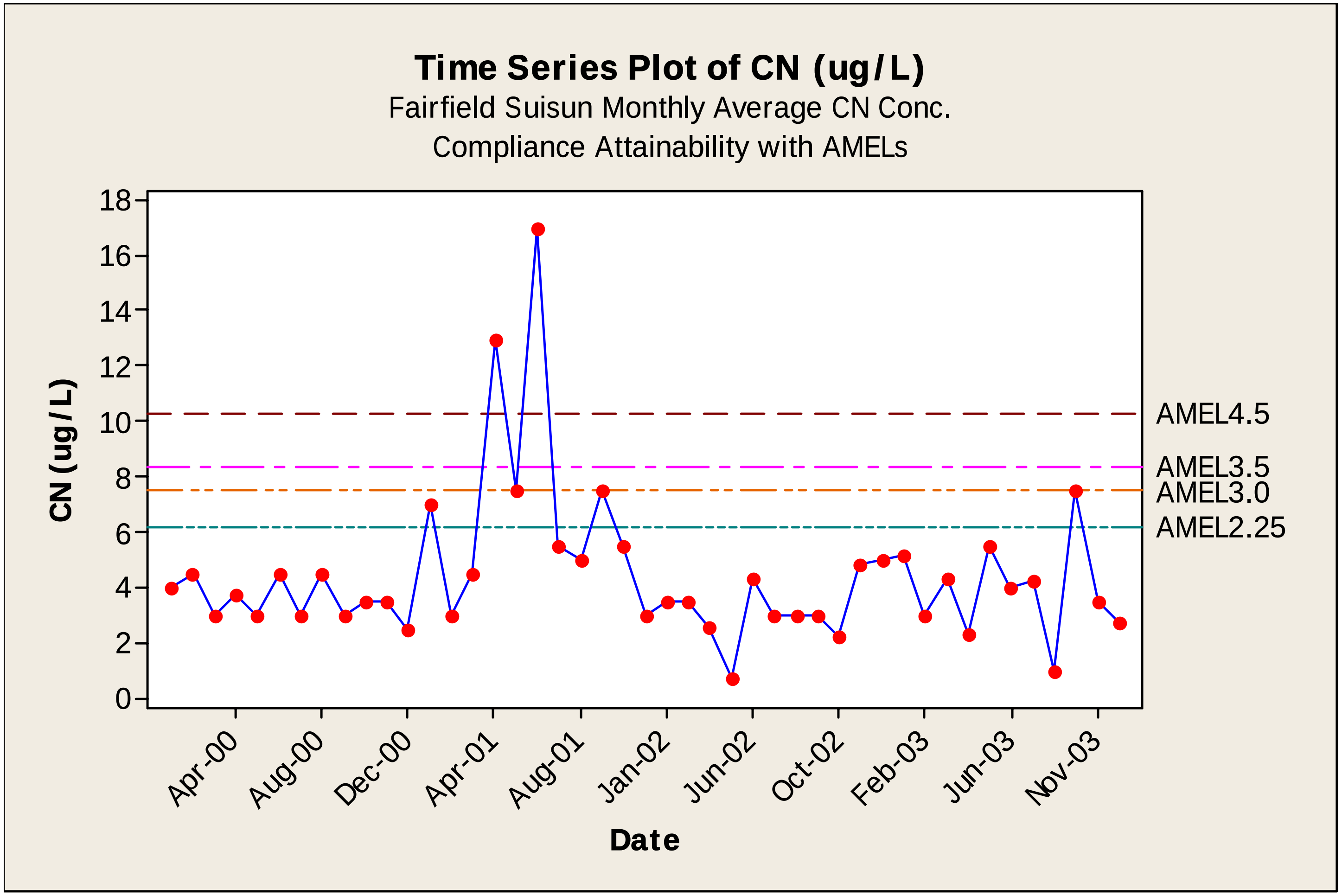
2. Fairfield Suisun


Cyanide Effluent Concentration Time Series Plot
Fairfiled Suisun
Compliance Attainability at AF=2.25

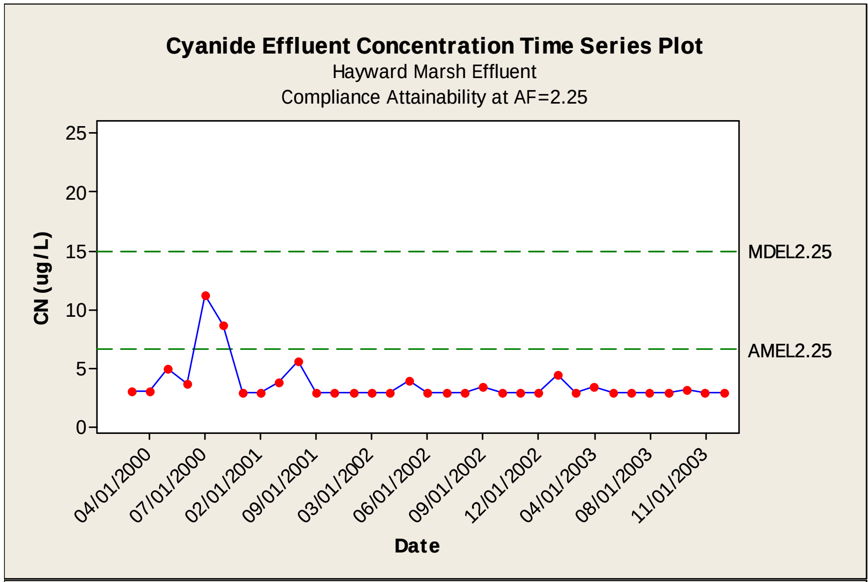

Cyanide Effluent Concentration Time Series Plot
Fairfiled Suisun
Compliance Attainability at AF=3.0

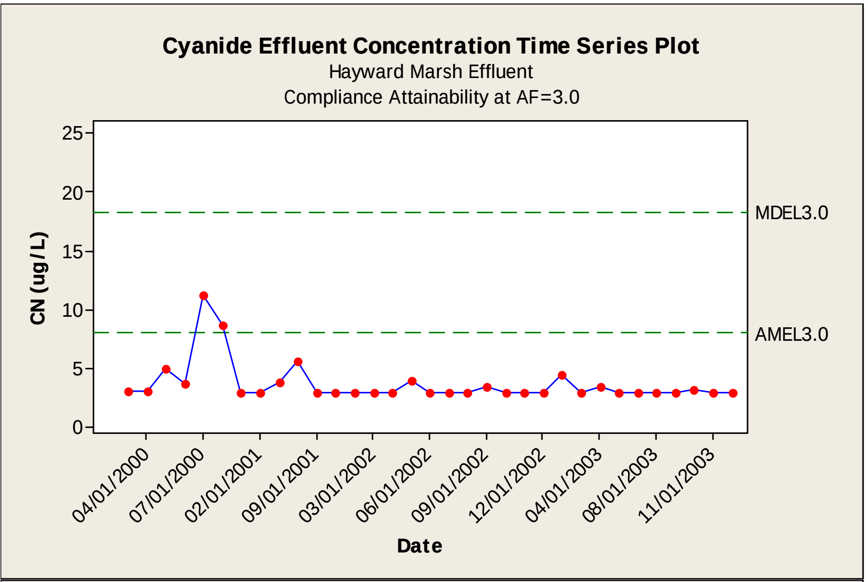

Cyanide Effluent Concentration Time Series Plot
Fairfiled Suisun
Compliance Attainability at AF=3.5

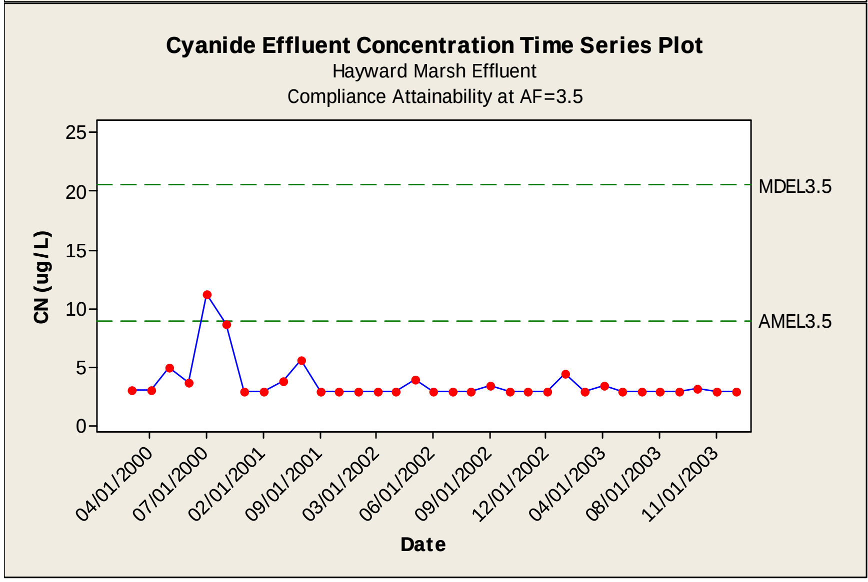

Cyanide Effluent Concentration Time Series Plot
Fairfiled Suisun
Compliance Attainability at AF=4.5

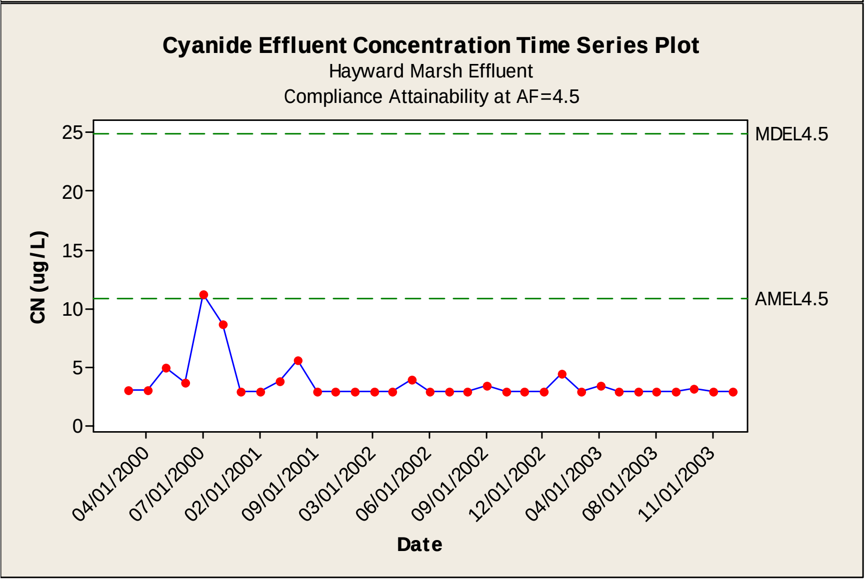

Time Series Plot of CN (ug/L)
Fairfield Suisun Monthly Average CN Conc.
Compliance Attainability with AMELs
CN (ug/L)
0
2
4
6
8
10
12
14
16
18
AMEL4.5
AMEL3.5
AMEL3.0
AMEL2.25
Apr-00
Aug-00
Dec-00
Apr-01
Aug-01
Jan-02
Jun-02
Oct-02
Feb-03
Jun-03
Nov-03
Date

3. Hayward Marsh Effluent

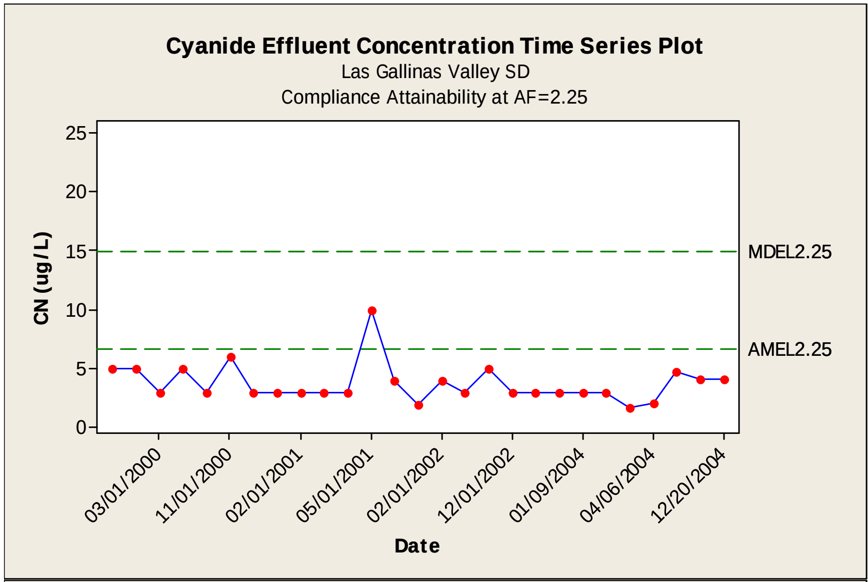

Cyanide Effluent Concentration Time Series Plot
Hayward Marsh Effluent
Compliance Attainability at AF=2.25

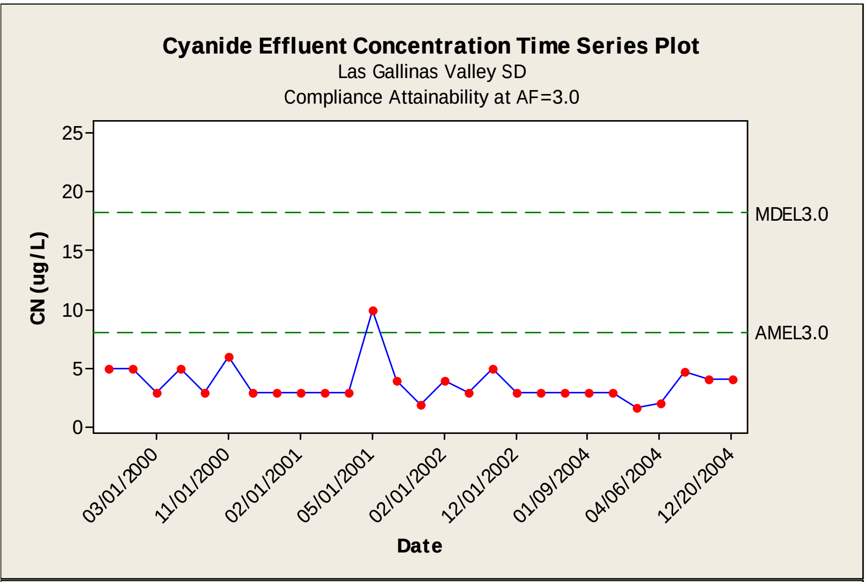

Cyanide Effluent Concentration Time Series Plot
Hayward Marsh Effluent
Compliance Attainability at AF=3.0

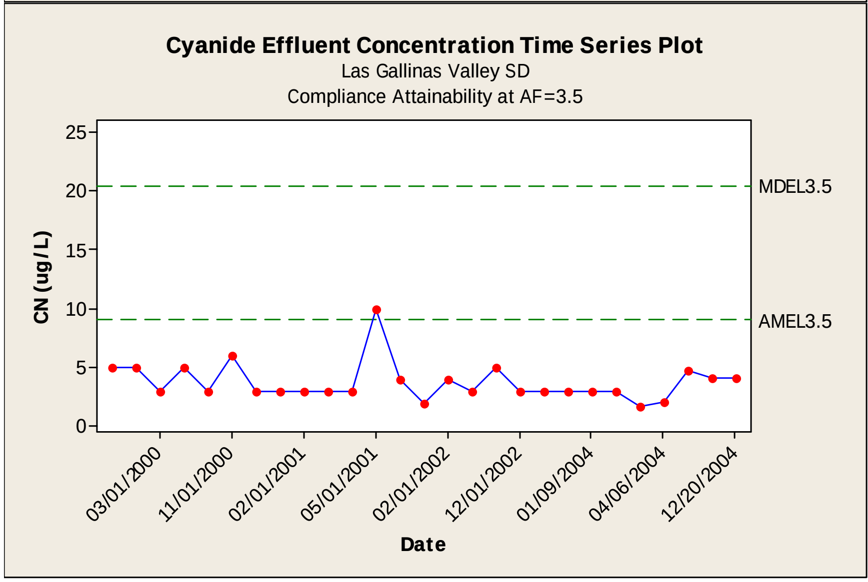

Cyanide Effluent Concentration Time Series Plot
Hayward Marsh Effluent
Compliance Attainability at AF=3.5

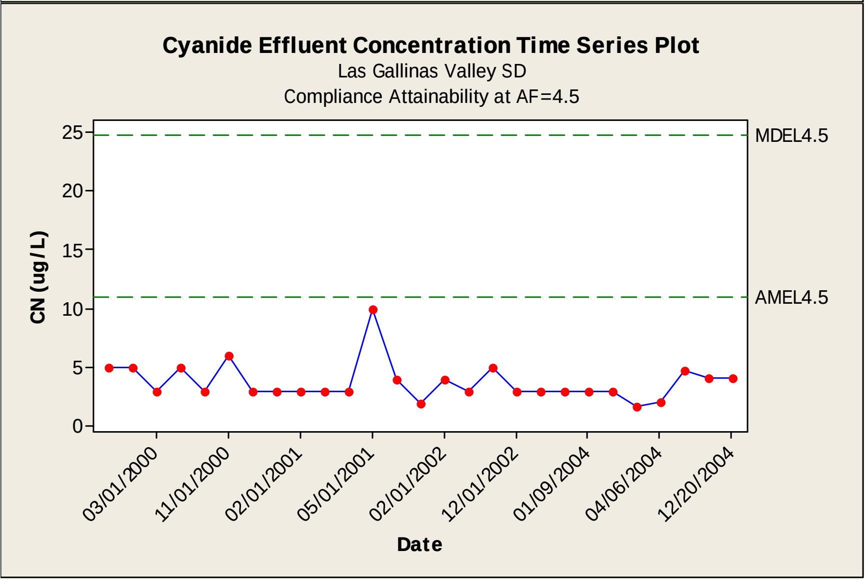

Cyanide Effluent Concentration Time Series Plot
Hayward Marsh Effluent
Compliance Attainability at AF=4.5

