SANTA CLARA RIVER

TOTAL MAXIMUM DAILY LOADS
FOR NITROGEN COMPOUNDS

STAFF REPORT

California Regional Water Quality Control Board
Los Angeles Region

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1 INTRODUCTION

Segments of Santa Clara River and its tributaries are impaired by ammonia, nitrate and nitrite and are included on the California 2002 303(d) list of water quality limited segments, which was approved by the State Water Resources Control Board on February 4, 2003. Additionally, one segment of the Santa Clara River is included on the State Monitoring List for organic enrichment/low dissolved oxygen. Two segments of the Santa Clara River are included on the State Enforceable Programs list for ammonia with one of those segments also listed for nitrite as nitrogen. Figure 1 depicts the Santa Clara River with the EPA reach designations. The Clean Water Act requires Total Maximum Daily Loads (TMDLs) be developed to restore impaired waterbodies, and the Porter-Cologne Water Quality Act requires that an Implementation Plan be developed to achieve water quality objectives. This document fulfills these statutory requirements and serves as the basis for amending the Water Quality Control Plan for the Los Angeles Region (Basin Plan) to achieve water quality standards in Santa Clara River for nutrients. This document contains:

- A description of the Santa Clara watershed including the segments of Santa Clara River and its tributaries that are impaired by nitrogen compounds,
- The data and methods to quantify the nitrogen compounds TMDL for Santa Clara River,
- Waste load and load allocations of nitrogen compounds sources in the Santa Clara River, and
- An Implementation Plan to achieve water quality objectives for nitrogen compounds in the Santa Clara River.

This TMDL addresses the requirements prescribed by Section 303(d) of the Clean Water Act, 40 CFR 130.2 and 130.7, and U.S. Environmental Protection Agency guidance (U.S. EPA, 1991).

Santa Clara River Total Maximum Daily Loads for Nitrogen Compounds

This TMDL is based on analysis provided by Systech Engineering Inc. and Dr. Arturo Keller of UC Santa Barbara under contract to the Santa Clara River Stakeholder Group Steering Committee (Steering Committee) with financial support from the California Regional Water Quality Control Board-Los Angeles (Regional Board). Key analyses and data are referenced throughout this report as the "Technical Support Document" (Appendix A) and contain: The Santa Clara River TMDL Nutrient Analysis, Source Analysis and Linkage Analysis: Hydrology and Water Quality by Systech Engineering Inc. and Determination of the Critical Water Quality Conditions for the Impaired Reaches of the Santa Clara River Watershed, Analysis of Potential Nutrient Load Allocation of the Reaches of the Santa Clara River Considered in the 1998 303(d) List, and Analysis of pH variation in the Impaired Reaches of the Santa Clara River.

The nitrogen compound impairments in the River threaten warm water fish and wildlife habitats and groundwater recharge beneficial uses. Modeling was completed to link the documented nutrient sources to the in-stream water quality. The sources were characterized, in order of relative impact, as point discharges, groundwater with nonpoint source loading, and other nonpoint sources. Critical conditions were identified as occurring during low flow. Numeric targets and allocations for ammonia, nitrate and nitrite were set according to a model scenario which attains water quality objectives with a 10 percent margin of safety everywhere in the watershed except EPA Reach 7, where additional monitoring is required.

The Implementation Plan of this TMDL is designed to attain water quality objectives for nitrate, nitrite, and ammonia and to ensure protection of beneficial uses in the Santa Clara River. Attaining the nitrogen compound objectives will likely address ancillary nutrient effects, including dissolved oxygen and organic enrichment and ecological health indicators. The implementation plan requires continued studies to verify this assumption. There are insufficient data to characterize nitrogen sources from groundwater, septic systems, and agricultural drainage and runoff. There are also limited data regarding aquatic life and eutrophic impacts of the Santa Clara River. Consequently, the Implementation Plan includes monitoring to assess these parameters. Should these studies demonstrate that aquatic life habitat needs lower nitrogen targets than proposed in this TMDL, the Regional Board may revise targets and reallocate wasteloads through a reevaluation process included in the Implementation Plan.

1.1 Regulatory Background

Section 303(d) of the Clean Water Act (CWA) requires that "Each State shall identify those waters within its boundaries for which the effluent limitations are not stringent enough to implement any water quality standard applicable to such waters." The CWA also requires states to establish a priority ranking for waters on the 303(d) list of impaired waters and establish TMDLs for such waters.

The elements of a TMDL are described in 40 CFR 130.2 and 130.7 and Section 303(d) of the CWA, as well as in the U.S. Environmental Protection Agency guidance (U.S. EPA, 1991). A TMDL is defined as the "sum of the individual waste load allocations for point sources and load allocations for nonpoint sources and natural background" (40 CFR 130.2) such that the capacity of the waterbody to assimilate pollutant loadings (the Loading Capacity) is not exceeded. TMDLs are also required to account for seasonal variations, and include a margin of safety to address uncertainty in the analysis.

States must develop water quality management plans to implement the TMDL (40 CFR 130.6). The U.S. EPA has oversight authority for the 303(d) program and is required to review and either approve or disapprove the TMDLs submitted by states. If the U.S. EPA disapproves a TMDL submitted by a state, U.S. EPA is required to establish a TMDL for that waterbody.

The Regional Board identified over 700 waterbody-pollutant combinations in the Los Angeles Region where TMDLs are required (LARWCQB, 1996, 1998). A schedule for development of TMDLs in the Los Angeles Region was established in a consent decree (Heal the Bay Inc., et al. v. Browner C 98-4825 SBA) approved on March 22, 1999. The consent decree combined waterbody pollutant combinations in the Los Angeles Region into 92 TMDL analytical units. According to the consent decree, the Santa Clara River Nitrogen TMDL must be approved or established by US EPA by March 22, 2004. In accordance with the consent decree, this document summarizes the analyses performed and presents the TMDL for nitrogen compounds and related effects for the Santa Clara River.

Ammonia is one of the key nitrogen compounds addressed by this TMDL. The Basin Plan includes an objective-specific compliance schedule for the inland surface water ammonia objectives. Specifically, the Basin Plan provided dischargers until June 13, 2002, 8 years from adoption of the Basin Plan, to make the necessary adjustments and improvements to meet the objectives or to conduct studies leading to an approved site-specific objective for ammonia. At public hearings on January 11, 2001 and May 31, 2001, the Regional Board heard status reports on Publicly Own Treatment Works (POTWs) progress toward compliance with inland surface water ammonia objectives from Regional Board staff. The status report indicated that Saugus and Valencia Treatment Plants expected to be in compliance with the ammonia objective by June 2003. Due to recent delays, the Regional Board will consider a Time Schedule Order for to extend the compliance date for the Saugus WRP until September 2003. Santa Paula Wastewater Treatment Facility, and Fillmore Wastewater Treatment Plant have done some research, modified the treatment plants and conducted some experimentation with process operation. Without nitrifying and denitrifying, the Santa Paula and Fillmore POTWs will not be able to meet the water quality objective for ammonia, nitrite and nitrate.

1.2 Environmental Setting

The Santa Clara River is the largest river system in the Los Angeles Region that remains in a relatively natural state. Like most areas in southern California, the watershed of the Santa Clara River has been subjected to significant land use and flow modifications due to urban development and agricultural practices. However, compared to other watersheds in southern California, the Santa Clara River still retains many forested areas and relatively undisturbed tributaries, and has important biological resources, including the endangered steelhead trout and stickleback. The mountains are composed of marine and terrestrial sedimentary and volcanic rocks. The basins are filled with a mixture of deposits of sands, silts and clays interspersed throughout the region, representing the exposure of several of the underlying formations.

1.2.1 Historic and Current Flow

Much of the lower watershed was originally Spanish land grants used for grazing cattle and dry-land farming. Urbanization since the late 1940's has continuously modified the land use, resulting in discharge of imported water and municipal wastewater. Since the 1950's, agriculture has shifted from seasonal dry-land farming to predominantly year-round irrigated farming of citrus, avocado and row crops.

The basin drains from the east beginning in the Transverse Ranges below Soledad Pass through the Santa Clara River and its major tributaries, Castaic, Piru, Hopper, Sespe and Santa Paula Creeks. Natural flow in all the major streams and tributaries in the basin is intermittent and ephemeral, with most of the streamflow related to flood flows. At certain times of the year, the river is continuous from the headwaters to the discharge at the estuary. The controlled release of water from Lake Piru since 1955 and from Pyramid Lake since 1975 has resulted in fewer days of no flow in the lower portion of the Santa Clara River, in Ventura County above the Freeman Diversion. In addition, the release of treated wastewater treatment plant effluent and imported water has resulted in an additional flow in the Santa Clara River across the Los Angeles-Ventura County line. This surface flow, however, may not persist as it percolates to the underlying groundwater within a relatively short distance downstream of the Los Angeles-Ventura County line. Part of the year a dry or low flow gap exists from the point the surface water disappears to the confluence of the river with Piru Creek. Water from Northern California is imported by United Water Conservation District through Pyramid Lake and Lake Piru, and periodically released down Piru Creek and the lower portion of the Santa Clara River, in Ventura County. Water is also imported by Castaic Lake Water Agency for municipal use in the Santa Clarita Valley and releases in Castaic Creek. In addition, some of this imported water enters the watershed either as treated effluent, irrigation return flow or via groundwater (USGS, 1998).

Thus, the flow of the Santa Clara River (SCR) has been modified due to the climatic conditions, partial drawdown of some regional aquifers from decades of pumping, release of treated effluent and imported water (USGS, 1998). Discharges from waste water treatment plants, and nonpoint source emissions in the watershed have changed the flow and concentration of nutrients and other contaminants in receiving waters.

1.2.2 Climate

The climate of the Santa Clara River watershed is mild and characterized as Mediterranean, typical of much of southern California. Average annual temperature ranges from about 70°F near the coast to 60°F inland. On the coastal plain the maximum temperature is about 100°F and the minimum only slightly below freezing. Frosts on the coastal plain are uncommon. Inland, maximum temperatures are higher, minimum temperatures are lower, and frosts are much more frequent. Like the rest of coastal Southern California, the climate is of the Mediterranean type with a long dry summer and a short, comparatively wet winter. Almost all of the precipitation occurs in the November-to-April period. Even during the wet season, skies are clear and humidity low during a very large percentage of the time.

1.2.3 Discharges in the Watershed

The Regional Board has granted National Pollutant Discharge Elimination System (NPDES) permits to five major dischargers (average effluent flow rate exceeds 0.5 million gallons per day (MGD)) and numerous minor dischargers in the Santa Clara River watershed. The major dischargers include four Water Reclamation Plants (WRP) that discharge into the Santa Clara River, the Saugus, Valencia, Santa Paula and Fillmore WRPs. The Fillmore WRP discharges to percolation ponds during dry weather and to the River during wet weather. In addition, the City of San Buenaventura WRP discharges to the Santa Clara River estuary. Minor discharges in the Santa Clara River watershed include dewatering and construction projects that are covered by general NPDES permits. In addition, other minor dischargers include MS4 permittees and industrial facilities that are covered by individual permits. The number of minor discharge permits varies in number and duration each year. The major and minor discharges are discussed in Section 2.3, Source Assessment.

Among the minor NPDES discharge permits are those for storm runoff from construction sites. In 2000, there were 310 sites enrolled under the construction storm water permit with a similar number of sites located in the upper and lower watershed. The majority of these are residential sites 10 acres or larger in size.

1.2.4 Surface Water/Groundwater Interactions

The underlying groundwater basins are, from east to west, Upper Santa Clara, Piru, Fillmore, Santa Paula, Oxnard Forebay and Oxnard Plain. Under natural conditions, groundwater flow is predominately seaward. In the Oxnard Plain, overpumping has resulted in seawater intrusion toward the centers of pumping.

The watershed has been studied extensively beginning in 1957 and as recently as 2002(United Water Conservation District 1957, 1968, USGS 1995, 1996, 1999, 2002). These studies find that a large amount of groundwater recharge occurs at the upstream end of the Piru Basin, at about the L.A./Ventura county line. Controlled surface recharge also occurs by conservation releases from Piru reservoir via Piru Creek, Castaic Lake via Castaic Creek and waste discharges. A large amount of surface recharge is introduced by Sespe Creek and is associated with groundwater discharge from the Fillmore Basin. Groundwater discharge also occurs at the downstream end of the Santa Paula basin and includes water high in sulfates. The surface flow is usually diverted at the Freeman Diversion in the Santa Paula Basin for agricultural supply water.

1.2.5 Habitat

Extensive patches of high quality riparian habitat are present along the length of the river and its tributaries. Two endangered fish, the unarmored stickleback and the steelhead trout reside in the river. One of the largest of the Santa Clara River's tributaries, Sespe Creek, is designated a wild trout stream by the State of California and supports significant spawning and rearing habitat for the steelhead trout. Sespe Creek is also designated a Wild and Scenic River. According to a presentation by Ian Smith, Los Angeles County Parks and Recreation and Kate Simons, Fish and Wildlife, in Santa Clarita, on March 12, 2003 to the Wetland Recovery Project Managers Meeting, the Santa Clara River serves as an important wildlife corridor and habitat for several endangered, listed or indicator species including: Arroyo Toad, Slender Horned Spineflower, Southwest Willow Flycatcher, Red-Legged Frog, California Gnat Catcher, Plummers Mariposa Lily, Ocelated Humboldt Lily, Prostrand Navarretia, Forest Camp Sandwort, Summer Taninger, Riverside Fairy Shrimp, Nevins Barberry and Loggerhead Shrike. The estuary at the mouth of the river supports a large variety of wildlife as well.

1.2.6 Reach Designations

The Santa Clara River is characterized by a number of reaches according to two reach designations as shown in Table 1, Regional Board Basin Plan and USEPA (2002 303(d) list). Unless otherwise noted, the USEPA reach designations are used to develop numeric targets and wasteload allocations. The Source and Linkage Analyses are also based on US EPA designations.

Table 1. Santa Clara River Reach designations - US EPA

EPA Reach	Regional Board Reach	Designation
EPA Reach 1	RB Reach 1	Santa Clara Estuary to Highway 101 Bridge
EPA Reach 2	RB Reach 2	Highway 101 Bridge to Freeman Diversion
EPA Reach 3	RB Reaches 3 & 4 (partial)	Freeman Diversion to Timber Canyon (above Santa Paula Creek)
EPA Reach 4	RB Reach 4	Timber Canyon to Grimes Canyon
EPA Reach 5	RB Reach 4	Grimes Canyon to Propane Road
EPA Reach 6	RB Reach 4	Propane Road to Blue Cut Gauging Station
EPA Reach 7	RB Reach 5	Blue Cut Gauging Station to West Pier Highway 99
EPA Reach 8	RB Reach 6	West Pier Highway 99 to Bouquet Canyon Road Bridge
EPA Reach 9	RB Reach 7	Bouquet Canyon Road Bridge to above Lang Gauging Station

EPA Reach	Regional Board Reach	Designation
EPA Reach 10	RB Reach 8	Above Lang Gauging Station

1.2.7 Aquatic Life Habitat

The beneficial uses of the Santa Clara River include aquatic life habitat. Two recent studies by UCLA and Department of Fish and Game (Appendix B) contain observations and evaluations of aquatic life habitat in the Santa Clara River. The UCLA (2003) study of algae, macroinvertebrates, chemistry and physical characteristics found that segments of the Santa Clara River showed a decreased diversity of sensitive macroinvertebrates below the Valencia WRP relative to another site just upstream of the outflow and that other indicators of biological health did not change consistently (UCLA, 2003). The Implementation Plan of this TMDL includes development of a monitoring program to document the aquatic life conditions in the Santa Clara River.

1.3 Santa Clara River Nutrient TMDL Stakeholder Participation Process

The stakeholder involvement process for the Santa Clara River Nutrient TMDL began in November 2001 with a kick-off meeting led by the Regional Board. Stakeholders include representatives of wastewater treatment plants, cities, counties, private property owners, agricultural organizations, and environmental groups with interests in the watershed; a complete stakeholder list is attached. These groups were informed by the Regional Water Quality Control Board of the ensuing TMDL and were invited to participate in its development. At the kickoff meeting the Regional Board presented the preferred conceptual process for the TMDL, involving a coordinated effort among the Regional Board, stakeholders and outside consultants. This approach is different from the approach used in other TMDLs, where the process has typically been either a Regional Board-led or a stakeholder-led process. This is a new coordinated approach among stakeholders and the Regional Board developed to improve participation of all interested parties.

1.3.1 Technical Steering Committee Involvement

A Steering Committee was formed to allow those stakeholders interested in taking a more active role in the TMDL technical work to guide and participate in the analysis. Steering committee meetings were held monthly, with quarterly stakeholder meetings for summary and update purposes. A complete list of Steering Committee members and a meeting schedule summary is presented below.

Steering Committee:

- Los Angeles Regional Water Quality Control Board (Regional Board)*: Jon Bishop, Samuel Unger, Elizabeth Erickson, Dr. C.P. Lai
- Los Angeles County Sanitation District (LACSD)*: Victoria Conway, Beth Bax, Christian Alarcon, Sharon Green, Heather Lamberson, Sharon Landau
- The Newhall Land and Farming Company (Newhall Land)*: Mark Subbotin, Norm Brown (Integrated Water Resources), Brandon Steets (Integrated Water Resources)
- City of Santa Clarita*: Heather Merenda, Travis Lang
- City of Fillmore*: Bert Rapp
- City of Santa Paula*: Norm Wilkinson, Bob Guerra
- United Water Conservation District (UWCD): Steve Bachman, Dan Detmer, Murray McEachron
- Ventura County Department of Public Works (VCDPW): Jayme Laber, Lorraine Timmons, Gail Robinson, Paul Tantet
- Los Angeles County Department of Public Works (LADPW): Ofori Amoah, Suk Chong, TJ Kim, Joy Krejci
- Ventura County Supervisor Kathy Long: Martin Hernandez
- Ventura County Farm Bureau: Rex Laird
- Friends of the Santa Clara River: Ron Bottorff, Richard Sweet
- California Department of Water Resources: Diane Sanchez
- University of California Santa Barbara (facilitator): Dr. Arturo Keller, Timothy Robinson
- California Center for Public Dispute Resolution (facilitator/conflict resolution expert): Judith Talbot
- Systech Engineering (modeler): Joel Herr

* These groups shared the costs for facilitation and modeling consultants.

