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TOTAL MAXIMUM DAILY LOADS FOR NITROGEN COMPOUNDS AND RELATED EFFECTS

LOS ANGELES RIVER AND TRIBUTARIES

California Regional Water Quality Control Board
Los Angeles Region

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1 INTRODUCTION

Many segments of the Los Angeles River and its tributaries contain elevated levels of nutrients that adversely impact the water and contribute to algae, odors, scum, foam, and toxicity. These impaired segments exceed water quality objectives (WQOs) for ammonia, pH, nutrients (including nitrogen compounds such as nitrite and nitrate), algae, odors, scum/foam and toxicity, which appears to be primarily related to ammonia. Impaired segments (i.e. reaches) of the Los Angeles River were included on the 1998 California 303(d) list of impaired waterbodies (LARWQCB, 1998a). To address these impairments, the Clean Water Act requires a Total Maximum Daily Load (TMDL) be developed to restore impaired waterbodies, including the Los Angeles River, to their full beneficial uses. Table 1 summarizes the segments of the Los Angeles River included on the 1998 California 303(d) list for ammonia, nutrients, algae, odors, scum/foam, and pH.

Ammonia, pH, nutrients (including nitrogen compounds such as nitrite and nitrate), algae, odors, scum/foam can be addressed through limitations on nitrogen compounds. The goal of this TMDL is to develop wasteload allocations for nitrogen compounds and an implementation plan to meet the water quality objectives in the Los Angeles River. Attaining the nitrogen compound objectives is intended to address impairments caused by pH, scum/foam, and algae as these effects are related to the presence of nitrogen in the waterbody. The TMDL implementation plan requires continued studies to verify this assumption, including special studies to assess the effectiveness of the nitrogen compound wasteload allocations established by this TMDL in eliminating pH, algae, odor, scum and foam impairments. The implementation plan includes a provision to revise nitrogen compound targets and wasteload allocations to address the nutrient, algae, foam, scum/odor and pH impairments, if required.

TABLE 1. SEGMENTS OF THE LOS ANGELES RIVER AND TRIBUTARIES LISTED AS IMPAIRED FOR NITROGEN, PH, OR EUTROPHIC EFFECTS (U.S. EPA, 1998)

Listed Waterbody Segment	Hydro Unit No	Miles of Impairment for Each Type of Nitrogen-Related Impairment					
		Ammonia	Nutrients	Algae	Odors	Scum/ Foam	pH
Los Angeles River (at Sepulveda Basin)	405.21	1.9	1.9	NL	1.9	1.9	NL
Los Angeles River (from Sepulveda Dam to Sepulveda Blvd.)	405.21	11.8	11.8	NL	11.8	11.8	NL
Los Angeles River (from Riverside Dr. to Figueroa St.)	405.21	7.2	7.2	NL	7.2	7.2	NL
Tujunga Wash (from Hansen Dam to Los Angeles River)	405.21	9.7	NL	NL	9.7	9.7	NL
Burbank Western Channel	405.21	6.4	NL	6.4	6.4	6.4	NL
Verdugo Wash (from Verdugo Rd. to Los Angeles River)	405.24	NL	NL	3.4	NL	NL	NL
Arroyo Seco (from West Holly Ave. to Los Angeles River)	405.15	NL	NL	7.0	NL	NL	NL
Los Angeles River (from Figueroa St. to Carson St.)	405.15	19.4	19.4	NL	19.4	19.4	NL
Rio Hondo (at the Spreading Grounds)	405.15	2.7	NL	NL	NL	NL	NL
Rio Hondo (from the Santa Ana Fwy. to Los Angeles River)	405.15	4.2	NL	NL	NL	NL	4.2
Compton Creek	405.15	NL	NL	NL	NL	NL	8.5
Los Angeles River (From Carson St. to estuary)	405.12	2.0	2.0	NL	NL	2.0	2.0
Total miles affected		65.3	42.4	16.8	56.4	58.4	14.7

NL: Not listed as impaired

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, 2000a). This TMDL is based on the analysis provided by the U.S. EPA of nitrogen sources in the Los Angeles River watershed. The Modeling Analysis for the Development of TMDLs for Nitrogen Compounds in the Los Angeles River and Tributaries by Tetra Tech, Inc. was used to analyze the assimilative capacity, seasonality, critical conditions and the linkage of nitrogen sources to in-stream water quality. These analyses formed the basis of the wasteload allocations to be established by this TMDL.

The Implementation Plan of this TMDL is designed to attain water quality objectives for oxidized nitrogen, and ammonia (collectively the nitrogen compound objectives) in the Los Angeles River. Attaining the nitrogen compound objectives will likely address ancillary nutrient effects, including dissolved oxygen and algal growth. The implementation plan requires continued studies to verify this assumption. The Implementation Plan includes special studies to assess both wet-weather and dry-weather runoff loads in the watershed, including residential, commercial, and industrial land uses and other sources. Should these studies demonstrate that eutrophic impairments would not be eliminated through attainment of the nitrogen targets proposed in this TMDL, the California Regional Water Quality Control Board, Los Angeles Region (Regional Board) may revise targets and reallocate loads through a reevaluation included in the Implementation Plan. Additional discussion is provided in the Implementation Plan of this document.

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 objective 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, 2000a). 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 loads (the loading capacity) is not exceeded. A TMDL is also required to account for seasonal variations and include a margin of safety to address uncertainty in the analysis (U.S. EPA, 2000).

States must develop water quality management plans to implement TMDLs (40 CFR 130.6). The Environmental Protection Agency has oversight authority for the 303(d) program and is required to review and either approve or disapprove TMDLs submitted by states. In California, the State Water Resources Control Board (State Board) and the nine Regional Water Quality Control Boards are responsible for preparing lists of impaired waterbodies under the 303(d) program and for preparing TMDLs, both subject to U.S. EPA approval. If U.S. EPA disapproves a TMDL submitted by a state, U.S. EPA is required to establish a TMDL for that waterbody. The Regional Boards also hold regulatory authority for many of the instruments used to implement the TMDLs, such as the National Pollutant Discharge Elimination System (NPDES) permits and state-specified Waste Discharge Requirements (WDRs).

The Regional Board identified over 700 waterbody-pollutant combinations in the Los Angeles Region where TMDLs would be required (LARWCQB, 1996, 1998a). These are referred to as "listed" or "303(d) listed" waterbodies or waterbody segments. A schedule for development of TMDLs in the Los Angeles Region was established in a consent decree (Consent Decree) approved on March 22, 1999 (Heal the Bay Inc., et al. v. Browner, C 98-4825 SBA). For the purpose of scheduling TMDL development, the decree combined the more than 700 waterbody-pollutant combinations into 92 TMDL analytical units.

This TMDL addresses Analytical Unit 11 of the Consent Decree. Analytical Unit 11 consists of segments of the Los Angeles River and tributaries with impairments from ammonia, nutrients, algae, pH values outside of the allowable range, odors, foam and scum. Table 1 identifies the listed waterbodies, the nitrogen-related impairments for which each is listed, and the number of miles of waterbody impaired by each. This TMDL also addresses oxidized nitrogen compounds (*i.e.*. nitrite and nitrate) because these compounds are related to the other nitrogen impairments and can be formed by oxidation of ammonia in the environment. Moreover the oxidized nitrogen compounds exceed the Water Quality Control Plan for the Coastal Watersheds of Los Angeles and

Ventura Counties (Basin Plan) objectives in certain reaches of the Los Angeles River. The Consent Decree schedule requires that U.S. EPA establish this TMDL by March 22, 2004. This report presents the TMDL for nitrogen and summarizes the analyses performed by U.S. EPA and the Regional Board to develop this TMDL.

The Basin Plan includes an ammonia objective and a criterion specific compliance schedule provision that requires publicly owned treatment works (POTWs) that discharge to inland surface waters until June 13, 2002 to: 1) make the necessary adjustments and improvements to meet the water quality objectives for ammonia or 2) 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 Owned Treatment Works' (POTWs') Progress toward Compliance with Inland Surface Water Ammonia Objectives" from Regional Board staff. The status report indicated that two of the major POTWs that discharge to the Los Angeles River, the Donald C. Tillman Water Reclamation Plant and the Los Angeles-Glendale Water Reclamation Plant, have initiated pilot tests with a target compliance date of 2005. The City of Los Angeles Bureau of Sanitation (City) reported that it could not meet the 2002 target compliance date because completion of a downstream relief sewer, scheduled for November 2005, is required to account for the anticipated derating of the Donald C. Tillman and Los Angeles-Glendale POTWs. The treatment capacity of these two POTWs will be reduced due to implementation of nitrification/denitrification processes to meet the ammonia objective. The target compliance date for the Burbank POTW is 2003.