4. Las Gallinas Valley Sanitary District

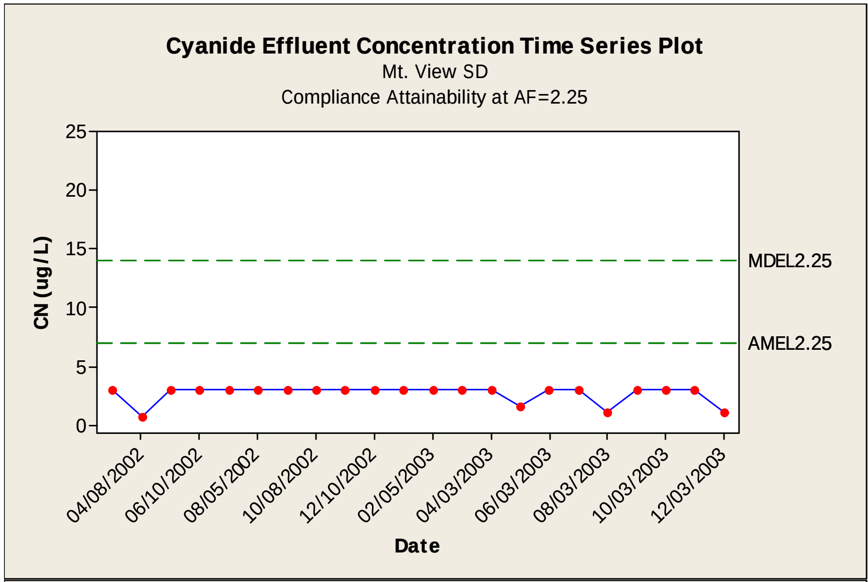


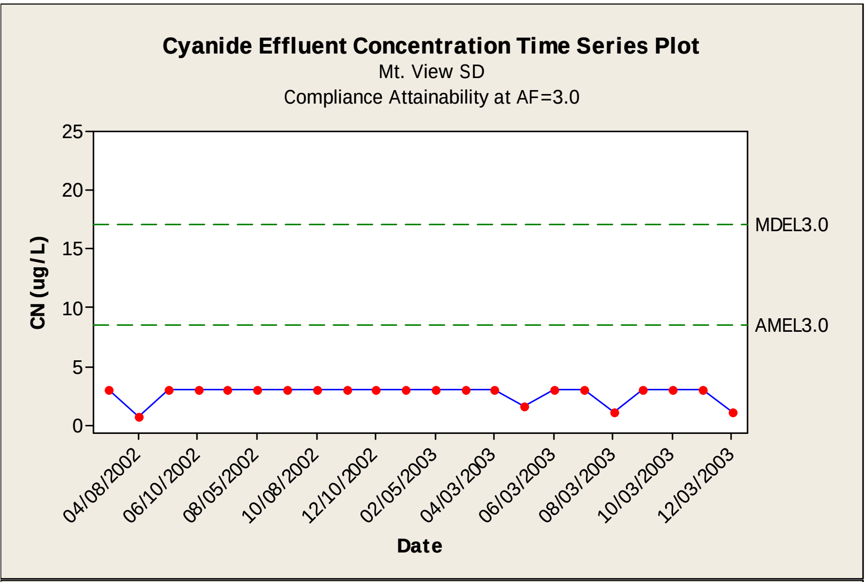


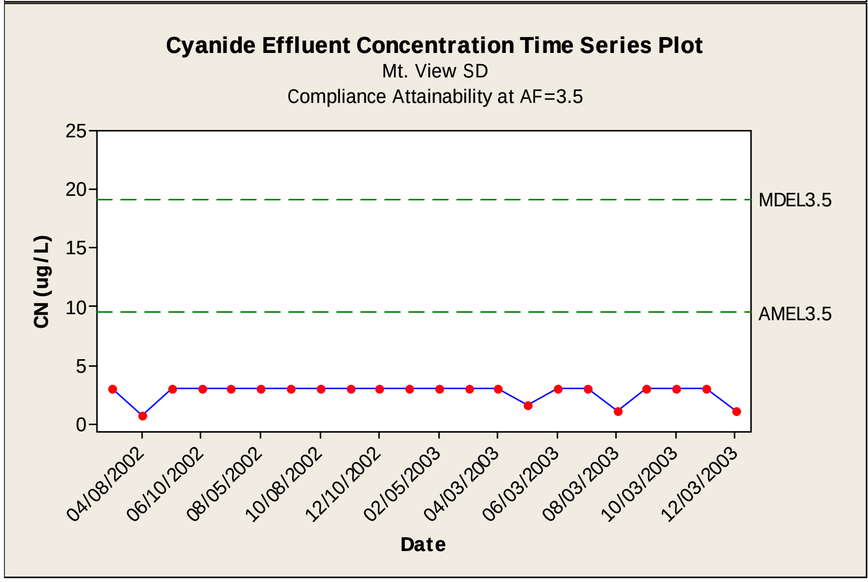


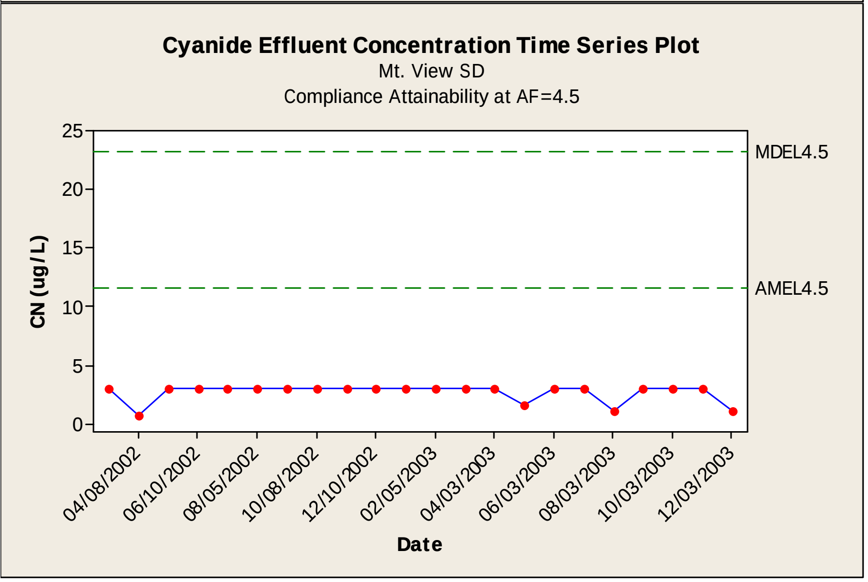


5. Mountain View

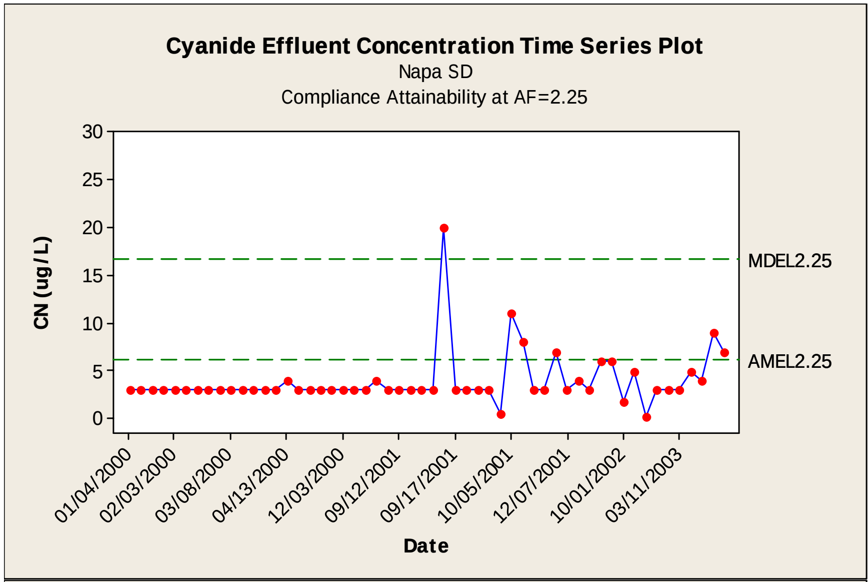


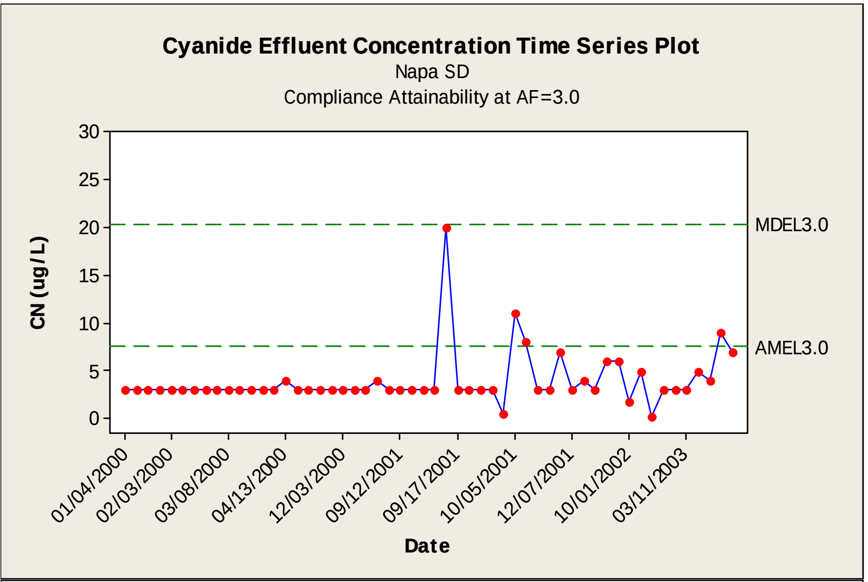


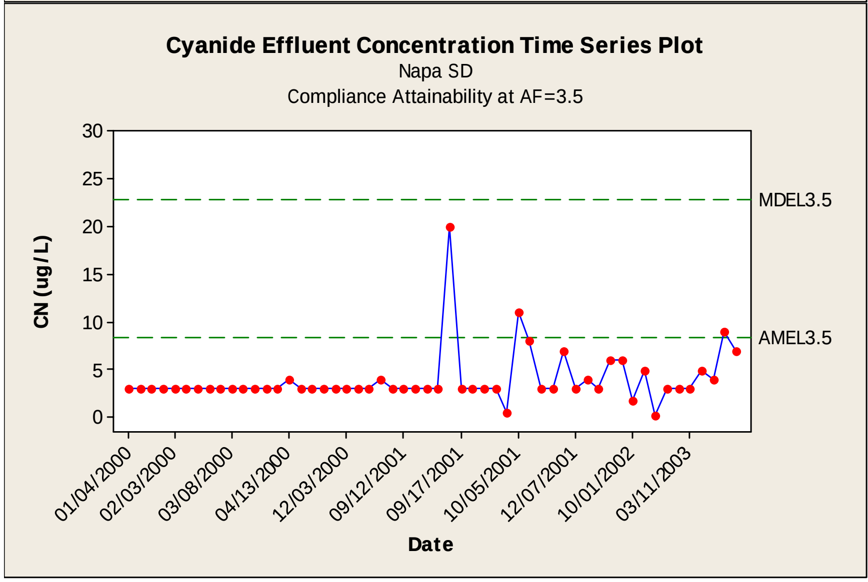


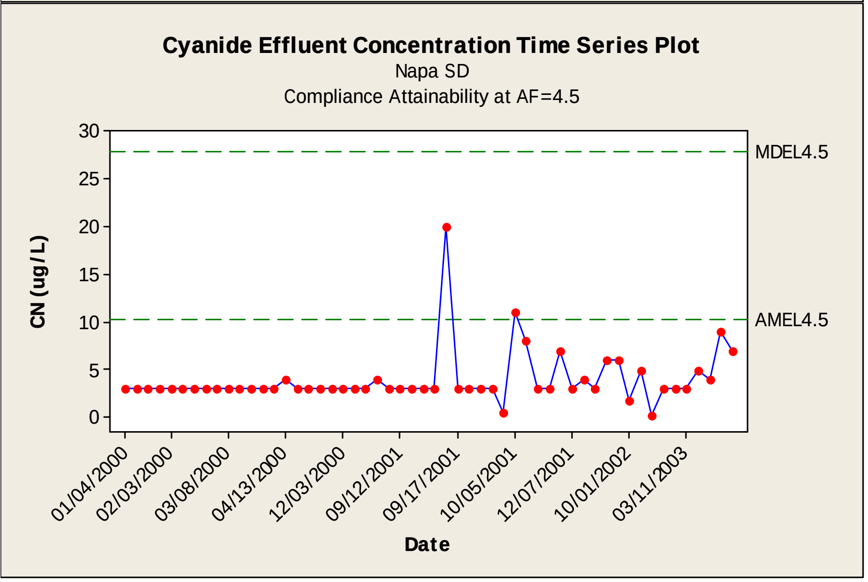


6. Napa Sanitation District

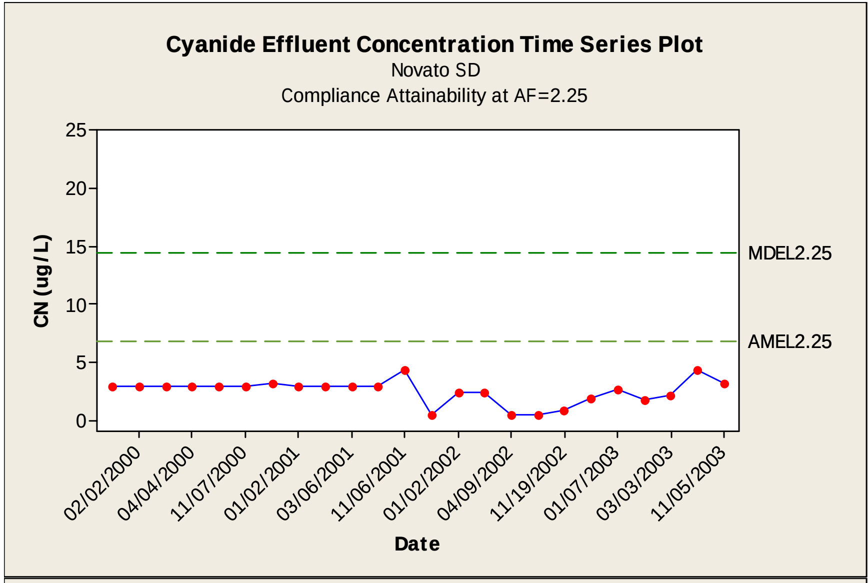


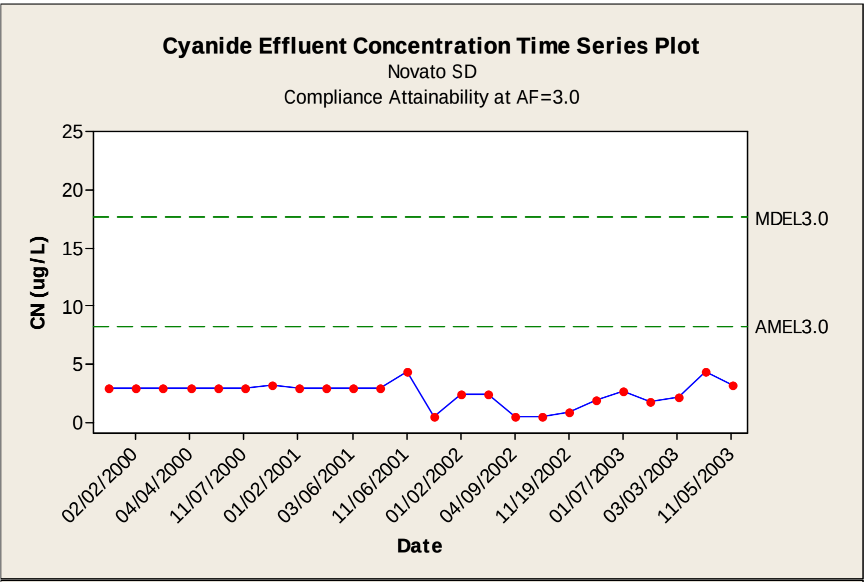






7. Novato SD


Cyanide Effluent Concentration Time Series Plot
Novato SD
Compliance Attainability at AF=2.25
CN (ug/L)
25
20
15
10
5
0
MDEL2.25
AMEL2.25
02/02/2000
04/04/2000
11/07/2000
01/02/2001
03/06/2001
11/06/2001
01/02/2002
04/09/2002
11/19/2002
01/07/2003
03/03/2003
11/05/2003
Date


Cyanide Effluent Concentration Time Series Plot
Novato SD
Compliance Attainability at AF=3.0
CN (ug/L)
25
20
15
10
5
0
MDEL3.0
AMEL3.0
02/02/2000
04/04/2000
11/07/2000
01/02/2001
03/06/2001
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01/02/2002
04/09/2002
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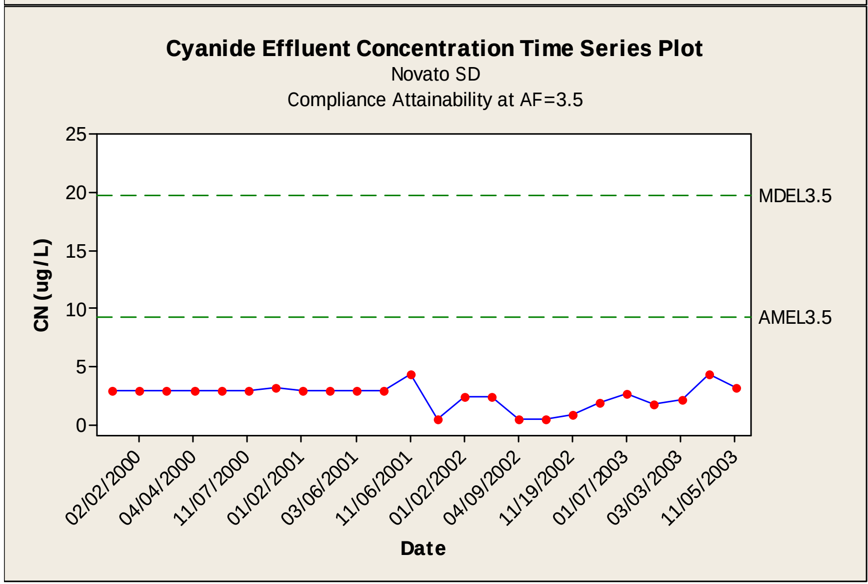
01/07/2003
03/03/2003
11/05/2003
Date


Cyanide Effluent Concentration Time Series Plot
Novato SD
Compliance Attainability at AF=3.5
CN (ug/L)
25
20
15
10
5
0
MDEL3.5
AMEL3.5
02/02/2000
04/04/2000
11/07/2000
01/02/2001
03/06/2001
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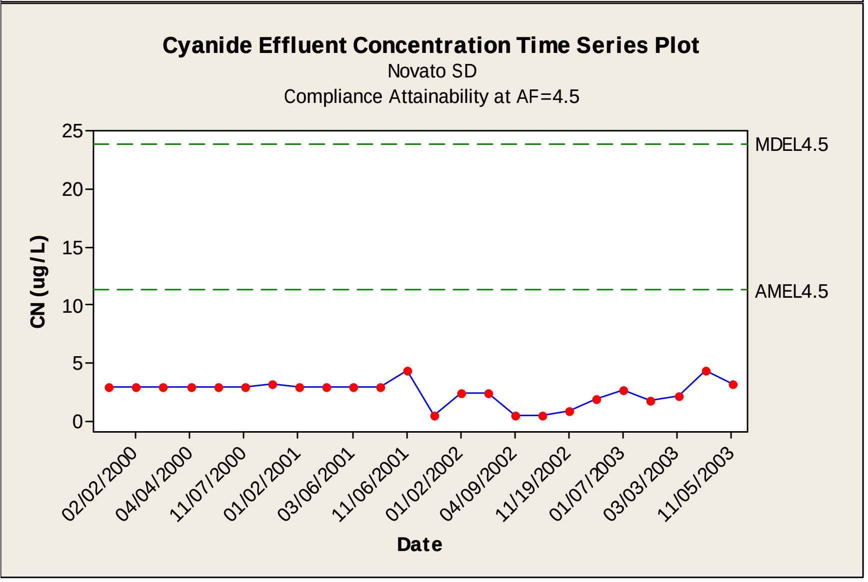
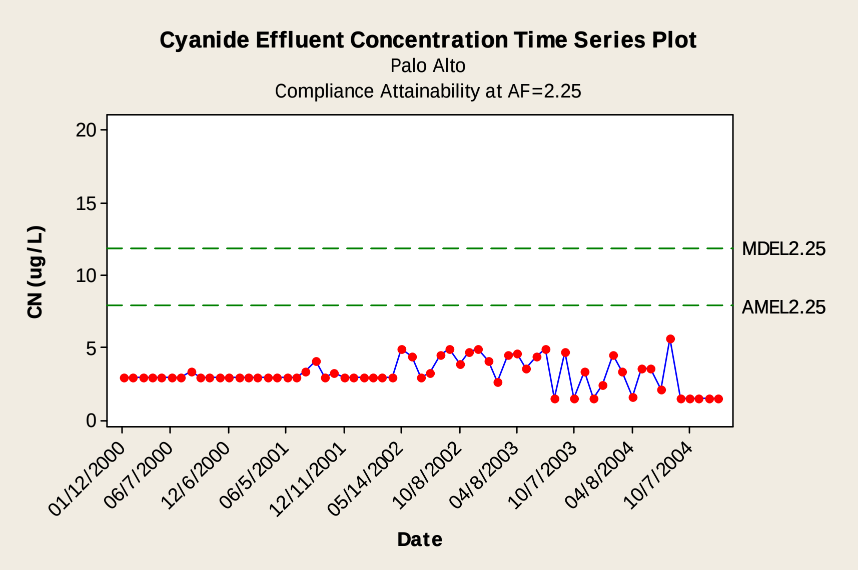
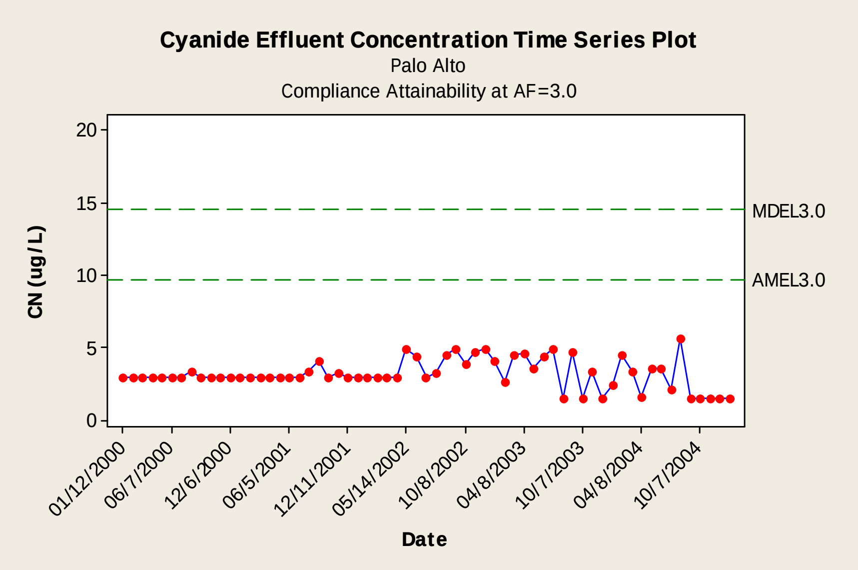
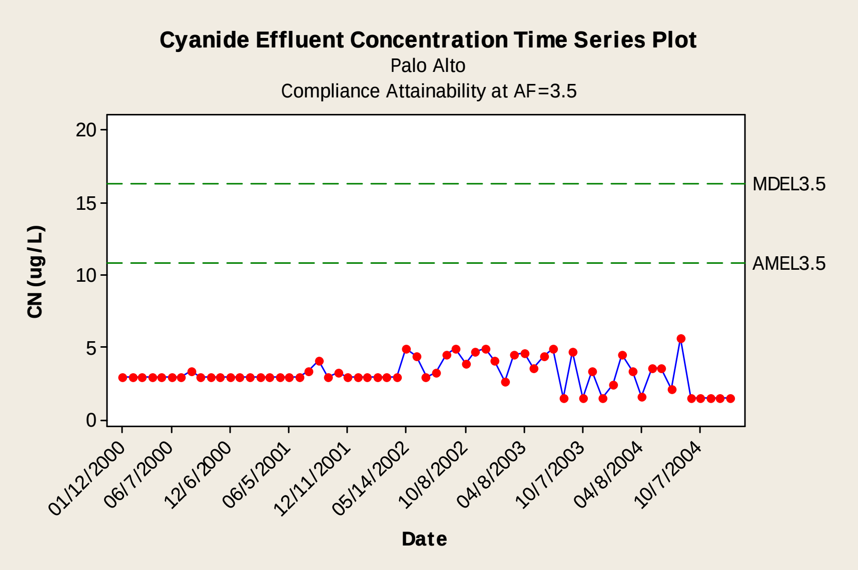
01/02/2002
04/09/2002
11/19/2002
01/07/2003
03/03/2003
11/05/2003
Date