The following provides a summary of the Steering Committee meetings:

Date	Meeting Highlights	Meeting Type
2/11/02	Define problem, discuss data needs.	Steering Committee.
3/4/02	Discuss: draft problem statement, modeling RFP, funding for modeling, facilitators' and stakeholders' roles.	Steering Committee.
3/29/02	Presentations by four contractors for modeling proposals.	Steering Committee.
4/3/02	Discuss timeframe and focus of modeling analysis; compare BASINS v. WARMF; select modeling consultant; discuss costs.	Steering Committee.
4/22/02	Review and discuss revised problem statement, overview on the nature of – and approaches to setting–numeric targets.	Steering Committee.
6/11/02	Review and discuss source assessment results: subregions; loading mechanisms and data sources, loading by subregions. Identify data gaps.	Steering Committee.
6/22/02	Presentation on progress to date and source assessment.	Public - Stakeholders
7/22/02	Discuss: available water quality data; current and future WQ sampling plans. Overview of procedure for hydrologic modeling; water effects ratios and source assessment update.	Steering Committee.
8/19/02	Present and discuss hydrologic modeling results.	Steering Committee.
9/9/02	Present and discuss linkage analysis results. Updates on WWTP upgrades. Brief discussion on numeric targets.	Steering Committee.
9/23/02	Detailed response to comments on linkage analysis.	Steering Committee.
10/15/02	Presentation on progress to date and linkage analysis.	Public - Stakeholders
10/31/02	Discuss: basis for numeric targets, revisions to linkage analysis.	Steering Committee.
11/18/02	Present and discuss modeling scenarios (base case and permit) to meet numeric targets;	

	implications of changes to 303 (d) list.	Steering Committee.
12/9/02	Present and discuss modeling scenarios (representing four different strategies) to meet numeric targets; next steps for writing technical TMDL document.	Steering Committee.
2/3/03	Present and discuss: key points in problem statement and linkage analysis sections of TMDL; possible studies which could be part of the implementation phase.	Steering Committee.
4/16/03	Present and discuss key elements of draft staff report on technical options; WWTP cost options.	Steering Committee.
5/15/03	Review and discuss revisions to draft staff report on technical options.	Steering Committee
6/5/03	Review and discuss revisions to draft staff report on technical option	Steering Committee
6/12/03	CEQA Scoping	Public

The Steering Committee members contracted outside experts to provide technical facilitation and modeling services in support of the TMDL analysis. The Steering Committee selected Dr. Arturo Keller from the UC Santa Barbara Bren School of Environmental Science and Management as technical facilitator. Dr. Keller was asked to conduct project management, summarize and coordinate technical analysis and facilitate Stakeholder meetings. This process was intended to assist the Regional Board in developing stakeholder consensus on the nutrient TMDL plan for the Santa Clara River watershed. Facilitation was funded by the RWQCB.

1.3.2 Meeting Facilitation

The facilitator coordinated and assisted the TMDL development process, including organization and facilitation of quarterly meetings open to all stakeholders. Principal work items for meeting facilitation included:

- Facilitation of Santa Clara River nutrient TMDL meetings (including production and distribution of agendas and meeting minutes summaries);
- Integration of stakeholder and Regional Board interests and concerns;
- Oversight and assistance in modeling work;

- Organization and execution of modeling laboratory sessions for stakeholders interested in learning how to use the watershed model;
- Use of the calibrated model to simulate implementation scenarios requested by stakeholders and the Regional Board; and,
- Presentation of a report summarizing modeling results for various load allocation scenarios.

Dr. Keller drafted a request for proposals (RFP) for the modeling consultant selection process and led the interviews for modeling consultant applicants. The Steering Committee selected Systech Engineering, Inc. (San Ramon, California) for the modeling work. The cost of the modeling effort was shared by LACSD, LADPW, Newhall Land, and the cities of Santa Clarita, Fillmore and Santa Paula.

1.3.3 Model Development and Calibration.

After consideration of watershed modeling proposals from several consultants, the Steering Committee selected Systech, Engineering, Inc. who proposed to model the watershed using the WARMF (Watershed Analysis Risk Management Framework) watershed modeling software. Systech's scope of work included two primary tasks: (1) to provide a nutrient source load identification and characterization analysis, and (2) to provide a linkage analysis, linking nutrient source loads with in-stream concentrations using the WARMF watershed model.

The level of involvement of stakeholders was very high throughout the modeling process. Stakeholders provided water quality and flow input data sets as well as detailed comments on each of the task reports provided by Systech. Stakeholders also participated in model setup, calibration, sensitivity analysis, verification and scenario selection. Consensus from the Steering Committee was achieved subsequent to each stage of model development.

With support from the stakeholder group, Systech used the WARMF model to integrate all water quality, air quality, hydrologic, meteorological, topographic, land use and soil type data in a single, consistent spatial-database. A Source Identification and Characterization report was presented that described assumptions and results of the source analysis, together with an assessment of the relative magnitude of point and non-point sources in the various subcatchments of the Santa Clara River watershed.

Following identification and quantification of all point and nonpoint nutrient sources in the Santa Clara River watershed, the WARMF modeling sought to characterize the magnitude and timing of nutrient loading to surface water bodies. This step, known as the linkage analysis, involves the linkage of nutrient source loads to in-stream concentrations. Systech provided a linkage analysis report to the Steering Committee, and further analysis was conducted by, and on behalf of, the stakeholder group to test new and different assumptions and scenarios using the model. Systech also provided a calibrated executable version of the model that allows the facilitator and Steering Committee members to perform simulations of different scenarios independently.

1.3.4 Summary

A high level of stakeholder involvement has occurred throughout the TMDL development process. There have been no interventions from outside groups, and much of the work has been performed, or paid for, by members of the Steering Committee. All parties involved consider the process to be a significant improvement over other methods used for TMDL development. This TMDL process should receive statewide attention as an excellent model for a successful stakeholder-Regional Board cooperative effort.

2 PROBLEM IDENTIFICATION

The 2002 water quality assessment identifies reaches of the Santa Clara River that are impaired for ammonia (Reach 3) and nitrate and nitrite (Reach 7). Nitrite and nitrate are biostimulatory substances that can cause or contribute to eutrophic effects such as low dissolved oxygen and algae growth in inland surface waters such as the Santa Clara River. Excessive ammonia can cause aquatic life toxicity in inland surface waters such as the Santa Clara River. Although the Santa Clara River is not listed as impaired for the effects of nitrogen impairment, Regional Board staff finds evidence that the following effects may be of concern in the Santa Clara River, including:

- The 1998 303 (d) list contains an impairment for organic enrichment and dissolved oxygen in Reach 8. Although this impairment was removed from the 2002 303(d) list, it was placed on the State of California "Monitoring List" indicating that the State considers monitoring to be appropriate and a high priority.
- Studies by UCLA and California Department of Fish and Game (Appendix B) indicate low diversity of benthic macroinvertebrate samples in the area below the Valencia WRP outfall. More data are required to assess the status of aquatic life habitat.
- Observations of algae by Regional Board staff and other researchers and stakeholders.

This TMDL addresses impairments on the 2002 303(d) list and it is appropriate to consider water quality effects that these impairments can cause. Consequently, this section provides an overview of water quality standards for the Santa Clara River, reviews water quality data used in the 1998 water quality assessment and additional data used to analyze sources in this TMDL.

2.1 Water Quality Standards

California state water quality standards consist of the following elements: 1) beneficial uses; 2) narrative and/or numeric water quality objectives; and 3) an antidegradation policy. For inland surface waters in the Los Angeles Region, beneficial uses are identified in the Basin Plan. Numeric and narrative objectives are specified in the Basin Plan, designed to be protective of the beneficial uses in each waterbody in the region or State Water Quality Control Plans. The Basin Plan for the Los Angeles Regional (1994) defines 14 beneficial uses for the Santa Clara River.

2.1.1 Beneficial Uses

The Basin Plan has identified the following beneficial uses for the Santa Clara River:

Table 2. Beneficial Uses of the Santa Clara River and Tributaries

STREAM REACH	Hydro Unit No.	MUN	IND	PROC	AGR	GWR	FRSH	REC1	REC2	WARM	COLD	WILD	RARE	MIGR	WET
Santa Clara River	403.11	P*	E	E	E	E	E	E	E	E	E	E	E	E	E
Santa Clara River	403.21	P*	E	E	E	E	E	Ed	E	E		E	E	E	E
Santa Clara River	403.31	P*	E	E	E	E	E	Ed	E	E		E	E	E	E
Santa Clara River	403.41	P*	E	E	E	E	E	E	E	E		E	E	E	E
Lake Piru	403.42	P	E	E	E	E	P	E	E	E	E	E	E		
Pyramid Lake	403.42	E	E	E	E	E	P	E	E	E	E	E	E		
Castaic Lagoon	403.51	E*	E	E	E	E	E	E	E	E		E			
Elizabeth Lake	403.51	P	I	I	I	I	I	I	E	I		E			
Lake Hughes	403.51	P	P	P	P	P	P	E	E	E		E			
Mint Canyon Creek	403.51	I	I	I	I	I	I	Im	I	I		E			
Munz Lake	403.51	P*	P	P	P	E	P	E	E	E		E			
Santa Clara River	403.51	P*	E	E	E	E	E	E	E	E		E	E		E
Santa Clara River (Soledad Cyn)	403.55	E*	E	E	E	E	E	E	E	E		E	Ei		E
Brown Barranca/ Long Canyon		P*	E	E	E	E	E	E	E	E		E	E	E	E
Wheeler Canyon/ Todd Barranca		P*	E	E	E	E	E	E	E	E		E	E	E	E

E Existing beneficial use
P Potential beneficial use
I Intermittent beneficial use
* Conditional designation that may be considered for exemption at a later date

d Limited public access precludes full utilization
i Soledad Canyon is the habitat of the Unarmored Three-Spine Stickleback
m Access prohibited by Los Angeles County DPW in the concrete-channelized area
s Access prohibited by Los Angeles County DPW

Unless otherwise noted, these designated beneficial uses are either existing or potential. The designated beneficial uses are briefly described below.

2.111 MUN; Municipal and Domestic Supply

Municipal and Domestic Supply (MUN) is defined as uses of water for community, military, or individual water supply systems including, but not limited to, drinking water supply. The MUN designations for the Santa Clara River are designated as potential uses, except for SCR Hydro Unit 403.55 and Mint Canyon Creek that are designated as existing and intermittent, respectively. The MUN designations that are noted with an asterisk are conditional designations that were designated under SB 88-63 and RB 89-03. Conditional designations are currently not recognized under federal law and are not water quality standards subject to enforcement at this time. (See Letter from Alexis Strauss [USEPA] to Celeste Cantú [State Board], Feb. 15, 2002.)

2.112 GWR; Groundwater Recharge

The Basin Plan defines groundwater recharge as: "Uses of water for natural or artificial recharge of ground water for purposes of future extraction, maintenance of water quality, or halting seawater intrusion into freshwater aquifers."

Water use in the Santa Clara River watershed supports the GWR designation of the Santa Clara River as an existing beneficial use. Surface water infiltrates into aquifers underlying the Santa Clara River from pervious land surfaces, the river and tributaries, and from engineered recharge basins. Groundwater from the alluvial and Saugus aquifers is extracted for municipal supply and agricultural supply and discharges to the surface water as a TMDL source.

Because the State has designated GWR as a beneficial use for the Santa Clara River, the use becomes a federally recognized (and hence enforceable) "state water quality standard." Consequently, GWR is a beneficial use that the TMDL must protect.

2.11.3 AGR; Agricultural Supply

Agricultural Supply is defined as uses of water for “farming, horticulture, or ranching including, but not limited to, irrigation, stock watering, or support of vegetation through range grazing.” AGR is an existing beneficial use of the Santa Clara River, with surface water directly diverted for irrigation and groundwater extracted for irrigation.

2.11.4 IND, PROC, and FRSH; Industrial and Surface Water Quality

Industrial Service Supply, Industrial Process Supply, and Freshwater Replenishment are designated as existing beneficial uses of the Santa Clara River. Industrial Service Supply and Industrial Process Supply are both defined as uses of water for industrial activities, with PROC denoting uses that depend on water quality and IND denoting uses that do not depend on water quality. FRSH is defined as uses of water for natural or artificial maintenance of surface water quality.

2.11.5 REC-1 and REC-2: Recreational Uses

Water Contact Recreation (REC-1) and Non-Contact Water Recreation (REC-2) are defined as uses of water for recreational activities involving body contact and proximity to water. Some of these activities include fishing, sightseeing and aesthetic enjoyment in conjunction with recreational activities. These beneficial uses are directly affected by ammonia and nitrogen because ammonia causes fish and aquatic life toxicity and nitrogen in surface water can lead to excessive aquatic growth.

2.1.1.6 WARM, WILD, RARE, WET, COLD; Habitat Related Uses

Several habitats related beneficial uses are designated for the Santa Clara River. These uses include warm freshwater habitat, cold freshwater habitat, wildlife habitat, rare, threatened or endangered species habitat, migration of aquatic organisms, and wetland habitat. These habitat-related beneficial uses are affected by ammonia and nitrogen because ammonia causes fish and aquatic life toxicity and nitrogen in surface water can lead to excessive aquatic growth.

2.1.2 Water Quality Objectives

The Basin Plan provides water quality objectives (WQOs) for nitrogen compounds and their related effects, including numeric and narrative objectives discussed below. Both types of objectives are used in developing numeric targets and wasteload allocations.

2.1.2.1 Ammonia

The Basin Plan provides the following objectives for ammonia:

> The neutral, un-ionized ammonia species (NH_3) is highly toxic to fish and other aquatic life. The ratio of toxic NH_3 to total ammonia (NH_4^+ + NH_3) is primarily a function of pH, but is also affected by temperature and other factors. Additional impacts can occur as the oxidation of ammonia lowers the dissolved oxygen content of the water, further stressing aquatic organisms. Ammonia also combines with chlorine (often both are present) to form chloramines – persistent toxic compounds that extend the effects of ammonia and chlorine downstream.
>
> *In order to protect aquatic life, ammonia concentrations in receiving waters shall not exceed the values listed for the corresponding in-stream conditions in Tables 3-1 to 3-4 [of the Basin Plan.]*

The Basin Plan objectives for ammonia currently are based on "Ambient Water Quality Criteria for Ammonia – 1984," developed by EPA, which contains criteria for protection of freshwater aquatic life. In 1999, EPA revised its recommended values for the Criteria Continuous Concentration (CCC) through a memorandum entitled "Revised Tables for Freshwater Ammonia Concentrations."

The EPA's updated 1999 criteria reflect research and data analyzed since 1985, and represent a revision of several elements in the 1984 guidance, including the relationship between ammonia toxicity, pH and temperature, and the recognition of increased sensitivity of early life stage forms of fish to ammonia toxicity. The 1984 criteria were based on un-ionized ammonia (NH_3), while the 1999 criteria are expressed only as total (un-ionized plus ionized or NH_3 + NH_4^+) ammonia. The criteria apply to freshwater and do not impact the Ammonia Water Quality Objectives contained in the California Ocean Plan.

Chronic values presented in the updated criteria were derived based on regression analysis. In the past, hypothesis testing was used whereby the chronic value was derived by calculating the geometric mean of the "no observed effects concentration" (NOEC) and the "lowest observed effects concentration" (LOEC). Regression analysis is the preferred method because it is more reflective of the magnitude of the toxic response. The results of hypothesis testing vary depending on the values tested and the variability of the database. The updated chronic criteria are raised slightly because one of the chronic toxicity tests involving white sucker used to develop the 1984 criteria was no longer considered valid.

The toxicity of ammonia is a function of pH and temperature, as indicated in these documents. Low pH and low temperature result in lower toxicity. The target for ammonia also depends on the averaging time, as follows:

1) The one-hour average concentration of total ammonia as nitrogen (in mg N/L) shall not exceed (more than once every three years on average) the criteria maximum concentration (CMC) calculated as follows:

Where salmonid fish are present:

$$CMC = \frac{0.275}{1+10^{7.204-pH}} + \frac{39.0}{1+10^{pH-7.204}}$$

Where salmonid fish are not present:

$$CMC = \frac{0.411}{1+10^{7.204-pH}} + \frac{58.4}{1+10^{pH-7.204}}$$

2) The thirty-day average concentration of total ammonia as nitrogen (in mg N/L) shall not exceed (more than once every three years on average) the criteria continuous concentration (CCC) calculated as follows:

Where early life stage fish are present:

$$CCC = \left(\frac{0.0577}{1+10^{7.688-pH}} + \frac{2.487}{1+10^{pH-7.688}} \right) * MIN(2.85, 1.45x10^{0.028*(25-T)})$$

Where early life stage fish are not present:

$$CCC = \left(\frac{0.0577}{1+10^{7.688-pH}} + \frac{2.487}{1+10^{pH-7.688}} \right) * 1.45x10^{0.028*(25-MAX(T,7))}$$

where T = temperature in ^{o}C.

3) The highest four-day average within the 30-day period shall not exceed 2.5 times the CCC.

The most significant differences in the 1999 U.S. EPA guidance for ammonia are:

- Acute criteria are no longer temperature-dependent but remain dependent on pH and fish species present,
- There is a greater recognition of the temperature dependence of the chronic criteria, especially at low temperatures,
- An Early Life Stage (ELS) chronic criterion was introduced,

- Chronic criteria are no longer dependent on the presence or absence of specified fish species, but remain dependent on pH and temperature, and
- A 30-day averaging period for the ammonia chronic criteria replaced the 4-day averaging period.

The 1984 chronic criteria were dependent mainly on pH and there was no temperature dependency below 20 degrees. The updated chronic criteria are dependent on pH and temperature. At lower temperatures, the chronic criteria are also dependent on the presence or absence of early life stages of fish (ELS), regardless of species. Another significant revision to the 1999 Update is EPA's recommendation of 30 days as the averaging period for the chronic criteria instead of 4 days. The averaging period has been extended because the most sensitive test species used; fathead minnow (Pimephales promelas) and fingernail clam (Muscullum transversum) show their sensitivity after long periods of exposure.

The Regional Board approved revised Basin Plan objectives for ammonia based on EPA's updated criteria on April 25, 2002. The revised objectives were approved by State Board on April 30, 2003 and were approved by the Office of Administrative Law (OAL) on June 5, 2003. This TMDL has been developed to be consistent with the updated objectives. Further, the Regional Board's resolution adopting the TMDL will specify that the ammonia allocations will take effect following the approval of the revised criteria by USEPA.

2.12.2 Oxidized Nitrogen

In terms of use protection levels for nitrate as nitrogen, the primary drinking water standard is 10 mg-nitrogen/L. The drinking water standard for nitrite as nitrogen is 1 mg-nitrogen/L. Since nitrite oxidizes to nitrate under ambient conditions, when both nitrate plus nitrite are present, their sum should not exceed 10 mg nitrogen/L when considering the protection of a drinking water beneficial use. Many segments of the Santa Clara River have been designated with a conditional potential MUN beneficial use as noted in Section 1.4.1. These waters do not have this beneficial use until the State undertakes additional study and modifies its Basin Plan.

The Basin Plan establishes numeric water quality objectives for nitrogen in surface waters in the Los Angeles Region, including Santa Clara River and its tributaries, expressed as nitrate-nitrogen plus nitrite-nitrogen (NO_3-N +NO_2-N). Table 3-8 of the Basin Plan prescribes water quality objectives for nitrate-nitrogen plus nitrite-nitrogen (NO_3-N +NO_2-N) for reaches above Freeman Diversion equal to 5 or 10 mg/L nitrogen. Below Highway 101, numeric objectives are not defined in the Basin Plan, but narrative objectives apply.