The Regional Board approved a Basin Plan amendment to update the ammonia objectives in inland surface waters on April 25, 2002. The revised ammonia objectives apply to waters with beneficial uses pertaining to aquatic life such as wildlife habitat (WILD) or warm freshwater habitat (WARM). This update was based on the U.S. EPA "1999 Update of Ambient Water Quality Criteria for Ammonia" (U.S. EPA, 1999). The revised objectives will be finalized once the State Board, the Office of Administrative

Law, and U.S. EPA approve the amendment. This TMDL has been developed to be consistent with the updated objectives.

1.2 Environmental Setting: The Los Angeles River

This TMDL addresses the loading of nitrogen compounds to five reaches and twelve tributaries to the Los Angeles River. The Los Angeles River flows for 55 miles from the Santa Monica Mountains at the western end of the San Fernando Valley to the Pacific Ocean at San Pedro Bay. It drains a watershed with an area of 834 square miles. Figure 1 shows the location of the waterbodies addressed by this TMDL. The main stem of the Los Angeles River runs from the upstream end of the Sepulveda Basin downstream to the beginning of San Pedro Bay, a total of five reaches. The seven listed reaches of tributaries are: Tujunga Wash below Hansen Dam; Burbank Western Channel Verdugo Wash from Verdugo Road to the Los Angeles River confluence; Arroyo Seco below Devils Gate Dam; Rio Hondo at the spreading grounds; Rio Hondo downstream of the spreading grounds, from the Santa Ana Freeway to the Los Angeles River confluence; and Compton Creek.

Approximately 44% of the watershed area can be classified as forest or open space. These areas are primarily within the headwaters of the Los Angeles River in the Santa Monica, Santa Susana, and San Gabriel Mountains. There is little agricultural activity in these areas. Approximately 36% of the land use can be categorized as residential, 10% as industrial, 7.5% as retail commercial, and 3% as other. Most of the area devoted to these more urban uses is found in the lower portions of the watershed.

The natural hydrology of the river and many of its tributaries have been altered for flood control purposes. Many stretches of the river and its tributaries have been channelized and flood control reservoirs have been constructed. Most of the main stem of the Los Angeles River is lined with concrete, and most tributaries are lined with concrete for most or all of their lengths. However, soft-bottomed segments of the river occur where groundwater upwelling prevented armoring of the river bottom. These areas support riparian habitat in many areas this habitat is quite extensive.

The main stem of the Los Angeles River begins by definition at the confluence of Arroyo Calabasas (which drains northeastern portion of the Santa Monica Mountains) and Bell Creek (which drains the Simi Hills) at mile 55 (*i.e.* 55 miles upstream of San Pedro Bay). The river flows east from its origin along the southern edge of the San FernandoValley. In this region, the Los Angeles River receives flow from Browns Canyon, Aliso Creek and Bull Creek, non-listed tributaries that drain the Santa Susana Mountains. The lower portions of Arroyo Calabasas and Bell Creek are channelized. Browns Canyon, Aliso Creek and Bull Creek are completely channelized. This portion of the Los Angeles River is not listed for nitrogen compounds or related effects.

The river enters the Sepulveda Basin at mile 41. Sepulveda Basin is a 2,150-acre open space designed to collect floodwaters during major storms. Because the area is periodically inundated, it remains in natural or semi-natural conditions and supports a variety of low-intensity land uses. Sepulveda Basin and Glendale Narrows supports various beneficial uses. The wildlife habitat (WILD) beneficial use applies to the Sepulveda Basin and Glendale Narrows. The water contact recreation (REC1) beneficial use applies to the Sepulveda Basin. The Donald C. Tillman Wastewater Reclamation Plant, a POTW operated by the City of Los Angeles, discharges directly to the Los Angeles River within the basin and also via two lakes in the Sepulveda Basin that are used for recreational and wildlife habitat. The POTW has a capacity of 80 million gallons per day (mgd) and contributes a substantial flow to the Los Angeles River. The average monthly flow for the period 1995 to 2000 was approximately 53 mgd (*i.e.*. 80 cubic feet per second (ft^3/s)). During storm runoff, POTW effluent accounts for 15-40% of the total flow in the river at this point. During dry weather, the discharge from Donald C. Tillman constitutes a large proportion of the flow in the river.

Below the Sepulveda Basin, Pacoima Wash and Tujunga Wash enter the Los Angeles River. Both tributaries drain portions of the Angeles National Forest in the San Gabriel

Mountains. Pacoima Wash is channelized below Lopez Dam to the Los Angeles River; that reach is listed for nitrogen or related effects. Tujunga Wash is listed for the 10-mile reach below Hansen Dam. It is entirely channelized in this reach. Some of the discharge from Hansen Dam is diverted to spreading grounds for groundwater recharge, but most of the flow enters the channelized portion of the stream.

Further downstream, where the Los Angeles River continues flowing east in the San Fernando Valley, Burbank Western Channel and Verdugo Wash enter at mile 30 and mile 28 respectively. Both are channelized streams that drain the Verdugo Mountains. Verdugo Wash is listed for algae. The Western Channel is listed for multiple nitrogen-related effects below the point where it receives flow from the Burbank Water Reclamation Plant, a POTW with a design capacity of 9 mgd. Average monthly flows from this POTW in the period 1995 to 2000 were about 4 mgd, or about 6 ft^3/s. During the periods of wet weather when the flow exceeds the Los Angles Zoo's wastewater retention basin capacity, excess flow from the wastewater facility is discharged through North and/or South bypasses to a paved channel adjacent to Golden State Freeway (I-5), which is tributary to Los Angeles River at Colorado Street in Glendale.

At the eastern end of the San Fernando Valley, the Los Angeles River turns south at the eastern end of the Hollywood Hills and flows through Griffith Park and Elysian Park in an area known as the Glendale Narrows. This area is fed by natural springs during periods of high groundwater. This potential source was analyzed and found to have a negligible contribution of nitrogen compounds during critical conditions. The river is channelized and the sides are lined with concrete, but the river bottom in this area is unlined because the water table is high and groundwater routinely discharges into the channel, in varying volumes depending on the varying water table. The Los Angeles/Glendale Water Reclamation Plant, operated by the City of Los Angeles, is a 20-mgd POTW, which discharges to the Los Angeles River in the Narrows (at mile 29). The monthly average effluent discharge in the period 1995 to 2000 from this plant area was approximately 13 mgd, or 19 ft^3/s.

Another factor affecting hydrologic conditions in the Los Angeles River Narrows has been the increasing releases of reclaimed water. Reclaimed water releases from the Los Angeles-Glendale WRP were started in 1976-1977 and from the Donald C. Tillman WRP in 1985-1986. These year-round releases tend to keep the alluvium of the Los Angeles River Narrows saturated, even in dry years. Also there is up to 3,000 acre-feet of recharge from delivered water within the Los Angeles Narrows-Pollock Well Field area that adds to the rising groundwater. Rising groundwater also occurs above the Verdugo Narrows and in the reach upgradient from Gage F-57C-R (Figure 2). During dry periods, conditions in the unlined reach are stabilized with regard to percolation and rising water by releases of treated wastewater. In wet periods, rising groundwater above Gage F-57C-R has been related to the increase of rising groundwater above the Verdugo Narrows. For 2000-01 the total rising groundwater flow at Gage F-57C-R and F-252-R was estimated at 3,900 acre-feet (ULARA Watermaster Report, 2000-2001 Water Year, May 2002).

The first major tributary below the Narrows is Arroyo Seco (mile 24), which drains areas of Pasadena and portions of the Angeles National Forest in the San Gabriel Mountains. The 10-mile length of the Arroyo below Devils Gate Dam to the Los Angeles River is channelized, and is listed for algae.

The Rio Hondo is a channelized tributary and joins the Los Angeles River at mile 10. The Rio Hondo and its tributaries drain a large area in the eastern portion of the watershed. Flow in the Rio Hondo is managed by the County Sanitation Districts of Los Angeles County (CSDLAC). At the Whittier Narrows the Rio Hondo and the adjacent San Gabriel River both enter a large spreading grounds, managed by the CSDLAC. Flow from the two rivers intermingles during storm events, producing substantial flows in the Los Angeles River downstream of the spreading grounds. During other periods, especially during dry weather, virtually all the water in Rio Hondo goes to groundwater recharge, so little or no flow exits the spreading grounds into the Los Angeles River. Rio Hondo is listed for ammonia both at the spreading grounds and downstream, in the reach from the Santa Ana Freeway to the Los Angeles River confluence.

Compton Creek is the last large tributary to the system, entering the Los Angeles River at mile 6. Compton Creek is channelized for most of its 8.5-mile length. Impairments to Compton are related to pH that is outside of the allowable range in the Basin Plan.