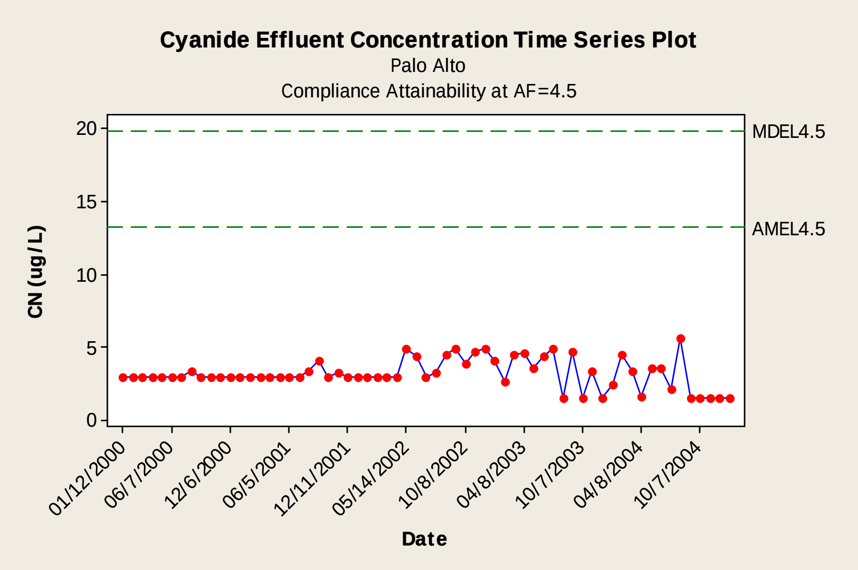

Cyanide Effluent Concentration Time Series Plot
Novato SD
Compliance Attainability at AF=4.5
CN (ug/L)
25
20
15
10
5
0
MDEL4.5
AMEL4.5
02/02/2000
04/04/2000
11/07/2000
01/02/2001
03/06/2001
11/06/2001
01/02/2002
04/09/2002
11/19/2002
01/07/2003
03/03/2003
11/05/2003
Date

8. City of Palo Alto

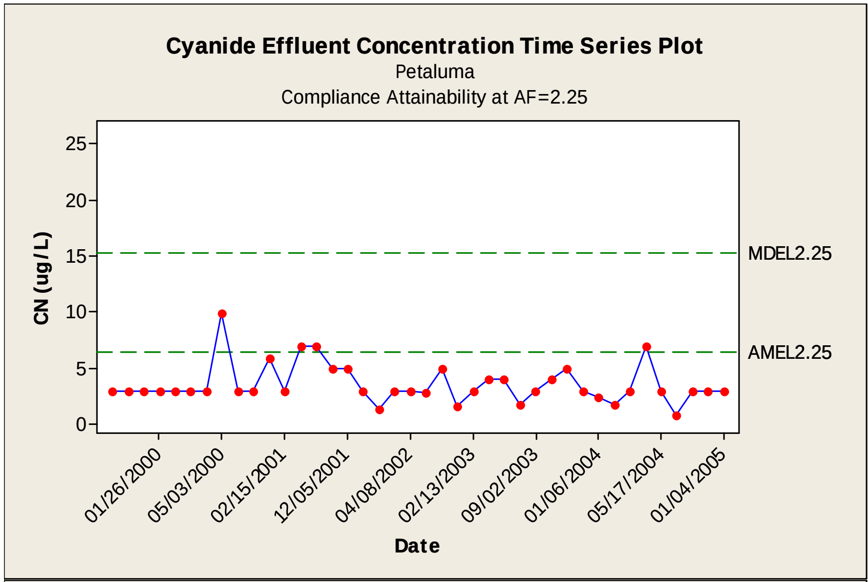

Cyanide Effluent Concentration Time Series Plot
Palo Alto
Compliance Attainability at AF=2.25

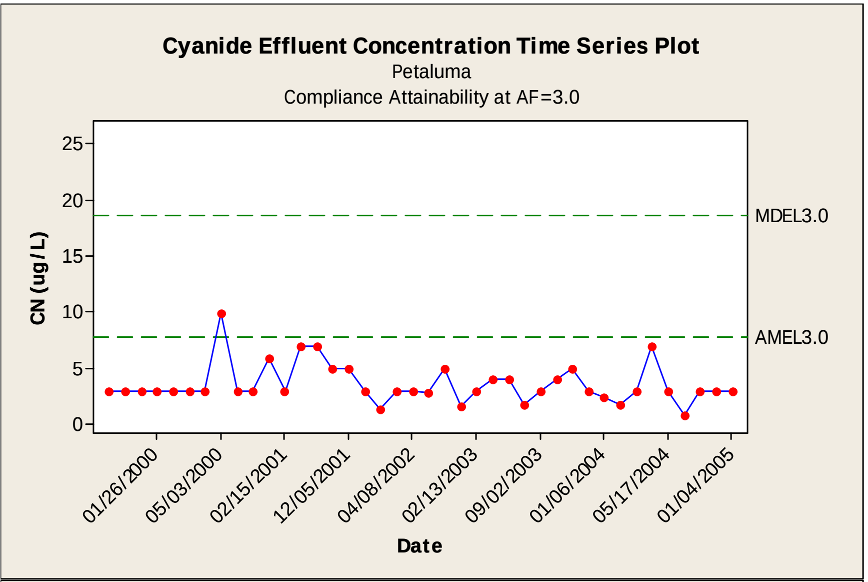

Cyanide Effluent Concentration Time Series Plot
Palo Alto
Compliance Attainability at AF=3.0

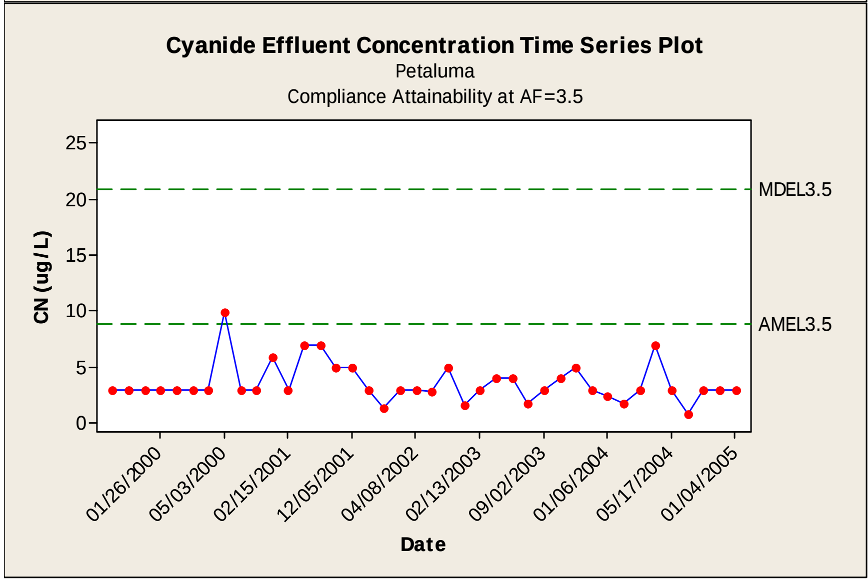

Cyanide Effluent Concentration Time Series Plot
Palo Alto
Compliance Attainability at AF=3.5

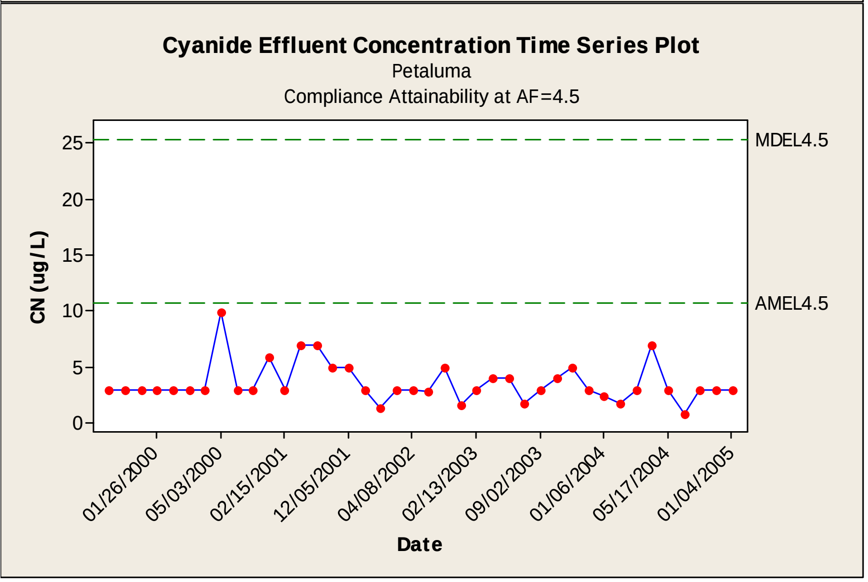

Cyanide Effluent Concentration Time Series Plot
Palo Alto
Compliance Attainability at AF=4.5

9. City of Petaluma

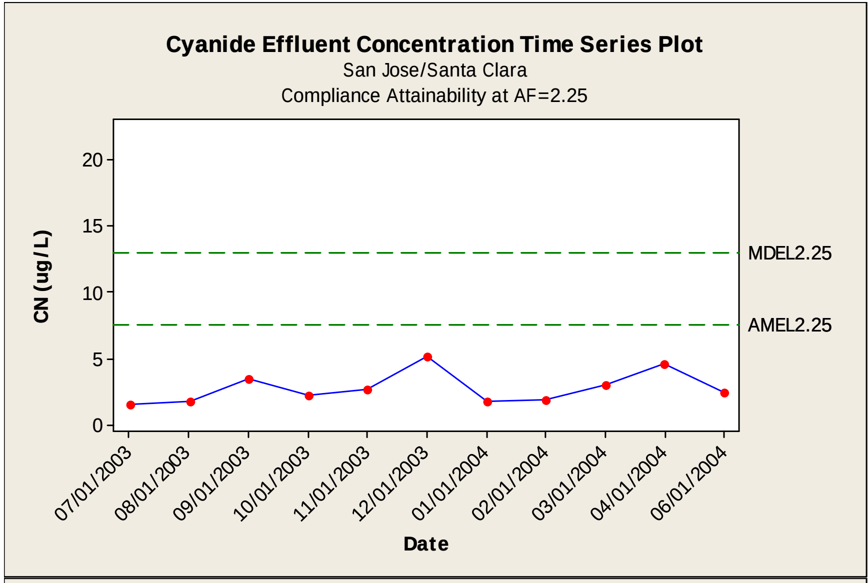


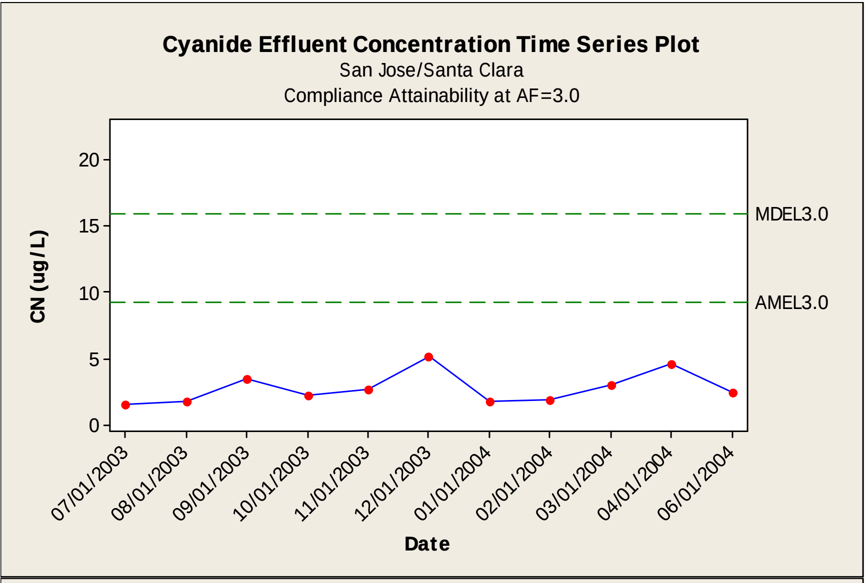


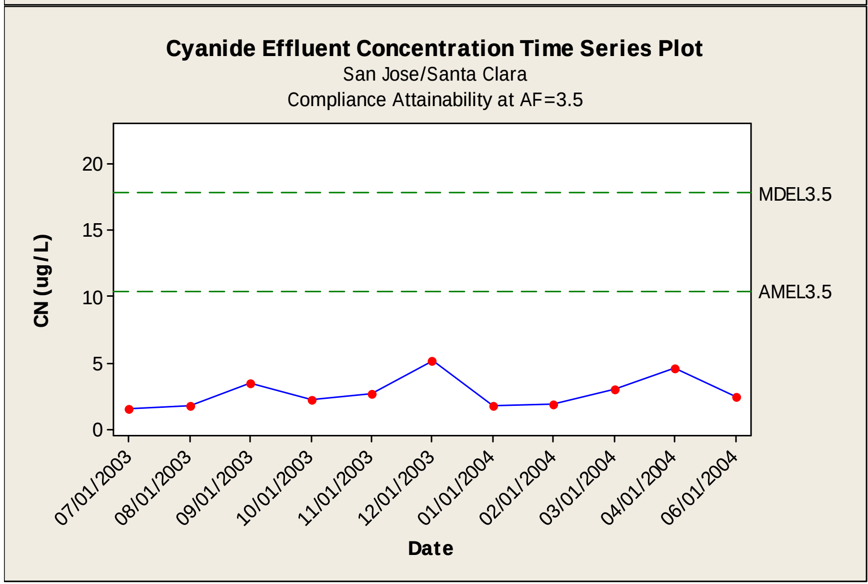


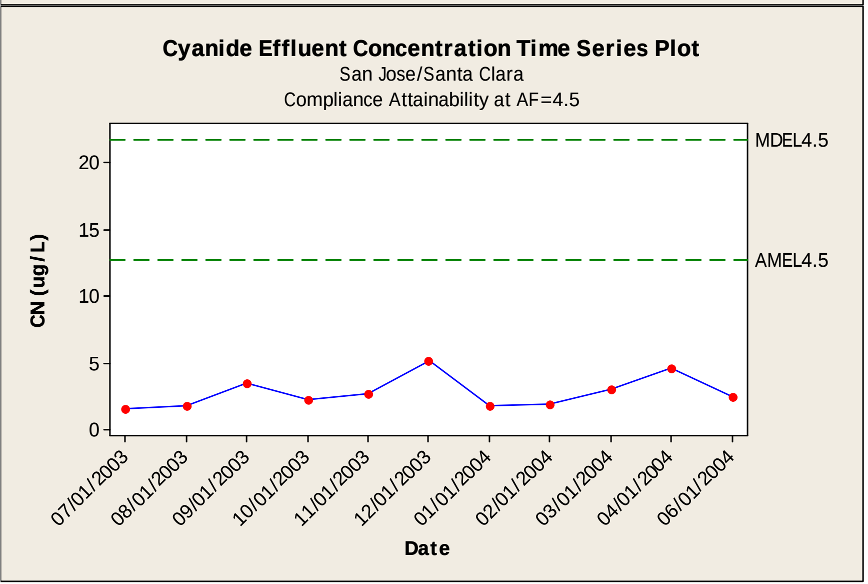


10. San Jose/Santa Clara

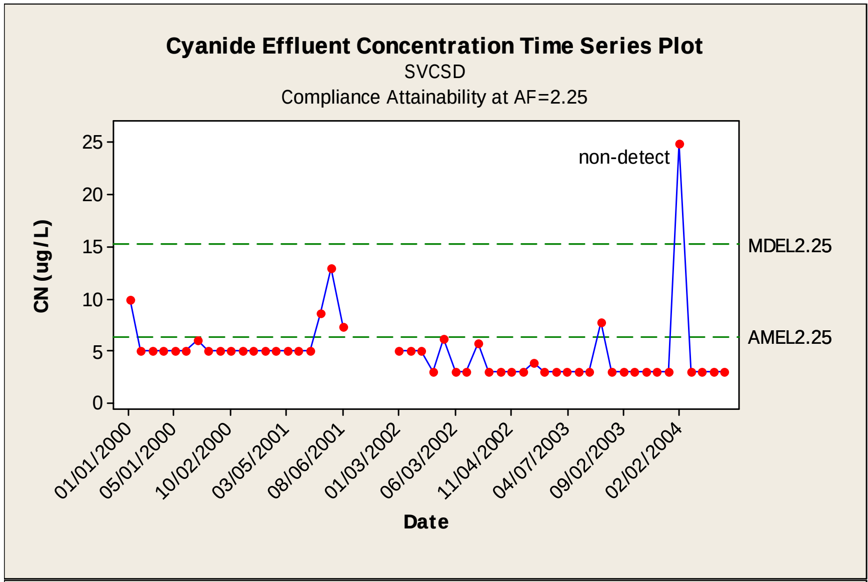

Cyanide Effluent Concentration Time Series Plot
San Jose/Santa Clara
Compliance Attainability at AF=2.25


Cyanide Effluent Concentration Time Series Plot
San Jose/Santa Clara
Compliance Attainability at AF=3.0

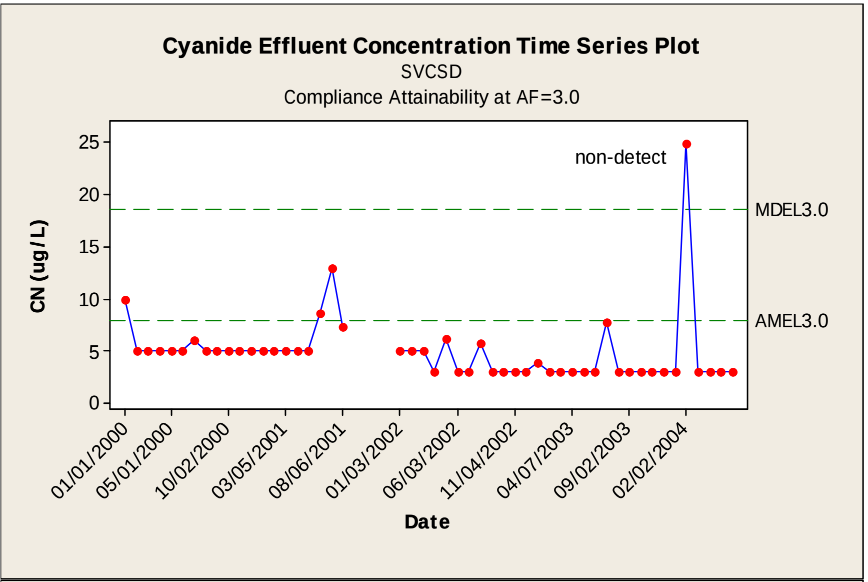

Cyanide Effluent Concentration Time Series Plot
San Jose/Santa Clara
Compliance Attainability at AF=3.5


Cyanide Effluent Concentration Time Series Plot
San Jose/Santa Clara
Compliance Attainability at AF=4.5

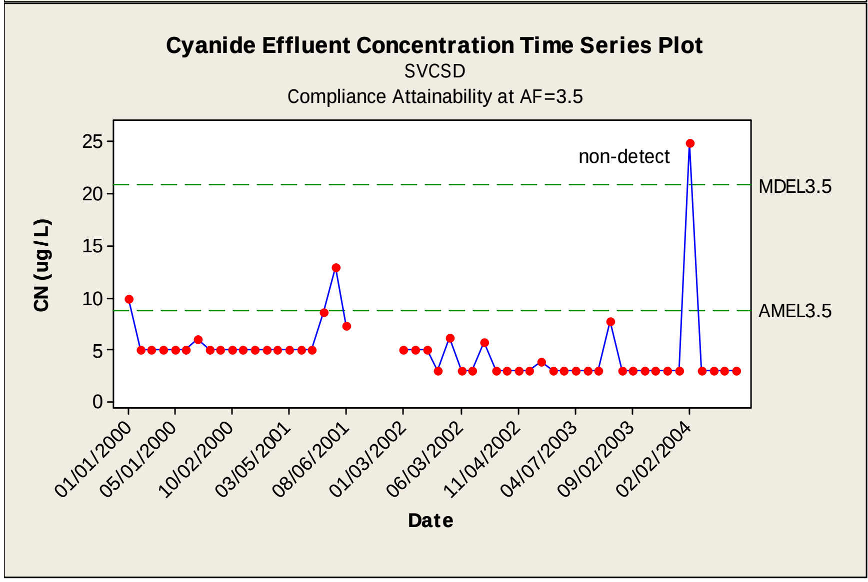
11. Sonoma Valley County Sanitation District



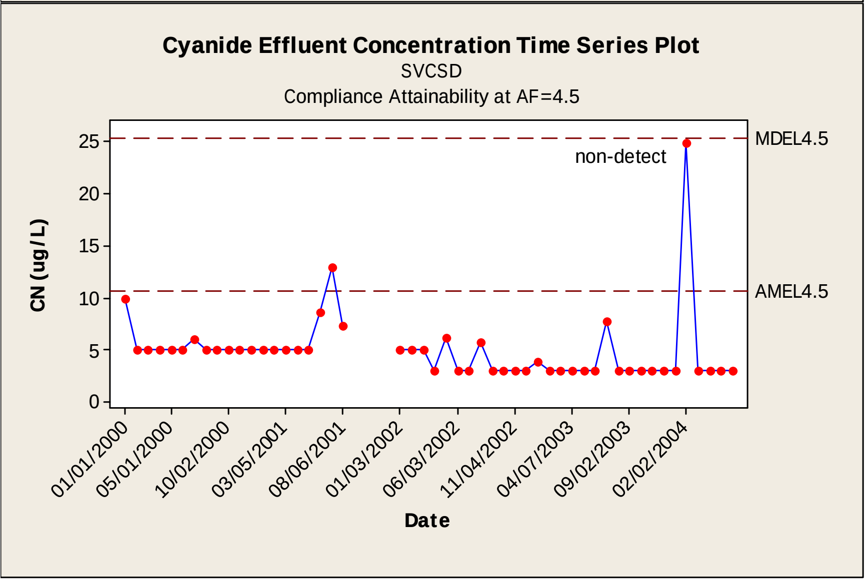
Cyanide Effluent Concentration Time Series Plot
SVCSD
Compliance Attainability at AF=2.25



Cyanide Effluent Concentration Time Series Plot
SVCSD
Compliance Attainability at AF=3.0