2.12.3 Biostimulatory Substances

The Basin Plan specifies, "Waters shall not contain biostimulatory substances in concentrations that promote aquatic growth to the extent that such growth causes nuisance or adversely affects beneficial uses." The Basin Plan also recognizes that such excessive growth can cause water quality problems (e.g., high pH) and aesthetic problems (e.g., odor, scum). Excess nitrogen, as ammonia, nitrite or nitrate, promotes the growth of algae and is considered a biostimulatory substance subject to the narrative objective.

2.12.4 Toxicity

The Basin Plan states that "All waters shall be maintained free of toxic substances in concentrations that are toxic to, or that produce detrimental physiological responses in, human, plant, or aquatic life. The survival of aquatic life in surface waters, subjected to waste discharge or other controllable water quality factors, shall not be less than that for the same waterbody in areas unaffected by the waste discharge or, when necessary, other control water." Ammonia causes aquatic life toxicity and is considered a toxic substance.

2.12.5 Groundwater Objectives

Because the numeric objective for nitrogen in Regional Ground Waters is either greater than or equal to the numeric objective for nitrogen in Inland Surface Waters for the Santa Clara River Watershed, Regional Board staff conclude that the existing water quality objective for nitrogen established in the Basin Plan for selected constituents in Inland Surface Waters is protective of the GWR beneficial use.

The implementation plan includes groundwater monitoring to verify that nitrogen loads from rising groundwater are not causing exceedances of the numeric targets for ammonia and nitrite+nitrate. If monitoring shows that rising groundwater is causing exceedances of numeric targets, load allocations or revision of the groundwater objective for nitrogen by the Regional Board may be appropriate.

2.12.6 Alternatives Considered by Regional Board

Two alternatives were considered for developing an appropriate water quality objective for ammonia in the Santa Clara River: 1) Use existing Basin Plan objectives; and 2) apply the "1999 Update of Ambient Water Quality Criteria for Ammonia" developed by U.S. EPA. The criteria used for selecting the recommended alternative included:

- Consistency with State and federal water quality laws and policies;
- level of beneficial use protection; and
- consistency with the current science regarding water quality necessary to reasonably protect the beneficial uses of the Santa Clara River.

Under Alternative 1, Using existing Basin Plan objectives, the existing Basin Plan water quality objective for ammonia would remain unchanged and would continue to apply to Santa Clara River without consideration of the updated criteria for ammonia. Under Alternative 2, the 1999 Update of Ambient Water Quality Criteria for Ammonia would be applied to Santa Clara

River as a water quality objective. Alternative 2 is the recommended alternative since the action would:

- be consistent with recent modifications to State and federal water quality regulations;
- facilitate development of an objective that would be protective of Santa Clara River's beneficial uses; and
- improve the scientific basis upon which the water quality objective is based.

Adoption of Alternative 1 (using existing Basin Plan objectives for ammonia) would be inconsistent with the updated objectives.

2.1.3 Antidegradation

State Board Resolution 68-16, Statement of Policy with Respect to Maintaining High Quality Water in California, known as the "Antidegradation Policy," protects surface and ground waters from degradation. According to the Antidegradation Policy, any actions that can adversely affect water quality in all surface and ground waters must be consistent with the maximum benefit to the people of the state, must not unreasonably affect present and anticipated beneficial use of such water, and must not result in water quality less than that prescribed in water quality plans and policies. Furthermore, any actions that can adversely affect surface waters are also subject to the federal Antidegradation Policy (40 CFR 131.12). The proposed TMDL will not lower water quality, and will in fact improve water quality as it is designed to achieve compliance with existing water quality standards.

2.2 Basis of Listing

In 1996, Regional Board staff conducted a Water Quality Assessment that identified exceedances of water quality objectives (WQOs) for nitrogen compounds in the Santa Clara River. The water quality assessment data are summarized in Table 3. Table 3 shows the number of samples, the range of values, the average value and the standard deviation, with exceedances of the water quality objectives noted in bold.

Table 3. Summary of water quality data – 1996 water quality assessment. Exceedances indicated in bold.

EPA Reach	Statistical Information	NH_3 (mg/L)	NO_3+NO_2 (mg/L)	DO (mg/L)	pH (-)	Temp (°C)
1 and 2	# of Samples	No data	2 samples	No data	6 meas.	19 meas.
	Range		0.8-0.9		7.7-8.3	9-28
	Average±Std Dev		0.85±0.05		8.0±0.2	16±6
3	# of Samples	5 samples	5 samples	No data	3 meas.	20 meas.
	Range	**0.02-0.45**	1.6-3.2		8.2-8.3	13-28
	Average±Std Dev	**0.25±0.19**	2.5±0.7		8.2±0.05	19±3
4	# of Samples	No data	17 samples	17 meas.	17 meas.	21 meas.
	Range		0.6-3.5	7.0-10.7	7.8-8.4	7-29
	Average±Std Dev		2.2±1.0	9.1±1.1	8.0±0.2	17±6
5 and 6	# of Samples	3 samples	9 samples	No data	11 meas.	15 meas.
	Range	**0.11-0.8**	**0.6-22.6**		7.5-8.6	17-29
	Average±Std Dev	**0.5±0.3**	**5.5**		8.1±0.3	22±3
7	# of Samples	4 samples	8 samples	8 meas.	13 meas.	14 meas.
	Range	**0.07-0.44**	**1.3-7.5**	8.1-8.9	7.3-8.5	21-27
	Average±Std Dev	**0.26±0.13**	**4.5±1.9**	8.2±0.4	8.2±0.4	23±2
8	# of Samples	69 samples	89 samples	20 meas.	91 meas.	88 meas.
	Range	**ND-4.9**	**0.3-15.4**	4.2-10.8	6.8-8.4	10-27
	Average±Std Dev	**1.4±1.3**	**5.7±2.4**	7.4±2.0	7.8±0.3	18±4
9 and 10	# of Samples	No data	15 samples	6 meas.	15 meas.	3 meas.

EPA Reach	Statistical Information	NH_3 (mg/L)	NO_3+NO_2 (mg/L)	DO (mg/L)	pH (-)	Temp (^oC)
	Range		ND-4.5	5.7-9.8	7.9-8.6	18-30
	Average±Std Dev		0.5	7.6±1.2	8.1±0.2	25±5
Brown Barranca /Long Canyon	# of Samples	No data	6 samples	No data	6 meas.	3 meas.
	Range		2.5-9.9		7.4-8.4	15-17
	Average±Std Dev		4.8±2.7		7.8±0.3	16±1
Wheeler Canyon/ Todd Barranca	# of Samples	No data	**12 samples**	No data	12 meas.	7 meas.
	Range		**0.8-25.8**		7.3-8.1	3-31
	Average±Std Dev		**5.6**		7.7±0.2	19±9
Sespe Creek*	# of Samples	No data	4 samples	1 meas.	6 meas.	4 meas.
	Range		ND-1.3	10.8	8.0-8.6	18-25
	Average±Std Dev		0.4		8.2±0.2	23±3
Torrey Canyon	# of Samples	No data	**3 samples**	No data	4 meas.	2 meas.
	Range		**1.2-17.7**		7.1-8.2	12-14
	Average±Std Dev		**7.0**		7.6±0.5	

*Algae was noted in Sespe creek.

Based on the water quality assessment, U.S. EPA listed the Santa Clara River (SCR) segments, tributaries and waterbodies in Table 4 as impaired in the 1998 303(d) list of impaired waterbodies in California.

Table 4. Santa Clara River (SCR) Impairments, 1998 (303)d List

Nutrient/Effect	Impaired Waterbody/Segment
Ammonia	SCR Reach 3, Freeman Diversion to Fillmore Street A
Ammonia, nitrate+nitrite	SCR Reach 5 (EPA Reach 7), Blue Cut to West Pier Hwy 99
Ammonia, nitrate+nitrite, organic enrichment/DO	SCR Reach 6 (EPA Reach 8), Hwy 99 to Bouquet Canyon Rd

Nutrient/Effect	Impaired Waterbody/Segment
Nitrate+nitrite	Brown Barranca/Long Canyon
Nitrate+nitrite	Wheeler Canyon/Todd Barranca
Nitrate+nitrite	Mint Canyon Creek

1. The Regional Board assessed the water quality impairment again in 2002. Based on the results of that analysis, the State Water Resources Control Board approved a 2002 Federal Clean Water Act Section 303(d) List of Water Quality Limited Segments on February 4, 2003 (Resolution No. 2003-0009). California's 2002 section 303(d) list is presently awaiting final approval by the U.S. Environmental Protection Agency (USEPA), but the State and USEPA have proposed listing the Santa Clara River for nitrogen compound impairments. The listings are summarized in Tables 5 and 6.

Table 5. Santa Clara River (SCR) Impairments 2002 303(d) List

Nutrient/Effect	Impaired Waterbody/Segment	Extent
Ammonia	SCR Reach 3, Freeman Diversion to A. Street	31 Miles
Nitrate and nitrite	SCR Reach 7, Blue Cut to West Pier Hwy 99	9.4 Miles
Nitrate and nitrite	Brown Barranca/Long Canyon	2.6 Miles
Nitrate and nitrite	Wheeler Canyon/Todd Barranca	10 Miles
Nitrate and nitrite	Mint Canyon Creek Reach 1	8.1 Miles

Table 6 summarizes the Santa Clara River segments that were included on the US EPA 1998 303(d) List for nitrogen compounds and related effect impairments that have been revised to be included on the State Enforceable Programs or Monitoring lists.

Table 6. Santa Clara River segments included on State Enforceable Programs or Monitoring Lists

List Status	Nutrient/Effect	Impaired Waterbody/Segment	Extent
Enforceable Program	Ammonia	Reach 7 (Blue Cut to West Pier Hwy 99)	9.4 Miles

List Status	Nutrient/Effect	Impaired Waterbody/Segment	Extent
Monitoring Program	Organic Enrichment/Dissolved Oxygen	Reach 8 (West Pier Hwy 99 to Bouquet Cyn Bridge)	5.6 Miles
Enforceable Program	Ammonia	Reach 8 (West Pier Hwy 99 to Bouquet Cyn Bridge)	5.6 Miles

The eutrophic effects observed in lakes within the Santa Clara watershed are addressed in this TMDL as water sources. Impairments of these lakes will be addressed in a future Regional Board action.

3 NUMERIC TARGETS

Numeric targets for this TMDL are the target conditions in the waterbody necessary to support the beneficial uses. Numeric targets for this TMDL were based on the water quality objectives in the Basin Plan and the explicit Margin of Safety (10%) described in Section 6.3.

The water quality objectives for ammonia, and nitrate plus nitrite are intended to support aquatic life, recreation, water supply and other beneficial uses. Given that the 1994 Basin Plan contains numeric objectives for nitrate/nitrite, nitrite and nitrate, and Regional Board Orders provide guidance on using the 1999 EPA ammonia criteria, these objectives are appropriate numeric targets for the TMDL.

3.1 Ammonia

The numeric targets for ammonia are consistent with the recently revised Basin Plan objectives based on US EPA's 1999 update of Ambient Water Quality Criteria for Ammonia. The ammonia targets will take effect following approval by US EPA. For this TMDL, the ammonia targets are based on the criteria developed by U.S. EPA, in the "1999 Update of Ambient Water Quality Criteria for Ammonia," December 1999 and adopted by the Regional Board in 2002. The 1999 Update contains U.S. EPA's most recent freshwater aquatic life criteria for ammonia and supersedes all previous freshwater aquatic life criteria for ammonia. In this revision the acute criteria is dependent on pH and the chronic criteria is based on pH and temperature of the receiving water. A review of pH data does not show evidence of a seasonal signal. However, dischargers have noted that there may be a seasonal variation in temperature. This will be subject of a special study by the dischargers to determine possible effects on ammonia targets. The 1999 U.S. EPA Ambient Water Quality for Ammonia acknowledges that ammonia toxicity may be dependent on the ionic composition of the waterbody. This issue can be addressed by performing a water effects ratio (WER) study or other site-specific approaches, if approved by the Regional Board through the Basin Plan amendment process. The Basin Plan outlines the requirements for development of a Site-Specific Objective (SSO). At this time, stakeholders have initiated a WER study for ammonia in the Santa Clara River in conformance with a Work Plan that has been approved by Regional Board staff. It is anticipated that the WER study will serve as the basis for development of a proposed SSO and revised effluent limits, as appropriate, for Regional Board approval. A SSO based on a WER for ammonia would be implemented as a Basin Plan Amendment that, if approved, would amend both the Basin Plan and this TMDL. The SSO would be required to demonstrate that both the ammonia objectives would be in conformance with the Antidegradation Policy (State Board Resolution 68-16). A separate analysis would be required to support a SSO to determine if any increases in ammonia effluent limits would cause exceedances of the water quality objectives for nitrate or nitrate + nitrite.

For ammonia, numeric targets that are pH and temperature dependent will be applied to protect water quality criteria for aquatic life. Numeric targets for this TMDL are concentration based. The implementation provisions for the Application of Ammonia Objectives to Inland Surface Waters in the Los Angeles Region indicate that the selection of acute ammonia objectives is based on the equations for “salmonids present” in Reach 3 because this segment is designated in the Basin Plan as “MIGR.” The acute ammonia objectives in Reach 7 is based on the equations for “salmonids not present” because Reach 7 is not designated in the Basin Plan as either “COLD” or “MIGR.” The implementation provisions for the Application of Ammonia Objectives to Inland Surface Waters in the Los Angeles Region indicate that the selection of chronic ammonia objectives is based on the equations for “early life stages for fish are absent” because the Santa Clara River watershed listed segments are not designated in the Basin Plan as

"SPWN." The acute numeric targets and chronic numeric targets for ammonia will be calculated using the equations set forth in Resolution No. 2002-11.

For illustrative purposes, based on the pH and temperature data in EPA Reaches 3, 7 and 8 for the past five years, thirty day ammonia targets range from 1.7- mg/L to 1.9 mg/L in Reach 3, 1.2 mg/L to 2.0 mg/L in Reach 7, and 3.2 mg/L in Reach 8. These numeric targets are based on the median concentrations of pH and temperature and do not assume application of an ammonia water effects ratio.

A statistical summary of in-stream pH and temperature in the Santa Clara River is presented in Tables 7 and 8, collected from 1989 to 2000 by several agencies, as noted in the Source Analysis report. For calculation of the Criteria Continuous Concentration, the 50-percentile of pH and temperature was used. The criteria maximum concentration (CMC) is based on the 95th percentile of pH data. Tables 7 and 8 show the pH generally increases while the temperature generally decreases from upstream to downstream locations.

Table 7. Statistical Summary of pH data from 1989-2000

Statistical Parameter	Reach 8	Reach 7 above Valencia	Reach 7 below Valencia	Reach 7 at County Line	Reach 3 above Santa Paula	Reach 3 at Santa Paula	Reach 3 below Santa Paula
50th percentile	7.33	7.89	7.78	8.20	8.00	8.00	8.08
90th percentile	7.53	8.16	8.04	8.30	8.30	8.30	8.35
95th percentile	7.62	8.24	8.17	8.41	8.37	8.37	8.43
Mean	7.31	7.85	7.73	8.15	8.00	8.00	8.03
Standard Deviation	0.22	0.29	0.31	0.21	0.26	0.26	0.31
CV*	0.03	0.04	0.04	0.03	0.03	0.03	0.04

*CV = coefficient of variation

Table 8. Statistical Summary of temperature (in ^{o}C) data from 1989-2000

Statistical Parameter	Reach 8	Reach 7 above Valencia	Reach 7 below Valencia	Reach 7 at County Line	Reach 3 above Santa Paula	Reach 3 at Santa Paula	Reach 3 below Santa Paula
50 percentile	19.89	18.23	20.22	19.03	16.68	16.81	16.81
90 percentile	24.34	23.68	25.32	24.59	19.00	19.73	19.87
95 percentile	25.02	24.58	25.90	25.41	19.48	20.44	20.57
Mean	19.55	18.43	20.21	19.22	16.39	16.52	16.52
Standard Deviation	3.92	4.05	3.97	4.15	2.32	2.78	2.85
CV	0.20	0.22	0.20	0.22	0.14	0.17	0.17

Using this information, the CCC for each segment is calculated using the corresponding equations and are presented in Table 9. A 10% margin of safety (to be discussed further in Section 6.3) is considered for the Ammonia Numeric Target, using the same rationale as for the Nitrate plus Nitrate numeric target, to be discussed in Section 3.2. Based on the temperature in these segments of the Santa Clara River, there is no need to differentiate between the CCC for "early life stages of fish present" and "early life stages of fish not present".

Table 9. Ammonia Water Quality Objectives and Numeric Targets (mg/L as Nitrogen)

Reach	Water Quality Objective		Numeric Target	
	One-hour average	**Thirty-day average**	**One-hour average**	**Thirty-day average**
Reach 8	16.5	3.5	14.8	3.2
Reach 7 above Valencia	5.5	2.2	4.82	2.0
Reach 7 below Valencia	6.1	2.3	5.5	2.0
Reach 7 at County Line	3.8	1.3	3.4.3	1.2
Reach 3 above Santa Paula	2.7	2.1	2.4	1.9
Reach 3 at Santa Paula	2.7	2.1	2.4	1.9
Reach3 below Santa Paula	2.4	1.9	2.2	1.7

3.2 Nitrate and Nitrite

For this TMDL, initial numeric targets for oxidized nitrogen are based on the existing objectives in the Basin Plan for each reach and the explicit Margin of Safety(10%). Tables 10 and 11 give these targets. In accordance with the Basin Plan, which does not provide guidance for interpreting the water quality objectives as averages, the numeric targets for nitrite, nitrate, and nitrite+nitrate are daily maximum values.

Table 10. Water Quality Objectives and Numeric Targets for Nitrate plus Nitrite (mg/L as Nitrogen)

Reach	Nitrate + Nitrite WQO	Numeric Target
8 (above Lang)	5	4.5
7 (above Bouquet)	5	4.5
6 (above Hwy99)	10	9.0
5 (above Blue Cut)	5	4.5
4 (above Fillmore)	5	4.5
3 (above Freeman diversion)	5	4.5
2 (above Hwy101)	10	9.0
1 (above estuary)	10	9.0

Table 11. Water Quality Objectives and Numeric Targets for Nitrate and Nitrite (mg/L as Nitrogen)

Reach	Nitrate WQO mg/L	Nitrate Numeric Target	Nitrite WQO mg/L	Nitrite Numeric Target
8 (above Lang)	5	4.5	1	.9
7 (above Bouquet)	5	4.5	1	.9
6 (above Hwy99)	10	9.0	1	.9
5 (above Blue Cut)	5	4.5	1	.9
4 (above Fillmore)	5	4.5	1	.9
3 (above Freeman diversion)	5	4.5	1	.9
2 (above Hwy101)	10	9	1	.9
1 (above estuary)	10	9	1	.9

3.3 Nitrogen Effects

The 2002 303(d) list that triggered the development of this TMDL documents impairments of the Santa Clara River by ammonia and nitrate+nitrite. Ammonia, nitrate and nitrite are known to impact aquatic life through toxicity, organic enrichment and eutrophication processes, which result in decreased, dissolved oxygen. The 1998 section 303(d) listing included narrative measures of impairment, specifically organic enrichment/dissolved oxygen in Reach 8. Based on information since 1998, this section 303(d) listing was transferred to the 2002 'Monitoring List' by State Board, indicating a high priority for monitoring before the next section 303(d) list is completed.