The tidal portion of the Los Angeles River begins in Long Beach at Willow Street (mile 3) and runs approximately three miles before joining with Queensway Bay located between the Port of Long Beach and the City of Long Beach. In this reach, the channel has a soft bottom with concrete-lined sides. Sandbars accumulate in the portion of the river where tidal influence is limited. Compton Creek receives up to 720 mgd of hydrotest and stormwater from Southern California Edison Company on an intermittent basis. The wastewater then flows to the Los Angeles River about ¼-mile downstream from Del Amo Boulevard, above the tidal prism. This discharge is not a significant source of nitrogen compounds discharged to Compton Creek. The ammonia load from Compton Creek was analyzed and found to be negligible.

During dry weather, most of the flow in the Los Angeles River is comprised of wastewater effluent from three POTWs in the Los Angeles River watershed: The Donald C. Tillman Water Reclamation Plant, the Los Angeles-Glendale Water Reclamation Plant, and the Burbank Water Reclamation Plant. In most months the mean monthly discharge in the river is approximately equal to the sum of the measured effluent from the Donald C. Tillman, Los Angeles-Glendale, and Burbank POTWs. During periods of storm runoff, however, the river's flow is much greater, by as much as two to three orders of magnitude. The river's mean monthly discharge greatly exceeds the POTW effluent volume during months with substantial rainfall, such as December 1996; January, November, and December 1997; February through May 1998; and others. In dry-weather months such as February through October 1997, POTW mean monthly discharges totaled 70% to 100% of the monthly average flow in the river. In months with major rain events, such as February through May 1998, POTW monthly average discharges together was less than 20% of the monthly average flow in the river.

The high flows in the wet season originate as storm runoff both from the large areas of undeveloped open space in the mountains of the tributaries' headwaters, and from the equally large urban land uses in the flat low-lying areas of the watershed. Rainfall in the headwaters flows rapidly because the watershed and stream channels for the most part are steep. In the urban areas, about 5,000 miles of storm drains in the watershed convey urban runoff to the Los Angeles River. Those storm drains are designed to convey stormwater flows rapidly through the system. Altogether, the watershed produces storm flow in the river with a sharply peaked hydrographic, where flow increases quite rapidly after the beginning of rain events in the watershed, and declines rapidly after rainfall ceases. The Los Angeles River TMDL therefore needs to account for differences in flow between wet and dry seasons; for differences between storm runoff and periods of no runoff, both during wet seasons and dry seasons; and also for differences in the relative contributions from point sources and urban runoff.

1.3 ELEMENTS OF A TMDL; ORGANIZATION OF THIS DOCUMENT

Guidance from U.S. EPA (1991) identifies seven elements of a TMDL. Sections 2 through 8 of this document are organized such that each section describes one of the elements, with the analysis and findings of this TMDL for that element. Section 9 includes an analysis of costs that may be incurred to meet the TMDL. The elements are:

- Section 2: Problem Identification. This section reviews the data used to add the waterbody to the 303(d) list, and summarizes existing conditions using that evidence along with any new information acquired since the listing. For this TMDL, the problem encompasses nitrogen compounds (ammonia, nitrite and nitrate), and effects which may be caused by nitrogen loading: pH outside of the allowable range, algae, foam/scum, and odors. This element identifies those reaches that fail to support all designated beneficial uses; the beneficial uses that are not supported for each reach; the water quality objectives (WQOs) designed to protect those beneficial uses; and, in summary, the evidence supporting the decision to list each reach, such as the number and severity of excellencies observed.

- Section 3: Numeric Targets. For this TMDL, the numeric targets consist of WQOs described in the Basin Plan. The implementation Plan includes studies to verify that attainment of the WQOs for constituents having numeric criteria will address impairments by constituents having narrative objectives, such as algae, scum/foam, and odors.
- Section 4: Source Assessment. This section develops the quantitative estimate of nitrogen loadings from point sources and non-point sources into the Los Angeles River.
- Section 5: Linkage Analysis. This analysis shows how the sources of nitrogen compounds into the waterbody are linked to the observed conditions in the impaired waterbody. The linkage analysis addresses the critical conditions of stream flow, loading, and water quality parameters.
- Section 6: Pollutant Allocation. Each pollutant source is allocated a quantitative load of nitrogen compounds that it can discharge to meet the numeric targets. Allocations are designed such that the waterbody will not exceed numeric targets for the nitrogen compounds or related effects. Allocations are based on critical conditions, so that the allocated pollutant loads may be expected to remove the impairments at all times.
- Section 7: Implementation. This section describes the plans, regulatory tools, or other mechanisms by which the wasteload allocations and load allocations are to be achieved. This section contains a cost analysis. The TMDL provides cost estimates to implement effluent treatment (nitrification/denitrification) at the major Publicly Owned Treatment Works (POTWs) discharging to the Los Angeles River. The cost estimates were developed by stakeholders.
- Section 8: Monitoring. This TMDL includes a requirement for monitoring the waterbody to ensure that the water quality standards for nitrogen compounds are attained and that related impairments such as pH, algae, odor, and foam/scum also are removed. If the monitoring results demonstrate the TMDL has not succeeded in removing the impairments, then revised allocations will be developed.

2 PROBLEM IDENTIFICATION

This section provides an overview of water quality standards for the Los Angeles River and 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*s*. 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 13 beneficial uses for the Los Angeles River. Table 2 summarizes these beneficial uses. Other waterbodies within the watershed have a conditional designation for MUN. These waterbodies are indicated with an asterisk in the Basin Plan. Conditional designations are not recognized are under federal law and are not considered water quality standards requiring TMDL development to protect at this time. (See Letter from Alexis Strauss [U.S. EPA] to Celeste Cantú [State Board], Feb. 15, 2002.)

Table 2. Beneficial Uses in 303 (d) Listed Reaches of the Los Angeles River (LARWQCB, 1994.)

STREAM REACH	Hydro Unit No.	MUN	GWR	REC1	REC2	WILD	WARM	SHELL	RARE	MIGR	SPWN	WET	MAR	IND	PROC
Los Angeles River to Estuary	405.12	P*	E	Es	E	E	E	Ps	E	P	P		E	P	P
Los Angeles River	405.15	P*	E	Es	E	P	E							P	
Los Angeles River	405.21	P*	E	E	E	E	E							P	
Compton Creek	405.15	P*	E	Es	E	E	E					E			
Rio Hondo Spreading Grounds and below	405.15	P*	I	Pm	E	I	P								
Rio Hondo	405.41	P*	I	Im	E	I	P		E			E			
Arroyo Seco S. of Devils Gate (L)	405.15	P*		I	I	P	P								
Arroyo Seco S. of Devils Gate (U)	405.31	P*		Im	I	P	P		E						
Verdugo Wash	405.24	P*	I	Pm	I	P	P								
Burbank Western Channel	405.21	P*		Pm	I	P	P								
Tujunga Wash	405.21	P*	I	Pm	I	P	P								

E: Existing beneficial use
P: Potential beneficial use
I: Intermittent beneficial use
s: Access prohibited by Los Angeles County DPW
m: Access prohibited by Los Angeles County DPW in the concrete-channelized area
* Conditional designation which may be considered for exemption at a later date

2.1.1 Beneficial Uses

Nitrogen loadings to the Los Angeles River may result in impairments of beneficial uses associated with aquatic life (WILD[1], WARM[2], RARE[3], WET[4], MAR[5]), recreation (REC1[6] and REC2[7]) and water supply (GWR[8]). The Basin Plan (1994) identifies beneficial uses as existing (E), potential (P), or intermittent (I) uses. Several potential beneficial uses could be impacted, including SHELL[9], MIGR[10], SPWN[11], IND[12], and PROC[13]. Concentration of ammonia, a nitrogen compound, often exceeds water quality objectives for chronic and acute toxicity to aquatic life. Nitrate and nitrite, two oxidized nitrogen compounds, have, on infrequent occasions, been present in concentrations exceeding water quality objectives in the Basin Plan. All three of these nitrogen compounds may stimulate the production of algae that can impair aquatic life, water supply and recreational beneficial uses. Algal growth in some instances has produced algal mats in the waterbody that can result in eutrophic conditions where low dissolved oxygen concentration can harm aquatic life. The decay of these mats may also cause impairments by scum, odors, and foam that affect recreational uses of the river.

Analysis indicates that six of the beneficial uses are the most sensitive to nitrogen compounds and related effects such that protecting those uses will serve to protect all related beneficial uses. Therefore, this document focuses on key beneficial use designations, including WARM, WILD, WET, RARE, GWR, REC1, and REC2.

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[1] WILD: wildlife habitat
[2] WARM: warm freshwater habitat
[3] RARE: rare, threatened, or endangered species
[4] WET: wetland habitat
[5] MAR: marine habitat
[6] REC-1: water contact recreation
[7] REC-2: non-contact water recreation
[8] GWR: ground water recharge
[9] SHELL: shellfish harvesting
[10] MIGR: migration of aquatic organisms
[11] SPWN: spawning, reproduction, and/or early development
[12] IND: industrial service supply
[13] PROC: Industrial service supply

Existing use designations for warm freshwater, wildlife, wetland, and rare, threatened or endangered species (WARM, WILD, WET, and RARE) habitats apply over much of the main stem and Compton Creek in the lower part of the watershed. The WARM designation applies as a potential use to the remaining listed tributaries. The Wildlife use designation (WILD) is for the protection of fish and wildlife. This use applies to most of the main stem of the Los Angeles River, as an intermittent use in Rio Hondo, and as potential use in the remainder of the tributaries. Water quality objectives developed for the protection of fish and wildlife are applicable to the reaches with the WARM, WILD, WET and RARE designations.