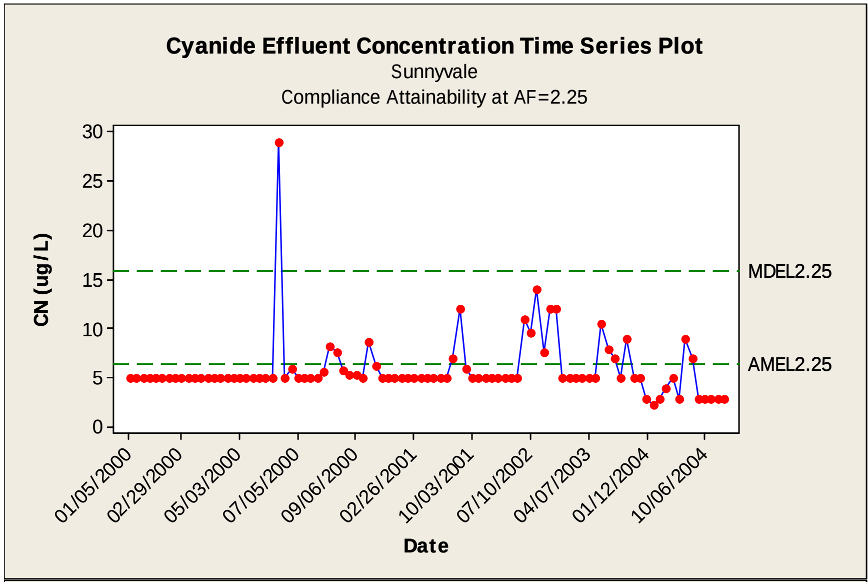


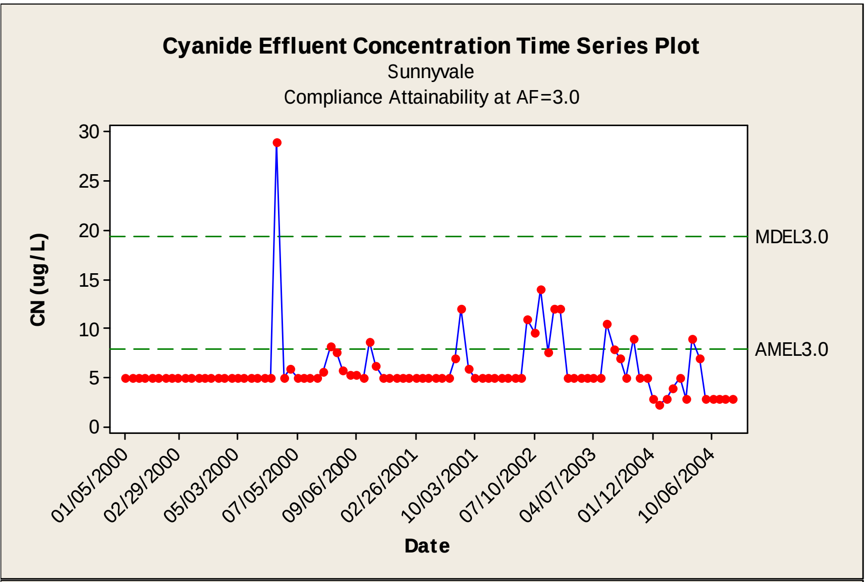
Cyanide Effluent Concentration Time Series Plot
SVCSD
Compliance Attainability at AF=3.5

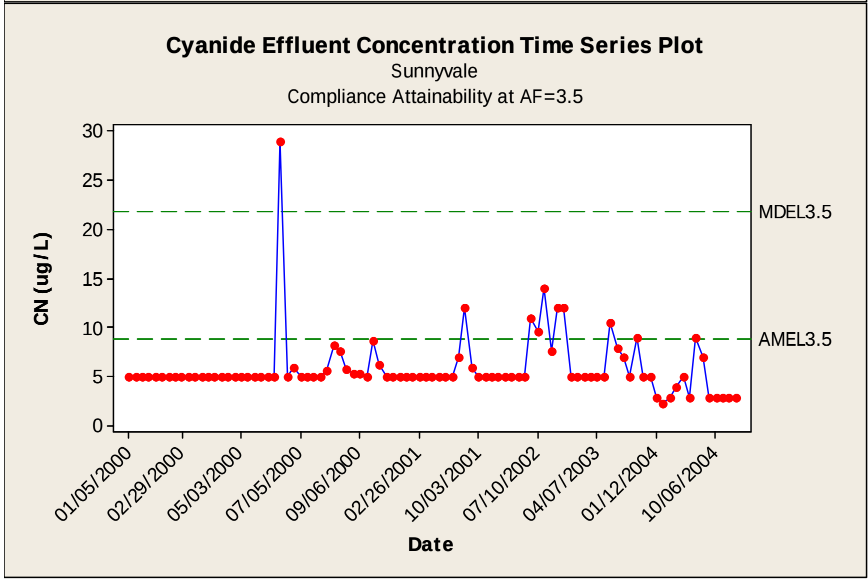


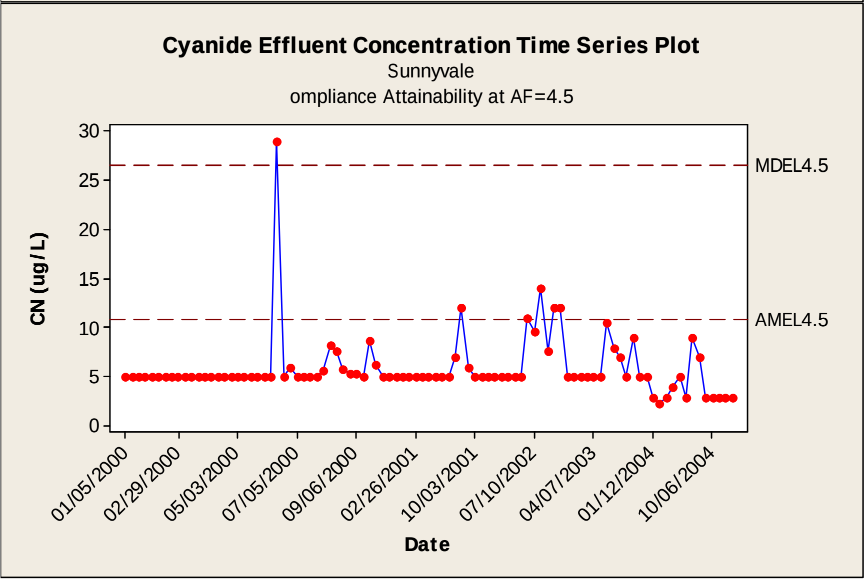
Cyanide Effluent Concentration Time Series Plot
SVCSD
Compliance Attainability at AF=4.5

12. City of Sunnyvale

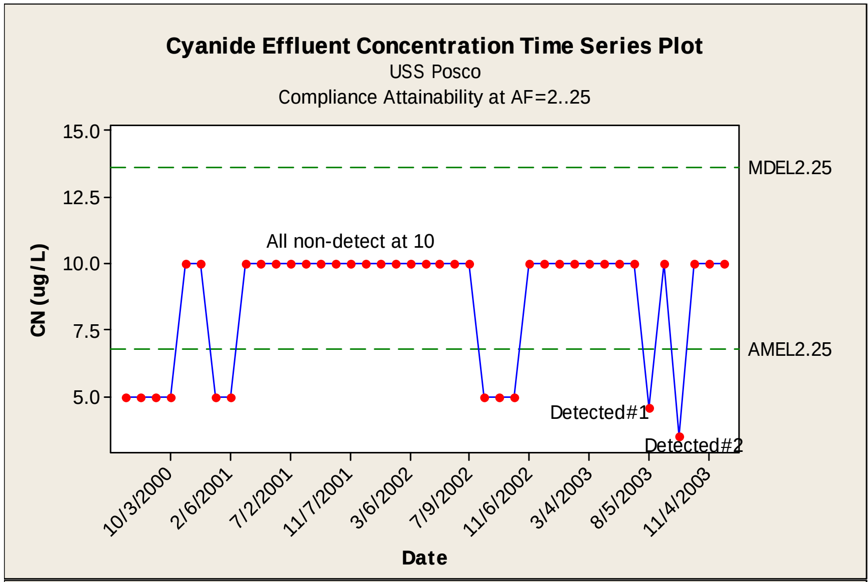

Cyanide Effluent Concentration Time Series Plot
Sunnyvale
Compliance Attainability at AF=2.25

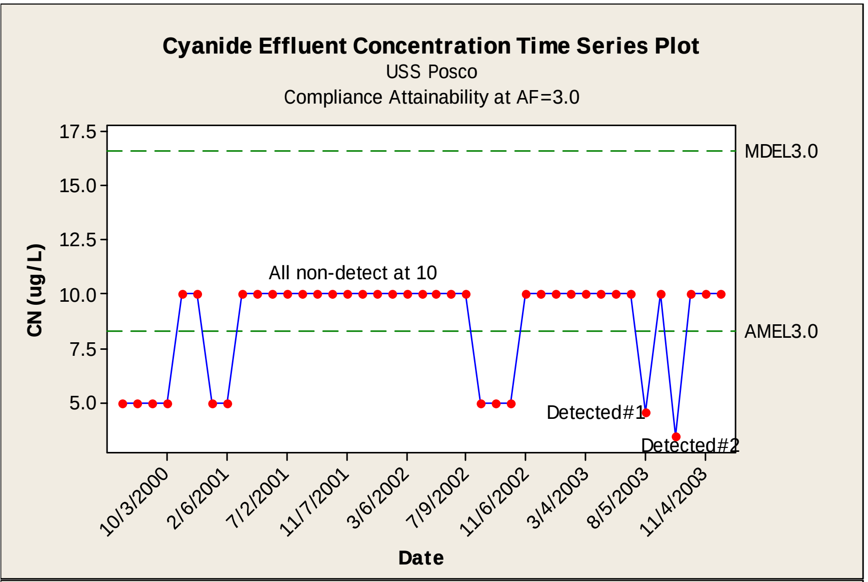

Cyanide Effluent Concentration Time Series Plot
Sunnyvale
Compliance Attainability at AF=3.0


Cyanide Effluent Concentration Time Series Plot
Sunnyvale
Compliance Attainability at AF=3.5


Cyanide Effluent Concentration Time Series Plot
Sunnyvale
ompliance Attainability at AF=4.5

13. USS Posco


Cyanide Effluent Concentration Time Series Plot
USS Posco
Compliance Attainability at AF=2..25
CN (ug/L)
15.0
12.5
10.0
7.5
5.0
MDEL2.25
AMEL2.25
All non-detect at 10
Detected#1
Detected#2
10/3/2000
2/6/2001
7/2/2001
11/7/2001
3/6/2002
7/9/2002
11/6/2002
3/4/2003
8/5/2003
11/4/2003
Date


Cyanide Effluent Concentration Time Series Plot
USS Posco
Compliance Attainability at AF=3.0
CN (ug/L)
17.5
15.0
12.5
10.0
7.5
5.0
MDEL3.0
AMEL3.0
All non-detect at 10
Detected#1
Detected#2
10/3/2000
2/6/2001
7/2/2001
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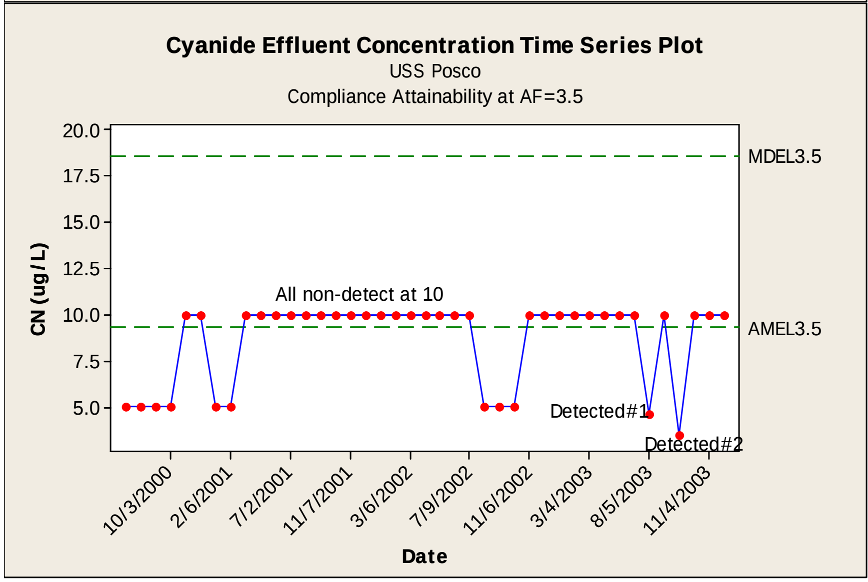
3/6/2002
7/9/2002
11/6/2002
3/4/2003
8/5/2003
11/4/2003
Date


Cyanide Effluent Concentration Time Series Plot
USS Posco
Compliance Attainability at AF=3.5
CN (ug/L)
20.0
17.5
15.0
12.5
10.0
7.5
5.0
MDEL3.5
AMEL3.5
All non-detect at 10
Detected#1
Detected#2
10/3/2000
2/6/2001
7/2/2001
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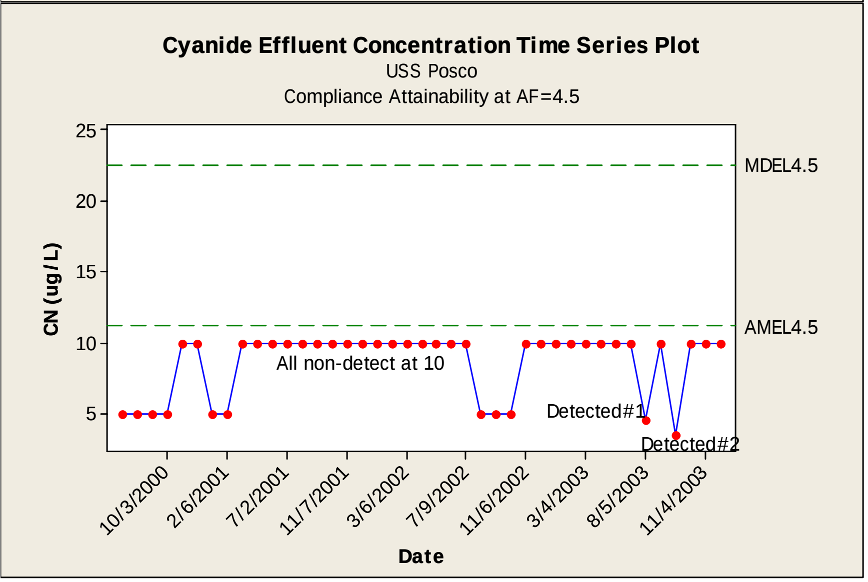
3/6/2002
7/9/2002
11/6/2002
3/4/2003
8/5/2003
11/4/2003
Date


Cyanide Effluent Concentration Time Series Plot
USS Posco
Compliance Attainability at AF=4.5
CN (ug/L)
25
20
15
10
5
MDEL4.5
AMEL4.5
All non-detect at 10
Detected#1
Detected#2
10/3/2000
2/6/2001
7/2/2001
11/7/2001
3/6/2002
7/9/2002
11/6/2002
3/4/2003
8/5/2003
11/4/2003
Date

APPENDIX G

Notice of Filing and Public Hearing

California Regional Water Quality Control Board
San Francisco Bay Region

1.1 **Linda S. Adams**
Secretary for

1515 Clay Street, Suite 1400, Oakland, California 94612
(510) 622-2300 • Fax (510) 622-2460
http://www.waterboards.ca.gov/sanfranciscobay

2 **Arnold Schwarzenegger**
Governor

August 16, 2006

NOTICE OF PUBLIC HEARINGS
NOTICE OF FILING A DRAFT ENVIRONMENTAL DOCUMENT
To Amend the
Water Quality Control Plan for the San Francisco Bay Basin

NOTICE IS HEREBY GIVEN that the San Francisco Bay Regional Water Quality Control Board (Water Board) will consider an amendment to the Water Quality Control Plan for San Francisco Bay Basin ("the Basin Plan"). The proposed amendment would:

Establish new marine site-specific water quality objectives for cyanide in San Francisco Bay, and include an implementation plan to accomplish those objectives

Action on the proposed amendment will be taken in accordance with a regulatory program certified under Section 21080.5 of the Public Resources Code as exempt from the requirement to prepare an environmental impact report under the California Environmental Quality Act (Public Resources Code Section 2100 et seq.) and with other applicable laws and regulations.

There will be two public hearings on the proposed Basin Plan amendment:

DATES:	October 11, 2006 December 13, 2006
TIME:	9:00 a.m. (approximate)
LOCATION:	Elihu M. Harris State Building First Floor Auditorium 1515 Clay Street Oakland, CA 94612
STAFF CONTACTS:	Naomi Feger San Francisco Bay Regional Water Quality Control Board 1515 Clay Street, Suite 1400 Oakland, CA 94612 510.622.2328 (ph.) 510.622.2460 (fax) nfeger@waterboards.ca.gov
	Barbara Baginska San Francisco Bay Regional Water Quality Control Board 1515 Clay Street, Suite 1400 Oakland, CA 94612 510.622.2474 (ph.) 510.622.2460 (fax) bbaginska@waterboards.ca.gov

MATERIALS: The proposed Basin Plan amendment, supporting staff report, and other documentation will be available online on August 18, 2006 at www.waterboards.ca.gov/sanfranciscobay/basinplan.htm . Paper copies will also be available from:

Terry Adams
San Francisco Bay Regional Water Quality Control Board
1515 Clay Street, Suite 1400
Oakland, CA 94612
510.622.2306 (ph.)
510.622.2460 (fax)
tadams@waterboards.ca.gov

The 45 day public comment period for the proposed amendment expires at 5:00 p.m. on **October 2, 2006**. All written comments, evidence, proposed testimony and exhibits on or concerning the proposed amendment shall be submitted no later than this date and time to either of the staff contacts identified above. Non-evidentiary policy statements to be made at the October hearing need not be submitted in advance.

The Water Board will receive oral public testimony on the proposed amendment at the October hearing. At the conclusion of the October hearing, in response to written comments and testimony received, the Water Board may recommend that staff make changes to the proposed amendment to be presented for its consideration at the subsequent hearing.

The Water Board will not take action until the December hearing. Water Board staff will release any proposed changes to the proposed Basin Plan amendment and/or accompanying staff report prior to the December hearing. Oral public testimony at the December hearing will be limited to comments on changes to the Basin Plan amendment the Water Board or its staff may propose subsequent to the August 18 version. At the conclusion of the December hearing, the Water Board will consider adoption of the proposed Basin Plan amendment, including changes to the proposed amendment that are consistent with the general purpose of the proposed amendment and are a logical outgrowth of the evidence and testimony received.

The public hearings will be conducted in accordance with 23 Cal. Code of Regs. § 649.3. Time limits may be imposed on oral testimony at the public hearings; groups are encouraged to designate a spokesperson.

A map and directions to the hearing are available online at www.waterboards.ca.gov/sanfranciscobay/direction.htm . The location of the hearings is accessible to persons with disabilities. Individuals who require special accommodations are requested to contact Executive Assistant Mary Tryon, (510) 622 2399, mtryon@waterboards.ca.gov, at least five (5) working days before a meeting. TTY users may contact the California Relay Service at 1-800-735-2929 or voice line at 1-800-735-2922.

Bruce H. Wolfe
Executive Officer

APPENDIX H

Environmental Checklist

1. **Project Title:** Adoption of site-specific water quality objectives for cyanide for San Francisco Bay.

2. **Lead Agency Name and Address:**
California Regional Water Quality Control Board,
San Francisco Bay Region
1515 Clay Street, Suite 1400
Oakland, California 94612

3. **Contact Person and Phone Number:**

Naomi Feger	(510) 622-2328
Barbara Baginska	(510) 622-2474

4. **Project Location:** San Francisco Bay

5. **Project Sponsor's Name and Address:**
California Regional Water Quality Control Board,
San Francisco Bay Region
1515 Clay Street, Suite 1400
Oakland, California 94612

6. **General Plan Designation:** Not Applicable

7. **Zoning:** Not Applicable

8. **Description of Project:**

   The project is a proposed Basin Plan amendment adopting new cyanide water quality objectives for San Francisco Bay. Additional details are provided in the attached explanation.

9. **Surrounding Land Uses and Setting:**

   San Francisco Bay is surrounded by urban areas.

10. **Other public agencies whose approval is required** (e.g., permits, financing approval, or participation agreement.)

    The California State Water Resources Control Board, the California Office of Administrative Law, and the U.S. Environmental Protection Agency must approve the proposed Basin Plan amendment.