3.4 Alternatives Considered by Regional Board

Two alternatives were considered for developing an appropriate numeric target for algae: 1) develop the numeric target for algae based on a narrative objective; and 2) not include a numeric target for algae and require special studies for algae impairment. The criteria used for selecting the recommended alternative included:

- consistency with State and federal water quality initiatives policies;
- level of beneficial use protection;
- consistency with the current science regarding water quality necessary to reasonably protect the beneficial uses; and
- applicability to existing condition of Santa Clara River.

Alternative 1 is not recommended because the 2002 proposed 303(d) list for the Santa Clara River does not include an impairment listing for algae. The available data on algal biomass in the Santa Clara River are not well documented as showing the connection between nitrogen and related effects. Therefore, application of Alternative 1 for Santa Clara River is inappropriate. Moreover, Alternative 1 does not offer an applicable technical approach for developing a measurable and enforceable compliance target for algae.

Alternative 2 is the recommended alternative since the action would be consistent with State and federal water quality initiatives under the Regional Technical Advisory Group (RTAG), which has been established to address federal requirements for States to adopt numeric criteria for nutrients. This TMDL requires evaluation of the algae condition of the Santa Clara River and set triggers that would develop appropriate numeric targets to attain the water quality objective for biostimulatory substances should algae or other nutrient related impairments be measured during TMDL monitoring. In addition, Alternative 2 facilitates the development of an appropriate numeric target if needed that would be protective of Santa Clara River's beneficial uses and improves the scientific basis upon which the numeric target is based.

4 SOURCE ASSESSMENT

The Source Analysis is a detailed summary of nutrient sources in the Santa Clara River watershed and is based on data from the Regional Board permit programs, agencies responsible for reservoir releases and groundwater basin management, agricultural experts, municipalities, and water treatment agencies. The data used to develop the TMDL is summarized in the Technical Support Document (Appendix A). During development of the Source Analysis, Systech met with members of the Steering Committee regularly to review the accuracy and completeness of the Source Analysis. The Steering Committee concluded that the data are sufficient to conduct a thorough loading analysis. The Source Analysis is provided in the Technical Support Document (Appendix A) and is briefly summarized below.

Systech characterized the sources as follows: direct sources, subsurface discharges and land application sources. Direct sources are those that discharge pollutants directly to the Santa Clara River. The subsurface discharges and land application sources are those in which pollutants are discharged to land surface or subsurface and are transported to the Santa Clara River via surface runoff or groundwater flow.

Direct point sources are those which discharge directly to the Santa Clara River and its tributaries and include reservoir releases and direct point source discharges. These surface water discharges are permitted through the NPDES program administered by the Regional Board. Direct point sources were assessed by evaluating discharge monitoring reports and from other data supplied by major dischargers. Reservoir discharges were evaluated based on flow data from USGS gauging stations downstream of the dams and water quality data for Piru Creek, which was also used to assess Castaic Creek due to the lack of data for Castaic Creek.

Subsurface discharges include groundwater discharges to the Santa Clara River and septic system discharges. Groundwater sources were identified through Regional Board permits. However, because there are little data associated with these discharges, a State of California waste discharge database was used to define flow and combined with nominal pollutant concentration data from package sewage treatment plants to estimate loads. Septic system loading was estimated by multiplying the number of septic systems, an assumed number of people per septic system and nominal loadings for nitrogen and phosphorus based on literature values. This load was then modeled by distributing its location in the upper portion of the watershed in relation to the location of the Santa Clara River. The number of septic systems was based on estimates from Los Angeles County Department of Health Services (DHS) personnel.

Land application sources include diversions for groundwater recharge and/or irrigation, agricultural pumping, atmospheric deposition, and fertilizer application. The source analysis analyzed eight diversions with two reaching groundwater and six used for irrigation. The loading was calculated from the flow and average monthly concentrations from water quality monitoring near each diversion. Agricultural pumping flow and well water quality was obtained from data supplied by United Water Conservation District for Ventura County. For Los Angeles County, pumping was assumed to provide irrigation water for crops, based on crop irrigation requirements from local agricultural experts. Nominal concentrations based on groundwater quality data were assumed for ammonia, nitrate, and phosphorus. Atmospheric deposition loads were estimated for both wet and dry conditions. Wet atmospheric deposition was estimated based on rainfall data from various meteorological stations, and rain chemistry from Tanbark

Flat in the mountains east of the watershed in Los Angeles County. Dry deposition was based on particulate deposition rates from Joshua Tree National Monument, the nearest of a national network of monitoring stations. Fertilization loading rates were derived from agricultural production records from Ventura County records and discussions with local agricultural experts.

The time period used for the Source Analysis is water years 1990-2000 (10/1/1989 – 9/30/2000). The loading is described seasonally by averaging the loading for each month in the 11-year time frame.

The Source Analysis also included a Loading Balance, which compared the direct and surface loadings to the in-stream loading, i.e. the loading estimated based on measured flow rates and nutrient concentrations. The loading balance provides a check that the loading in the river is accounted for by the sources. The in-stream loading was estimated for each catchment. For all catchments, the total of the direct and indirect loadings exceeded the in-stream loadings. However, for EPA Reach 7 and the catchment upstream of Sespe Creek, the direct sources exceed the in-stream loadings for ammonia, suggesting that nitrification is an important process in this reach.

Systech subdivided the watershed into nine major subbasins; Mint Canyon Creek, Santa Clara EPA Reach 9, Santa Clara EPA Reach 8, Santa Clara EPA Reach 7, Santa Clara River above Sespe Creek, Sespe Creek, Santa Clara River Reach 3, Wheeler Canyon/Todd Barranca, and Brown Barranca/Long Canyon. Regional pollution loads and source contributions of pollutants to the water quality impaired segments were calculated by Watershed Analysis Risk Management Framework (WARMF), which will be described in detail in the Linkage Analysis section. Source loadings include assimilation, transformation and dilution of all loads to yield the mass loading to the reach. The following summary of source loadings by reach is in lbs/day for select wet and dry years (Table 12).

Table 12. Total Point and Nonpoint Source (NPS) Loadings by Reach

EPA Reach	NPS lb/day	Point Source lb/day	NPS lb/day	Point Source lb/day
Ammonia (1991-dry year)			***Ammonia (1998 wet year)***	
8	0.0005	43.2	0.06	41.
7	0.008	23.7	0.132	67.47
3	0.007	72.3	0.088	55.35
Nitrate(1991-dry year)			***Nitrate(1998 wet year)***	
8	6.74	197.6	78.1	130.3
7	29.99	829.1	339	1128.06
3	31.53	180.8	374.9	218.96

The results show that point source loads contribute almost all of ammonia, nitrite, and phosphorus in the water quality impaired segments of the Santa Clara River watershed. The source of nitrate in impaired segments is combination of point, nonpoint, and groundwater sources. The nonpoint source load contribution is greater in the wet year than the dry year.

The primary purpose of the model is to calculate TMDLs for the water quality impaired river segments in the watershed. There are no data to calibrate the three smaller impaired tributaries (Mint Canyon Creek, Wheeler Canyon / Todd Barranca, and Brown Barranca/Long Canyon). The flow and pollutants are routed downstream to the main stem of the Santa Clara River where data is more plentiful. The linkage analysis indicates the importance of point sources, managed flows, and groundwater interactions between Blue Cut and Santa Paula Creek, for which there are adequate data available.

The water quality parameters of concern are nutrients, principally ammonia, nitrite, and nitrate. Point source loads contribute ammonia, nitrite, and nitrate to the impaired river segments. Nonpoint source loads also contribute nitrate to the impaired river segments through groundwater accretion. To a degree, nitrification of ammonia, nutrient assimilation, and denitrification, which removes nitrate from the water, appears to occur in the riverbed of the impaired river segments, located in most cases downstream of the WRP discharges. Because of the assimilation processes that may be occurring within river segments of the watershed, it is important to distinguish between loading to the rivers, and loading in the rivers, the latter of which is directly reflective of water quality.

5 LINKAGE ANALYSIS

Systech Engineering, Inc. (Systech) was contracted by the Steering Committee of the Santa Clara River Nutrient TMDL stakeholder group to conduct an analysis linking the nitrogen (ammonia, nitrite, and nitrate) and phosphorus sources in the Santa Clara River watershed to the in-stream water quality. The Linkage Analysis is the second task completed by Systech to develop and calibrate a model linking the pollutant sources and in-stream water quality. During development of the Linkage Analysis, Systech met with members of the Steering Committee regularly to review the assumptions and accuracy of the Linkage Analysis. The detailed report is presented in the Technical Support Document (Appendix A).

5.1 Model Description

The linkage analysis of the Santa Clara River watershed is based on a dynamic water quality model to determine the linkage between inputs to the Santa Clara River and the water quality of the river. The watershed model selected for this Linkage Analysis is the Watershed Analysis Risk Management Framework (WARMF). WARMF is capable of simulating the physical and chemical processes that affect river hydrology and water quality.

WARMF is a comprehensive modeling framework which links land catchments, river segments, and reservoir segments into a seamless watershed network. WARMF provides such linkage by simulating the hydrology, the nonpoint source loads from land catchments, and then the resulting receiving water quality from the point and nonpoint source loads of pollutants. The model was run on a daily time step from October 1, 1989 to September 30, 2000.

5.1.1 Model Setup

The Santa Clara River watershed is divided into land catchments, river segments, and reservoir segments. Each is linked together in a network so that output from catchments is automatically input to the adjacent river segment, and each river segment is connected to the segment downstream, to reservoir segments, and back to river segments to form a complete network. Figure 2 in Appendix F shows the land catchments, river segments and reservoir segments in the Santa Clara River Watershed.

Each catchment is divided into the canopy, land surface, and several soil layers. Below the surface, it is assumed that each soil layer has uniform hydrology and water quality. The nonpoint source loads from land catchments include pollutants associated with surface runoff and those associated with ground water accretion to the adjacent river segment. Each river segment is assumed to be completely mixed. Reservoir segments are divided into horizontal layers, each of which is assumed to be well mixed.

The time period selected for modeling was water years 1990-2000 (10/1/1989-9/30/2000). This time period has sufficient data to calibrate the model and includes a variety of hydrologic conditions. In particular, water years 1991 (10/1/1990-9/30/1991) and 1998 (10/1/1997-9/30/1998) represent a very dry year and a very wet year, respectively. These two years will be used to represent critical hydrologic conditions when using the model for watershed management and TMDL calculation. WARMF is typically run with a daily time step because meteorological and point source input data is most available at that temporal resolution. The WARMF model for the Santa Clara River watershed has been set up to run on a daily time step.

5.1.2 Hydrology Model

The WARMF hydrology model is based on the mass balance of water, driven by precipitation. Water is routed from catchments to river segments, and reservoir segments. The model also includes prescribed flows, such as point sources, reservoir releases, diversions, and groundwater pumping. The accuracy of hydrologic model therefore depends on the accuracy of data for precipitation and prescribed flows.

Each catchment is assigned to a meteorology station. To translate the precipitation recorded at a meteorology station to the precipitation occurring at a catchment, a precipitation multiplier is used to account for orographic effects. A temperature lapse rate is used to transpose the temperature at the meteorology station to the temperature at the catchment due to elevation differences between the catchment and the meteorology station. Falling precipitation is divided into rainfall and snowfall based on temperature. The canopy intercepts some rainfall. The remaining throughfall reaching the soil surface percolates into the soil. Snowfall accumulates and melts on the soil surface with the water volume tracked each day.

WARMF represents the soil by layers. Each layer has a specific thickness, field capacity, porosity, hydraulic conductivity, and slope. The moisture content of each soil layer is tracked every day. Water percolating into the soil first raises the moisture content to field capacity. At moisture levels above field capacity, lateral flow occurs according to Darcy's Law. When all soil layers reach saturation, overland flow occurs.

Septic system discharges occur in the Santa Clara River watershed. The number of people served by septics per catchment is specified and the per capita flow and loading is the same for all septic systems.

Catchments can have pumping according to a flow schedule. The pumped water can be used for municipal/industrial purposes, in which case the model removes the water. The pumped water can also be applied to the land surface as irrigation, in which case the model removes the volume of water from the lowest soil layer of the catchment, and then applies it at its known location.

5.1.3 Water Quality Model

The water quality model is based on a mass balance of each chemical constituent. As part of the water quality simulation, temperature simulation is based on heat transfer with ambient air. As the model routes water through catchments, rivers, and reservoir segments, the associated chemical constituents are routed with the water. At each step of the simulation, chemical interactions are simulated to transform nitrogen compounds. WARMF tracks each chemical compound with its sources, such as point sources, septic systems, and land uses. When two quantities of water are mixed, the chemical constituents are also mixed and the source of the new mixture is a mass weighted average of the sources for each chemical.

Water quality simulation begins with atmospheric deposition to the land surface. Wet deposition is applied to the canopy and land surface based on the chemical concentrations in rain. Dry deposition is loaded to the canopy and land surface based on a monthly deposition rate and air quality concentrations determined by meteorological studies.

To perform the calculations, WARMF requires monitoring stations with precipitation chemistry and air quality data. Rainfall chemistry data came from several air stations, including a station at Tanbark Flat in the mountains east of the watershed in Los Angeles County (NADP 2002).

Atmospheric deposition is joined by land application from fertilizers, urban debris, and wildlife. The canopy absorbs some of the total deposition to incorporate into its biomass, and the remainder is then carried by throughfall to the soil surface. As rainfall and snow melt percolate into the soil, they carry the chemical constituents washed down from the canopy. Once inside the soil, chemicals undergo many processes, including competitive cation exchange, anion adsorption, chemical reactions, and uptake by vegetation. The pH is calculated from alkalinity and inorganic carbon by tracking the mass of each of the cations and anions. As lateral flow occurs, dissolved constituents are carried with it to river segments. When the soil is saturated, chemicals accumulated on the soil surface flow with overland flow to river segments. It is noted that in some of the more urbanized areas of the Santa Clara River watershed, storm drains convey runoff to the Santa Clara River, both during wet and dry weather. These sources are modeled as runoff from land surfaces rather than direct sources. However, as discussed in the Section 6, Allocations, this source is considered a point source because these discharges are regulated under NPDES permits that address the runoff through the storm drain systems in Los Angeles and Ventura counties. This regulatory consideration does not affect the accuracy of the Linkage Analysis.

Chemical constituents associated with septic systems and subsurface discharges are mixed with the constituents already present in the soil layers. Water pumped out of the catchment carries with it the dissolved constituents in the soil solution.

5.1.4 Model Calibration and Sensitivity Analysis

Hydrology and water quality calibration have been conducted for the Santa Clara River watershed. The calibration results are discussed in three sections: the perennial western tributaries, the intermittent flow eastern tributaries, and the main stem of the Santa Clara River. Since nutrients are the primary interest, the Santa Clara River Nutrient TMDL Steering Committee has recommended that calibration priority should be given to those nutrients of immediate concern (all forms of nitrogen). Phosphorus and dissolved oxygen are also included because they affect algal growth, which removes nitrogen. Chemical constituents such as pH, the major cations and anions, and total dissolved solids, were not calibrated.

Some calibration priority has also been given to simulation of low flow conditions, since those are believed to be the most critical for calculation of TMDLs. However, it is also important to achieve a good overall water balance and representation of peak flows to simulate timing of flows and distribution between high flow and low flow periods. Calibration is also focused on the impaired streams of the watershed. WARMF calculates simulation results for flow and all chemical constituents for all river segments in the watershed. The results presented here are for those locations relevant to the impaired streams and for which there is observed data to compare against simulation results.

In the Santa Clara River, water quality modeling requires proper hydrologic accounting. This includes the accounting of uncontrolled flows (natural unimpaired flow and water losses or gains across the riverbed), managed flows with good records (reservoir releases, large diversions, and point source discharges), and managed flows with poor records (dewatering operations, small diversions, and small point source discharges). In a heavily managed river like the Santa Clara River, the accuracy of simulation depends on the accuracy of managed flow data. The estimates of groundwater gains and losses between Blue Cut and Santa Paula Creek are also key to predicting flow and water quality. At this point, the model has been calibrated to match the seasonal pattern and range of observed values. Further improvement can be made with more data and time in the future. The procedure and parameters used for hydrology are believed to be scientifically appropriate

The WARMF model for the Santa Clara River contains many different parameter inputs. For parameters for which there is more uncertainty, sensitivity analysis can be performed to evaluate how their parameter values affect the match between model predictions and observed data variability (see Table 6 and Table 8 in Appendix A, Technical Support Document-Linkage Analysis). Appropriate parameter values can be selected quickly during the model calibration. Figure 3 in Appendix F shows the simulated and observed data of ammonia, nitrite, and nitrate for Santa Clara River at Castaic Creek. For Santa Clara River, many parameters are considered known and are not adjusted. The values of these parameters are within the range of available scientific literatures. The parameters that need to be adjusted for Santa Clara River mainly are nitrification and denitrification rates. After several iteration to minimize relative and absolute errors, a set of best-fit rates was developed. The values of those two parameters are within reasonable range of available literatures.

The sensitivity analysis was used to determine the effect of pollution sources on the predicted water quality responses. For the Santa Clara River nutrient TMDL study, the analysis provided information about the relative importance of controlling point source discharges, atmospheric deposition (air quality), septic system discharges, and fertilizer applications, dewatering operations in order to meet the water quality standards for nutrients (ammonia, nitrite and nitrate).

At the direction of the Steering Committee, WARMF model calibration refinement for nitrogen compounds was conducted. The original calibration of the WARMF model application for the Santa Clara River was presented in the Task 2 report prepared by Systech Engineering, Inc. The original calibration was generally based on standard rates of nitrification and denitrification in the various segments of the river. However, in some regions the apparent rate of disappearance of ammonia, nitrite and/or nitrate is faster or slower, based on an evaluation of the observed data. This could be due to additional assimilation of these nitrogen compounds by in-stream and riparian vegetation, increased volatilization of ammonia due to the relatively high surface area and mixing energy of the rocky river bottom, or slightly anoxic conditions which would reduce the rate of nitrification and increase denitrification in some regions. Given the length of the river segments, from a few hundred meters to several kilometers, it is conceivable that all of these processes take place within a river segment. Thus, it seems appropriate to adjust the first-order rate constants for the rate of ammonia, nitrite and nitrate disappearance. The segments indicated in Table 13 were evaluated with respect to their nitrification and denitrification rates.

After several iterations to minimize relative and absolute errors, a set of best-fit rate constants was developed (Table 14). Some of the guiding concepts in the calibration refinement were:

- Slightly overpredict concentrations relative to observed data, to provide a small additional margin of safety;
- Calibrate nitrate and nitrite together, given that any nitrite is likely to rapidly convert to nitrate, and that adjustment of nitrite concentrations alone is difficult given the dependence on both the rate of nitrification and denitrification;

- Consistently adjust rate constants throughout a region;
- For those segments where no observed data is available, adjust the rate constants by interpolating the values from segments where data is available.