The municipal supply (MUN) use designation applies to several tributaries to the Los Angeles River and all groundwater in the Los Angeles River watershed. Other waterbodies within Region 4 also have a conditional designation for MUN. These waterbodies are indicated with an asterisk in the Basin Plan. However, conditional designations are not recognized are under federal law and are not water quality standards requiring TMDL development at this time. (See Letter from Alexis Strauss [U.S. EPA] to Celeste Cantú [State Board], Feb. 15, 2002.)

The ground water recharge (GWR) use designation applies to the Los Angeles River and its tributaries as either an existing or intermittent beneficial use. The Basin Plan provides a nitrogen (nitrate, nitrite) objective for groundwater: "Ground waters shall not exceed 10 mg/L nitrogen as nitrate-nitrogen plus nitrite-nitrogen (NO_3-N + NO_2-N), 45 mg/L as nitrate (NO_3), 10 mg/L as nitrate-nitrogen (NO_3-N), or 1 mg/L as nitrate-nitrogen (NO_2-N)."

Recreational uses for body contact (REC1) and secondary contact (REC2) apply to almost all the listed river segments and tributaries as either existing, potential or intermittent. Although access to the Los Angeles River and the concrete-channelized areas of Tujunga, Verdugo, Burbank Western Channel, Arroyo Seco, and Rio Hondo is limited by Los Angeles County Department of Public Works, people are still observed using the Los Angeles River for recreational purposes. Recreational activities have been observed along the Los Angeles River include bird watching, jogging, hiking, soccer playing, and bicycling. Currently, public access is restricted along most of the main stems of the Los Angles River. This restriction is for public safety reasons. Water flows in the concrete channel can be 20 to 40 cubic feet per second (CFAs) and are able to sweep away people who are in close proximity. In spite of the posted prohibition signs, homeless people and others come in direct contact with the river's water for wading, bathing or other purposes. In 1990, it was estimated that 150 homeless individuals lived along the downtown portion of the river (Beneficial Uses of the LA and San Gabriel Rivers – May 2001). Objectives designed to protect human health (*e.g.*, bacterial objectives), and the aesthetic quality of the resource (*e.g.*, visual, tastes and odors) is appropriate to protect recreational uses of the river.

2.1.2 Water Quality Objectives (WQOs)

The Basin Plan provides 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 Objectives for Ammonia

Water quality objectives for ammonia are based on the "U.S. EPA 1999 Update of Ambient Water Quality Criteria for Ammonia (U.S. EPA 1999). Although the updated EPA criteria have not yet been incorporated into the Basin Plan, these criteria have been adopted by the Regional Board. The Resolution adopted by the Regional Board that amended the Basin Plan to include the updated ammonia objective is currently under review by the State Board.

2.1.2.1.1 Basic for evaluation and proposed ammonia objective for Los Angeles River

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.

Oxidation of ammonia to nitrate may lead to groundwater impacts in the area of recharge.

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.

In order to protect underlying groundwater basins, ammonia shall not be present at levels that, when oxidized to nitrate, pose a threat to groundwater.

On April 25, 2002 the Los Angeles Regional Water Quality Control Board approved a basin plan amendment to update the ammonia objectives in inland surface waters (Resolution No. 2002-011). This update was based on the U.S. EPA "1999 Update of Ambient Water Quality Criteria for Ammonia" (U.S. EPA 1999). The revised objectives will be finalized once the Office of Administrative Law has approved them. This TMDL has been developed to be consistent with these updated objectives.

The U.S. EPA's revised ammonia 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.

The most significant differences in the 1999 U.S. EPA guidance relative to the existing Basin Plan objectives for ammonia are:

1. Acute criteria are no longer temperature-dependent but remain dependent on pH and fish species present.
2. A greater recognition of the temperature dependence of the chronic criteria, especially at low temperatures.
3. An Early Life Stage (ELS) chronic criterion was introduced.
4. Chronic criteria are no longer dependent on the presence or absence of specified fish species, but remain dependent on pH and temperature.
5. A 30-day averaging period for the ammonia chronic criteria replaced the 4-day averaging period.

Additional information about the updated criteria, including technical rationale and comparisons to existing objectives, is found in the RWQCB Draft Staff Report, "Proposed Amendment of the Water Quality Control Plan, Los Angeles Region, to Revise Ammonia Objectives, April 24, 2002," which is provided in Appendix 1.

The revised objectives are not yet approved by the Office of Administrative Law (OAL), but the TMDL has been developed to be consistent with the updated objectives. Further, the Regional Board's resolution adopting the TMDL will specify that the TMDL will take effect following the approval of the revised criteria by OAL. Reaches listed for ammonia are: several reaches of the Los Angeles River main stem; the Burbank Western Channel; Tujunga Wash; and Rio Hondo at and below the spreading grounds.

Calculation of ammonia objectives as reflected in the April 25, 2002, Basin Plan amendment approved by the Regional Board:

1 The one-hour average concentration of total ammonia as nitrogen (in mg N/L) does not exceed (more than once every three years on average) the CMC (acute criteria) calculated using the following equations.

Where salmonid fish are present:

$$CMC = \left(\frac{0.275}{1+10^{7.204-pH}}\right)+\left(\frac{39.0}{1+10^{pH-7.204}}\right) \qquad \text{(Equation 1a)}$$

Or where salmonid fish are not present:

$$CMC = \left(\frac{0.411}{1+10^{7.204-pH}}\right)+\left(\frac{58.4}{1+10^{pH-7.204}}\right) \qquad \text{(Equation 1b)}$$

2 The thirty-day average concentration of total ammonia nitrogen (in mg N/L) does not exceed (more than once every three years on the average) the CCC (chronic criteria) calculated using the following equations.

Where early life stage fish are present:

$$CCC = \left(\frac{0.0577}{1+10^{7.688-pH}}+\frac{2.487}{1+10^{pH-7.688}}\right)*MIN\left(2.85,1.45*10^{0.028*(25-T)}\right) \qquad \text{(Equation 2a)}$$

where MIN indicates use of the lesser of the two values contained within the parentheses.

Or where early life stage fish are not present:

$$CCC = \left(\frac{0.0577}{1+10^{7.688-pH}}+\frac{2.487}{1+10^{pH-7.688}}\right)*1.45*10^{0.028*(25-MAX(T,7))} \qquad \text{(Equation 2b)}$$

where MAX indicates use of the greater of the two values contained within the parentheses and,

T = temperature expressed in °C.

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

In addition to the ammonia objectives for surface waters, the Basin Plan states, “ammonia shall not be present at levels that, when oxidized to nitrate, pose a threat to groundwater” (LARWQCB, 1994). The primary drinking water Maximum Contaminant Level (MCL) is 45 mg/L for nitrate (NO_3), 10 mg/L for nitrite-nitrogen (NO_3 -N), and 1 mg/L for nitrite-nitrogen (NO_2-N). These MCLs are relevant to the extent that portions of the Los Angeles River recharge underlying groundwater.

Currently, the City of Los Angeles, City of Burbank, and the County Sanitation Districts of Los Angeles County are conducting a water effects ratio (WER) study for ammonia in the Los Angeles River. The objective of the study is to support development of a site-specific objective for ammonia in the Los Angeles River. If the WER study results in a revised ammonia objective, this TMDL will need to be revised to reflect the new ammonia target. A change in the levels of ammonia will require a reevaluation of the wasteload allocation for all of the nitrogen compounds because ammonia is converted to nitrite and nitrate in the Los Angeles River. Similarly, nitrate, nitrite, and organic nitrogen are converted to ammonia.

2.1.2.1.2 Alternatives Considered

Two alternatives were considered for developing of an appropriate water quality objective for ammonia in the Los Angeles River: 1) Using existing Basin Plan objectives; 2) Applying the “1999 Update of Ambient Water Quality Criteria for Ammonia” developed by U.S. EPA in developing ammonia objectives for Los Angeles River. The criteria used for selecting the recommended alternative included:

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

a) Alternative 1 – Using existing Basin Plan objectives
   Under this alternative the existing Basin Plan water quality objective for ammonia would remain unchanged and would continue to apply to Los Angeles River without consideration of the updated criteria for ammonia.
b) Alternative 2 – Applying the "1999 Update of Ambient Water Quality Criteria for Ammonia"

Under this alternative the 1999 Update of Ambient Water Quality Criteria for Ammonia would be applied to Los Angeles River as a water quality objective.