ENVIRONMENTAL IMPACTS:

Issues:	*Potentially Significant Impact*	*Less Than Significant With Mitigation Incorporation*	*Less Than Significant Impact*	*No Impact*
I. AESTHETICS -- Would the project:				
a) Have a substantial adverse effect on a scenic vista?	☐	☐	☐	☒
b) Substantially damage scenic resources, including, but not limited to, trees, rock outcroppings, and historic buildings within a state scenic highway?	☐	☐	☐	☒
c) Substantially degrade the existing visual character or quality of the site and its surroundings?	☐	☐	☐	☒
d) Create a new source of substantial light or glare which would adversely affect day or nighttime views in the area?	☐	☐	☐	☒
II. AGRICULTURE RESOURCES -- In determining whether impacts to agricultural resources are significant environmental effects, lead agencies may refer to the California Agricultural Land Evaluation and Site Assessment Model (1997) prepared by the California Department of Conservation as an optional model to use in assessing impacts on agriculture and farmland. **Would the project:**				
a) Convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance (Farmland), as shown on the maps prepared pursuant to the Farmland Mapping and Monitoring Program of the California Resources Agency, to non-agricultural use?	☐	☐	☐	☒
b) Conflict with existing zoning for agricultural use, or a Williamson Act contract?	☐	☐	☐	☒
c) Involve other changes in the existing environment which, due to their location or nature, could result in conversion of Farmland, to non-agricultural use?	☐	☐	☐	☒

ENVIRONMENTAL IMPACTS:

Issues:	*Potentially Significant Impact*	*Less Than Significant With Mitigation Incorporation*	*Less Than Significant Impact*	*No Impact*
III. AIR QUALITY -- Where available, the significance criteria established by the applicable air quality management or air pollution control district may be relied upon to make the following determinations. **Would the project:**				
a) Conflict with or obstruct implementation of the applicable air quality plan?	☐	☐	☐	☒
b) Violate any air quality standard or contribute substantially to an existing or projected air quality violation?	☐	☐	☐	☒
c) Result in a cumulatively considerable net increase of any criteria pollutant for which the project region is non-attainment under an applicable federal or state ambient air quality standard (including releasing emissions which exceed quantitative thresholds for ozone precursors)?	☐	☐	☐	☒
d) Expose sensitive receptors to substantial pollutant concentrations?	☐	☐	☐	☒
e) Create objectionable odors affecting a substantial number of people?	☐	☐	☐	☒
IV. BIOLOGICAL RESOURCES -- Would the project:				
a) Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations, or by the California Department of Fish and Game or U.S. Fish and Wildlife Service?	☐	☐	☒	☐
b) Have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, regulations or by the California Department of Fish and Game or U.S. Fish and Wildlife Service?	☐	☐	☐	☒

ENVIRONMENTAL IMPACTS:

Issues:	*Potentially Significant Impact*	*Less Than Significant With Mitigation Incorporation*	*Less Than Significant Impact*	*No Impact*
IV. BIOLOGICAL RESOURCES -- (cont.):				
c) Have a substantial adverse effect on federally protected wetlands as defined by Section 404 of the Clean Water Act (including, but not limited to, marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means?	☐	☐	☐	☒
d) Interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites?	☐	☐	☐	☒
e) Conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance?	☐	☐	☐	☒
f) Conflict with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional, or state habitat conservation plan?	☐	☐	☐	☒
V. CULTURAL RESOURCES -- Would the project:				
a) Cause a substantial adverse change in the significance of a historical resource as defined in §15064.5?	☐	☐	☐	☒
b) Cause a substantial adverse change in the significance of a unique archaeological resource pursuant to §15064.5?	☐	☐	☐	☒
c) Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature?	☐	☐	☐	☒
d) Disturb any human remains, including those interred outside of formal cemeteries?	☐	☐	☐	☒

ENVIRONMENTAL IMPACTS:

Issues:	*Potentially Significant Impact*	*Less Than Significant With Mitigation Incorporation*	*Less Than Significant Impact*	*No Impact*
VI. GEOLOGY AND SOILS -- Would the project:				
a) Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:				
i) Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault? Refer to Division of Mines and Geology Special Publication 42.	☐	☐	☐	☒
ii) Strong seismic ground shaking?	☐	☐	☐	☒
iii) Seismic-related ground failure, including liquefaction?	☐	☐	☐	☒
iv) Landslides?	☐	☐	☐	☒
b) Result in substantial soil erosion or the loss of topsoil?	☐	☐	☐	☒
c) Be located on geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse?	☐	☐	☐	☒
d) Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial risks to life or property?	☐	☐	☐	☒
e) Have soils incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems where sewers are not available for the disposal of wastewater?	☐	☐	☐	☒
VII. HAZARDS AND HAZARDOUS MATERIALS -- Would the project:				
a) Create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials?	☐	☐	☐	☒

ENVIRONMENTAL IMPACTS:

Issues:	*Potentially Significant Impact*	*Less Than Significant With Mitigation Incorporation*	*Less Than Significant Impact*	*No Impact*
VII. HAZARDS AND HAZARDOUS MATERIALS -- (cont.):				
b) Create a significant hazard to the public or the environment through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment?	☐	☐	☐	☒
c) Emit hazardous emissions or handle hazardous or acutely hazardous materials, substances, or waste within one-quarter mile of an existing or proposed school?	☐	☐	☐	☒
d) Be located on a site which is included on a list of hazardous materials sites compiled pursuant to Government Code Section 65962.5 and, as a result, would it create a significant hazard to the public or the environment?	☐	☐	☐	☒
e) For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project result in a safety hazard for people residing or working in the project area?	☐	☐	☐	☒
f) For a project within the vicinity of a private airstrip, would the project result in a safety hazard for people residing or working in the project area?	☐	☐	☐	☒
g) Impair implementation of or physically interfere with an adopted emergency response plan or emergency evacuation plan?	☐	☐	☐	☒
h) Expose people or structures to a significant risk of loss, injury or death involving wildland fires, including where wildlands are adjacent to urbanized areas or where residences are intermixed with wildlands?	☐	☐	☐	☒

ENVIRONMENTAL IMPACTS:

Issues:	*Potentially Significant Impact*	*Less Than Significant With Mitigation Incorporation*	*Less Than Significant Impact*	*No Impact*
VIII. HYDROLOGY AND WATER QUALITY -- Would the project:				
a) Violate any water quality standards or waste discharge requirements?	☐	☐	☐	☒
b) Substantially deplete groundwater supplies or interfere substantially with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level (e.g., the production rate of pre-existing nearby wells would drop to a level which would not support existing land uses or planned uses for which permits have been granted)?	☐	☐	☐	☒
c) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, in a manner which would result in substantial erosion of siltation on- or off-site?	☐	☐	☐	☒
d) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, or substantially increase the rate or amount of surface runoff in a manner which would result in flooding on- or off-site?	☐	☐	☐	☒
e) Create or contribute runoff water which would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff?	☐	☐	☐	☒
f) Otherwise substantially degrade water quality?	☐	☐	☐	☒
g) Place housing within a 100-year flood hazard area as mapped on a federal Flood Hazard Boundary or Flood Insurance Rate Map or other flood hazard delineation map?	☐	☐	☐	☒
h) Place within a 100-year flood hazard area structures which would impede or redirect flood flows?	☐	☐	☐	☒

ENVIRONMENTAL IMPACTS:

Issues:	*Potentially Significant Impact*	*Less Than Significant With Mitigation Incorporation*	*Less Than Significant Impact*	*No Impact*
VIII. HYDROLOGY AND WATER QUALITY – (cont.):				
i) Expose people or structures to a significant risk of loss, injury or death involving flooding, including flooding as a result of the failure of a levee or dam?	☐	☐	☐	☒
j) Inundation of seiche, tsunami, or mudflow?	☐	☐	☐	☒
IX. LAND USE AND PLANNING -- Would the project:				
a) Physically divide an established community?	☐	☐	☐	☒
b) Conflict with any applicable land use plan, policy, or regulation of an agency with jurisdiction over the project (including, but not limited to the general plan, specific plan, local coastal program, or zoning ordinance) adopted for the purpose of avoiding or mitigating an environmental effect?	☐	☐	☐	☒
c) Conflict with any applicable habitat conservation plan or natural community conservation plan?	☐	☐	☐	☒
X. MINERAL RESOURCES -- Would the project:				
a) Result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the state?	☐	☐	☐	☒
b) Result in the loss of availability of a locally-important mineral resource recovery site delineated on a local general plan, specific plan or other land use plan?	☐	☐	☐	☒
XI. NOISE -- Would the project result in:				
a) Exposure of persons to or generation of noise levels in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies?	☐	☐	☐	☒

ENVIRONMENTAL IMPACTS:

Issues:	*Potentially Significant Impact*	*Less Than Significant With Mitigation Incorporation*	*Less Than Significant Impact*	*No Impact*
XI. NOISE – (cont.) in:				
b) Exposure of persons to or generation of excessive groundborne vibration or groundborne noise levels?	☐	☐	☐	☒
c) A substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project?	☐	☐	☐	☒
d) A substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project?	☐	☐	☐	☒
e) For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project expose people residing or working in the project area to excessive noise levels?	☐	☐	☐	☒
f) For a project within the vicinity of a private airstrip, would the project expose people residing or working in the project area to excessive noise levels?	☐	☐	☐	☒
XII. POPULATION AND HOUSING -- Would the project:				
a) Induce substantial population growth in an area, either directly (for example, by proposing new homes and businesses) or indirectly (for example, through extension of roads or other infrastructure)?	☐	☐	☐	☒
b) Displace substantial numbers of existing housing, necessitating the construction of replacement housing elsewhere?	☐	☐	☐	☒
c) Displace substantial numbers of people necessitating the construction of replacement housing elsewhere?	☐	☐	☐	☒

ENVIRONMENTAL IMPACTS:

Issues:	*Potentially Significant Impact*	*Less Than Significant With Mitigation Incorporation*	*Less Than Significant Impact*	*No Impact*
XIII. PUBLIC SERVICES --				
a) Would the project result in substantial adverse physical impacts associated with the provision of new or physically altered governmental facilities, need for new or physically altered governmental facilities, the construction of which could cause significant environmental impacts, in order to maintain acceptable service ratios, response times, or other performance objectives for any of the public services:				
Fire protection?	☐	☐	☐	☒
Police protection?	☐	☐	☐	☒
Schools?	☐	☐	☐	☒
Parks?	☐	☐	☐	☒
Other public facilities?	☐	☐	☐	☒
XIV. RECREATION --				
a) Would the project increase the use of existing neighborhood and regional parks or other recreational facilities such that substantial physical deterioration of the facility would occur or be accelerated?	☐	☐	☐	☒
b) Does the project include recreational facilities or require the construction or expansion of recreational facilities which might have an adverse physical effect on the environment?	☐	☐	☐	☒
XV. TRANSPORTATION / TRAFFIC -- Would the project:				
a) Cause an increase in traffic which is substantial in relation to the existing traffic load and capacity of the street system (i.e., result in a substantial increase in either the number of vehicle trips, the volume-to-capacity ratio on roads, or congestion at intersections)?	☐	☐	☐	☒
b) Exceed, either individually or cumulatively, a level of service standard established by the county congestion management agency for designated roads or highways?	☐	☐	☐	☒
c) Result in a change in air traffic patterns, including either an increase in traffic levels or a change in location that results in substantial safety risks?	☐	☐	☐	☒

ENVIRONMENTAL IMPACTS:

XV. TRANSPORTATION / TRAFFIC – (cont.):

Issues:	*Potentially Significant Impact*	*Less Than Significant With Mitigation Incorporation*	*Less Than Significant Impact*	*No Impact*
d) Substantially increase hazards due to a design feature (e.g., sharp curves or dangerous intersections) or incompatible uses (e.g., farm equipment)?	☐	☐	☐	☒
e) Result in inadequate emergency access?	☐	☐	☐	☒
f) Result in inadequate parking capacity?	☐	☐	☐	☒
g) Conflict with adopted policies, plans, or programs supporting alternative transportation (e.g., bus turnouts, bicycle racks)?	☐	☐	☐	☒

XVI. UTILITIES AND SERVICE SYSTEMS -- Would the project:

Issues:	*Potentially Significant Impact*	*Less Than Significant With Mitigation Incorporation*	*Less Than Significant Impact*	*No Impact*
a) Exceed wastewater treatment requirements of the applicable Regional Water Quality Control Board?	☐	☐	☐	☒
b) Require or result in the construction of new water or wastewater treatment facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?	☐	☐	☐	☒
c) Require or result in the construction of new storm water drainage facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?	☐	☐	☐	☒
d) Have sufficient water supplies available to serve the project from existing entitlements and resources, or are new or expanded entitlements needed?	☐	☐	☐	☒
e) Result in a determination by the wastewater treatment provider which serves or may serve the project that it has adequate capacity to serve the project's projected demand in addition to the provider's existing commitments?	☐	☐	☐	☒
f) Be served by a landfill with sufficient permitted capacity to accommodate the project's solid waste disposal needs?	☐	☐	☐	☒

ENVIRONMENTAL IMPACTS:

Issues:	*Potentially Significant Impact*	*Less Than Significant With Mitigation Incorporation*	*Less Than Significant Impact*	*No Impact*
XVI. UTILITIES AND SERVICE SYSTEMS – (cont.):				
g) Comply with federal, state, and local statutes and regulations related to solid waste?	☐	☐	☐	☒

Issues:	*Potentially Significant Impact*	*Less Than Significant With Mitigation Incorporation*	*Less Than Significant Impact*	*No Impact*
XVII. MANDATORY FINDINGS OF SIGNIFICANCE				
a) Does the project have the potential to degrade the quality of the environment, substantially reduce the habitat of a fish or wildlife species, cause a fish or wildlife population to drop below self-sustaining levels, threaten to eliminate a plant or animal community, reduce the number or restrict the range of a rare or endangered plant or animal or eliminate important examples of the major periods of California history or prehistory?	☐	☐	☐	☒
b) Does the project have impacts that are individually limited, but cumulative considerable? ("Cumulative considerable" means that the incremental effects of a project are considerable when viewed in connection with the effects of past projects, the effects of other current projects, and the effects of probable future projects)?	☐	☐	☐	☒
c) Does the project have environmental effects which will cause substantial adverse effects on human beings, either directly or indirectly?	☐	☐	☐	☒

EXPLANATION

Project Description

The proposed Project is an amendment to the Basin Plan that establishes site-specific marine water quality objectives for cyanide in San Francisco Bay and an implementation plan to ensure that existing water quality is maintained, beneficial uses are protected, and current good discharger performance sustained. It also requires the imposition of effluent limits under the "Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California" (SIP) in wastewater NPDES permits and sets forth calculated dilution credits for specific dischargers, currently authorized to discharge into shallow waters, which will be used to calculate effluent limits. In addition to site-specific objectives for cyanide, the amendment also includes clarifying language for existing copper and nickel site-specific objectives, imposing effluent limits in Lower South San Francisco Bay NPDES permits.

The proposed objectives are based on the U.S. EPA promulgated National Toxics Rule (NTR) marine cyanide criteria, which have been modified for San Francisco Bay. The same criteria were adopted by the State of Washington for Puget Sound in 1997. The amendment proposes to adopt an acute water quality objective of 9.4 μg/L and a chronic water quality objective of 2.9 μg/L which are less stringent than the NTR criteria of 1.0 μg/L for both acute and chronic water quality objectives. The new objectives better reflect the most recent toxicity data for four *Cancer* species that are common to San Francisco Bay.

Environmental Analysis

The proposed project will not have a significant impact on the environment. The proposed site-specific objectives are fully protective of the most sensitive beneficial uses, as fully explained throughout the Staff Report. Additionally, the implementation plan ensures that dischargers continue to maintain or improve their current good performance. As explained in the Staff Report, less stringent effluent limits derived from the relaxed site-specific objectives and the application of dilution credits for shallow water dischargers, are not likely to increase loadings into the San Francisco Bay (see Staff Report Section 9.4 (Anti-degradation)). In the unlikely event that effluent concentrations increase in response to less stringent effluent limits, the cyanide loadings would increase by less than 15 kilograms per day over current loadings. Under this worst-case scenario, this additional loading is minor considering the assimilative capacity of the Bay for cyanide and considering that cyanide attenuates quickly. In any case, even under unlikely worst-case scenario, even the most sensitive beneficial uses would continue to be protected and there would be no significant adverse impacts.

An explanation for each box checked on the environmental checklist is provided below:

I. Aesthetics

Any physical changes to the aesthetic environment as a result of the Basin Plan amendment would be small in scale. The Basin Plan amendment would not substantially affect any scenic resource or vista, or degrade the existing visual character or quality of any site or its surroundings. It would not create any new source of light or glare.

II. Agriculture Resources

The proposed Basin Plan amendment and implementation would not result in any changes to agricultural resources and would not contribute to the conversion of farmland to non-agricultural use. It would not affect agricultural zoning or any Williamson Act contract.

III. Air Quality

The proposed Basin Plan amendment will not have adverse impacts on air quality. As it would not cause any change in population or employment, it would not generate ongoing traffic-related emissions. It would also not involve the construction of any permanent emissions sources. For these reasons, no permanent change in air emissions would occur, and the Basin Plan amendment would not conflict with applicable air quality plans. It would not expose sensitive receptors to ongoing pollutant emissions and therefore would not pose health risks or create objectionable odors.

IV. Biological Resources

The Basin Plan amendment is designed to protect biological resources, including wildlife and rare and endangered species. Two key issues were considered while assessing whether the proposed amendment was protective of biological resources: (1) the measured and potential sensitivity of species relative to the proposed objective and (2) potential frequency and duration of exposure to cyanide concentrations approaching the proposed objective. The existing cyanide toxicity studies document that the proposed site-specific objectives for cyanide are protective of sensitive saltwater and freshwater aquatic organisms. Available data show that, rainbow trout is the most sensitive fish tested among marine and freshwater species. The proposed acute objective of 9.4 μg/L is more than four times lower than the Species Mean Acute Value (44.73 μg/L) for rainbow trout (*Oncorhynchus mykiss*) ensuring a level of protectiveness. Similarly, the proposed chronic site-specific objective of 2.9 μg/L is much smaller than the cyanide concentration of 8 μg/L, the concentration at which the brook trout (*Salvelinus fontinalis*) starts exhibiting adverse effects.

Under the proposed Basin Plan amendment, existing shallow water dischargers will have water quality-based effluent limits to implement the site-specific objectives. The NPDES permit process will ensure that the sources of cyanide in the treatment plant influent are tracked and regulated by the dischargers and that the occurrences of elevated cyanide concentrations in the effluent are short-term only. Increased cyanide levels will be limited to any assigned mixing zone and will not exceed the acute toxic conditions as described above.

V. Cultural Resources

The Basin Plan amendment and the implementation plan for cyanide would not directly affect cultural resources.

VI. Geology and Soils

The implementation activities resulting from the Basin Plan amendment do not involve construction, earthmoving or soil disturbing activities and therefore would not adversely impact local geology and soils.

VII. Hazards and Hazardous Materials

The proposed Basin Plan amendment and the implementation plan for cyanide address water quality issues and would not directly involve the handling or transport of hazards and hazardous materials. Hazardous waste management activities resulting from the Basin Plan amendment would not interfere with any emergency response plans or emergency evacuation plans and would not affect the potential for wildland fires.

VIII. Hydrology and Water Quality

The proposed project amends the Basin Plan to establish site-specific marine water quality objectives for cyanide that relax the current National Toxics Rule objectives of 1 µg/L.

The results of the Regional Monitoring Program confirm that ambient cyanide concentrations in the water column of San Francisco Bay are consistently low and currently do not exceed 0.4 µg/L despite industrial and municipal wastewater discharges to the Bay containing cyanide. This suggests that the controls on wastewater dischargers have been adequate to prevent degradation or water quality impairment with respect to cyanide and that source control programs that are in place are sufficient. The proposed amendment will not affect these controls and the ambient water quality conditions should not change despite relaxing water quality objectives. In addition, this project contains an implementation plan that describes a monitoring strategy to ensure that ambient cyanide concentrations in San Francisco Bay are maintained. It is proposed that dischargers will monitor ambient levels of cyanide. An ambient trigger concentration of 1 µg/L will be established as the basis for initiation of localized review of effluent limit compliance where the trigger is exceeded.

Increased loadings due to less stringent water quality objectives are unlikely to occur as current performance by wastewater dischargers is expected at a minimum to be maintained after the Basin Plan amendment is adopted.

IX. Land Use and Planning

The Basin Plan amendment regulates water quality and would not conflict with any land use plan, policy, or regulation, and would not affect any habitat conservation plan or natural community conservation plan.

X. Mineral Resources

The proposed project addresses water quality and will not have any impact on mineral resources.

XI. Noise

The proposed project addresses water quality and will not directly cause an increase in noise levels.

XII. Population and Housing

The Basin Plan amendment would not affect the population of the Bay Area, Central Valley, or California. It would not induce growth through such means as constructing new housing or businesses, or by extending roads or infrastructure. The Basin Plan amendment would also not displace any existing housing or any people that would need replacement housing.

XIII. Public Services

The Basin Plan amendment would not affect populations or involve construction of substantial new government facilities. The Basin Plan amendment would not affect service ratios, response times, or other performance objectives for any public services, including fire protection, police protection, schools, or parks.

XIV. Recreation

The proposed project addresses water quality and will not directly affect recreational activities. No recreational facilities would need to be constructed or expanded.

XV. Transportation / Traffic

Because the Basin Plan amendment would not increase population or provide employment, it would not affect transportation facilities or generate any additional traffic.

XVI. Utilities and Service Systems

The project would amend the Basin Plan, which is the basis for wastewater treatment requirements in the Bay Area; therefore, the Basin Plan amendment would be consistent with such requirements.

Because the Basin Plan amendment would not affect water demands or supplies, it would not require the construction of new or expanded water or wastewater treatment facilities and storm water management facilities.

XVII. Mandatory Findings of Significance

The proposed Basin Plan amendment is intended to maintain all beneficial uses in San Francisco Bay. The proposed amendment does not have the potential to degrade the quality of the environment, substantially reduce fish or wildlife habitat, cause fish or wildlife population to drop below self-sustaining levels or threaten to eliminate a plant or animal community. The proposed amendment is based on the latest science pertaining to the toxicity of cyanide to aquatic organisms. Therefore, the proposed water quality objectives will fully protect beneficial uses of the Bay.

There are no potential adverse impacts that would interact in such a way as to further degrade the environment and no cumulative effects would occur. Therefore, the incremental effects of the Basin Plan amendment would be negligible when viewed in the context of the overall environmental changes foreseeable in the Bay Area as California's population grows and urban development occurs. For this reason, the Basin Plan amendment's cumulative effects would be less-than-significant, and adopting the Basin Plan amendment would require no mandatory findings of significance.

There are no direct significant impacts from the proposed project that would cause adverse effects to human beings. There are also no indirect, significant adverse impacts resulting from the proposed Basin Plan amendment and implementation plan.

APPENDIX I

Draft Model Permit Language for Municipal Dischargers

DRAFT MODEL NPDES PERMIT PROVISION FOR MUNICIPAL WASTEWATER DISCHARGERS - SAN FRANCISCO BAY

Cyanide Action Plan

As part of the implementation of the marine cyanide site-specific objective, the discharger shall implement appropriate pretreatment, source control and pollution prevention for cyanide. The discharger shall consider reductions in effluent concentration achieved through source control and economically feasible optimization of treatment plant processes if new information on cyanide minimization in disinfection processes becomes available. Identifying contributors of cyanide from the discharger's service area shall be in accordance with the following tasks and time schedule.