Table 13. Identification of river segments in Santa Clara River

ID	Segment Designation	Approximate boundaries of SCR segment
7	EPA Reach 3 below Santa Paula	Between Adams Canyon and Todd Barranca
9	EPA Reach 3 at Santa Paula	Between Todd Barranca and Santa Paula Creek
69	EPA Reach 3 above Santa Paula	Above Santa Paula Creek and below Reach 4
111	EPA Reach 7 at County Line	Between Salt Canyon and Potrero Canyon Creeks
56	EPA Reach 7 below Valencia	Between Castaic Creek and Valencia WRP
129	EPA Reach 7 above Valencia	Between Valencia WWTP and Highway 5
159	EPA Reach 8	Between Bouquet Canyon Creek and the South Fork

Table 14. Nitrification and denitrification rate constants (in day^{-1}) for the refined calibration. Segment IDs are presented from lower to upper watershed.

Reach	3	3	3	7	7	7	7	7	7	8	8	8	9
Segment ID	7	9	69	111	113	115	56	137	129	47	149	159	167
Nitrification rate	1.0	0.8	0.7	0.8	0.6	0.4	0.35	0.035	1.0	0.65	0.35	0.0	0.2
Denitrification rate	0.4	0.4	0.3	0.05	0.1	0.2	0.3	0.0	0.3	0.3	0.3	0.15	0.0

Note that common values for nitrification rate constants range from 0 to 1.0 day^{-1} and for denitrification from 0 to 0.5 day^{-1}, depending on redox conditions (aerobic or anaerobic).

The results of the calibration refinement are presented in the following figures for those river segments where there is adequate observed data. Tables 15 to 17 present the statistics of the calibration, in terms of concentrations at 50, 90, 95, 99 and 99.9 percentiles, as well as relative error (RE), absolute error (AE) and root mean square error (RMSE), as defined here:

$$RE = \frac{1}{n}\sum_{i=1}^{n}(x_i - c_i)$$

$$AE = \frac{1}{n}\sum_{i=1}^{n}\left|(x_i - c_i)\right|$$

$$RMSE = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(x_i - c_i)^2}$$

where x_i is the simulated value, c_i is the observed value and n is the number of observations. RE is the average of all errors over all time steps (11-year at a daily time step or 4018 time steps). It is a measure of model accuracy and any consistent bias. However, over-predictions can cancel out under-predictions. AE is the absolute value of the average of all errors over all time steps, and provides another measure of model accuracy, indicating whether the simulated values are generally close to the observed values. RMSE is a measure of model precision, and magnifies the effect of larger than average errors.

Table 15. Statistics of Ammonia calibration refinement

Reach ID	7	9	69	111	56	137	129	159
Number of Observations	22	9	0	10	136	138	50	138
Observed								
50 percentile	0.08	0.43	N.D.	0.65	3.62	6.39	0.35	9.52
90 percentile	0.39	3.14	N.D.	1.31	7.46	13.56	2.70	15.40
95 percentile	0.50	4.81	N.D.	1.36	8.43	15.36	3.36	16.76
99 percentile	1.61	6.15	N.D.	1.39	11.84	20.44	10.05	20.86
99.9 percentile	1.88	6.46	N.D.	1.40	12.83	25.29	11.62	22.45
Simulated								
50 percentile	0.22	0.52	0.00	0.46	4.00	7.42	0.75	9.56
90 percentile	0.76	1.85	0.01	0.96	5.88	11.17	1.68	12.72
95 percentile	1.11	2.67	0.04	1.14	6.75	12.36	2.04	14.13
99 percentile	2.31	5.05	0.17	1.48	9.27	16.23	2.69	16.98
99.9 percentile	4.39	7.44	0.36	2.08	12.59	18.93	4.12	19.22
Relative error	-0.020	-0.968	N.D.	-0.034	0.677	2.011	-0.338	-1.972
Absolute error	0.214	1.158	N.D.	0.281	1.938	3.367	1.071	3.618
Root mean square	0.404	2.068	N.D.	0.326	2.486	4.192	2.172	5.022

N.D. = No data

Table 16. Statistics of Nitrate calibration refinement

Reach ID	7	9	69	111	56	137	129	159
Number of Observations	276	11	48	58	41	41	39	38
Observed								
50 percentile	1.51	1.40	1.73	5.26	4.61	5.59	4.15	2.32
90 percentile	2.39	2.30	2.70	6.67	6.90	8.33	5.90	5.05
95 percentile	2.64	2.55	3.07	7.25	7.54	9.62	6.78	5.58
99 percentile	4.13	2.75	3.41	8.06	8.88	11.38	7.56	8.02
99.9 percentile	4.52	2.80	3.49	8.12	9.62	11.49	7.82	8.48
Simulated								
50 percentile	1.45	1.75	1.99	5.10	4.73	5.88	4.37	3.73
90 percentile	2.71	2.85	2.36	7.98	7.25	8.53	6.33	5.38
95 percentile	3.89	4.15	3.06	8.77	7.82	9.09	6.74	5.83
99 percentile	5.74	5.54	4.60	11.24	9.77	11.79	8.55	7.63
99.9 percentile	6.73	6.17	5.21	12.98	10.93	12.50	9.93	8.03
Relative error	-0.189	-0.025	0.104	0.29	0.128	0.0247	0.0393	1.331
Absolute error	0.491	0.488	0.566	1.65	1.503	1.722	1.262	2.105
Root mean square	0.621	0.589	0.728	2.162	1.987	2.429	1.509	2.543

Table 17. Statistics of Nitrite calibration refinement

Reach ID	7	9	69	111	56	137	129	159
Number Observations	19	12	14	16	40	41	39	38
Observed								
50 percentile	0.00	0.00	0.00	0.00	0.88	0.62	0.21	1.02
90 percentile	0.40	0.00	0.00	0.49	1.31	0.92	0.80	2.74
95 percentile	1.20	0.14	0.00	0.49	1.69	1.32	0.95	3.14
99 percentile	1.20	0.27	0.00	0.49	2.07	1.41	1.04	4.16
99.9 percentile	1.20	0.30	0.00	0.49	2.25	1.45	1.06	4.50
Simulated								
50 percentile	0.07	0.10	0.00	0.09	0.21	0.09	0.21	0.16
90 percentile	0.25	0.35	0.00	0.24	0.35	0.21	0.56	0.43
95 percentile	0.38	0.50	0.01	0.29	0.39	0.24	0.67	0.51
99 percentile	0.81	0.97	0.06	0.39	0.48	0.29	0.91	0.72
99.9 percentile	1.55	1.46	0.14	0.53	0.80	0.34	1.44	0.99
Relative error	-0.063	0.0624	0.0007	-0.069	-0.649	-0.497	-0.1	-1.251
Absolute error	0.195	0.0932	0.0007	0.183	0.655	0.497	0.228	1.27
Root mean square	0.393	0.105	0.0011	0.226	0.786	0.583	0.3	1.55

The calibration processes performed and parameters used for Santa Clara River are believed to be appropriate and within the range of available scientific data.

6 ALLOCATIONS

This study evaluates a number of nitrogen allocations from point and nonpoint Sources (PS and NPS) present in the reaches of the Santa Clara River (SCR) considered in the 1998 303(d) listing, namely Reaches 3, 7 and 8 (US EPA designation -Figures 4 and 5 in Appendix F). For modeling purposes, these reaches have been segmented further, providing an opportunity to consider water quality monitoring data for a number of segments, and to evaluate the PS and

NPS loads for each segment. The segments are presented in Figures 4 and 5, using the identification number used in the WARMF model. The approximate locations and descriptions of segment boundaries are presented in Table 13 for reference. For this analysis, the WARMF model was used as described in the Linkage Analysis, with a refined calibration of the nitrogen processes as described in the Technical Support Document (Appendix A).

The load allocations require a consideration of the numeric targets, which are based on the Water Quality Objectives (WQO), defined in the Basin Plan. Numeric targets have been defined based on the WQO and Margin of safety with the intent of preventing the exceedance of the WQO. For example, in most reaches the combined nitrate plus nitrite WQO is 5.0 mg/L as $N\text{-}NO_3 + N\text{-}NO_2$, except in Reach 8 where the WQO is 10.0 mg/L as $N\text{-}NO_3 + N\text{-}NO_2$. The numeric target has been set with a 10% explicit Margin of Safety (MOS), such that it is 4.5 mg/L as $N\text{-}NO_3 + N\text{-}NO_2$ in most reaches except Reach 8 where it is 9.0 mg/L as $N\text{-}NO_3 + N\text{-}NO_2$.

The Total Maximum Daily Load (TMDL) for each segment must be divided into a Waste Load Allocation (WLA) from point sources and a Load Allocation (LA) from nonpoint sources. In addition, the TMDL must consider a margin of safety (MOS) and Future Growth (FG), such that:

$$TMDL = WLA + LA + MOS + FG$$

6.1 Wasteload Allocations: Point Source Loading Analysis

Wasteload allocations were set through analysis of different alternatives constructed using observed meteorological conditions from 10/01/1989 to 9/30/2000, based on the calibrated WARMF model. These alternatives modified the ammonia, nitrate and nitrite concentrations in the treated WRP effluent at the flowrates indicated in Table 32. Four key alternatives were considered: 1) concentrations of ammonia, nitrate, and nitrite in WRP effluent are set equal to the numeric targets; 2) point source loads remain equal to Alternative 1 except that the ammonia concentration in the Saugus WRP effluent is lowered to 2 mg/L; 3) point source loads are based on performance of WRP upgrades for ammonia treatment where a nitrate effluent concentration of 8.0 mg/L is anticipated; and 4) point source loads are based on performance of WRP upgrades where a nitrate effluent concentration of 6.7 mg/L is anticipated. In addition to the wasteload allocations for the Water Reclamation Plants and Publicly Owned Treatment Works, wasteload allocations are developed for the municipal separate storm sewer system permittees in the upper reaches of the watershed.

One important consideration in developing wasteload allocations is the interaction between various nitrogen species, since ammonia oxidizes to nitrite, which then oxidizes to nitrate. Ammonia, nitrite and nitrate can also be assimilated by the in-stream and riparian vegetation, and ammonia may be lost to the atmosphere due to volatilization. Nitrate might be reduced to nitrogen gas under low oxygen conditions, such as those that might exist in some sediment and in slow-flowing pools along the river. Thus, loading alternatives have to consider all these interactions.

Simulations for the SCR segments identified in Table 18 were run for the four alternatives considered. Table 18 presents the results for the four alternatives considered. Results for selected segments are illustrated in Figures 6 to 28 of Appendix F.

Table 18. Model Results for the Four Alternatives Considered

	Alternative 1	**Alternative 2**	**Alternative 3**	**Alternative 4**
Description	Effluent Limits = Numeric Targets	Effluent Limits = Numeric Targets except $[NH_3] = 2$ mg-N/L at Saugus WRP	Based on performance of WRP ammonia treatment upgrades with $[NO_3^-] + [NO_2^-] = 8.1$ mg-N/L	Based on performance of WRP ammonia treatment upgrades with $[NO_3^-] + [NO_2^-] =$ 6.8 mg-N/L at Valencia and [NO3-] + $[NO_2^-]$ = 7.1mg-N/L at Saugus
% Time Ammonia Numeric Targets exceeded*				
River Segment ID 7	0%	0%	0%	0%
River Segment ID 9	0%	0%	0%	0%

	Alternative 1	Alternative 2	Alternative 3	Alternative 4
River Segment ID 69	0%	0%	0%	0%
River Segment ID 111	0%	0%	0%	0%
River Segment ID 56	0%	0%	0%	0%
River Segment ID 129	< 0.1%	one exceedance	< 0.1%	<5% ****
River Segment ID 159	10%**	one exceedance	10% ****	<5% ****
% Time Nitrate+Nitrite Numeric Targets exceeded				
River Segment ID 7	0%	0%	0%	0%
River Segment ID 9	0%	0%	0%	0%
River Segment ID 69	0%	0%	0%	0%
River Segment ID 111	0%	0%	<1%	0%
River Segment ID 56	0%	0%	47%	See Figure 22
River Segment ID 129	21%***	8.5% (WQO exceeded about 1%)	13%****	5%*****
River Segment ID 159	6% (WQO exceeded < 0.1%)	6% (WQO exceeded < 0.1%)	<1%	<5%

*Ammonia WQO is based on a 30-day average concentration, not an instantaneous sample or a daily average value. The ammonia WQO for a daily average is approximately an order of magnitude greater than the CCC, such that these levels of ammonia would have no observable effect on even the most sensitive species. Thus, the percent exceedances in this table is conservative.
**During first significant storms of the winter, due to some episodic NPS load of ammonia and nitrate.
***Nitrate + nitrite concentrations rise in the upper segments of Reach 7 as ammonia is partially transformed to nitrite and nitrite to nitrate.
****Exceedances most likely at the end of the dry season or the first strong storm events
*****This is the tightest condition in the entire watershed and would require frequent monitoring to ensure compliance.

The first alternative considers PS effluent concentrations at the Numeric Targets for the respective nutrients. Results for EPA Reach 7 are presented in Figures 6-11 of Appendix F. Alternative 2 involves reducing the ammonia loading from the Saugus WRP, by reducing effluent concentrations to 2.0 mg/L as $N\text{-}NH_3$, leaving all other effluent concentrations equal to targets. The results for Reach 8 and the Reach 7 segment immediately above the Valencia WWTP are presented in Figures 12 and 13 in Appendix F. Alternative 3 considers the expected performance of upgraded WRPs. The LACSD and the Santa Paula WRP plants are in the process of upgrading to include a Nitrification-Denitrification (NDN) module. From practical experience with the NDN process at the Whittier Narrows WRP, CSDLAC considers that it can control ammonia effluent concentrations to below 2.0 mg/L as N-NH_3, 0.1 mg/L as N-NO_2 and around 8.0 mg/L as N-NO_3 at the Saugus WRP. Since the Valencia WRP treats solids generated at both plants, CSDLAC anticipates effluent concentrations may be 2 mg/L NH3 and 10 mg/L as NO2+NO3. The effluent conditions considered in this alternative are presented in Table 19. Although the alternative was evaluated with both current and future flowrates, only the higher future flowrate is presented here.

Table 19. Scenario Using Effluent Concentrations NDN process at Whittier Narrows WRP

POTW	NH_3 (mg/L)	NO_2 (mg/L)	NO_3 (mg/L)	Flowrate (m^3/s)
Saugus	3.15	0.1	8.0	0.28475
Valencia	2.00	0.1	8.0	0.94625
Santa Paula + Fillmore	1.84	0.1	8.0	0.18

Results for Alternative 3 are presented for selected segments Figures 14 to 16 in Appendix F. Based on the results of Alternative 3, an “Intermediate Scenario,” Alternative 4, was constructed, with the goal of meeting the numeric targets and yet recognize the feasibility of performance of the upgraded NDN processes at the WRPs. Presented here is the result of many iterations to find a suitable balance between nitrogen compounds, as ammonia, nitrite and nitrate loading all contribute to the nitrate + nitrite numeric target. In addition, there is a need to balance the total nitrogen loading from the Saugus and Valencia WRP, since effluent from Saugus affects the levels of nitrate above and below the Valencia WRP in Reach 7. This is somewhat complicated due to the sharp change in the nitrate + nitrite WQO between Reach 7 and 8. The Intermediate alternative conditions are presented in Table 20.

Table 20. Effluent Concentrations for Intermediate alternative

POTW	**NH_3** (mg/L)	**NO_2** (mg/L)	**NO_3** (mg/L)	**Flow rate** (m^3/s)
Saugus	2.00	0.1	7.00	0.28475
Valencia	1.75	0.1	6.70	0.94625
Santa Paula + Fillmore	2.00	0.1	8.00	0.18

*Note: Saugus and Valencia WRPs may not achieve these concentrations without construction of additional treatment at these facilities.

The simulation results are presented in Figures 17-28 of Appendix F. With the lower effluent concentrations from the Saugus WRP (below the numeric targets for Reach 8), the ammonia and numeric targets for Reach 8 and segment 129 (Reach 7 above Valencia) are met throughout the 11-year simulation (Figures 17-20) more than 95 % of the time. Nitrite + nitrite concentrations in segment 129 are below 4.34 mg/L 95% of the time.

The simulation of Alternative 4, the “Intermediate Scenario” shows ammonia concentrations below Valencia and down to the County Line (Figures 21 and 23 of the Analysis of Potential Load Allocation Report) would be well below the numeric target for these segments of Reach 7. Nitrate + nitrite in segment 129 is in compliance with the numeric target exactly 95% of the time (Figure 22). This is the tightest condition in the entire watershed and would require frequent monitoring to ensure compliance. Once the river flows down to the County Line, the nitrate + nitrite numeric target is met all the time throughout the 11-year simulation period (Figure 22).

Both the ammonia and nitrate + nitrite numeric targets are met above, at and below Santa Paula all the time throughout the 11-year simulation period under the Intermediate Scenario (Figures 25-28). The higher assimilative capacity in Reach 3 as well as reduced nitrogen loading relative to current operating conditions for the Santa Paula and Fillmore WRPs results in full compliance.

The nitrogen compound loads corresponding to the Intermediate Scenario can be divided into current and future load, as presented in Table 21.

Table 21. Current and future loads considering Alternative 4 (Intermediate Scenario)

POTW	Current Load			Future Load		
	NH_3 (kg/day)	NO_2 (kg/day)	NO_3 (kg/day)	NH_3 (kg/day)	NO_2 (kg/day)	NO_3 (kg/day)
Saugus	41.5	2.1	145.2	49.2	2.5	172.2
Valencia	75.6	4.3	289.4	143.1	8.2	547.8
Santa Paula + Fillmore	25.9	1.3	103.7	31.1	1.6	124.4

6.1.1 Minor Point Sources

Minor point sources are not considered to contribute loads ammonia, nitrite, or nitrate to the Santa Clara River that would have a significant effect on achievement of numeric targets. However, because these sources can potentially have localized effects on water quality, they are allocated concentration-based wasteloads equivalent to the water quality objective. These wasteloads will be implemented through the individual NPDES permits and the Monitoring and Reporting Programs associated with those permits.

6.1.2 MS4 and Stormwater Sources

Municipal separate storm sewer systems (MS4s) and other stormwater sources regulated under NPDES permits are considered minor loads of ammonia, nitrite, and nitrate to the Santa Clara River. However, because these sources can potentially have localized effects on water quality, they are allocated concentration-based wasteloads equivalent to the water quality objective. These wasteloads will be implemented through the stormwater NPDES permits and the Monitoring and Reporting Programs associated with those permits.