2.1.2.1.3 Recommended Alternative

Alternative 2 is the recommended alternative since the action would:

a) be consistent with State and federal water quality laws and policies;
b) facilitate development of an objective that would be protective of Los Angeles River's beneficial uses; and
c) improve the scientific basis upon which the water quality objective is based.

Adoption of Alternative 1 (Using existing Basin Plan objectives) would be inconsistent with the updated objectives

2.1.2.2 Objectives for nitrate, nitrite, and total nitrogen

Nitrate, nitrite, and total nitrogen are considered nutrients that are known to promote plant and algae growth. This TMDL proposes a numeric target for oxidized nitrogen compounds that is based on existing objectives in the Basin Plan. For the main stem of the Los Angeles River and the Rio Hondo, the Basin Plan provides objectives for nitrate-nitrogen + nitrite-nitrogen (NO_3-N+NO_2-N) of 8 mg/L above Figueroa Street, between Figueroa Street and Los Angles River Estuary including Rio Hondo below Santa Ana Freeway, and Rio Hondo above Santa Ana Freeway, and 10 mg/L for other tributary reaches including Santa Anita Creek, Eaton Canyon Creek, Arroyo Seco, Big Tujunga

Creek, and Pacoima Wash. Also, the Basin Plan designates ground water recharge (GWR) as a beneficial use of the main stem of the Los Angeles River. The Basin Plan designates municipal supply (MUN) as a beneficial use for ground waters of the San Fernando Basin and Central Basin that underlie the Los Angeles River. The following objective applies to all ground waters of the Region: "Ground waters shall not exceed 10 mg/L nitrogen as nitrate-nitrogen plus nitrite-nitrogen (NO_3-N+NO_2-N), 45 mg/L as nitrate (NO_3), 10 mg/L as nitrate-nitrogen (NO3-N), or 1 mg/L as nitrite-nitrogen (NO2-N)."

2.1.2.3 Objective for pH

The Basin Plan specifies a numeric objective for pH, stating that pH "shall not be depressed below 6.5 or raised above 8.5 as a result of waste discharges" and a narrative objective, stating that ambient pH levels "shall not be changed more than 0.5 units from natural conditions as a result of waste discharge." The pH of the impaired waterbody relates to this TMDL in a number of other ways. High pH may be due to respiration of algae which is a reflection of nuisance biomass, as noted below. pH also has a major effect on ammonia toxicity. As reflected in Appendix 1, increasing pH greatly increases ammonia toxicity, so the numeric objective for ammonia sharply declines with increasing pH.

2.1.2.4 Objective for Toxicity

For toxicity, the Basin Plan specifies 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, animal, or aquatic life. Compliance with this objective will be determined by use of indicator organism, analyses of species diversity, population density, growth anomalies, bioassays of appropriate duration or other appropriate methods as specified by the Regional Board. The survival of aquatic life in surface waters subjected to a waste discharge or other controllable water quality factors, shall not be less than that of the same waterbody in areas unaffected by the waste discharge, or when necessary, other control water.

The acute toxicity objective for discharges indicates that the average survival in undiluted effluent for any three consecutive 96-hour static or continuous flow bioassay tests shall be at least 90%, with no single test having less than 70% survival when using an established U.S. EPA, State Board, or other protocol authorized by the Regional Board. To determine compliance with chronic toxicity, critical life stage tests for at least three species with approved testing protocols shall be used to screen for the most sensitive species. The test species used for screening shall include a vertebrate, an invertebrate, and an aquatic plant. The sensitive species shall then be used for routine monitoring.

2.1.2.5 Objectives for nutrients, algae, odors, foam and scum

The Basin Plan addresses provides narrative objectives for biostimulatory substances, color, solid, suspended, or settleable materials, taste and odor, and floating material which applies to nutrients, algae, odor, scum, and foam. The objective for biostimulatory substances 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.* pH altered beyond the acceptable range) and aesthetic problems (*e.g.*, odor, scum). Other problems associated with excessive algae growth include decreased flow velocity and reduction of recreation uses. The narrative objective for scum requires that the waters should be free of foams and scum "in concentrations that cause nuisance or adversely affect beneficial uses."

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. 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 waters of the United States are also subject to the federal Antidegradation Policy (40 CFR 131.12). The proposed TMDL will not degrade water quality, and will in fact improve water quality as it is designed to achieve compliance with existing water quality standards.

2.2 WATER QUALITY DATA SUMMARY

This section summarizes water quality data for the Los Angeles River pertaining to nitrogen compounds and their effects. The summary includes data considered by the Regional Board and U.S. EPA in developing the 1998 303(d) list for nitrogen compounds and their effects in addition to more recent data that was used to develop the source assessment and linkage analysis for this TMDL.

2.2.1 Ammonia

The ammonia data used in the Regional Board's water quality assessment of the Los Angeles River are summarized in Table 3. These data are from Regional Board studies and data collected by the Los Angeles Department of Public Works between 1988 and 1994. For the purpose of the 303(d) listing, a reach was considered to be non-supporting if greater than 10% of the samples exceeded the criterion.

For Tujunga Wash, the maximum reported ammonia concentration was 2.4 mg/L, and the variation of the ammonia concentration data did not suggest ammonia concentration routinely exceeded the standard. Recent data for Rio Hondo reflected the changes in the major source for this reach. The Whittier Narrows Wastewater Reclamation Facility (WNWRRF) implemented a nitrification-denitrification process in 1997. Concentration of ammonia in the WNWRRF effluent has decreased; the mean concentration prior to

1997 was about 13 mg/L, and since 1997 is about 2.4 mg/L. The State Board has recommended that the Rio Hondo be delisted for ammonia and placed on the enforceable program list. Additional investigation and monitoring will be conducted during the implementation of this TMDL to more accurately quantify ammonia sources and instream concentrations in Tujunga Wash. Therefore, this TMDL does not provide ammonia wasteload allocations in Tujunga Wash or Rio Hondo. If the results from the monitoring program show that wasteload allocations are required to meet water quality standards, establishment of wasteload allocations will be considered by the Regional Board through a revision of the TMDL.

TABLE 3. SUMMARY OF AMMONIA DATA USED IN LISTING PROCESS.

Waterbody Name	Number of Samples	Mean (Std Dev) (mg/L)	Range (mg/L)	Listed for Ammonia
Los Angeles River (at Sepulveda Basin)	10	8.8 (6.0)	2.2 – 20.1	yes
Los Angeles River (Dam to Riverside Dr.)	95	10.7 (4.8)	ND – 34.9	yes
Los Angeles River (Riverside Dr. to Figueroa St.)	20	9.1 (2.7)	2.2 – 14.9	yes
Tujunga Wash (up to Hansen Dam)	7	0.6 (0.8)	ND – 2.4	yes
Burbank Western Channel	11	12.0 (2.7)	8.3 – 16.3	yes
Verdugo Wash (up to Verdugo Rd.)	8	0.3 (0.4)	ND – 1.3	no
Arroyo Seco (up to Devils Gate Dam)	10	0.5 (0.9)	ND – 3.0	no
Los Angeles River (Figueroa St. to Carson St.)	162	6.0 (4.5)	ND – 29.8	yes
Rio Hondo (at Spreading Grounds)	65	4.4 (4.6)	ND – 18.2	yes
Rio Hondo (below spreading grounds, to Santa Ana Fwy)	57	0.3 (0.5)	ND – 2.6	yes
Compton Creek	58	0.7 (1.7)	ND – 12.1	no
Los Angeles River (Carson St. to Estuary)	94	6.0 (4.5)	ND – 29.8	yes

Table 4 displays more recent data on ammonia for six monitoring locations, four in the Los Angeles River and two in the Burbank Western Channel. These data were collected by the three major POTWs discharging to the Los Angeles River, whose NPDES permits specify quarterly sampling of the receiving water upstream and downstream of the treatment plant discharge points. These data were compared to the updated ammonia objective in the Basin Plan after adjusting for pH and temperature. The adjustments were made using the pH and temperature data collected concomitantly with the ammonia data. Most of these data exceeded the 30-day chronic objective (bolded in Table 4). A subset of these values also exceeds the 1-hour acute objective (underlined in Table 4).

TABLE 4. AMMONIA CONCENTRATIONS (MG/L) IN LOS ANGELES RIVER RELATIVE TO MAJOR POTWS (SOURCES: CITY OF BURBANK 1998-2000; CITY OF LOS ANGELES 1998A-2000A, 1999B-2000B.)