Task	Compliance Date
(1) Review and Update of Potential Cyanide Contributors	no later than 3 months after permit adoption

Submit an inventory of all potential contributors of cyanide to the treatment plant, acceptable to the Executive Officer, and proceed with Task 2, below. If no contributors of cyanide from the discharger's service area are identified, no further action is required during the life of this permit, unless the discharger receives a request to discharge detectable levels of cyanide to the sanitary sewer. In such an event the discharger will notify the Executive Officer and proceed with Task 2, below.

(2) Implement Cyanide Pollution Prevention Program

Submittal of Final Report	1 year after completion of Task 1

The discharger shall implement a local program aimed at the prevention of illicit discharges of cyanide to the sewer system. The local program shall consist, at a minimum, of the following elements:

a) Maintain list of potential contributors (e.g., metal plating operations, hazardous waste recycling, etc.).

b) Monitor total cyanide monthly in influents and effluents using low detection level cyanide analytical methods.

c) Within a year of permit adoption, perform a site inspection of each potential contributor to assess the need to include the facility in an ongoing program.

d) For facilities in the ongoing program or those covered by the pretreatment program, follow EPA Guidance, such as Industrial User Inspection and Sampling Manual for POTWs (EPA 831-B-94-01), that provides inspection and wastewater sampling procedures such as:

- Perform routine inspections of facilities.
- Develop and distribute educational materials regarding the need to prevent illicit discharges to the sewer system.

e) Prepare an emergency monitoring and response plan to be implemented in the event that a significant cyanide discharge occurs that causes an exceedance of effluent limits. The Plan should include procedures to verify the delivery, use and shipment of cyanide from a facility suspected of illicit discharges (i.e., verify that State Hazardous Waste Manifests are consistent with the facility's permit application and self-monitoring report information and comparable to other disposal practices of similar local facilities).

f) Submit Final Report acceptable to the Executive Officer, documenting the above, within one year after completion of Task (1).

APPENDIX J

Basin Plan and SIP Requirements for Approval of Dilution Credit for Shallow Water Dischargers

There are provisions imposed by the San Francisco Bay Water Quality Control Plan (Basin Plan) and the *Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays and Estuaries of California* (SIP) that must be addressed as a condition of the award of a dilution credit to shallow water discharges. These provisions are discussed below.

Basin Plan:

The Basin Plan allows that a dilution credit may be granted for shallow water dischargers on a discharger-by-discharger and pollutant-by-pollutant basis.

For the proposed Basin Plan amendment and dilution credit consideration, each shallow water discharger has been specifically evaluated. Additionally, the dilution credit in the proposed Basin Plan applies only to cyanide, satisfying the pollutant-by-pollutant requirement.

The Basin Plan also stipulates that the Water Board may "grant a dilution credit…if the discharger demonstrates that a pretreatment and source control program is in place, including the following:

- *Completion of a source identification study,*
- *Development and implementation of a source reduction plan, and*
- *Commitment of resources to fully implement the source control and reduction plan."*

As stated previously in this Staff Report, the cyanide measured in effluent is often a product of wastewater disinfection and is therefore not amenable to source control by municipal agencies. This is evident through inspection of influent and effluent cyanide data for Bay region treatment facilities (see Section 3.5) and is well supported in the literature (Zheng et al, 2004b; WERF 2003).

A number of the shallow water dischargers (Palo Alto, San Jose, Novato Sanitary District, Sonoma County Water Agency) have performed source identification studies. Industrial sources of cyanide (metal finishers and electroplaters) were identified in the Palo Alto and San Jose service areas and are being controlled through the industrial pretreatment programs at these respective municipalities. No significant cyanide sources were identified in the studies performed by Novato and Sonoma County Water Agency.

It has been demonstrated that in many treatment plants, disinfection, particularly the use of chlorination, creates a source of cyanide which obviates the need for individual cyanide source identification studies at each facility. The proposed Basin Plan amendment requires that each shallow water discharger performs an assessment of potential cyanide sources within its service area as an initial NPDES permit requirement. This will ensure that potentially significant cyanide sources are identified and will allow agencies to initiate illicit discharge prevention procedures for these sources. The NPDES permit will require the commitment of resources to fully implement source control and pollutant minimization plans.

In addition to source identification and control, the Basin Plan requires that a demonstration be made that water quality objectives will be achieved, by ensuring the following:

A demonstration that the proposed effluent limitations will result in compliance with water quality objectives, including the narrative chronic toxicity objective, in the receiving water

Effluent limitations will be established on a permit-by-permit basis. Based on the monitoring and modeling studies conducted, the projected effluent limitations derived using the proposed dilution credits will result in compliance with water quality objectives, including the narrative chronic toxicity objective, in the receiving waters. The available receiving water data (253 samples collected between 2003 to 2005 near shallow water discharges) indicate that existing concentrations of cyanide in the discharge gradients from shallow water dischargers range from less than 1 µg/L to 7.2 µg/L, and are therefore, in all cases, below the proposed acute cyanide saltwater objective of 9.4 µg/L. About ninety- five percent of the data collected from receiving waters indicate values below 2.9 µg/L, the proposed chronic objective. The receiving water samples above the chronic objective are based on one-time grab samples and are not expected to be sustained for a four-day period of time, the applicable duration of the chronic objective. In addition, the proposed Cyanide Action Plan will include cyanide as a pollutant of concern for all dischargers in their Pollutant Minimization Plans and will reinforce the identification and control of potentially significant illicit discharges in service areas where such sources exist, adding to the existing capability to control such discharges.

An evaluation of worst-case conditions (in terms of tidal cycle, currents, or in-stream flows, as appropriate) through monitoring and/or modeling to demonstrate that water quality objectives will continue to be met, taking into account the averaging period associated with each objective…

The monitoring and modeling performed for shallow water dischargers provides empirical evidence (n=253) and/or predicted values to address steady state conditions along the discharge gradients. The modeling considered worst case conditions and appropriate averaging periods to ensure that water quality conditions will be met. Appendix E in the Staff Report provides details of how critical design flow conditions over an extreme low tide cycle and dry season inflows were used to demonstrate mixing and effluent dilution characteristics that are representative of worst-case conditions.

An evaluation of the effects of mass loading resulting from allowing higher concentrations of pollutants in the discharge, in particular, the potential for accumulation of pollutants in aquatic life or sediments to levels that would impair aquatic life or threaten human health.

Cyanide degrades in the receiving water and does not accumulate in sediment or biota. Levels of cyanide in shallow water discharger effluent do not approach levels of concern to human health (e.g., the OEHHA drinking water public health goal of 150 µg/L).

The Basin Plan also requires that the effluent limits resulting from a dilution credit must be consistent with anti-backsliding provisions of the Clean Water Act (CWA).

Anti-backsliding provisions apply in cases where final effluent limits have been adopted in permits. For wastewater dischargers of cyanide to the San Francisco Bay, no final cyanide limits exist in their current NPDES permits. Therefore, the anti-backsliding provisions of the CWA do not apply in the case of cyanide. .

State Implementation Policy (SIP):

The "RWQCB shall consider the presence of pollutants in the discharge that are carcinogenic, teratogenic, persistent, bioaccumulative, or attractive to aquatic organisms."

As stated in Section 3.3, cyanide is not carcinogenic, teratogenic, persistent, or bioaccumulative.

The "RWQCB also shall consider…the level of flushing in water bodies such as…enclosed bays, estuaries…where pollutants may not be readily flushed through the system."

The monitoring and modeling studies used in the consideration of dilution credits and mixing zones along the discharge gradients reflect consideration of the hydrodynamics that occur near shallow water discharges and provide evidence of tidal mixing, dilution or degradation. Because cyanide degrades rapidly, does not accumulate in the Bay, and is present at low ambient concentrations in the Bay, it appears to readily flush through the system.

Mixing zone study and mixing zone conditions

An independent monitoring or modeling study was performed by each shallow water discharger to evaluate dilution and degradation of cyanide in the receiving waters following the procedures set in the SIP for incompletely mixed discharges (Table 1). The methodology employed to determine dilution credits from these studies is summarized in Section 6 and is detailed in Appendix K.

"A mixing zone shall be as small as practicable."

The extent of the mixing zone for each discharger is defined in Appendix D and is summarized in Table 1. The proposed mixing zones were selected to be as small as practicable.

Table 1: Description of mixing zone studies and dimensions to establish dilution credits for shallow water dischargers in San Francisco Bay.

Discharger	**Immediate Receiving Water Body** [a]	**Study Type**	**Mixing Zone Area** (acres)	**Receiving Water Area** (acres)	**Description**
American Canyon	North Slough	Monitoring	0.3	32	Dead-end slough to Napa River (estuarine)
Fairfield Suisun Sewer District	Boynton Slough	Monitoring/ Modeling	3.5	35	Dead-end slough to Suisun Slough/ Marsh
Hayward Marsh	Hayward Marsh	Modeling	6.2 [b]	40	Wetlands (man-made dead-end system) to Lower San Francisco Bay
Las Gallinas	Miller Creek	Monitoring	1.0	8	Minor tributary to San Pablo Bay
Mt. View SD	McNabney Marsh/ Peyton Slough	Monitoring	0.1	135	Dead-end slough to Carquinez Strait
Napa SD	Napa River (estuarine)	Monitoring/ Modeling[c]	0.4	Less than half river width	Major tributary to San Pablo Bay
Novato SD	San Pablo Bay	Modeling	0.1	57600	950 feet off shore
City of Palo Alto	Man-made channel	Modeling	4.2	5.2	Dead-end channel to South San Francisco Bay
City of Petaluma	Petaluma River (estuarine)	Modeling	0.8	Less than half river width	Minor tributary to San Pablo Bay
City of San Jose/ Santa Clara	Artesian Slough	Monitoring	19.8	60	Dead-end slough to Coyote Creek (major tributary), South San Francisco Bay
Sonoma County Water Agency	Schell Slough	Monitoring/ Modeling	0.2	6.4	Dead-end slough San Pablo Bay
City of Sunnyvale	Moffett Channel	Monitoring	5.8	8.3	Highly modified channel to Guadalupe Slough (Minor tributary), South San Francisco Bay
USS Posco	New York Slough	Modeling	0.2	265	Dredged slough channel to Suisun Bay

[a] The estimated mixing zone does not extend beyond the water body where the effluent outfall is located. For example for Fairfield Suisun SD the mixing zone is 3.5 acres and Boynton Slough channel is 35 acres.

[b] This area represents the approximate total surface area of mixing channels that drain the marsh before discharging the excess treated effluent to Lower San Francisco Bay.

[c] Napa SD submitted a new Mixing Zone Study Report (Limno-Tech, 2006) to the Water Board as part of their permitting process. This study provides additional information on mixing and dilution under critical design flow conditions and includes tidal effects.

Also, "…a mixing zone shall not:

(1) Compromise the integrity of the entire water body…

Cyanide is not currently compromising the integrity of the Bay or the receiving waters adjacent to the proposed mixing zones. Ambient monitoring indicates that cyanide levels throughout the

Bay proper are below 0.4 µg/L, which is less than the detection limit of 1 µg/L, and significantly lower than the proposed cyanide site-specific chronic objective of 2.9 µg/L. Ambient levels of cyanide in the vicinity of the proposed mixing zones of the shallow water discharges are also below 1 µg/L. These ambient levels integrate the existing shallow water discharges of cyanide. As detailed in Section 9.4.1, the proposed consideration of dilution credits in setting effluent limits for shallow water dischargers will not cause or contribute to increased cyanide concentrations in the Bay.

(2) cause acutely toxic conditions to aquatic life passing through the mixing zone…

The copepod *Acartia clausi*, the most acutely sensitive saltwater species, has an acute LC50 value of 30 µg/L in exposures to free cyanide; Rainbow trout, the most acutely sensitive freshwater species, has an acute LC50 value of 44 µg/L free cyanide. U.S. EPA presumes that the "no acute effect" level for acute toxicity is typically one half of the LC50 value. Therefore, the approximate "no acute effect" levels for acute toxicity for *Acartia* and Rainbow trout are 15 µg/L and 22 µg/L free cyanide, respectively. Measured levels of total cyanide along the discharge gradients of shallow water dischargers are less than 7 µg/L, typically less than 3 µg/L, and do not currently approach these concentration thresholds for acute toxicity or the proposed acute objective for cyanide. Total cyanide levels along the discharge gradients are not anticipated to increase under the proposed effluent limits. Therefore, it is concluded that proposed effluent limits will not result in acutely toxic conditions in shallow water discharger mixing zones.

(3) restrict the passage of aquatic life…

Cyanide is not known to interfere with the movement of aquatic species and does not restrict the passage of aquatic life. The discharge locations are either dead-end sloughs or otherwise sited to avoid creation of migration barriers for fish.

(4) adversely impact biologically sensitive or critical habitats…

American Canyon: the mixing zone is not within a designated critical habitat. North Slough is a dead end slough channel and the mixing zone represents about 1 percent of the water body. Discharge to North Slough occurs only during the wet season. Discharge during the dry season occurs to a constructed wetland. Aquatic life in the channel is composed primarily of estuarine species. It is assumed that biologically sensitive species may occur within the slough channel and constructed wetland. Effluent data (15 samples) from American Canyon indicate that all data are below 3 µg/L. It is expected that the proposed chronic objective will be met in the receiving water and sensitive species will be protected.

Fairfield Suisun Sewer District: The mixing zone is at the edge of designated critical habitat (Suisun Marsh) for the Delta smelt. The mixing zone represents 10 percent of Boynton Slough, a slough channel within the larger Suisun Marsh and Suisun Bay. Delta smelt spawning areas are restricted to the Delta and the freshwater reaches of the San Francisco Estuary (FWS, 2004). The extent to which Delta smelt distribution varies from year to year is not well understood. Delta smelt is not known to spawn within Suisun Marsh; however, little is known about specific spawning microhabitats. Delta smelt larvae survival is linked primarily to salinity levels and temperature, which are not suitable in the uppermost northern area of the Suisun Marsh. Delta smelt that may find their way into Boyton Slough are not expected to remain within the slough channel for extended periods of time. The mixing zone is not expected to adversely impact Delta smelt or other biologically sensitive habitats.

Hayward Marsh Union Sanitary District: The mixing zone occurs in 6.2 acres of channels within a 60 acre brackish marsh. Discharge from the treatment plant is routed to freshwater treatment basins that discharge to channels within the brackish marsh. During low flow conditions, assumed in the modeling study, the mixing zone would be expected to remain within the channels. The marsh is not within a designated critical habitat. It is assumed that biologically sensitive species may occur within the marsh. Effluent data from the freshwater basins indicate average cyanide concentrations (33 samples) of 2.9 µg/L. Dilution modeling based on salinity measurements indicates a 3:25 to 1 dilution occurs within the mixing zone, thus the proposed chronic objective would be met in the receiving water and sensitive species would be protected.

Las GallinasValley Sanitary District: The mixing zone is within a designated critical habitat for steelhead trout. Surveys of Miller Creek (1981, 1993 and 1997) indicated the presence of steelhead upstream of highway 101. The outfall discharges one mile upstream from San Pablo Bay, to Miller Creek, a tidally influenced perennial creek at considerable distance from suitable spawning and rearing areas for steelhead. Discharge to Miller Creek occurs only during the wet season from November to May when freshwater flows are high. Effluent data from Las Gallinas indicate average cyanide concentrations (26 samples) of 2.6 µg/L. The mixing zone represents an area of 1 acre, which is 12 percent of this segment of Miller Creek. It is assumed that biologically sensitive species may occur within Miller Creek; however, they are likely to be fish species that are sensitive to cyanide at levels greater than the proposed acute water quality objective and would therefore be protected. Sensitive species are only expected to remain within the mixing zone for short periods of time, less than a chronic period averaging time. The available receiving water data indicate cyanide levels below the chronic objective.

Mt. View: The mixing zone is not within a designated critical habitat. The outfall discharges to a constructed marsh and then to sensitive habitat, McNabney Marsh. No detectable levels of cyanide using low detection level analytical methods have been measured in McNabney Marsh. Biologically sensitive species will not be adversely impacted by allowing a mixing zone.

Napa Sanitation District: The receiving water is the Napa River, which is designated critical habitat for steelhead trout. Discharge to the Napa River will occur only during the wet season, from November to May through a diffuser, when water levels in the River are high and predominantly fresh. Average cyanide concentrations in effluent are below the chronic objective. Modeling of the mixing zone indicates that only a portion of the width of the Napa River will be impacted by effluent discharged from the Napa Sanitation District; therefore passage of fish can occur outside of the mixing zone (Limno-Tech, 2006). Sensitive species are only expected to remain within the mixing zones for short periods of time, less than a chronic period averaging time, and will therefore not be adversely impacted.

Novato Sanitary District: The mixing zone is not within a designated critical habitat. The outfall discharges directly to San Pablo Bay in shallow water, 950 feet offshore during the wet season from November to May, via a multi-port diffuser. The mixing zone represents 0.14 acres of San Pablo Bay which is 57, 600 acres in size. Average effluent concentrations during 2000 to 2004 are below the chronic objective of 2.9 µg/L. Aquatic life is composed primarily of estuarine species. It is assumed that biologically sensitive species may occur within San Pablo Bay and are likely to move with the tides and not remain within the mixing zone for periods longer than the duration of the tidal cycle of 6 hours. Impacts to sensitive species within the mixing zone are not likely to occur.

City of Palo Alto: The receiving water is a 5.2 acre man-made channel that is not designated critical habitat. The mixing zone occurs within 4.2 acres of the man-made channel. Sampling of the effluent at the outfall indicates an average concentration of 3.3 µg/L and a maximum concentration of 5 µg/L (50 samples). Palo Alto conducted an evaluation of the biological community within its discharge channel and found that the channel supported a diverse assemblage of aquatic fauna. The study results, which included sampling at a reference site, are included in the Staff Report as Appendix M. Northern Anchovy were found to be present in the discharge channel, an indirect indicator that their food source, the copepod, was also present. Copepods (*Acartia clausi*) are the most sensitive marine species that could be present in estuarine/marine waters of the Bay. The estimated concentration of cyanide for no acute effects to the copepod is 15µg/L. Based on the biological survey, there is no indication of impacts to beneficial uses or adverse impacts to sensitive species within the mixing zone.

Petaluma: The receiving water is the Petaluma River, which is designated critical habitat for steelhead trout. However, surveys conducted within the Petaluma River to date have not found evidence of salmonids. Discharge to the Petaluma River will occur only during the wet season, from November to May when water levels in the River are high and predominantly fresh. Dilution modeling indicates that the discharge plume is distributed immediately downstream of the outfall. Therefore it is assumed that only a portion of the width of the Petaluma River will be impacted by the discharge allowing for passage of fish to occur outside of the mixing zone. Sensitive species are only expected to remain within the mixing zone for short periods of time, less than a chronic period averaging time. In addition, effluent data indicate that average cyanide concentrations are at the chronic objective. The mixing zone will not adversely impact sensitive species.

City of San Jose/Santa Clara: The mixing zone occurs within Artesian Slough which is not designated critical habitat. The size of the assigned mixing zone is 19.8 acres; however, ambient cyanide concentrations exceeding the chronic objective of 2.9µg/L were only detected sporadically within a portion of this mixing zone (6.2 acre) in close proximity to the discharge. The overall mixing zone represents less than 30 percent of Artesian Slough which is a dead-end channel. Artesian Slough discharges to Coyote Creek, which is designated critical habitat for steelhead trout. Receiving water data indicate that average concentrations within the mixing zone are generally below the chronic objective of 2.9µg/L. All concentrations of cyanide within Coyote Creek were measured at levels lower than the chronic objective. Fish migrating through Coyote Creek are expected to remain within the mixing zone in Artesian Slough for short periods of time, less than a chronic period averaging time. Biologically sensitive species are assumed to be present within Artesian Slough. It is expected that the proposed chronic objective will be met in the receiving water and concentrations of cyanide within the mixing zone will not adversely impact sensitive species.

Sonoma County Water Agency: The mixing zone within Schell Slough accounts for 0.2 acres of a 6.4 acre slough. The mixing zone is linked to a critical habitat for steelhead in Schell Creek. Schell Creek is considered to be a migratory corridor only and no steelhead were found there during more recent surveys. Discharge to Schell Slough occurs only during the wet season. Average concentrations within the receiving water indicate levels of cyanide below the chronic objective. Aquatic life in the channel is composed primarily of estuarine species. It is assumed that biologically sensitive species may occur within the slough channel. It is expected that the proposed chronic objective will be met in the mixing zone. Sensitive species are only expected to remain within Schell Slough for periods less than a four-day average chronic time period. Cyanide levels within the mixing zone are not expected to adversely impact sensitive species.

City of Sunnyvale: The mixing zone is not within a critical habitat. The mixing zone occurs within 5.8 acres of the 8.3 acre Moffett Channel. Moffett Channel discharges to Guadalupe Slough. It is assumed that biologically sensitive species exist within Moffett Channel and Guadalupe Slough. The average concentration of effluent data from 2000 to 2004 was 4.4µg/L. However, more than 50 percent of the 80 samples collected were non-detect levels at a detection level of 5 µg/L. Sensitive species are only expected to remain within the channel for periods less than a chronic period averaging time, and cyanide levels within the channel are likely to be at levels less than the chronic objective. Cyanide levels within the mixing zone are not expected to adversely impact sensitive species.

USS Posco: The mixing zone is at the southern edge of designated critical habitat (Suisun Bay) for the Delta smelt. In the recently adopted NPDES permit (Water Board, 2006), the Water Board granted the discharger a dilution credit of 5:1 based on a mixing zone modeling study and determined that USS Posco met the requirements specified in the Basin Plan and the SIP for an exception to discharge prohibition. The results of the modeling study indicated that the mixing zone area for a dilution of 3.25:1, as proposed for cyanide, extends approximately 50 feet from the outfall, which accounts for 0.2 acres. Therefore the mixing zone is small compared to the receiving water body, New York Slough, that exceeds 265 acres in size. New York Slough has not been identified as a hatching habitat for Delta smelt and is largely unsuitable for larvae survival. The small size of the mixing zone and flow conditions near the outfall ensure that the Delta smelt and sensitive species would be protected.