Wasteload allocations were set through analysis of different alternatives based on the WARMF model. One alternative evaluated modified ammonia, nitrite, and nitrate concentrations for wasteload allocations for the MS4 permittees in the upper reaches of the watershed. Large storm events can flush the landscape, resulting in infrequent peak concentrations (Report on Point and Non-Point Source Analysis for Segment 56 in Reach 7, below Valencia WRP, 2003). However, the overall load is insignificant. In addition, mass emission monitoring data conducted for MS4 NPDES Permit compliance indicate that the MS4 discharges are below the WLA in both wet and dry weather samples.

On November 22, 2002, the United States Environmental Protection Agency issued a Memorandum clarifying and providing guidance for establishing waste load allocations for storm water discharges in TMDLs. It is noted that TMDLs issued by the Regional Board prior to November 22, 2002 did not contain wasteload allocations for MS4 permittees. However, as the MS4 permittees are a minor load of ammonia, nitrite, and nitrate to the Santa Clara River, the compliance alternative is an iterative approach, which is consistent with the November 22, 2002 memorandum. This iterative, or adaptive management BMP approach, will be based on BMPs currently required in the NPDES permits for stormwater management.

6.1.3 Alternatives Considered by Regional Board

Four alternatives were considered for waste load allocations for ammonia in the Santa Clara River: 1) set concentrations of ammonia, nitrate, and nitrite in WRP effluent equal to the numeric targets; 2) keep point source loads equal to Alternative 1 except for the ammonia concentration in the Saugus WRP, where effluent is reduced to 2 mg/L; 3) anticipate performance of WRP upgrades for ammonia treatment, with nitrate + nitrite effluent concentration of 8.1 mg-N/L; and 4) anticipate performance of WRP upgrades, with nitrate + nitrite effluent concentration of 6.8 mg-N/L for Valencia WRP, 7.1 mg-N/L for Saugus WRP and 8.1 mg-N/L for Santa Paula + Fillmore WRP. The criteria used for selecting the recommended alternative included:

- attainment of numeric targets
- level of beneficial use protection; and

- consistency with the current science regarding water quality necessary to reasonably protect the beneficial uses.

Alternative 4 is the recommended alternative since the action would:

- Be consistent with State and federal water quality regulations;
- consider the expected performance of upgraded WRP (LACSD and Santa Paula WRP plants are in the process of upgrading to include a Nitrification-Denitrification (NDN) module);
- facilitate development of appropriate waste load allocations to meet numeric targets and yet recognize the feasibility of performance of the upgraded NDN processes at the WRPs; and
- improve the scientific basis upon which the waste load allocations are based.

Adoption of Alternatives 1 and 2 would be inconsistent with the scientific study of in-stream phenomenon and performance of upgraded WRPs. Nitrate plus nitrite concentrations in the segment of Reach 7 between Highway 5 and the Valencia WRP could exceed the numeric target based on Alternative 1. Alternative 2 involves reducing the ammonia loading from the Saugus WRP by reducing effluent concentrations. Under these conditions, without consideration of the expected performance upgrades at LACSD and the Santa Paula WRP, the ammonia, nitrate, and nitrite numeric targets are met most of the time. Under Alternative 3, with consideration of expected performance upgrades at the WRPs, and nitrate effluent concentrations for all segments set at 8 mg/L, the nitrate + nitrite concentrations would exceed the numeric target in some reaches.

6.2 Load Allocations: Nonpoint Source Loading Analysis

The previous analysis considers changes in nitrogen loading from the three major point sources while the NPS nitrogen (ammonia + nitrate + nitrite) loading remains at levels similar to existing conditions. However, the flowrates will be higher than in the calibration alternative, given that a significant increase in overall WRP flowrates is anticipated. Thus, the relative contribution of the NPS to overall in-stream loading varies with respect to the original calibration. One way to evaluate the role of these smaller sources, including the small PS as well as NPS such as atmospheric deposition, septic systems, fertilizer application in farms and residential areas, etc., is to set the nitrogen compound loading to zero and observe the resulting water quality.

Based on the above analysis, load allocations for nonpoint sources are set equivalent to the water quality objectives.

NPS loading in Reach 8 and above is significant, both for ammonia and nitrate. Nitrite NPS loading in general is very low throughout the watershed, given that there sources are very small, so it won't be discussed in specific, although the simulated nitrate + nitrite concentrations for an accurate comparison against the previous alternatives is presented. Atmospheric deposition of both ammonia and nitrate is important in Reaches 8 and 9 of the Santa Clara River, given the proximity to the greater Los Angeles basin, where a significant amount of these air pollutants is emitted, and the very large surface area of these two Reaches. Nitrate is produced from the transformation of nitrogen oxides (NOx) to nitric acid and then nitrate. Ammonia appears to be delivered to the river mostly in storm events, while nitrate loading is also through shallow groundwater flows, with an average nitrate + nitrite concentration in the river of 1.5 mg/L. Large storm events flush the landscape, resulting in some peak concentrations.

The contribution from NPS loading of ammonia and nitrate decreases in Reach 7, as these compounds are assimilated. The overall surface area of Reach 7 is smaller, decreasing the magnitude of the loading from atmospheric deposition. The population served by septic systems is also much smaller, given the higher level of urbanization in Reaches 8 and 9 in particular. Thus, the in-stream concentrations generally decrease going downstream. As in Reach 8, ammonia contributions are mostly driven by storm events, while nitrate has both groundwater and storm event contributions.

In Reach 3, NPS ammonia in-stream loading is negligible. Nitrate loading is quite significant above Santa Paula, with an average nitrate + nitrite concentration of 1.26 mg/L. The contributions from NPS nitrate loads decreases going downstream, both due to dilution in WRP effluent and assimilation or transformation of nitrate.

With respect to increases in NPS loading in the future, the conditions at and below the Valencia WRP dictate what can be done in Reaches 8 and 9. Additional NPS loading in these areas needs to be assimilated before it reaches the Valencia WRP, or be associated with sufficient flow to dilute the concentrations in the river.

In Reach 7 below segment 129, the proportion of farmland relative to other land uses increases to 7-8% of the total land surface, and is generally located close to the river. Although there is room for additional NPS loading in these segments, this region will be required to be monitored frequently to ensure compliance with the numeric targets, as outlined in the implementation plan. The TMDL includes monitoring of the effectiveness of Best Management Practices to ensure that NPS loading does not cause exceedances of numeric targets as urbanization of this region progresses.

Nitrate peaks from groundwater discharges in the upper watershed are attributed to NPS loading. Although infrequent, the model predicts in-stream nitrate levels in excess of numeric targets associated with wet weather discharge of groundwater. However, it may underestimate the loading to surface water, which should be attributed to groundwater because of limited groundwater data and modeling limitations on groundwater modeling. As a result, non attainment of modeled numeric targets may be due to NPS loading and measurement of shallow discharging groundwater is part of the implementation plan. NPS reductions to protect groundwater are necessarily an estimate.

An initial allocation of a 20% concentration reduction for future septic system leachate is considered sufficient to prevent groundwater impairments in Reach 7 and 8. Additional monitoring requirements associated with these new septic systems and other WDR permits issued by the Regional Board are expected to identify existing septic systems, which are failing for appropriate regulatory action, by the Regional Board or the Department of Health Services.

An allocation of 20% concentration reduction for agriculture is considered sufficient to achieve compliance in Brown/Todd Barranca and Torrey Canyon where loading is all from agricultural practices.

If shallow groundwater loading continues to show contributions to surface impairment, then additional allocation reductions would be recommended. These additional reductions should be developed on a site-specific basis depending on the location of the non-attainment of shallow groundwater conditions as per Table 22.

Table 22. Additional Reductions to Groundwater Contributions

Reach not attaining GW numeric target	Implementation Plan change
EPA Reach 6 or 7	Existing and future Septic System discharge concentrations reduced below GW numeric target
EPA Reach 3,4, or 5	Agricultural discharge concentration reduced to below GW numeric targets.

6.3 Margin of Safety

A Margin of Safety (MOS) is imposed to compensate for uncertainties in the analytical assessment of the linkage between the allocated source load and the targeted in-stream water quality. MOS can be implicit or explicit. For example, considering a 10% MOS for the WQO in determining the Numeric Targets is an explicit MOS. If an additional MOS is considered based on uncertainty in the model, due to data limitations and/or model assumptions, this is considered an implicit MOS.

An explicit 10% MOS has been considered in the numeric targets of this TMDL. For regions with frequent monitoring, such as segment 159 of Reach 8 and segments 56 and 129 of Reach 7, this safety level appears adequate. For the region below segment 129, as the river enters the farmland in the lower Reach 7, the 95 percentile of observed nitrate + nitrite concentration is 3.55 mg/L. Under current conditions, the difference between the WQO of 5 mg/L and this concentration is around 30%. This should be sufficiently ample difference to meet the WQO.

Increased frequency of monitoring during the critical conditions should result in higher confidence in model results, without the need to formally establish a higher MOS.

A 10% MOS assumes that the model represents the physical conditions present in the river such that the calibration of the model to fill data gaps has a level of accuracy similar to other models of its class. The WARMF model's strengths include the ability to predict chemical transformation of nutrient species with varying pH and dilution and to integrate large amounts of data and area. Based on this, it can be argued that the model accurately depicts the concentrations of nutrient species, especially the large difference between the nutrient load applied to land and the nutrient load transported in the river. As a result, model predictions of the reductions required in the nonpoint source loading of land-applied nutrients are likely to be accurate and consistent with a 10% MOS.

WARMF practitioners report that the model is not designed to model groundwater discharge and blends nonpoint source contributions to groundwater over an entire watershed unit. Model predictions of nonpoint source loading to groundwater and subsequent discharge to the river may be underestimated. However, these nitrogen sources appear minor relative to the nitrogen contained in the WRP discharges.

The modeled linkage analysis predicts that with a 10% explicit MOS, an implicit MOS from conservative assumptions, modeling calibration, and the allocations presented, the water quality objectives can be attained within all reaches of the Santa Clara River. The exception is Reach 7, adjacent to the Valencia WRP outfall where assumptions of unique local conditions (i.e., high in-stream denitrification rates) were made and the WQOs is attained 95% of the time. This TMDL sets forth special studies to determine the nitrification/denitrification rates in the vicinity of the Valencia WRP outfall.

There are a number of built-in assumptions in the Intermediate Alternative, which provide additional safety. For example, the simulations have been conducted at higher flowrates than the situation that will be present during the first few years of operation of the upgraded WRP. Thus, nitrogen loading will be lower than the alternative considers. Monthly ammonia numerical targets are met on a daily basis more than 95% of the time or better. Point source loading has been considered towards the upper range of the experience at the Whittier Narrows WRP, to provide an additional margin of safety. The calibration refinement tends to slightly overpredict concentrations in most cases.

An increased monitoring program, particularly in those segments where the concentrations are close to the numeric target, and during the critical conditions, should adequately provide information to make refinements in the load allocations in future years.

In addition, this TMDL includes special studies to address the follow assumptions:

- Rapid nitrogen compound disappearance in Reaches 7 and 8: the observed data imply a rapid disappearance of ammonia, nitrite and nitrate in the upper SCR. Whether this will continue to be the case when the WRP are upgraded to NDN needs to be monitored. Changes in conditions might result in the need to refine the model and revisit the load allocations.
- Atmospheric deposition: an important nonpoint source load in the upper watershed is atmospheric deposition. The magnitude of this load was estimated in the source analysis, but it would be of use to all the stakeholders in the upper watershed to know if the assumptions are correct, and it might lead to either increased or decreased loading from other sources.

- NPS loading: The NPS load to the river is predicted to increase during first storm events. Monitoring of all N compounds to verify this prediction is considered in the studies.
- Nitrate loading via groundwater discharge: The WARMF model uses prescribed groundwater discharge flows along the various segments. Nitrate concentrations in these groundwater discharges is based on the initial condition in 1989 (from the USGS report), incremented over time with N loading to the surface that migrates into the various layers of the aquifer. However, given the nature of the WARMF model, the nitrate concentrations are homogeneous for each layer of the aquifer, based on the assumption of immediate mixing in a layer. Thus, the nitrate loading via groundwater discharge might be underestimated in areas where the nutrient load is concentrated and is near the discharge area. A study to collect groundwater nitrate concentrations at the discharge points as well as corresponding surface water concentrations immediately above and below the discharge would reduce the uncertainty associated with this loading. The study should consider spatial and temporal variability.

7 FUTURE GROWTH

The population in the Santa Clarita Valley is expected to grow by nearly 80% from 2000 to 2015 based on 1994 studies by Southern California Association of Governments (SCAG). The SCAG studies indicate that the population in Ventura County is expected to grow by 20%. Population growth will impact Santa Clara River in the form of additional nutrient loads in POTW effluent and potentially, greater nonpoint source loads. The load will increase proportionally to the population increase if it is assumed that future domestic water use per person and future nutrient load per household are approximately equal to current water use and nutrient loads. Under those assumptions, the volume of wastewater discharged by the POTW is also projected to increase proportional to population increase.

Because impairments are based on in-stream nitrogen concentrations, increased loads (i.e. flows) from POTWs is not expected to result in impairment of the Santa Clara River because the relative nitrogen concentrations will remain unchanged as long as nitrogen compounds do not accumulate in the sediments or other areas within the watershed. Therefore, the projected future increase in nitrogen loads from current and future POTWs in the watershed due to population growth are expected to be assimilated adequately. WLAs for POTWs are specified proportional to discharge volume, such that the nutrient concentration in the discharge will equal the concentration based WLAs. However, future growth may result in increased nitrogen concentrations in groundwater in the Santa Clara River watershed. This TMDL includes a special study to evaluate the effects of future nitrogen loading on groundwater to determine whether there will be effects from, for example, use of reclaimed water for irrigation, .

Future growth that would exceed existing POTW capacity will be accommodated by increasing existing POTW capacity or construction of new POTWs. Either alternative entails the construction of new treatment capacity that will require a modification to existing or new NPDES permits. Revision of WLAs can be incorporated into the NPDES permits, if appropriate. The numeric targets for POTWs with increasing capacity or new POTWs will be set on a concentration basis, and the WLAs will be calculated based on the new design capacity and effluent concentrations needed to meet in-stream water quality standards.

Future Growth can be considered in several ways. For the two WRP in Los Angeles County, Saugus and Valencia, the information from the County Sanitation Districts of Los Angeles County (CSDLAC) indicates that these two plants will be upgraded to a capacity of 6.5 MGD and 21.6 MGD, respectively. For the Fillmore and Santa Paula area, the modeling considered that the Fillmore plant will be phased out and that all of its flow will be directed to the upgraded Santa Paula WRP. A growth factor of 1.2 was applied to their combined flow, considering the slower growth rate in this area relative to that of the upper reaches. The current and projected flowrates for these facilities is presented in Table 23. For agricultural NPS, no additional future growth was considered since the acreage devoted to agriculture is unlikely to increase, given the increasing urbanization of the watershed. There is the potential to convert orchards (e.g. citrus or avocado) to row crops, but this was not evaluated in this analysis given the lack of information on such plans.

Increased use of reclaimed water is a major component of future growth of the Santa Clarita Valley. The Castaic Lake Water Agency has proposed to use reclaimed water from the Saugus and Valencia WRPs. Although increased use of reclaimed water may reduce the loading of ammonia, nitrite, and nitrate to the Santa Clara River, the magnitude of this reduction has not been quantified. Use of reclaimed water system in the vicinity of the impaired reaches could remove diluting effects through local or temporary increases in groundwater concentrations through direct percolation or leaching. This TMDL includes evaluation of the effects of reclaimed water on the in-stream water quality and establishment of reclaimed water limits for ammonia, nitrite, and nitrate if required.

Table 23. Current and projected Flowrates of Major Point Sources in SCR

	Current (m^3/s)	Projected (m^3/s)	% Increase
Saugus	**0.24**	0.28475	18.6%
Valencia	**0.50**	0.94625	89.3%
Santa Paula & Fillmore	**0.15**	**0.18**	20 %

8 CRITICAL CONDITION AND SEASONALITY

Critical conditions and seasonality were analyzed by evaluating the conditions that lead to high concentrations of inorganic nitrogen species (i.e. ammonia, nitrite and nitrate) in the impaired reaches and tributaries of the Santa Clara River watershed. The analysis was divided into three sections: (1) an analysis of the low flow conditions and the correlation between low flow and high concentrations of these nitrogen species; (2) an evaluation of the timing of point and nonpoint source discharges of these nitrogen species to the river and tributaries, to determine the possibility of high concentration peaks during the initial storm events (first flush effect); and

(3) an analysis of conditions where rising groundwater might be a significant contribution to total loading.

The statistical correlation of flow and concentrations indicates that the highest concentrations are typically going to be found during low flow periods when there is reduced dilution. For these catchments, this is of particular importance given that in many instances there is practically no flow during significant periods of time. On the other hand, since there is no carrier medium, there is generally little or no loading occurring at this time from non point sources (NPS). Thus the concern is that point source (PS) loading be controlled during these low flow periods so that it does not exceed the desired numeric targets.

From the timing analysis it is concluded that for these catchments, NPS loading is very small in general, with only a few days in the 11-year simulation where the relative magnitude of NPS loading is of significance for water quality. These high NPS load days occur early in the rainy season, and typically follow a period of dry years. In the case of ammonia, this is mostly a concern if the NPS ammonia load is applied right before the rain events. These findings can be used to better design Best Management Practices, with regards to the timing of the NPS loading so that it is reduced in the months before the rainy season, and in particular after a number of dry years.

The analysis of contribution from groundwater to the observed nitrate concentrations in the Santa Clara River indicates that this is more likely to occur in the lower watershed (Reach 3), and be less important in the upper watershed (Reach 7). However, it is important to note that the groundwater component of the model is spatially very simplified. It is necessary to obtain time-series data of nitrate concentrations in several wells in the area, which can then be coupled to a groundwater flow model to estimate the magnitude of the contribution from groundwater.

In conclusion, the most critical conditions for water quality in the Santa Clara River are low-flow conditions, in particular at the end of the dry season. The first strong storm events can cause significant short-term increases in nitrate concentrations in the river. Groundwater may be an important contributor in the lower watershed to increasing nitrate concentrations during the dry season. The groundwater contribution needs additional studies to confirm the magnitude and temporal variation of this load. These results need to be confirmed with additional monitoring data, in particular for Reach 3 where the observed data is sparse in many locations.

9 SUMMARY OF TMDL

This TMDL sets Waste Load Allocations for ammonia, nitrate, nitrite, and Nitrate+Nitrite for POTWs discharging to the Santa Clara River and its tributaries. Effluent limits are designed to ensure compliance with the water quality standards for ammonia based on the updated ammonia criteria, and nitrate and nitrite based on the existing Basin Plan objective. Under this TMDL the ammonia loadings will be reduced from approximately 605 kg/day to approximately 61 kg/day (10%of 1998 load). This represents a 90% reduction in the total ammonia loads. Table 24 compares the proposed WLAs to the current loading estimates.