Sample date	Burbank Western Channel: headwaters	Burbank Western Channel: below Burbank WRP	Los Angeles River headwaters (entering Sepulveda Basin)	Los Angeles River: exiting Sepulveda Basin	Los Angeles River: Glendale Narrows	Los Angeles River: below Glendale WRP
Feb. 98	<0.1	**10**	NA	NA	**10.3**	NA
May 98	<0.1	**4.0**	NA	NA	**3.0**	NA
Aug. 98	0.1	**11**	NA	NA	**4.3**	NA
Nov. 98	<0.1	**11**	<dl	**5.4**	**3.5**	2.2
Feb. 99	0.2	**16**	<dl	**6.9**	**7.2**	**6.7**
May 99	0.2	**19**	<dl	**5.8**	**7.6**	**5.6**
Aug. 99	0.2	**13**	0.1	**8.0**	**7.5**	**5.7**
Nov. 99	0.1	**16**	0.3	**10.4**	**7.8**	**5.6**
Feb. 00	**<5**	**15**	0.8	**11.8**	**7.7**	**7.5**
May 00	**<1**	**19**	0.5	**9.5**	**9.5**	**7.6**
Aug. 00	**0.8**	**10**	0.5	**10.9**	**9.6**	**9.0**
Nov. 00	0.1	**21**	<dl	**10.9**	**7.1**	**8.5**
Feb. 01	0.3	**22**	1.9	**17.4**	**11.4**	**11.8**
May. 01	0.2	**13**	ND	**12.3**	**8.2**	**8.3**
Aug. 01	0.32	**11**	0.3	**6.2**	**4.8**	**3.5**
Nov. 01	0.09	**18**	ND	**4.5**	**3.1**	**3.6**

Samples in bold exceeded 30-day chronic criterion for ammonia in the "1999 Update of Ambient Water Quality Criteria for Ammonia"; samples underlined exceeded both chronic and 1-day acute criterion; dl: detection limit, NA: not available

The POTW effluent data indicate that the treatment plants are a significant source of ammonia, one of the primary causes of impairment in the Los Angeles River. Table 5 summarizes ammonia concentration data for POTW effluent and the Los Angeles River in locations upstream and downstream of the POTWs' discharge points.

TABLE 5. AMMONIA CONCENTRATIONS (MG/L) IN LOS ANGELES RIVER RELATIVE TO POTWS (SOURCES: CITY OF BURBANK 1998-2000; CITY OF LOS ANGELES 1998A-2000A, 1999B-2000B.)

	Tillman Upstream	Tillman WRP Effluent	Tillman Downstream	Burbank Upstream	Burbank WRP Effluent	Burbank Downstream	Glendale Upstream	Glendale WRP Effluent	Glendale Downstream
Feb-98	NA	**2.2**	NA	<0.1	**13.0**	**10.0**	**10.3**	**13.7**	NA
May-98	NA	**6.1**	NA	<0.1	**12.0**	**4.0**	3.0	**7.7**	NA
Aug-98	NA	**5.0**	NA	0.1	**15.0**	**11.0**	**4.3**	**9.2**	NA
Nov-98	<dl	0.5	**5.4**	<0.1	**12.0**	**11.0**	**3.5**	**4.5**	2.2
Feb-99	<dl	**2.8**	**6.9**	0.2	**20.0**	**16.0**	**7.2**	**9.4**	**6.7**
May-99	<dl	0.3	**5.8**	0.2	**22.0**	**19.0**	**7.6**	**9.1**	**5.6**
Aug-99	0.1	**3.5**	**8.0**	0.2	**14.0**	**13.0**	**7.5**	**8.1**	**5.7**
Nov-99	0.3	**5.9**	**10.4**	0.1	1.8	**16.0**	**7.8**	**7.2**	**5.6**
Feb-00	0.8	**5.0**	**11.8**	<5	**13.8**	**15**	**7.7**	**8.2**	**7.5**
May-00	0.5	**7.5**	**9.5**	**<1**	**18**	**19**	**9.5**	**9.0**	**7.6**
Aug-00	0.5	**8.1**	**10.9**	**0.8**	**15**	**10**	**9.6**	**8.9**	**9.0**
Nov-00	<dl	**3.8**	**10.9**	0.1	**25**	**21**	**7.1**	**9.5**	**8.5**
Feb. 01	1.9	**11.9**	**17.4**	0.3	**25**	**22**	11.4	**14.7**	**11.8**
May. 01	ND	**7.3**	**12.3**	0.2	**17**	**13**	8.2	**10.3**	**8.3**
Aug. 01	0.3	**2.1**	**6.2**	0.32	**15**	**11**	4.8	**5.3**	**3.5**
Nov. 01	ND	0.9	**4.5**	0.09	**16**	**18**	3.1	**6.5**	**3.6**

Samples in bold exceeded 30-day chronic criterion for ammonia in the "1999 Update of Ambient Water Quality Criteria for Ammonia"; samples underlined exceeded both chronic and 1-day acute criterion; dl: detection limit, NA: not available

Ammonia concentrations in the POTW effluent are often as much as 10 times greater than the WQO for chronic toxicity, and in many cases exceeds the WQO for acute toxicity. Ammonia concentration in the receiving water shows similar exceedances. In some cases, ammonia concentration downstream of the Donald C. Tillman POTW is greater than the upstream concentration and effluent concentration. The data also show the ammonia concentration in the effluent of the Los Angeles-Glendale POTW is in some cases greater than the upstream concentration while the downstream concentration is less than the upstream concentration. These data may result from sampling and analytical variability or may suggest the presence of some other influence, such as additional ammonia sources and transformation of other substances in the POTW effluent, such as organic nitrogen, into ammonia. This issue is further addressed in the Linkage Analysis. The ammonia problem appears to be limited to the main stem of the Los Angeles River and the Burbank Western Channel. Therefore this TMDL addresses those reaches for ammonia.

2.2.2 Toxicity

Toxicity tests performed by the POTWs indicated chronic toxicity in the Los Angeles River and Burbank Western Channel both upstream and downstream of these treatment plants (Table 6). There was also acute toxicity in a smaller number of samples. Effluent toxicity tests performed by the POTWs as part of their NPDES monitoring requirements indicated both acute and chronic toxicity in the effluent, and results of a Toxic Identification Evaluation (TIE) showed that the toxicity was caused by ammonia. Additionally, results from the Los Angeles River Toxicity Testing Project (UC Davis, 2002.) indicate that ammonia was the cause or a contributor to the toxicity in the majority of samples from Reaches 3, 4, and 5. Therefore it is reasonable to assume the toxicity in receiving water may be related to ammonia concentrations in the river. Table 6 compares the toxicity data from the Los Angeles River upstream and downstream of the POTWs and the POTW effluent toxicity data. The presence of toxicity upstream of the POTWs in some of the samples suggests that additional factors may also be contributing to the observed toxicity.

TABLE 6. TOXICITY IN LOS ANGELES RIVER (SOURCES: CITY OF BURBANK 1998-2000; CITY OF LOS ANGELES 1998A-2000A, 1999B-2000B.)

Chronic toxicity (TUc).

	Tillman Upstream	Tillman POTW Effluent	Tillman Downstream	Burbank Upstream	Burbank POTW Effluent	Burbank Downstream	Glendale Upstream	Glendale POTW Effluent	Glendale Downstream
Feb-98	NA	NA	NA	1.0	1.0	1.0	**>10**	**>10**	**1.3**
May-98	NA	NA	NA	**5.6**	1.0	**1.8**	**10**	**10**	**10**
Aug-98	NA	NA	NA	1.0	**1.8**	1.0	**4.0**	**10**	**10**
Nov-98	**10**	<1.0	**4.0**	1.0	1.0	1.0	**>10**	**>10**	**>10**
Feb-99	**>10**	<1.0	**4.0**	1.0	1.0	1.0	**10**	**>10**	**10**
May-99	**10**	**1.3**	**2.0**	1.0	1.0	1.0	**2.0**	**1.3**	<1.0
Aug-99	**>10**	**>10**	**4.0**	1.0	1.0	1.0	**1.3**	**1.3**	**1.3**
Nov-99	**4.0**	**4.0**	**1.3**	**3.1**	1.0	**5.6**	**1.3**	<1.0	<1.0
Feb-00	**10**	**4.0**	**4.0**	**1.8**	**1.8**	**1.8**	**>10**	**4.0**	**>10**
May-00	**2**	**>10**	**>10**	**5.6**	**1.8**	1.0	1.0	1.0	1.0
Aug-00	NA	NA	NA	**5.6**	1.0	1.0	**10**	2.0	2.0
Nov-00	**7.0**	**7.0**	**7.0**	1.0	1.0	1.0	**>10**	**10**	**10**
Feb. 01	**>10**	**>10**	**4**	1	**1.8**	**3.13**	**10**	**10**	**4**
May. 01	**>16**	**>16**	**>16**	1	1	1	**>10**	**>10**	**>10**
Aug. 01	**>16**	**>16**	**16**	1	**1.8**	**1.8**	**16**	**16**	**16**
Nov. 01	**>16**	**>16**	**>16**	1	**1.8**	**1.8**	**2**	**4**	**4**

* Samples in bold exceeded 30-day chronic criterion; TUc: toxicity units for chronic toxicity; NA: not available

Acute toxicity (% Survival).