(5) produce undesirable or nuisance aquatic life
(6) result in floating debris, oil or scum;
(7) produce objectionable color, odor, taste, or turbidity;
(8) cause objectionable bottom deposits;
(9) cause nuisance;

At the concentrations in question, cyanide is not known to produce undesirable or nuisance aquatic life, floating debris, oil, scum, objectionable color, odor, taste turbidity, objectionable bottom deposits or nuisance conditions.

(10) dominate the receiving water body or overlap a mixing zone from different outfalls;

The mixing zones are summarized in Table 1 above. The proposed mixing zones represent only a portion of the immediate receiving water bodies, which are generally dead end slough channels, and an even smaller percentage of the larger water body, e.g. Napa, Petaluma Rivers, Suisun Marsh or specific San Francisco Bay segments associated with the outfall locations.

(11) be allowed at or near any drinking water intake…"

No drinking water intakes are located in San Francisco Bay in the vicinity of the proposed Shallow Water Discharger attenuation zones.

APPENDIX K

Cyanide Attenuation and Dilution Studies

The purpose of this Appendix is to describe the methodology referenced in the Staff Report in the determination of attenuation and dilution for Shallow Water Dischargers to San Francisco Bay. As stated in the Staff Report, a special study performed by the City of San Jose in 2003 and 2004 serves as the foundation for evaluation of the attenuation factor concept in the Bay. This study included the development of a data set of effluent and receiving water cyanide concentrations over a 12 month period (n=149) in Lower South San Francisco Bay. Sampling was performed along the discharge gradient from the San Jose/Santa Clara Water Pollution Control Plant in Artesian Slough and Coyote Creek. This Appendix describes the methodology and results of that study. It also includes a comparison of the attenuation results with dilution results estimated from a dye experiment conducted in 1989. In addition, a summary of attenuation factors derived from measurements and modeling studies by other shallow water dischargers is also provided. Table 6, at the end of the Appendix, contains summary statistics on the shallow water discharger receiving water data collected for this proposed Basin Plan amendment.

This Appendix contains the following sections:

- Definition of Attenuation
- San Jose Study Description
- San Jose Study Results
- Comparison of Attenuation and Dilution Results
- Other Shallow Water Discharger Methods
- Other Shallow Water Discharger Results

Definition of Attenuation

Attenuation is defined to be the combination of dilution and degradation, where dilution is the mixing of treated effluent with Bay waters and degradation is the sum of all factors affecting the loss of cyanide in the environment, including volatilization, precipitation, sedimentation and microbial breakdown. The concept of an attenuation factor is considered to be a valid permitting approach for cyanide because cyanide is degradable and does not persist or accumulate in the aquatic environment. The City of San Jose study provides empirical and characteristic evidence of cyanide attenuation.

The formula for the determination of a cyanide “attenuation factor” (AF) value is as follows:

AF = Effluent cyanide concentration / cyanide concentration at a selected location along a discharge gradient

Synoptic (or quasi-synoptic) sampling data for effluent and receiving waters serve as the basis for attenuation factor calculations. For some Shallow Water Dischargers, where sufficient ambient data is not available, dilution estimates from mathematical modeling studies were used to provide a conservative estimate (i.e. an underestimate) of cyanide attenuation.

San Jose Study Description

The City of San Jose performed a special Cyanide Attenuation Study in 2003 and 2004 to examine changes in cyanide concentrations that occur with distance downstream from the WPCP discharge point in Artesian Slough. The information below is taken from the final report for this study titled *Cyanide Attenuation Study, Watershed Protection Group, Environmental Services Department, City of San Jose, September 1, 2004*.

The purpose of the San Jose special study was two-fold: (1) to examine cyanide formation in the WPCP and (2) to determine empirical attenuation factors for cyanide along the WPCP discharge gradient in Artesian Slough and Coyote Creek in the southernmost area of Lower South Bay. The second purpose for the study (determination of empirical attenuation factors) is the focus of the following discussion.

For the special study, the City of San Jose developed and utilized low detection limit analytical methods for total cyanide determinations in effluent and in the receiving waters. The City performed various method enhancement studies to ensure the generation of high quality information in the special study. These included a Method Detection Limit study and studies of the effect of sample preservation and holding time on cyanide results.

The cyanide analytical methods used in this study were a modified version of methods 4500-CN B, C and E from Standard Methods, 20th Edition (APHA/AWWA/WEF 1998) (see description in Appendix L). Modifications of the methods were employed to lower the detection limits for measuring total cyanide. The modified procedure provided a Method Detection Limit of 0.06 µg/l and a Practical Quantitation Limit (PQL)(Reporting Limit) of 0.30 µg/l for Bay water. The Method Detection Limit for effluent samples was 0.2 µg/l, and the PQL (Reporting Limit) for effluent was 1.0 µg/l.

Discharge gradient sampling locations included plant effluent and 13 ambient downstream locations. The sampling locations are shown in Figure 1.

The cyanide concentration values for effluent and ambient sampling locations used in the City of San Jose report were based on grab samples. Samples were obtained using a sample pumping system and apparatus as recommended in USEPA 1996 guidance for clean sampling techniques. The City studied the variability of effluent cyanide concentrations over a 72-hour period and found little variation in the daily means, maximums, minimums or standard deviations of the observed concentrations. The study involved 8 samples per day at three-hour time intervals (see Figure 2). Based on these results, the use of grab samples was deemed to be a representative sampling approach in effluent and in downstream waters affected by the effluent.

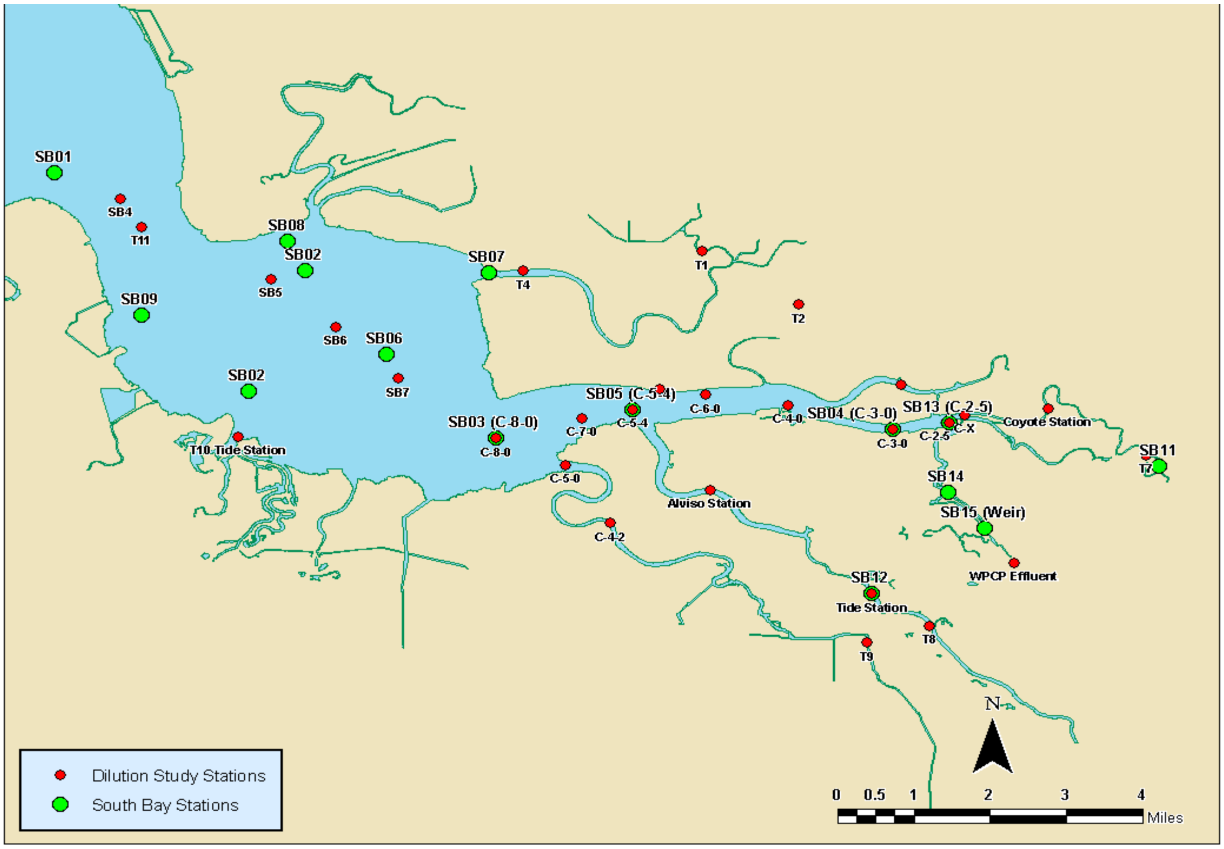


Figure 1. Sampling Locations for Empirical Cyanide Attenuation Study and Dye Experiment by San Jose/Santa Clara WPCP

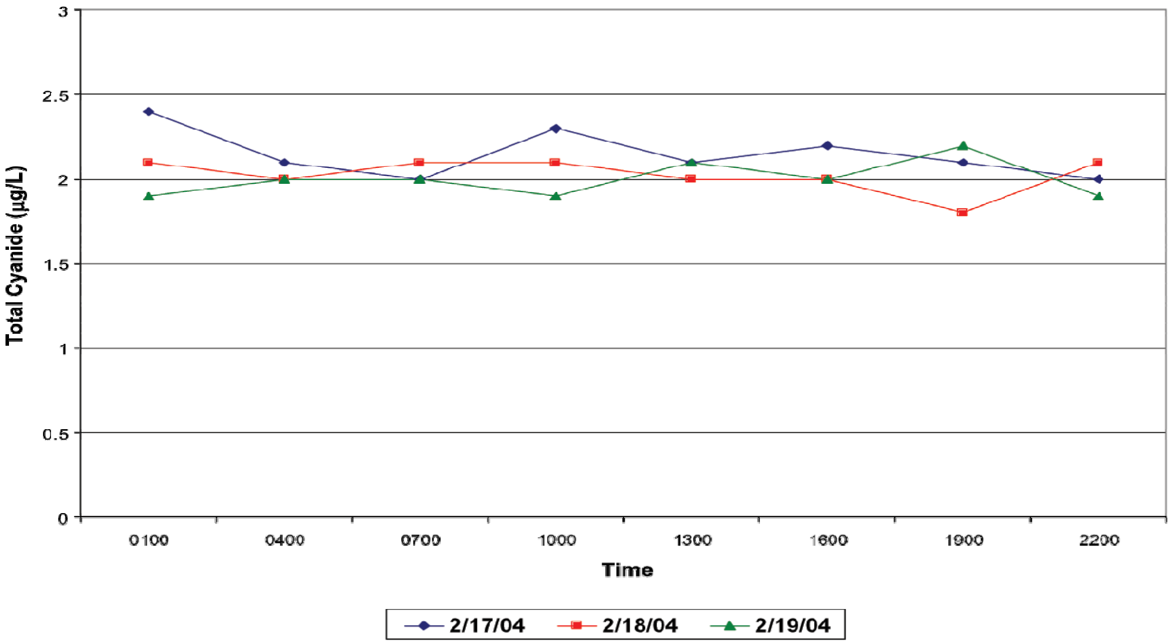


Figure 2. Variability of Effluent Cyanide Concentrations, San Jose/Santa Clara WPCP

The field sampling for each event was performed over a period of two days. Samples of effluent were typically taken during the field sampling period or the day before. Near-field ambient locations (SB15, SB14 and SB13) were typically collected over a one to 2 hour time period in each sampling event. Samples at other ambient locations were typically collected during the same 4 to 5 hour period (8AM to 1PM) each sampling day.

San Jose Study Results

The observed cyanide concentrations during the 12 month study (July 2003 to June 2004) are summarized in Table 1. It should be noted that cyanide concentrations in individual samples taken at the first two stations downstream from the effluent discharge point in Artesian Slough (SB15 and SB14) were at times slightly higher than the final effluent cyanide concentrations. The explanation for these differences is as follows: The final effluent sample is taken at the head of the effluent discharge channel; SB15 is located 790 meters downstream at the overflow weir from the discharge channel. In most instances, these samples were taken on the same day in the same 40 minute time period. Therefore, differences in concentration between these two whole effluent samples (which are essentially field duplicates) are attributable to analytical variability and short-term minor variability in effluent quality. In instances where samples were taken one day apart, apparent increases in cyanide concentration at downstream locations were likely the result of day-to-day variations in effluent cyanide concentrations in addition to analytical and short-term variability.

For the period November 2003 to June 2004 when samples were collected at all three locations, the median cyanide concentrations were 2.9 µg/l in final effluent, 3.0 µg/l at SB15 and 2.5 µg/l at SB14. In the calculation of attenuation factor values, final effluent concentrations (rather than the slightly higher SB15 concentrations) were used.

Attenuation factors were calculated for each monitoring event, using the above cyanide concentration data and the AF formula described above. The median attenuation factor values for stations SB04 and SB05 were 2.25 and 4.5, respectively. These values derived as follows:

- An attenuation factor value was calculated for each sampling event.
- The May 2004 event was excluded as an atypical event (excluding this event resulted in a more conservative, i.e. lower attenuation factor for each location)
- The median AF value at each location was determined from the data set of the individual AF values for each event.

Stations SB04 and SB05 were chosen as sites for the attenuation factor calculation based on the significant declines in cyanide concentrations observed at these locations. Under typical discharge conditions along the discharge gradient, dilution appears to be an important factor affecting the observed cyanide attenuation values. This is seen through examination of the calculated attenuation factors at stations SB04 and SB05 in comparison to calculated dilutions derived from salinity measurements taken at the same time as the cyanide samples. The salinity data used in the calculation of dilution is shown in Table 2. The comparison of these dilution values with the median attenuation factor values is shown in Table 3.

Table 1. Cyanide Attenuation Calculations in South San Francisco Bay (*City of San Jose Cyanide Attenuation Study, 2004*)

	2003						***2004***					
Station	***July***	***Aug***	***Sep***	***Oct***	***Nov***	***Dec***	***Jan***	***Feb***	***Mar***	***Apr***	***May***	***Jun***
Final effluent	1.6	1.8	3.5	2.3	2.7	5.2	1.8	2	3.1	4.7	63	2.5
SB15 (Weir)	NS	NS	NS	NS	2.7	5.5	2	1.7	3.4	5.2	59	2.2
SB14 (Triangle)	NS	NS	2.7	3.1	2.3	3.8	2	1.6	2.8	4.2	27	2.3
SB13 (Mouth)	NS	NS	1.3	2.4	1.6	1.6	1.5	1.6	1.2	2.2	7.2	2.1
SB04	1	0.8	1.2	1.8	0.7	0.7	1.1	0.9	0.8	1.7	3.3	1.3
SB05	0.4	0.6	0.5	0.9	0.2	0.4	0.4	0.7	0.3	0.4	1.1	0.8
SB03	0.3	0.3	0.4	0.5	0.2	0.4	0.2	0.4	0.4	0.4	0.8	0.6
SB06	0.3	0.2	0.3	0.3	0.2	0.3	0.2	0.5	0.3	0.4	0.4	0.5
SB02	0.2	0.2	0.3	0.2	0.1	0.2	0.3	0.4	0.2	0.2	0.3	0.3
SB08	0.3	0.2	0.3	0.3	0.1	0.1	0.4	0.4	0.2	0.2	0.4	0.3
SB10	0.3	0.3	0.3	0.4	0.2	0.2	0.3	0.2	0.3	0.3	0.4	0.3
SB07	0.5	0.4	0.3	0.4	0.3	0.4	0.3	0.3	0.4	0.4	0.4	0.3
SB09	0.2	0.2	0.3	0.2	0.1	0.3	0.3	0.2	0.2	0.2	0.4	0.4
SB01	0.2	0.2	0.2	0.2	0.1	0.1	0.3	0.2	0.2	0.2	0.2	0.2
SB11	0.5	0.4	0.6	0.4	0.6	0.9	0.8	0.8	1.1	0.7	0.3	0.4
SB12	0.3	0.3	0.3	0.3	0.4	0.5	0.4	0.5	NS	0.5	0.4	0.3

Station *2003* *2004* ***Median***

	July	***Aug***	***AF Value***	***Oct***	***Nov***	***Dec***	***Jan***	***Feb***	***Mar***	***Apr***	***May***	***Jun***	***AF Value***
With May 04													
Final effluent	1.6	1.8	3.5	2.3	2.7	5.2	1.8	2	3.1	4.7	63	2.5	
SB04	1	0.8	1.2	1.8	0.7	0.7	1.1	0.9	0.8	1.7	3.3	1.3	
AF	1.60	2.25	2.92	1.28	3.86	7.43	1.64	2.22	3.88	2.76	19.09	1.92	2.51
Without May 04													
Final effluent	1.6	1.8	3.5	2.3	2.7	5.2	1.8	2	3.1	4.7		2.5	
SB04	1	0.8	1.2	1.8	0.7	0.7	1.1	0.9	0.8	1.7		1.3	
AF	1.60	2.25	2.92	1.28	3.86	7.43	1.64	2.22	3.88	2.76		1.92	**2.25**
With May 04													
Final effluent	1.6	1.8	3.5	2.3	2.7	5.2	1.8	2	3.1	4.7	63	2.5	
SB05	0.4	0.6	0.5	0.9	0.2	0.4	0.4	0.7	0.3	0.4	1.1	0.8	
AF	4.00	3.00	7.00	2.56	13.50	13.00	4.50	2.86	10.33	11.75	57.27	3.13	5.75
Without May 04													
Final effluent	1.6	1.8	3.5	2.3	2.7	5.2	1.8	2	3.1	4.7		2.5	
SB05	0.4	0.6	0.5	0.9	0.2	0.4	0.4	0.7	0.3	0.4		0.8	
AF	4.00	3.00	7.00	2.56	13.50	13.00	4.50	2.86	10.33	11.75		3.13	**4.5**
With May 04													
Final effluent	1.6	1.8	3.5	2.3	2.7	5.2	1.8	2	3.1	4.7	63	2.5	
SB13 (Mouth)	NS	NS	1.3	2.4	1.6	1.6	1.5	1.6	1.2	2.2	7.2	2.1	
AF			2.69	0.96	1.69	3.25	1.20	1.25	2.58	2.14	8.75	1.19	1.91

Table 2. Dilution Calculations from San Jose Salinity Data (*City of San Jose 2004*)

Dilution at SB04 using Bay Salinity data at SB01

													Median Dilution Value
Final effluent	0.6	0.6	0.6	0.6	0.6	0.5	0.6	0.6	0.6	0.6	0.6	0.6	
SB04	6.2	12.8	5.1	5.3	17.6	16.5	7.6	1.9	6.7	1.3	4	3.5	
SB01	25.1	27.2	27.2	28.9	28.2	28.2	23	17.6	16.7	19.1	24.4	26.7	
Percent effluent	0.77	0.54	0.83	0.83	0.38	0.42	0.69	0.92	0.62	0.96	0.86	0.89	
Dilution	1.30	1.85	1.20	1.20	2.60	2.37	1.45	1.08	1.61	1.04	1.17	1.13	**1.25**

Dilution at SB04 using Bay Salinity data at SB02

Final effluent	0.6	0.6	0.6	0.6	0.6	0.5	0.6	0.6	0.6	0.6	0.6	0.6	
SB04	6.2	12.8	5.1	5.3	17.6	16.5	7.6	1.9	6.7	1.3	4	3.5	
SB02	24.7	26.7	27.7	26.6	26.2	27.7	22	12.2	16.5	18.5	22.8	24.9	
Percent effluent	0.77	0.53	0.83	0.82	0.34	0.41	0.67	0.89	0.62	0.96	0.85	0.88	
Dilution	1.30	1.88	1.20	1.22	2.98	2.43	1.49	1.13	1.62	1.04	1.18	1.14	**1.26**

Dilution at SB05 using Bay Salinity data at SB01

Final effluent	0.6	0.6	0.6	0.6	0.6	0.5	0.6	0.6	0.6	0.6	0.6	0.6	
SB05	19.7	19.4	18.9	12.2	24	24.5	19.7	4.7	13.5	10.6	8.2	10	
SB01	25.1	27.2	27.2	28.9	28.2	28.2	23	17.6	16.7	19.1	24.4	26.7	
Percent effluent	0.22	0.29	0.31	0.59	0.15	0.13	0.15	0.76	0.20	0.46	0.68	0.64	
Dilution	4.54	3.41	3.20	1.69	6.57	7.49	6.79	1.32	5.03	2.18	1.47	1.56	**3.31**

Dilution at SB05 using Bay Salinity data at SB02

Final effluent	0.6	0.6	0.6	0.6	0.6	0.5	0.6	0.6	0.6	0.6	0.6	0.6	
SB05	19.7	19.4	18.9	12.2	24	24.5	19.7	4.7	13.5	10.6	8.2	10	
SB02	24.7	26.7	27.7	26.6	26.2	27.7	22	12.2	16.5	18.5	22.8	24.9	
Percent effluent	0.21	0.28	0.32	0.55	0.09	0.12	0.11	0.65	0.19	0.44	0.66	0.61	
Dilution	4.82	3.58	3.08	1.81	11.64	8.50	9.30	1.55	5.30	2.27	1.52	1.63	**3.33**

Table 3. Effect of dilution on Attenuation Factors at Stations SB04 and SB05

Station	*Attenuation Factor (median)*	*Calculated Dilution (median)*
SB04	2.25	1.25
SB05	4.5	3.3

As shown in Table 3, the median attenuation factor at SB04 is 2.25, while the median dilution at SB04 based on salinity measurements and subsequent calculations of effluent percentages is 1.25. At SB05, the median attenuation factor is 4.5, while the calculated dilution ratio is 3.3. This finding is also supported qualitatively by historical dilution study results. Calculated AF values were 2.25 and 4.5 at SB04 and SB05, respectively. In a dilution study performed in 1990, the predicted dilutions at SB04 and SB05 were determined to be 2.1 and 4.5.