Table 24. Waste Load and Load Allocation Summary by Source

	Estimated Mean Loads (lb/day) (based on discharger effluent data for POTWs)				Proposed Future Waste Load Allocations (lb/day) ****				Reduction in current load due to WLAs and LAs			
Source	Saugus*	Valencia*	S+F*	NPS **	Saugus	Valencia	S+F	NPS ***	Saugus	Valencia	S+F	NPS
Ammonia as N	536	1226	329	12.8 (3.6)	109	316	69	10.2	80%	74%	80%	20%
Nitrate+ Nitrite as N	176	546	97	1584 (274)	385	1226	278	1267	+118%	+124%	+186%	20%
Total N from Point and Nonpoint	4507 lbs/day				3660 lbs/day				19%			

* Load from discharge monitoring reports in Appendix C where it is reported in kg/d, which can be multiplied by 2.205 to get lbs/day. S+F is a combined Santa Paula and Fillmore discharge

** Load from model calculation for wet year 1998 (and dry year 1991) when NPS contributions are large as quantified in "Source contributions" for NPS minus Point source in Appendix D which is a calculation of the non-assimilated nutrient load which is found in-stream.

***Load reductions set at 20% for agricultural BMPs

**** Includes additional flow (see Technical Support Document – Appendix A)

Table 25 presents the TMDL elements.

Table 25. Santa Clara River Nitrogen Compounds TMDL: Elements

Element	Santa Clara River Nitrogen Compounds TMDL
Problem Statement	Discharge of wastes containing nitrite, nitrate and ammonia to the Santa Clara River causes exceedances of water quality objectives for nitrate and nitrite established in the Basin Plan and of the water quality objectives for ammonia established in the U.S. Environmental Protection Agency 1999 ammonia criteria for Inland Surface Waters. Based on the 2002 303(d) list of impaired water bodies, the Santa Clara River is impaired by ammonia in reach 3 and nitrate plus nitrite in reach 7. Reach 8 of the Santa Clara River is included on the State Monitoring List for organic enrichment/dissolved oxygen. The State Monitoring List assigns a high priority for monitoring before the next section 303(d) list is completed. Nitrite and nitrate are biostimulatory substances that can cause or contribute to eutrophic effects such as low dissolved oxygen and algae growth in inland surface waters such as the Santa Clara River. Excessive ammonia can cause aquatic life toxicity in inland surface waters such as the Santa Clara River.

Element	Santa Clara River Nitrogen Compounds TMDL
Numeric Target (Interpretation of the numeric water quality objective, used to calculate the load allocations)	Numeric targets for this TMDL are listed as follows: • Total ammonia as nitrogen (NH_3-N) Based on the past five years of temperature and pH data, the ammonia numeric targets for the stream segments which receive the significant ammonia and nitrite + nitrate loads are provided below: Reach — One-hour NT (mg-N/L) — Thirty-day NT (mg-N/L) Reach 8 — 14.8 — 3.2 Reach 7 above Valencia — 4.8 — 2.0 Reach 7 below Valencia — 5.5 — 2.0 Reach 7 at County Line — 3.4 — 1.2 Reach 3 above Santa Paula — 2.4 — 1.9 Reach 3 at Santa Paula — 2.4 — 1.9 Reach 3 below Santa Paula — 2.2 — 1.7 • NO_3-N + NO_2-N 9.0 mg/L in Reach 8 4.5 mg/L in Reaches 3 and 7 Narrative objectives for biostimulatory substances and toxicity are based on the Basin Plan.. The TMDL analysis indicates that the numeric targets will implement the narrative objectives. The Implementation Plan includes monitoring and special studies to verify that the TMDL will implement the narrative objectives.
Source Analysis	The principal source of ammonia, nitrite, and nitrate to the Santa Clara River is discharges from the Saugus and Valencia Water Reclamation Plants and the Fillmore and Santa Paula Publicly Owned Treatment Works. Agricultural runoff, stormwater discharge and groundwater discharge may also contribute nitrate loads. Further evaluation of these sources is set forth in the Implementation Plan.
Linkage Analysis	Linkage between nitrogen sources and the in-stream water quality was established through hydrodynamic and water quality models. The Watershed Analysis Risk Management Framework was used to model the hydrodynamic characteristics and water quality of the Santa Clara River. The Linkage Analysis demonstrated that major point sources were the primary contributors to in-stream ammonia and nitrate plus nitrite loads. Nonpoint sources and minor point sources contributed a much smaller fraction of these in-stream loads.
Wasteload Allocations (for	Major point sources:

Element	Santa Clara River Nitrogen Compounds TMDL
point sources)	Concentration-based wasteloads are allocated to major point sources of ammonia in Reach 3, which include the Fillmore and Santa Paula POTWs; concentration-based wasteloads are allocated are allocated to major point sources of nitrite+nitrate in Reaches 7 and 8 , which include the Valencia and Saugus WRPs. Based on the linkage analysis for this TMDL, the ammonia WLAs for the major POTWs are provided below. The Implementation Plan provides reconsideration of the WLAs by the Regional Board based on WER studies and updated data 5 years after the effective date of the TMDL. Ammonia-nitrogen (NH_3-N): POTW — One-hour WLA — Thirty-day WLA Saugus WRP — 5.6 mg/L — 2.0 mg/L Valencia WRP — 5.2 mg/L — 1.75 mg/L Fillmore POTW — 4.2 mg/L — 2.0 mg/L Santa Paula POTW — 4.2 mg/L — 2.0 mg/L Although there is no 303(d) listing for Ammonia in Reaches 7 and 8, the TMDL analysis shows that the POTWs will be discharging at no more than 2.0 mg-N/L in Reach 8 and 1.75 mg-N/L in Reach 7, to achieve the nitrite + nitrate numerical targets for each of these reaches. Nitrate-nitrogen (NO_3-N) + Nitrite-nitrogen (NO_2-N): POTW — NO2-N — NO2-N+NO3-N Saugus WRP — 0.9 mg/L — 7.1 mg/L Valencia WRP — 0.9 mg/L — 6.8 mg/L Minor Point Sources: Concentration-based wasteloads are allocated to minor discharges enrolled under NPDES or WDR permits.. The allocations for minor point sources are based on the water quality objectives for ammonia, nitrite, nitrate and nitrite+nitrate. For minor dischargers discharging into Reach 7, the WLA for nitrate+nitrite is 6.8 mg/L. For minor dischargers discharging into Reach 3, the thirty-day WLA for ammonia is 2.0 mg/L and the one hour WLA for ammonia is 4.2 mg/L; the WLA for nitrate+nitrite is 8.1 mg/L. MS4 and Stormwater Sources: Concentration-based wasteloads are allocated to municipal, industrial and

Element	Santa Clara River Nitrogen Compounds TMDL
	construction stormwater sources regulated under NPDES permits. The allocations for minor point sources are based on the water quality objectives for ammonia, nitrite, and nitrate. For stormwater permittees discharging into Reach 7, the thirty-day WLA for ammonia is 1.75 mg/L and the one-hour WLA for ammonia is 5.2 mg/L; the WLA for nitrate+nitrite is 6.8 mg/L. For minor dischargers discharging into Reach 3, the thirty-day WLA for ammonia is 2.0 mg/L and the one-hour WLA for ammonia is 4.2 mg/L; the WLA for nitrate+nitrite is 8.1 mg/L.
Load Allocation (for nonpoint sources)	Concentration-based loads for total inorganic nitrogen are allocated for nonpoint sources. For nonpoint sources discharging to Reach 7, the ammonia + nitrate + nitrite (NH_3-N + NO_2-N + NO_3-N) load is 8.5 mg-N/L. For non-point sources discharging into other reaches of the Santa Clara River the ammonia + nitrate + nitrite (NH_3-N + NO_2-N + NO_3-N)loads are 10 mg-N/L. Monitoring is established in the TMDL Implementation Plan to verify the nitrogen nonpoint source contributions from agricultural and urban runoff and groundwater discharge.
Implementation	• Ammonia, nitrite, and nitrate reductions will be regulated through effluent limits prescribed in POTW and minor point source NPDES Permits, Best Management Practices required in NPDES MS4 Permits, and SWRCB Management Measures for non point source discharges. • Refer to Table 29 of this document for the Implementation Schedule The Implementation Plan includes upgrades to the WRPs and POTWs discharging to Santa Clara River for removal of ammonia, nitrate, and nitrite. To allow time for completion of the nitrification/denitrification facilities and/or modifications of existing nitrification/denitrification facilities which are integral to this TMDL, the amendment to the Basin Plan made by this TMDL allows for higher interim loads which the Regional Board (at its discretion) can incorporate into NPDES permits as interim effluent limits for a period not to exceed five years from the effective date of the TMDL, as follows: Interim Limits for Nitrate + Nitrite POTW — Daily Maximum Saugus WRP — 10 mg-N/L Valencia WRP — 10 mg-N/L Interim Limits* for Ammonia + Nitrate +Nitrite POTW — Monthly Average — Daily Maximum Fillmore WRP — 32.8 mg-N/L — 38.9 mg-N/L Santa Paula WRP — 41.8 mg-N/L — 49.0 mg-N/L

Element	Santa Clara River Nitrogen Compounds TMDL
	The Implementation Plan also includes special studies and monitoring to evaluate the effectiveness of nitrogen reductions for ammonia, nitrite, and nitrate on implementing narrative objectives for biostimulatory substances and toxicity. Ammonia, nitrite, and nitrate reductions will be regulated through effluent limits prescribed in NPDES permits and best management practices for MS4 and non point source discharges. The Implementation Plan also includes special studies to address issues regarding water quality standards and site specific objectives and a reconsideration of waste load allocations based on monitoring data and special studies.
Margin of Safety	An explicit margin of safety of 10% of the nitrogen loads is allocated to address uncertainty in the source and linkage analyses. In addition, an implicit margin of safety is incorporated through conservative model assumptions and statistical analysis. Impairment is typically based on exceeding the single sample objective in more than 10% of the samples. By incorporating an implicit margin of safety, the number of samples exceeding the water quality objective will be less than 10% of the samples measured in-stream.
Future Growth	Plans for the upper watershed include urban growth, which will expand the capacity of the Valencia Water Reclamation Plan, construction of an additional water reclamation plant, and increased use of reclaimed water. Wasteload and load allocations will be developed for these new sources as required to implement appropriate water quality objectives for ammonia, nitrite, nitrate, and nitrite+nitrate.
Seasonal Variations and Critical Conditions	The critical condition identified for this TMDL is based on the low flow condition defined as the 7Q10. In addition, the driest six months of the year are identified as a more critical condition for nutrients because less surface flow is available to dilute effluent discharge. The linkage analysis also indicates a critical condition during the first major storm event after a dry period. The implementation plan includes monitoring to verify this potential critical condition.

10 IMPLEMENTATION

This section describes the proposed implementation plan to meet water quality objectives for nitrogen and effects in the Santa Clara River. The Implementation Plan includes the following elements:

- Wastewater treatment to remove ammonia, nitrate and nitrite from POTW effluent;
- Implementation and evaluation of agricultural best management practices (BMPs) in the Santa Clara River watershed;
- Implementation of modeling and evaluation of groundwater conditions in the Upper Santa Clara River watershed; and
- Monitoring for ammonia, nitrite, nitrate, toxicity, algae, dissolved oxygen, scum, and foam in the Santa Clara River.

10.1 Alternatives Considered by Regional Board

In addition to the alternatives developed and described in Section 6, Allocations, two alternatives were considered for developing an appropriate implementation schedule to meet the ammonia, nitrate, nitrite, nitrate + nitrite objectives. Alternative 1 would require that waste load allocations be applied to POTWs on the effective date of the TMDL. Under Alternative 2, interim waste load allocation would be considered for an interim period before WLAs for nitrate-N, nitrite-N, nitrate-N + nitrite-N would apply to POTWs

Alternative 2 is the recommended alternative since this alternative would allow the dischargers time to complete the implementation of treatment facilities without increasing current ammonia, nitrate and nitrite loads in the interim period. As the treatment facilities are commissioned, the reductions in ammonia and nitrate loads will alleviate the corresponding impairments in the Santa Clara River. Alternative 1 would not provide the time needed for the dischargers to complete implementation of nitrification/denitrification facilities.

10.2 Wastewater Treatment

The WLAs for ammonia, nitrite, and nitrate established in this TMDL will be implemented as effluent limits in the NPDES permits for the POTWs discharging in the Santa Clara River. These effluent limits can be achieved by incorporating additional treatment facilities, which may include modifications to existing nitrification and denitrification operations and installation of denitrification filters at the POTWs. Nitrification reduces the ammonia load by oxidizing it to nitrite and nitrate, and denitrification reduces the nitrite and nitrate loads by reducing these compounds to gaseous nitrogen.

The regulatory framework for achieving the ammonia objective is established by the Basin Plan. The Basin Plan provides that the compliance date for the inland surface water ammonia objective is June 13, 2002. Specifically, the Basin Plan states that, "timing of compliance with this objective will be determined on a case-by-case basis. Discharges will have up to 8 years following the adoption of this plan by the Regional Board to (i) make the necessary adjustments/improvements to meet these objectives or (ii) to conduct studies leading to an approved site-specific objective for ammonia. If there is an immediate threat or impairment of beneficial uses due to ammonia, the objectives in Tables 3-1 to 3-4 shall apply" (Basin Plan, p. 3-3). On May 31, 2001 Regional Board staff presented a Status Report on POTWs Timely Progress toward Compliance with Inland Surface Water Ammonia Objectives to Protect Aquatic Life, as Stipulated in the Basin Plan. Staff reported that most of the POTWs in the Santa Clara River were expected to be in compliance with the ammonia objective within one year of the June 13, 2002 deadline. Staff recommended that the Regional Board evaluate on a case-by-case basis the appropriateness of (1) issuing Time Schedule Orders for those POTWs that will not achieve compliance by the deadline and/or (2) finding the discharges in violation of permit conditions and taking other enforcement actions.

Compliance with oxidized nitrogen targets will involve both point source and nonpoint source controls. For POTWs, compliance with nitrate and nitrite targets is related to compliance with the ammonia target, because the preferred method of meeting the ammonia target is to oxidize ammonia to nitrate (i.e. nitrify effluent). The nitrified effluent will need to be denitrified to meet nitrate and nitrite objectives.

Regional Board staff also considered enhancement or construction of wetlands as an alternative to nitrification/denitrification meet wasteload and as a potential BMP. Wetlands construction can remove nutrient compounds while providing support for habitat and recreational uses. Dischargers would provide appropriate monitoring to verify the effectiveness of wetlands treatment in meeting the numeric targets.

10.3 Interim Nitrate Limits

The POTWs in the Santa Clara watershed may require additional time to meet the oxidized nitrogen (nitrate, nitrite, and nitrate + nitrite) WLAs. As POTWs implement nitrification/denitrification processes to comply with the ammonia objective and existing effluent limitations for nitrate + nitrite additional oxidized nitrogen will be generated in the POTW effluent. To allow time for completion of a site-specific objective and for planning, design, and construction of additional nitrification and denitrification facilities, if needed, which are integral to this TMDL, the amendment to the Basin Plan that includes this TMDL allows for interim limits listed in Tables 25 and 26 while the appropriate upgrades are effected to achieve full compliance, if needed.

The interim effluent limits are based on POTW performance and are based on the 99th percentile of effluent performance data for the daily maximum and 95th percentile of effluent performance data for the monthly average limits for nitrite-nitrogen, and nitrate-nitrogen concentrations in POTW effluent. These interim limits will apply to ammonia, nitrate, nitrite, and nitrate + nitrite for the Fillmore and Santa Paula POTWs, as shown in Table 26. For the Saugus and Valencia POTWs, only nitrate + nitrite interim limits apply, as shown in Table 27. The time periods for interim limits are based on information provided by the POTWs. Interim limits were calculated assuming the detection limit for nitrite is 0.01 mg/L.

Table 26. Interim Limits for Fillmore and Santa Paula POTWs

	Ammonia+ Nitrate+nitrite (mg/L)
Fillmore	

Monthly Average	32.8
Daily Maximum	38.9
Santa Paula	
Monthly Average	41.8
Daily Maximum	49.0

Table 27. Interim Limits for Saugus and Valencia POTWs

	Nitrate+nitrite (Daily Maximum)
Saugus	10 mg/L
Valencia	10 mg/L

10.4 Nonpoint Source Control

Load allocations will be implemented in accordance with the State's Nonpoint Source Management Plan which describes a three-tiered approach to address nonpoint source loads, including: (1) voluntary implementation of Best Management Practices (BMPs), (2) regulatory-based enforcement of BMPs, and (3) prescription of effluent limitations. The management plan generally prescribes the least stringent option that will restore and protect water quality.

The status of implementation of nonpoint source BMPs throughout the Santa Clara watershed was documented for this TMDL (Appendix E) and demonstrates that substantial efforts have been expended to provide educational and funding support for voluntary implementation of Best Management Practices as defined in the Basin Plan. The State Water Control Board Nonpoint Source Implementation Guidance Document (2002) states that sufficient voluntary implementation is not necessary to proceed to regulatory-based enforcement.

The Regional Board has initiated the organization of oversight committees or identified an existing stakeholder group willing to be tasked with assisting in the implementation of nonpoint source controls through the TMDL. Agricultural, reclaimed water and septic system loading, and wetlands elimination have been identified as nonpoint source issues which require more oversight, monitoring and modeling than can be provided by Regional Board Nonpoint staff during the implementation period to ensure success of the TMDL.

An agricultural oversight committee (AOC) was formed to monitor and track the development of BMPs in the watershed. This group is providing educational outreach to growers and has begun monitoring agricultural impacts and documenting the extent and impact of existing BMPs. The agricultural oversight committee is comprised of local agricultural organizations, Regional Board staff and interested stakeholders. The committee's first meeting took place on September 18, 2002 at the Ventura County Farm Bureau. The committee will participate in the following activities with Regional Board Staff; 1) quantify fertilizer application practices and loading rates to groundwater through leaching and surface waster through runoff, 2) describe BMPs to manage, 3) identify extent of BMPs usage, 4) provide outreach, education, and fiscal support targeted by BMP and by prioritized areas, and 5) install and overview BMPs. In cases of non-compliance with BMPs by some of these stakeholders, the Regional Board may issue discharge permits, time schedule orders, or waivers as appropriate. The Regional Board staff recommends that when progress is made on these implementation plan tasks, then growers participating with the AOC may not be subject to discharge permits.

Groundwater discharge to the Santa Clara River is a nonpoint source, (DWR 1993, USGS 2003) which can affect the results of the TMDL. Water purveyors and users in the upper and lower watershed have entered a Memorandum of Understanding and formed a "MOU" committee tasked with constructing a working surface and groundwater model to quantify and monitor water transfer and storage programs proposed to optimize the utilization of the Santa Clara River watershed resource. The model is expected to be completed in June 2003 with ongoing monitoring provided by the group members to update the model during its use. Regional Board staff met with representatives of this committee in December 16, 2002. This committee may model the impact of proposed reclaimed water systems and provide this information to the Regional Board for the purposes of permitting these discharges and ensuring the resulting in-stream water quality is consistent with the requirements of the TMDL. Additional monitoring by this committee and its members and updating of the model with this data and periodic model analysis were already planned as part of the MOU agreement and will be included in permit requirements to ensure that reclaimed water systems and groundwater management plans will not prevent the success of the TMDL.