	Tillman Upstream	Tillman POTW	Tillman Downstream	Burbank Upstream	Burbank POTW	Burbank Downstream	Glendale Upstream	Glendale POTW	Glendale Downstream
Feb-98	NA	NA	NA	100	100	100	100	100	100
May-98	NA	NA	NA	100	100	**50**	NA	NA	NA
Nov-98	NA	NA	NA	NA	NA	NA	100	**5**	100
Dec-98	NA	NA	NA	NA	NA	NA	100	95	100
Jan-99	NA	NA	NA	NA	NA	NA	100	90	95
Feb-99	NA	NA	NA	100	**0**	**0**	85	100	100
May-99	NA	NA	NA	75	**0**	**0**	90	100	95
Aug-99	NA	NA	NA	100	90	100	**0**	**0**	**0**
Nov-99	NA	NA	NA	100	100	**0**	100	100	100
Feb-00	NA	NA	NA	80	**70**	**70**	**40**	**30**	85

Chronic toxicity (TUc).									
	Tillman Upstream	Tillman POTW Effluent	Tillman Downstream	Burbank Upstream	Burbank POTW Effluent	Burbank Downstream	Glendale Upstream	Glendale POTW Effluent	Glendale Downstream
May-00	NA	NA	NA	80	**0**	**0**	**70**	95	95
Aug-00	NA	NA	NA	85	**0**	**0**	93	98	93
Nov-00	NA	NA	NA	100	**0**	**0**	**55**	**65**	88
Feb. 01	NA	NA	NA	95	95	95	**60**	**15**	**55**
May. 01	NA	NA	NA	100	**0**	0	88	95	98
Aug. 01	NA	NA	NA	100	**0**	0	98	100	98
Nov. 01	NA	NA	NA	**47.5**	**0**	**12.5**	**70**	**40**	**43**

* Exceedances in bold type

2.2.3 Oxidized Nitrogen Compounds: nitrate and nitrite

The NO_3-N + NO_2-N data used in the Regional Board's water quality assessment of the Los Angeles River are summarized in Table 7. The ranges of reported data indicate that water quality concentrations in the Los Angeles River, Burbank Western Channel, and Rio Hondo (at the spreading grounds) exceed the objective (8mg/L for most of the Los Angeles River) for nitrite + nitrate.

TABLE 7. SUMMARY OF NO_3-N+NO_2-N DATA (MG/L) USED IN LISTING PROCESS

Waterbody Name	Number of Samples	Mean (Std Dev)	Range	Listed for Nutrients
Los Angeles River (at Sepulveda Basin)[1]	10	3.8 (4.1)	0.5 – 15.7	yes
Los Angeles River (Dam to Riverside Dr.)[1]	92	4.7 (3.9)	0.03 – 20.42	yes
Los Angeles River (Riverside Dr. to Figueroa St.)[1]	20	4.5 (1.1)	3.1 – 7.6	yes
Tujunga Wash (up to Hansen Dam)	7	0.1 (0.1)	ND – 0.22	no
Burbank Western Channel	11	3.9 (3.0)	0.4 – 11.7	no
Verdugo Wash (up to Verdugo Rd.)	8	2.6 (0.8)	1.1 –3.8	no
Arroyo Seco (up to Devil Gates Dam)	10	3.7 (1.5)	1.8 – 6.5	no
Los Angeles River (Figueroa St. to Carson St.)[1]	160	6.2 (3.8)	0 – 19.2	yes
Rio Hondo (at Spreading Grounds)[1]	64	2.7 (3.2)	0.2 – 14.5	no
Rio Hondo (up to Santa Ana Fwy)[1]	57	0.7 (1.1)	ND - 5	no
Compton Creek	57	0.4 (1.1)	ND – 7.6	no
Los Angeles River (Carson St. to Estuary)[1]	94	4.6 (2.4)	0.01 – 13.16	yes

[1]Objective for nitrate-nitrite in these reaches is 8 mg/L.

These data were analyzed relative to the WQOs for nitrate and for nitrite at four locations in the Los Angeles River, where the WQO for NO_3-N is 8 mg/L and the WQO for NO_2-N is 1 mg/L. Table 8 shows results. Approximately 20% of the samples at Tujunga and Arroyo Seco exceeded the nitrate objective. The percentage of exceedances was lower further down the river near Firestone Blvd (5%) and Wardlow Rd (1%). The mean NO_2-N concentration exceeded the 1 mg/L objective in about 40% of the samples, and did not change appreciably with distance down the river. The Tujunga Wash appears to have a nitrate and nitrite loading to the Los Angeles River. The Monitoring Program proposed by this TMDL includes further studies to investigate nitrogen compounds in Tujunga Wash.

TABLE 8. STATISTICAL SUMMARY OF NITRATE AND NITRITE DATA FOR LOS ANGELES RIVER 1988-95 (LACDPW) AS COMPARED TO THE BASIN PLAN OBJECTIVES

Nitrate-N (mg/L)				
Station	Los Angeles River at Tujunga	Los Angeles River at Arroyo Seco	Los Angeles River at Firestone Blvd	Los Angeles River at Wardlow Rd
No. of Samples	82	85	109	108
Ave. (SD)	4.65 (4.37)	6.41 (4.28)	3.79 (3.36)	3.15 (2.32)
Range	0.00 – 16.02	0.00 – 17.61	0.00 – 24.61	0.00 – 10.60
%>10 mg/L	17%	20%	5%	1%
Nitrite-N (mg/L)				
Station	Los Angeles River at Tujunga	Los Angeles River at Arroyo Seco	Los Angeles River at Firestone	Los Angeles River at Wardlow
No. of samples	82	83	107	106
Ave. (SD)	1.01 (1.30)	1.09 (1.36)	1.00 (1.35)	1.07 (1.35)
Range	0.00 – 7.68	0.00 – 8.70	0.00 – 6.33	0.00 – 7.41
%>1mg/L	38%	42%	38%	42%

More recent data from the wastewater treatment plant NPDES monitoring programs (Table 9) show that, although the POTWs contribute nitrite and nitrate to the receiving water, the concentrations in the effluent are generally not in exceedance of the 8 mg/L objective for NO_3-N + NO_2-N; however, nitrite and nitrate are also loaded to the Los Angeles River by conversion of ammonia and organic nitrogen that is discharged by the POTWs.

TABLE 9. NITRATE-N PLUS NITRITE-N CONCENTRATIONS IN THE LOS ANGELES RIVER (MG/L) RELATIVE TO MAJOR POTWS (SOURCES: CITY OF BURBANK 1998-2000; CITY OF LOS ANGELES 1998A-2000A, 1999B-2000B.)

	Tillman Upstream	Tillman POTW Effluent	Tillman Downstream	Burbank Upstream	Burbank POTW Effluent	Burbank Downstream	Glendale Upstream	Glendale POTW Effluent	Glendale Downstream
Feb-98	NA	2.5	NA	3.9	3.2	3.3	2.4	2	NA
May-98	NA	3.8	NA	**20.0**	3.6	4.8	2.7	2.6	NA
Aug-98	NA	1.2	NA	1.9	4.36	2.7	3.0	2.4	NA
Nov-98	NA	7.7	NA	7.3	3.3	3.1	**10.6**	5.4	5.4
Feb-99	6.0	6.1	4.7	5.3	1.26	1.67	5	4.1	5.5
May-99	4.0	7.9	5.9	2.4	0.49	1.22	5.4	4.1	5.7
Aug-99	4.2	3.7	2.5	2.0	2.32	3.85	2.6	3.4	4.0
Nov-99	4.0	5.0	3.7	4.2	1.59	4.18	4.6	3.8	5.7
Feb-00	5.1	5.8	3.6	2.0	5.6	5.5	4.0	3.3	4.3
May-00	4.1	2.3	1.8	0.5	2.4	1.9	2.9	3.3	4.2
Aug-00	2.3	1.8	2.0	0.6	3.9	6.5	2.8	2.4	3.2
Nov-00	5.2	6.0	3.3	2.1	0.6	1.0	4.9	3.7	4.7
Feb. 01	5.8	2.7	2.1	3	0.7	0.9	3.8	3.3	4.6
May. 01	4.7	2.3	1.7	1.5	0.8	1.8	3.4	3.4	4.2
Aug. 01	2.7	4.2	3.1	1.8	2.2	2.4	3.7	3.5	4.1
Nov. 01	3.9	6	6.4	3.2	4.7	0.7	6.6	4.7	5.9

Values greater than 8 mg/L are in bold; NA: not available

2.2.4 pH

The water column pH data reviewed by the Regional Board in the listing process suggest impairments in the lower portion of the Los Angeles River, Compton Creek and the lower portion of the Rio Hondo (Table 10). The fact that high pH values co-occur with high ammonia levels in the Los Angeles River and Rio Hondo suggest that ammonia toxicity is a problem in these areas.