A period of rapid degradation of cyanide was observed during the extraordinary May 26, 2004 sampling event by the City of San Jose (see Figure 3). In the May 2004 event, an illicit cyanide discharge to the WPCP produced an extremely elevated effluent concentration of 63 µg/l. Measurements along the discharge gradient at SB13, SB04 and SB05 indicated cyanide concentrations of 27 µg/l, 7.2 µg/l, 3.3 µg/l and 1.1 µg/l. The associated attenuation factors at these sites were 8.8, 19.1 and 57, respectively. These values demonstrate significant, rapid degradation of the elevated cyanide concentrations that far outweighed the effect of dilution. This May observation demonstrates that degradation would be anticipated to exert a greater influence along the discharge gradient at higher effluent cyanide concentrations.

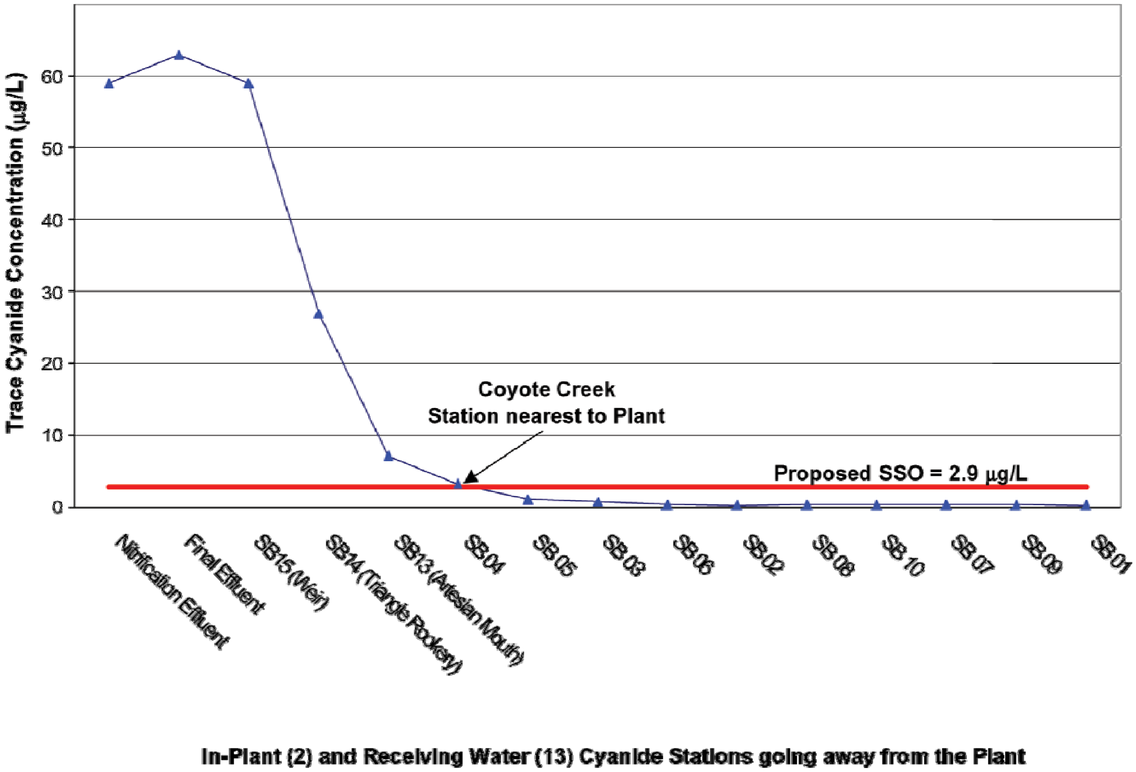


Figure 3 – High Cyanide Effluent Discharge and Receiving Water Gradient, San Jose/Santa Clara WPCP, May 26, 2004

The degradation of cyanide is also evident in the examination of ambient data in Table 1 for the far field Bay stations (SB02, SB06, SB07, SB08, SB09 and SB10) where concentrations were typically less than or equal to 0.4 µg/l and SB01, near the Dumbarton Bridge, where cyanide concentrations were always less than 0.3 µg/l. These observations are supported by RMP data that indicate cyanide levels below detection (at a detection limit of 0.4 µg/l) at other open Bay stations. Clearly, cyanide continues to degrade over time and does not accumulate in the water column of the Bay.

Comparison of Attenuation and Dilution Results

In 1989, the City conducted a study to evaluate the dilution of the San Jose/Santa Clara Water Pollution Control Plant's effluent in South San Francisco Bay (CH2M HILL 1990)[1]. This study was conducted between September 26 and 30, 1989, using Rhodamine WT, a fluorescent dye. Dye injection was continuous for three days. Continuous dye injection allowed the dilution measurements to include the cumulative effects of Plant effluent re-entrainment from tidal cycles in the study area. The study period was selected because it represented a critical period of neap tide conditions, minimum Delta outflow, and minimum freshwater flow from the creeks that would minimize dilution. Thus, the results are conservative. This study is still applicable today since average Plant flows were 111 MGD in 1989, as compared to 119 in 2005.

Measurements were made at 26 locations throughout the South Bay (Figure 1). A total of 110 measurements were made over a 3-day sampling period. Dilution at each station tended to decrease over time as a steady state condition was achieved in the receiving water. The observed minimum depth-averaged water column dilution (MAD) [2] increased with distance from the Plant. The MAD for station C-3-0 (SB04 at Drawbridge in Coyote Creek) was 3.2 (Table 4; Figure 1). The MAD for station C-5-4 (SB-05 at the mouth of Alviso Slough) was 19. The MADs at C-8-0 (at Calaveras Point, near station SB03) and further out into the Bay were found to be greater than 50. The MAD represents a very conservative measurement since it corresponds to the lowest value obtained for a particular station in the study. For example, the MAD for station SB04 was 3.2 but the maximum depth-averaged dilution for this site was greater than 50.

These dilution study results are similar to the Attenuation factors (AF) derived from the City's Cyanide Attenuation Study (Table 4). Attenuation factors for stations C-3-0, C-5-4, and the mouth of Coyote Creek were 2.25, 4.5, and 7.75, respectively. Cyanide Attenuation Study results indicated that attenuation appeared to be at least partially limited by the magnitude of cyanide concentration in the effluent that is higher cyanide concentration in the discharge produced higher attenuation factors. For example, in May 2004 an incident occurred at the Plant where approximately 60 µg/L of total cyanide was discharged from the Plant. However, the total cyanide measured at station SB04 in Coyote Creek during this incident was 3.3 µg/L. This corresponds to a station attenuation of 19, compared to the study mean station AF of 2.9 (median station AF = 2.25). WERF[3] investigators also found that "…influent with a high concentration of cyanide experienced a relatively rapid cyanide loss whereas low influent cyanide

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[1] CH2MHILL. 1990. South Bay Dilution Study (Provision E5D). Prepared for the City of San Jose Department of Water Pollution Control. Permit Assistance Program. September 1990.

[2] Lowest average of all points collected at a given location at one time when measurements were made at various depths.

[3] WERF. 2003. *Cyanide Formation and Fate in Complex Effluents and its Relation to Water Quality Criteria.* WERF publication No. 98-HHE-5. Water Environment Research Foundation, Alexandria, Va. Co-published by IWA Publishing, London, United Kingdom.

concentrations exhibited a lower loss rate" in a constructed wetland. Therefore, dilution and attenuation results from these studies are conservative (minimum) values. Ambient cyanide concentrations in Lower South Bay averaged 0.29 µg/L during the study, indicating that cyanide does not persist or accumulate in the receiving water.

Table 4. San Jose/Santa Clara Water Pollution Control Plant Cyanide Dilution/Attenuation Results

Site	Distance from Outfall (km)	Surface Water Area (Acres)	Median Attenuation Factor[1]	MAD[2]
SB15 (Weir)	0.0	0.0	0.9	
SB14	1.0	6.2	1.1	
SB13 (C-2-5)	3.2	19.8	1.7	1.3
SB04 (C-3-0)	4.1	40	2.25	3.2
C-4-0	6.0	87		3.5
C-6-0	7.5	140		10.6
SB05 (C-5-4)	8.7	193	4.5	19
C-7-0	9.6	238		46
SB03 (C-8-0)	11.2	331	7.75	>50

[1] From City's 2004 Cyanide Attenuation Study

[2] From City's 1990 Dilution Study; MAD - Minimum Depth-Averaged Water Column Dilution

Other Shallow Water Discharger Methods

The purpose of effluent and ambient monitoring by other Shallow Water Dischargers was to confirm that the results obtained by the City of San Jose were observed along other discharge gradients. Monitoring results and mathematical modeling study results were used to estimate the distances from individual discharge points where specific attenuation factor values are attained (see Appendices B and D). Grab samples of effluent and receiving water were taken at the following nine other Shallow Water Discharge locations.

- American Canyon
- Fairfield Suisun SD
- Las Gallinas Valley SD
- Mt. View SD
- Napa SD
- Palo Alto
- Petaluma
- Sonoma County Water Agency
- Sunnyvale

All samples were analyzed by the City of San Jose WPCP laboratory using the same analytical methods and detection limits employed in the San Jose special study (see Appendix L for a description of the analytical method). Therefore, the data obtained from the above sampling effort is deemed to be high quality and comparable with the City of San Jose and other shallow water discharger data.

Other Shallow Water Discharger Results

The characteristic cyanide attenuation curve observed along the San Jose discharge gradient were observed at each of the other Shallow Water Discharger locations either through modeling or empirical measurements (see Appendix D). Where empirical data were used, attenuation factors were calculated as described above for the City of San Jose results. Where modeling predictions of percent effluent were used, attenuation factors were calculated as follows:

AF = Dilution factor = 1 / [Percent effluent at a given location on the discharge gradient]

The effluent percentages corresponding to attenuation factors (AF) of 2.25, 3.5 and 4.5 were as follows:

For AF = 2.25, effluent percentage = 44.4
For AF = 3.5, effluent percentage = 28.6
For AF = 4.5, effluent percentage = 22.2

Table 5 provides a summary of distances along individual discharge gradients where specific attenuation factors exist for each of the shallow water dischargers. These distances define the approximate dimensions of attenuation zones for each discharger, depending on the selected AF value.

Table 5. Attenuation Zones for Shallow Water Dischargers

Discharger	***Study Used to Develop AF versus distance curve***	***Date of study***	***Estimated Distance in feet to AF = 2.25***	***Estimated Distance in feet to AF = 3.5***	***Estimated Distance in feet to AF = 4.5***
American Canyon	Empirical data	2005	2,100	3,000	NA
Fairfield-Suisun SD	Model/ Empirical data	2004	15,000	24,000	27,000
Las Gallinas Valley SD	Empirical data	2004	800	875	1,200
Mt. View SD	Empirical data	NA	NA	NA	NA
Napa SD	Empirical data	2005	1,500	2,500	8,500
Novato SD	Model Study	2004	120	170	190
Palo Alto	Model Study	1997	1,600	2,400	3,000
Petaluma	Model/ Empirical data	2001	410	410	5,500
San Jose Santa Clara	Empirical data	2003-2004	13,450	20,000	27,800
Sonoma County Water Agency	Model Study	1997	10,000	15,500	17,000
Sunnyvale	Empirical data	2004	1,100	7,200	NA
Union SD - Hayward Marsh	Model/Empirical data	2006	1,800	2,900	3,530
USS Posco	Model Study	2003	25	46	58

NA = Data or Estimation Not Available

Notes:

Attenuation factors are calculated as follows:

Where ambient measurements are available:

AF = [Cyanide concentration in ambient water] / [Cyanide concentration in effluent]

Where percent effluent predictions are available from modeling study:

AF = 1 / [Percent effluent at an ambient location]

AF = 2.25 at 44.4% effluent
AF = 3.5 at 28.6% effluent
AF = 4.5 at 22.2% effluent

Note: In this case, the AF = dilution ratio

Table 6: CYANIDE IN SHALLOW WATER DISCHARGER RECEIVING WATERS (µg/L)

	San Jose	Other SWD Data	ALL DATA
average	0.63	1.43	0.90
std dev	0.71	1.65	1.18
CV	1.14	1.16	1.31
n	149	76	225
90th percentile	1.60	4.00	2.20
99th percentile	3.46	6.70	6.43
max	4.20	6.70	6.70

APPENDIX L

City of San Jose Modified Analytical Methods for Total Cyanide

The City of San Jose Environmental Services Department used a modified version of Standard Methods 4500-CN B, C and E (Standard Methods, 20th Edition (APHA/AWWA/WEF 1998) Method B – Preliminary Treatment of Samples, Method C – Distillation, and Method E – Colorimetric determination) for the determination of cyanide in effluent and ambient water samples. Modifications to the methods were employed to optimize (lower) the detection limits for measuring total cyanide. Deviations from Standard Methods are shown below in bold.

Samples were preserved by the addition of NaOH to a pH of at least 12 and then stored at 4 degrees Centigrade. At the time of the analysis, **700 ml** of sample was placed in a 1-liter distillation flask. **40 ml of concentrated** sulfuric acid, **35 ml** of a concentrated MgCl2 solution, and 2 grams of sulfamic acid were added to each sample. The distillation equipment consisted of the distillation flask, a cold finger condenser, a sparger and the sparger vessel. An absorber solution of 0.04 N NaOH was added to the sparger vessel. The distillation flask was heated to boiling with a heating mantle and a stream of **nitrogen gas** was bubbled through each sample for **two hours**. The stream of **nitrogen gas** carries the hydrogen cyanide over to the absorbing solution into which the cyanide dissolves. An **8.75-fold concentration** of analyte occurred during the distillation step (**700 ml sample reduced to 80 ml** absorber solution). A 35-ml aliquot of the absorber solution was used for colorimetric analysis. A **35-ml sample** was pipetted into a 50-ml flask, color development reagents were added, and the final volume was brought up to **50 ml**. Therefore, the overall concentration effect was approximately **six-fold**. The color was allowed to develop for seven to fifteen minutes. Sample determination was done using a UV/VIS spectrophotometer set at 578 nm with a **10-cm** sample cell.

This modified procedure provided a Method Detection Limit (MDL) of 0.06 ppb for Bay water and distilled water. The procedure provided a MDL of 0.2 ppb in effluent. This resulted in Practical Quantitation Limits (PQLs) of 0.3 ppb in Bay water and 1.0 ppb in effluent using the protocol described in Standard Methods, 20th edition. In short, seven replicates of reagaent (matrix) water of known analyte concentration were analyzed. The standard deviation of the replicate analysis was multiplied by the appropriate student's t value to obtain the MDL. The PQL was set at five times the MDL.

Reference

City of San Jose. 2004. *Cyanide Attenuation Study*, Watershed Protection Group, Environmental Services Department, September 1.

APPENDIX M

Evaluation of Biological Community of Shallow Water Discharger Receiving Waters

There is a question whether existing concentrations of cyanide in the immediate vicinity of shallow water dischargers are having an adverse impact on aquatic organisms. A study performed in 1997 in the Palo Alto discharge channel has been reviewed to address this question. The results of this study provide a qualitative understanding of conditions in shallow sloughs near shallow water discharges in the San Francisco Bay.

Palo Alto Study Description

A comparative study of the Palo Alto discharge channel and a nearby tidal slough was conducted in 1997 to determine if the biological community in the discharge channel was stressed relative to channels not dominated by effluent. The Palo Alto discharge channel is a man-made channel created in the 1950's to convey treated effluent from the City of Palo Alto Water Quality Control Plant to San Francisco Bay. The channel is approximately 2000 feet long and ranges in width from 20 feet at low tide to 40 feet at high tide.

San Francisquito Creek is a tidally influenced natural stream that enters San Francisco Bay approximately 1000 feet northwest of the Palo Alto discharge channel. Water quality in San Francisquito Creek is marginally affected by the Palo Alto effluent discharge. Water quality modeling results performed for the City of Palo Alto in 1997 by RMA, Inc. indicate that the percentage of Palo Alto effluent at the mouth of San Francisquito Creek is approximately 20-30 percent.

The 1997 biological assessment included sampling for benthic organisms and fish at three locations in the discharge channel and three locations in San Francisquito Creek. Benthic samples were collected at low or incoming tide using an Eckman dredge. Three grab samples were taken at each location. Fish were collected at high tide using a bag seine with 0.5 inch mesh. Sediment samples were collected at each location from the center of the flow channel using an Eckman dredge and were analyzed for grain size and organic carbon concentrations.

Palo Alto Study Results

The results of the August 1997 biological assessment of benthic community and fish in the Palo Alto effluent channel indicated that it supported a diverse assemblage of aquatic fauna. The benthic community in the discharge channel was dominated by Arthropods (crustaceans *Corophium alienese* (amphipod), *Grandidierella japonica* (amphipod), and *Nippoleucon oregonensis*). Significant numbers of Mollusks (the clam *Macoma balthica*) and Annelids (oligochaete worms of the species *Tubificidae* and polychaete worms of the species *Eteone* and *Neanthes*) were also present. The types and abundances of organisms present in the channel were deemed to be representative of typical South Bay slough species and not indicative of highly stressed benthic communities. Results from the fish sampling effort indicated that topsmelt (*Atherinops affinis*) and northern anchovy (*Engraulis mordax*) were present in large numbers. These fish species are common to the sloughs of South San Francisco Bay.

As noted previously, a parallel sampling program was performed in San Francisquito Creek in the 1997 study to provide a reference for the sampling results for the discharge channel. Comparisons between the results from the discharge channel and the creek indicated the following:

- Benthic composition and density was similar in the two waters. Both waters support a diverse benthos community with strong numbers of marine/estuarine organisms.

- Mean diversity (as measured by the Shannon-Weaver diversity index) and equitability values for the benthic community were higher in the discharge channel. These values were not indicative of a highly stressed system; instead the values were typical of a tidal slough that experiences significant seasonal salinity variation.

- Numbers of taxa and numerical abundance of benthic organisms and fish (an indicator of productivity) was slightly higher in the creek than in the discharge channel; the hypothesis offered for this difference was a reduced opportunity for primary productivity in the dead-end effluent channel as opposed to the natural creek system tributary to San Francisquito Creek.

- Sediment grain size and organic carbon content were similar in the creek and discharge channel.

In the Conclusions for the 1997 study, it is stated that the discharge channel “supports a diverse and healthy aquatic fauna”. In the Executive Summary, it is stated that the “diversity and equitability indices indicate a healthy environment in both waterways”.

Discussion

Palo Alto provides a reasonable case study to evaluate local effects of cyanide. This plant is a type of worst-case scenario with respect to cyanide because of three factors: (1) shallow discharge into a dead-end slough, (2) known industrial sources of cyanide to the influent, and (3) the plant processes includes chlorination and biosolids incineration, both documented in-plant sources of cyanide. In addition, of the 225 samples near shallow water discharges, the seven highest receiving water concentrations were documented in the Palo Alto effluent channel. If biological effects of current operations would be detected anywhere in San Francisco Bay, it would be in the Palo Alto receiving waters.

During 1995-1996, the Palo Alto tertiary effluent discharge rate ranged from 20.4 to 43.9 mgd. In the month of August in 1995-1996, the average flow rate was 23.6 mgd. The effluent concentration of cyanide for 1995-1996 ranged from less than 3 to 40 µg/l. Palo Alto’s WQCP processes include advanced secondary processes, with activated sludge, nitrification, filtration and chlorine disinfection. Palo Alto is one of two facilities in the Bay area that incinerates its biosolids; return flows air scrubbing system for the incineration process contains cyanide. In the period from 2000 to 2003, effluent cyanide levels for Palo Alto averaged 3.3 µg/l, with maximum levels of 5.0 µg/l. From inspection of the effluent summary statistics presented in Table 16, it is observed that cyanide levels in the Palo Alto effluent are similar to a number of other Shallow Water Dischargers.

The most sensitive saltwater species to free cyanide is the copepod, *Acartia clausi*. The LC50 value for *Acartia* is 30 µg/l; the estimated concentration for no acute effects to *Acartia* is 15 µg/l. *Acartia clausi* is an estuarine copepod that exists globally and is the most abundant zooplankton species in San Francisco Bay (Davis, 1982). It is a prey organism for small fish such as anchovy. Sampling in the Palo Alto discharge channel did not include zooplankton collections, so direct information on the presence or abundance of *Acartia* in the channel is not available from the 1997 study. However, the presence of significant numbers of Northern Anchovy in the discharge channel at levels comparable to those in San Francisquito Creek suggests that prey items in the discharge channel were supportive of upper trophic level organisms.

The most acutely sensitive freshwater species to cyanide is Rainbow trout. This freshwater species would not be expected to be found in the Palo Alto discharge channel, which is a dead-end slough with very limited freshwater habitat. The estimated no acute effect concentration for Rainbow trout is 22 μg/l. In the event Rainbow trout were able to inhabit the discharge channel, acutely toxic conditions would not occur for this sensitive species. The most sensitive freshwater species to chronic effects are brook trout, bluegill and fathead minnow (see Section 4.5.2, Table 13). As for rainbow trout, these obligate freshwater species would not be able to tolerate the salinity conditions in the Palo Alto discharge channel.

Conclusions

Despite levels of cyanide in the Palo Alto effluent channel that exceed the NTR cyanide objective of 1.0 μg/l and the site specific chronic objective of 2.9 μg/l, the biological community in the Palo Alto discharge channel supports a diverse and healthy assemblage of aquatic organisms. This provides qualitative evidence to suggest that the proposed effluent limits and Cyanide Action Plan for Palo Alto and other shallow water dischargers, which will maintain existing effluent concentrations of cyanide, will be protective of aquatic life uses in the vicinity of those discharges.

Reference

Cressey, S. 1997. *Benthos and Fisheries Assessment, Palo Alto Wastewater Treatment Plant Discharge Channel.* Prepared for the City of Palo Alto under subcontract to Larry Walker Associates. November 1997.