The Septic Task Force is considering assisting Regional Board staff in monitoring the cumulative effects of septic system installation in the Upper Santa Clara River. The group was formed with the assistance of the Regional Water Quality Control Board and the Santa Monica Restoration Group to provide stakeholder guidance in the development of the Malibu nutrient and coliform TMDL.

10.5 Monitoring

The following describes key elements of the TMDL Monitoring Program.

10.5.1 Compliance Monitoring for POTWs

Effluent and receiving water monitoring requirements will be developed for the POTWs to ensure compliance with the limits for nitrogen species (including but not limited to ammonia, nitrate, nitrite, and nitrate plus nitrite). The frequency of sampling will be determined by the Regional Board to ensure that the effluent limits are met and that receiving water standards are not violated. Organic nitrogen will be included in the parameters to evaluate total nitrogen loadings to Santa Clara River and its tributaries.

POTW monitoring will include parameters to assess the narrative standards for nitrate, nitrite and ammonia in accordance with USEPA Protocol for Developing Nutrient TMDLS, 1999, #841 B 99 007, including, but not limited to water column measurements of temperature, pH and DO, ammonia, nitrate, nitrite, organic nitrogen, acute and chronic toxicity, algae mass and coverage, benthic invertebrates, macroinvertebrates, and fish surveys. The frequency of sampling will be determined by the Regional Board to statistically demonstrate that the sampling frequency is sufficient to ensure that the water quality standards are met. The monitoring program will also include sediment samples, if necessary, to ensure water quality standards for nutrients are attained. Observations for the presence of scum, odors, and the presence and extent of algal mats should be made at the same time the receiving waters are sampled, and coordinated, to the extent possible, with ongoing monitoring requirements for the WRPs and POTWs.

Additional monitoring will be required to refine the point source loading estimates from minor sources. The Regional Board will re-estimate the magnitude of minor point source loading and determine if additional monitoring of these sources is required to refine the point source load estimates and allocate waste loads to the minor point sources.

10.5.2 Nonpoint Source Monitoring

This TMDL includes monitoring to evaluate nutrient loadings associated with agricultural drainage and other nonpoint sources. The monitoring program will include both dry and wet weather discharges from agricultural, urban and open space sources. In addition, groundwater discharge will also be analyzed for nutrients to determine the magnitude of these loading and the need for load allocations. A key objective of these studies will be to determine the effectiveness of agricultural BMPs in reducing nutrient loadings. Consequently, flow and analytical data for nutrients will be required to estimate loadings from nonpoint sources.

10.5.3 MS4 Monitoring

MS4 Monitoring will be in accordance with Work Plans to be submitted by MS4 permittees in Los Angeles and Ventura Counties, respectively. The Work Plans can include a phased approach in which initial monitoring will be provided by existing mass emission monitoring stations and selected storm drains, if necessary, as proposed by the MS4 permittees and approved by the Regional Board Executive Officer. If, as a result of first phase monitoring, nitrogen loads from the storm sewer system are found to be a significant source or cause exceedances of applicable numeric targets for ammonia and/or nitrate + nitrite, the Work Plan will establish steps for further monitoring. Elements of future phased monitoring may include land use monitoring and tributary monitoring. BMPs, as established in the NPDES permits, will be implemented as necessary to reduce ammonia, nitrite, and nitrate loading, if required.

10.6 Special Studies

The Implementation Plan sets forth special studies to address issues associated with nutrient impairments that currently require more data to resolve. These special studies include:

- study of agricultural best management practices (BMPs) in the Santa Clara River watershed;
- study of groundwater conditions in the Upper Santa Clara River watershed; studies to address issues for which the data are insufficient to assess the nutrient influence in the Santa Clara River, including, but not limited to aquatic life , algae and dissolved oxygen.

Table 28 summarizes the Implementation Plan Milestones. The Implementation Plan provides a provision for reevaluating the TMDL five years after the effective date to consider revised water quality objectives, if appropriate.

Table 28. Implementation Schedule

Implementation Tasks, Milestones and Provisions	Responsible Party	Completion Date
1. Apply interim limits for NH_3-N and NO_3-N + NO_2-N to Fillmore and Santa Paula POTWs. 2. Apply interim limits for NO_3 to Saugus and Valencia WRPs. 3. Apply Wasteload Allocations (WLAs) to minor point source dischargers and MS4 permittees. 4. Include monitoring for nitrogen compounds in NPDES and WDR permits for minor dischargers as permits are renewed.	Fillmore and Santa Paula POTWs; NPDES and WDR permittees	Effective Date of TMDL
5. Submittal of Work Plans by Los Angeles County and Ventura County MS4 permittees to estimate nitrogen loadings associated with runoff loads from the storm sewer system for approval by the Regional Board's Executive Officer. If, as a result of carrying out the Work Plan, ammonia or nitrogen loads from the storm sewer system are found to be a significant source, the Work Plan will be modified to include determination of the effectiveness of BMPs in addressing nutrient loading in runoff from urban and suburban areas,	Los Angeles and Ventura Counties MS4 Permittees	1 year after the Effective Date of TMDL
6. Submittal of Work Plan by major NPDES permittees to assess and monitor the receiving water quality for organic enrichment and other nitrogen effects in the Santa Clara River for approval by the Regional Board's Executive Officer. The Work Plan will include evaluation of the effectiveness of the POTW in meeting WLAs.	Cities of Fillmore and Santa Paula, and County Sanitation Districts of Los Angeles County	1 year after Effective Date of TMDL
7. Submittal of special studies Work Plan by County Sanitation Districts of Los Angeles County to evaluate site-specific objectives (SSOs) for nitrate for approval by the	County Sanitation Districts of Los Angeles County	1 year after Effective Date of TMDL

Implementation Tasks, Milestones and Provisions	Responsible Party	Completion Date
Regional Board's Executive Officer		
8. Submittal of results from water effects ratio study for ammonia by County Sanitation Districts of Los Angeles County.	County Sanitation Districts of Los Angeles County	Effective Date of TMDL
9. Evaluation of feasibility of including stakeholders in the Upper Santa Clara River watershed in the Regional Board Septic Tank task force.	Regional Board	1 year after Effective Date of TMDL
10. Submittal of Work Plan by Stakeholder Group for nitrogen trading in the Santa Clara River watershed for approval of the Executive Officer.	Interested Stakeholders	2 years after Effective Date of TMDL
11. Regional Board considers a Basin Plan Amendment for site-specific objectives for ammonia and nitrite-nitrogen + nitrate-nitrogen based on results of Tasks 7 and 8.	Regional Board	1 year after Effective Date of TMDL for ammonia; 4 years after the Effective Date of the TMDL for nitrite-nitrogen + nitrate-nitrogen.
12. Based on the results Task 5-11 and NPDES Monitoring, complete implementation of advanced treatment or additional treatment modifications to achieve WLAs for POTWs, if necessary.	POTW Permittees	8 years after Effective Date of TMDL
13. Interim limits for ammonia, and nitrate expire and WLAs apply to POTWs. The Regional Board will consider extending the duration of the remaining schedule and re-evaluating interim limits if WLAs for POTWs are reduced after SSO considerations.	POTW Permittees Regional Board	Based on results of Tasks 6 and 11: if additional modifications or advanced nitrification/denitrification facilities are required interim limits will expire 8 years after the Effective Date of TMDL; if advanced treatment is not required, interim limits will expire 5 years after the Effective Date of the TMDL.

10.7 Cost Analysis

Regional Board staff analyzed the costs of implementation of the TMDL. Analysis of TMDL costs is complicated because the Saugus and Valencia WRPs and the Fillmore and Santa Paula POTWs are currently undergoing plant expansions and upgrades. These upgrades will expand capacity and comply with the criteria specific Basin Plan objective for ammonia through implementation of nitrification/denitrification. The Fillmore plant is under plans to be phased-out and sewage is planned to be treated a new regional facility wastewater treatment facility in Santa Paula. The Saugus and Valencia WRPs will be modified to include nitrification and denitrification of effluent. The City of Fillmore provided cost information, but Regional Board staff could not identify costs for compliance with this TMDL in the data provided. CSDLAC provided a cost study that focused on determining the effects of different averaging periods for the nitrite + nitrate objective. The cost study, described below, contains an analysis of costs for additional nitrification/denitrification to comply with a 5 mg/L effluent limit on a daily, monthly, and annual average. Because the WLAs for this TMDL are 6.8 mg/L, Regional Board staff used the methodology described below to estimate the magnitude of costs for implementation of this TMDL.

The cost analysis considers both effluent treatment at the Saugus and Valencia WRPs and implementation of agricultural best management practices. The cost analysis for effluent treatment is based on the estimated costs for upgrading the N/DN facilities as reported by the CSDLAC in a report by Montgomery Watson Harza, "Nitrogen Removal Evaluation for the Saugus and Valencia Water Reclamation Plants," December 2002. The Montgomery Watson Harza cost estimate is based on achievement of 5 mg/L for nitrate+nitrite as a daily maximum, monthly average and annual average for both Valencia and Saugus WRPs. The CSDLAC cost estimate provides the basis for Regional Board staff conclusion that the costs for advanced N/DN will have a minor impact on current sewage rates in Santa Clarita.

The costs associated with this TMDL for effluent treatment include additional treatment for ammonia and oxidized nitrogen removal from WRP discharge. The costs are based on Alternative No. 2 of the MWH report: 28.1 MGD combined capacity at Saugus and Valencia

WRPs with denitrification Filters. Table 4-3 of the MWH study reports a present worth of Alternative 2 ranging from $24.1 million to $78.2 million. Based on the MWH study, the cost estimate for the present worth of implementing advanced N/DN treatment is $34.7 million.

It is noted that the MWH reports correlates the N/DN costs to the interpretation of the numeric limit for nitrate+nitrite: annual average, monthly average, and instantaneous maximum. However, the correlation is not applicable to this TMDL, which contains concentration-based because the correlation is based on an analysis of mass loads. Because the Saugus and Valencia WRPs are currently undergoing upgrades at the present time that will reportedly achieve nitrate+nitrite effluent concentrations of 10 mg/L, the most representative cost estimate should be based on facility upgrades that will further reduce nitrate+nitrite by approximately 4 mg/L. This cost estimate corresponding to this performance objective is interpolated between the value for “annual average,” $24.1 million which is based on a 1.9 mg-N/L nitrate+nitrite reduction and the value for “monthly average,” $46.3 million which is based on a is 6.3 mg-N/L nitrate+nitrite reduction.

The costs of applying the TMDL remedies in the upper Santa Clara River watershed are relatively minor. The estimated costs for evaluating affordability are based on the present worth cost estimate above normalized to the number of connections and compared to state-wide sewage rates. For 28.1 MGD, the estimated number of people served are based a nominal rate of 100 gallons per day per person. The number of households is estimated based on an average of 4.5 persons per household. Therefore, the estimated number of connections is approximately 62,500. Consequently, the annualized cost per household, based on amortizing the present worth for 20 years at 5% interest is approximately $3.71 per month, an increase of approximately 40% over the current sewer rates.

Table 29 indicates sewage rates for major cities in California and allows comparison of the costs of TMDL implementation to the current monthly household sewer rates. The estimated sewage rates that would result from most costly TMDL (advanced nitrification/denitrification) remedy are well below the average in California, which is $19.82 for 2001.

Potential cost savings to community residents, which could be acquired through the sale of treated water, funding programs to assist in the construction costs, and avoidance of additional treatment costs for other pollutants (i.e. future TMDL requirements) are not included.

Table 29. Ranking of Sewage Rates for Major Cities (State Water Resources Control Board Wastewater user Charge Survey Report May 2001)

Location	Rate per Month per Household	Notes
California Low	$4.25	
City of Santa Clarita	$10.96	Existing rate
Santa Clarita with Enhanced Nitrification/Denitrification	**$12.71**	
Los Angeles County Average	$15.01	
California Average	$19.82	
Ventura County Average	$23.15	
San Diego County Average	$26.24	
Average of all California County Highs	$39.86	
San Luis Obispo County High	$55	
Ventura County High	$73.75	
San Diego County High	$75	
California High/Los Angeles County High	$145.50	

10.7.1 Agricultural Best Management Practices

Costs to implement agricultural BMPs are dependent on the extent to which BMPs have already been implemented in the watershed. Because this information is not readily available, several assumptions were made to estimate agricultural BMP costs. First, it is assumed that there is minimal implementation of agricultural BMPs. Although it is known that some farms likely employ some of these measures already, there is no way to estimate the number that do at this time. Secondly, each BMP listed was assumed to have been implemented separately from the other BMPs. In reality, some BMPs may be implemented together and therefore reduce the costs. Finally, implementation of the BMPs was assumed to occur concurrently and consistently across all of the agricultural acreage in the watershed.

Table 30 summarizes the estimated unit costs for each BMP. Since the acreage to be applied is to be determined by the AOC, it is premature to determine the estimated watershed costs. Watershed costs for each BMP were determined based on the acreage in the watershed to which the BMP could be applied. Tillage, crop residue, and irrigation systems were assumed to be implemented on all the agricultural acreage in the watershed. Contour farming, contour orchards, and hillside benches were estimated for agricultural acreage in hilly areas. Filter strips were assumed to be installed along the main channel and tributaries in agricultural areas for a total of 157 miles in the watershed. For simplicity, grassed waterways were assumed to be applied to the same miles of the waterways as the filter strips. The number of sediment basins, infiltration trenches, and sediment traps depend greatly on the amount of space available to install these devices. This information was not readily available, so watershed costs were not estimated for these BMPs. Because the number of individual farms in the watershed was not known, it was not possible to estimate the watershed cost for tail water recovery systems.

Table 30. Estimated Agricultural BMP Costs

Best Management Practice	Cost per acre[1]
Conservation Tillage	
No Till	($2.90)
Mulch Till	$17.20
Contour Farming	$61.90
Contour Orchard and Other Fruit Area	$131.80
Crop Residue Use	
Chopping and Chopping Waste	$48.75
Mulching using min. Tillage	$20.10
Filter Strip	

Best Management Practice	Cost per acre[1]
Filter Strip	$7,377.75
Filter Strip	$7,377.75
Filter Strip	$7,377.75
Buffer Strip	$1,217.70
Landscaping	$2,263.45
Grassed Waterway	$7,377.75
Hillside Bench	$1,080.15
Irrigation System: Sprinkler	$830.90
Irrigation System: Trickle	
Microspray System	$2,320.80
Drip Irrigation	$3,123.00
Irrigation System	
Tail water Recovery	$16,904.40
Irrigation Water Management	$458.40
Runoff Management system	
Sediment Basin	$573,430.70
Infiltration Trench	$51.60
Sediment Trap, Box Inlet	$593.10

1. Based on average costs presented in "Calleguas Creek Watershed Erosion and Sediment Control Plan for Mugu Lagoon", National Resources Conservation Service, May 1995.

As shown in Table 30, the BMP costs for agricultural on a watershed basis range widely, depending on the BMP. However, most of these BMPs would provide treatment benefits for constituents other than just nitrogen compounds. The overall costs will depend on the BMPs selected as well as extent of BMP implementation.

10.8 Pollutant Trading

Water quality trading is a market-based approach to improve and preserve water quality. Trading can provide greater efficiency in achieving water quality goals in watersheds by allowing one source to meet its regulatory obligations by using pollutant reductions created by another source that has lower pollution control costs. This TMDL includes a study to evaluate the feasibility of trading nitrogen load allocations in the Santa Clara River. A pollutant trading program for nitrogen in the Santa Clara River would require approval by US EPA.

In order to meet the EPA Trading Policy requirements, the TMDL will include a Trading Committee with representative stakeholders and interested parties that will perform the following tasks for the purposes of generating recommendations and a plan:

- Identify how trading will occur, trade administration, and eligible participants in trading;
- determine requirements to attain all necessary permits before entering a trade, including permit language that identifies the trade, provides notice to the public, and indicates any modified permit limits;
- ensure accountability;
- develop methods and procedures to determine compliance, such as the use of a baseline condition and how credits are generated beyond the baseline, and pollution reduction performance;
- identify when backsliding or anti-degradation is triggered in the context of a trade;
- determine appropriate trade ratios in light of the uncertainty of pollutant reduction performance; and
- establish a method for technical assistance for non-point best management practices.

The Committee will also follow the guidance for stakeholder-led studies described in the 2002 TMDL Strategy documents.

The Trading Committee will develop recommendations for a program to be implemented watershed wide. These recommendations and plan, upon approval of the Regional Board, will be initiated as an alternative compliance measure for the TMDL.

Upon approval and implementation of the trading program and within the first 2 years of the implementation plan, the Trading Committee, will evaluate the environmental effectiveness of the program so that adjustments can be made if necessary. The evaluations will include the following information:

- Ambient monitoring to ensure that impairments of designated uses (including existing uses) do not occur and to document water quality conditions;
- quantify nonpoint source pollutant removal efficiencies such as agricultural BMP studies; and
- determine whether the water quality objectives have been achieved.

11 REFERENCES

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TECHNICAL APPENDICES

Santa Rosa Animal Waste Control Demonstration Project Annual Report at Region 1

Wetlands at your service: Reducing Impacts of Agriculture at the Watershed Scale
By Joy B. Zedler

Ammonia Numeric Targets for Santa Clara River

Figure 84-Annual Average Discharge-Frequency Weighted Chloride Concentrations, Santa Clara River, Los Angeles-Ventura County Line

Figure 85- Annual Average Discharge-Frequency Weighted Nitrogen Concentrations, Santa Clara River, Los Angeles-Ventura County Line

Public Data Set, 303(d) assessment 2002, Santa Clara River Reach 5 (EPA Reach 7)

Expected Performance of Upgraded WWTP's

Stream Health Studies

Stickleback Health

Simulation of Ground-Water/Surface-Water Flow in the Santa Clara-Calleguas Basin, Ventura County, California

TECHNICAL SUPPORT DOCUMENTS

Analysis of pH variation in the impaired reaches of the Santa Clara River, Arturo A. Keller and Yi Zheng, Bren School of Environmental Science & Management, UCSB

WARMF model Calibration refinement for Nitrogen Compounds, Arturo A. Keller and Yi Zheng, Bren School of Environmental Science & Management, UCSB

Determination of the Critical Water Quality Conditions for the Impaired Reaches of the Santa Clara River Watershed, Arturo A. Keller and Yi Zheng, Bren School of Environmental Science & Management, UCSB

Report on Point and Non-Point Source Analysis for Segment 56 in Reach 7, below Valencia WRP, Arturo A. Keller and Yi Zheng, Bren School of Environmental Science & Management, UCSB

Analysis of Potential Nutrient Load allocation for the reaches of the Santa Clara River Considered in the 1998 303(d) list, Arturo A. Keller and Yi Zheng, Bren School of Environmental Science & Management, UCSB

Final Linkage Analysis-Santa Clara River Nutrient TMDL Analysis Parts I and II: Hydrology and Water Quality, Systech Engineering, Inc. for the SCR N TMDL Steering Committee.

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