TABLE 10. SUMMARY OF PH DATA REVIEWED USED IN THE LISTING PROCESS

Waterbody Name	Number of Samples	Range	Mean (Std Dev)	Listed for pH
Rio Hondo (up to Santa Ana Fwy)	57	7.3 – 9.9	8.1 (0.6)	yes
Compton Creek	59	6.9 – 9.9	8.1 (0.6)	yes
Los Angeles River (Carson St. to Estuary)	148	7.0 – 10.6	9.2 (0.9)	yes

A review of more recent pH data from the receiving water programs for the three large wastewater reclamation plants indicated several pH values greater than 8.5. The pH values tended to be higher upstream of the plants (Table 11). The pH values in effluent from the three wastewater plants were consistently around 7.2, lower than the ambient pH. Although the source of the elevated pH is not determined, nitrate and nitrite loading can result in increased algae photosynthesis that might cause the pH level to increase. The Implementation Plan includes a monitoring program to assure that the nitrogen wasteload allocations will result in attainment of the pH objectives.

TABLE 11. SUMMARY OF PH DATA IN THE LOS ANGELES RIVER (MG/L) RELATIVE TO MAJOR POTWS (SOURCES: CITY OF BURBANK 1998-2000; CITY OF LOS ANGELES 1998A-2000A, 1999B-2000B.)

	Tillman Upstream	Tillman POTW	Tillman Downstream	Burbank Upstream	Burbank POTW	Burbank Downstream	Los Angeles-Glendale Upstream	Glendale POTW	Los Angeles-Glendale Downstream
50th percentile	8.2	8.1	8.0	8.4	7.7	8.0	8.0	7.7	7.6
90th percentile	8.4	8.4	8.5	8.7	8.0	8.3	8.3	8.0	7.8

2.2.5 Nuisance effects: algae, odors, foam, and scum

The listings for algae, odors, foam and scum were based primarily on visual observations made by Regional Board staff during the 1996 listing process. To further investigate the 1996 listings, a survey of the algal biomass in the Los Angeles River was conducted in September 2000 (Characterization of Water Quality in the Los Angeles River, Ackerman, D., SCCWRP, 2000). The investigation provides some limited data on the distribution and abundance of algae along 30-m transects at four locations along the River and at two tributaries (Bell Creek and Arroyo Seco). Biomass measurements ranged from 0 to 3 kg/m^2. Values were lowest at Bell Creek and highest at the bottom of Arroyo Seco. There were essentially two types of algae observed in the river. One type was the long filamentous algae (*Rhizoclonium spp.*) that forms thick mats and is considered to be nuisance algae. The other type was the blue-green algae (*Cyanobacteria*) that forms a thin film on hard substrate. *Rhizoclonium spp.* was observed at high densities at the bottom of Arroyo Seco, its distribution was patchier in the River at Bell/Calabasas and at the Sepulveda Dam. This species was virtually absent at Bell Creek, near the Burbank Western Channel and above Arroyo Seco. Table 12 summarizes the data regarding algae distribution in the Los Angeles River watershed. Bell Creek and Los Angeles River at Bell Creek are above the Donald C. Tillman WRP. Sepulveda Dam is below the Donald C. Tillman WRP. Los Angeles River at Burbank Western Channel is below Burbank WRP. Los Angeles River above Arroyo Seco and Bottom of Arroyo Seco are below LA Glendale WRP.

TABLE 12. DISTRIBUTION AND ABUNDANCE OF ALGAL BIOMASS IN THE LOS ANGELES RIVER (SEPTEMBER 2000) (BIOMASS VALUES ARE EXPRESSED AS GRAMS/M2 WET WEIGHT (AND GRAMS /M2 DRY WEIGHT))

Station/ Transect number	Bell Creek	Los Angeles River at Bell/ Calabasas	Los Angeles River at Sepulveda Dam	Los Angeles River at Burbank Western Channel	Los Angeles River above Arroyo Seco	Bottom of Arroyo Seco
1	0	0	303 (2)	BG film*	BG film	1156 (191)
2	0	0	2 (0)	BG film	BG film	1450 (124)
3	0	0	77 (11)	BG film	BG film	1894 (301)
4	0	1425 (94)	207 (0)	BG film	BG film	2981 (367)
5	0	2339 (120)	0	BG film	243 (4)	2034 (225)
Average	---	753 (43)	118 (3)	---	---	1903 (242)

* BG film: Blue green algae film

Although this data set is limited, there appears to be a high degree of variability among stations (compare Los Angeles River above Arroyo Seco to the values at the bottom of Arroyo Seco) and within stations (*e.g.*, Los Angeles River at Bell Calabasas or Los Angeles River at Sepulveda Dam).

In summary, the data reviewed as part of this TMDL confirms the listings made by the Regional Board in 1998. Water quality concentrations around the POTWs exceed the chronic water quality criteria for ammonia and to a lesser extent the acute water quality criteria. Toxicity tests also indicate both acute and chronic toxicity that appears to be related to ammonia. There are exceedances of the nitrate and nitrite objectives in the ambient waters of the Los Angeles River. The percentage of these exceedances appeared to be higher in the upper reaches of the River than in the lower reaches of the river. More monitoring surveys are needed to evaluate the extent and magnitude of the algae in the reaches listed for algae.

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 are have been selected based on the water quality objectives in the Basin Plan discussed in Section 2 and listed in Table 13.

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 effect will be subject of a special study by the dischargers to determine 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 Los Angeles River in conformance with a workplan 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) and that any increase in ammonia effluent limits would not cause exceedances of the water quality objectives for nitrate or nitrite + nitrate.

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. Since most of Los Angeles River watershed listed segments are not designated in the Basin Plan as “COLD,” “MIGR,” and “SPWN,” it is assumed that salmonids are absent and early life stages needing special protection are not present in Los Angles watershed. The acute numeric target and chronic numeric target for ammonia will be calculated using the equations set forth in Resolution No. 2002-11before the interim effluent limits set forth in the implementation Plan of this TMDL expire (Section 7).

However, for illustrative purposes, based on the pH and temperature data downstream of the POTW outfalls from the last five years, one-hour ammonia targets range from 2.65 mg/L to 22.97 mg/L for the Donald C. Tillman WRP; 3.88 mg/L to 22.97 mg/L for the Burbank WRP; and 0.61 mg/L to 3.71 mg/L the Los Angeles-Glendale WRP. Thirty-day ammonia targets range from 0.47 mg/L to 2.87 mg/L for the Donald C. Tillman WRP; 1.01 mg/L to 2.12 mg/L for the Burbank WRP; and 0.61 mg/L to 3.71 mg/L for the Los Angeles-Glendale WRP. These numeric targets do not assume application of an ammonia water effects ratio.

The numeric targets for nitrate, nitrite, and nitrate + nitrite are based on the water quality objectives provided in the Basin Plan for the Los Angeles River. Dischargers have expressed concerns regarding several issues with the numeric targets for nitrate, nitrite, and nitrate + nitrite, including the appropriateness of an averaging period and establishment of a mixing zone downstream of the POTWs for compliance purposes. These issues will be addressed through special studies to be conducted by the Dischargers during the Implementation period at which time interim effluent limits apply. The

Regional Board will consider the results of those studies to determine if water quality objective modifications and site specific objectives are appropriate.

TABLE 13. SUMMARY OF NUMERIC TARGETS FOR THE LOS ANGELES RIVER NITROGEN TMDL

Parameter	Beneficial uses/ Basin Plan	Numeric target
Ammonia-nitrogen (NH_3-N)	WILD, WARM	Temp and pH dependent Based on the last two years of temperature and pH data provided by the dischargers, the ammonia numeric targets for the major POTWs are provided below: POTWs — One-hour average (mg/L) — Thirty-day average (mg/L) D.C. Tillman — 4.7 — 1.6 Los Angeles-Glendale — 8.7 — 2.4 Burbank — 10.1 — 2.3
Nitrate-nitrogen (NO_3-N)	Basin Plan	8 mg/L
Nitrite-nitrogen (NO_2 - N)	GWR	1 mg/L
(NO_3 N + NO_2 N)	Basin Plan	8 mg/L above Figueroa Street, between Figueroa Street and Los Angles River Estuary including Rio Hondo below Santa Ana Freeway, and Rio Hondo above Santa Ana Freeway 10 mg/L in other tributaries

Targets are also required for constituents with narrative objectives, and those also are addressed below to the extent feasible. The numeric targets in this TMDL reflect the total pollutant loading capacity of the water body for the nitrogen compounds, accounting for seasonal variations, future growth and margin of safety.

The Basin Plan contains narrative objectives for color, exotic vegetation, floating material, solid, suspended, or settleable materials, and taste and odor that apply to algae, foam/scum, and odor. These narrative objectives prohibit materials that cause nuisance or adversely affect beneficial uses. One mechanism by which excess algal biomass can adversely impact beneficial uses is through eutrophication that results in low dissolved oxygen (DO) concentrations. Another mechanism of impairment of REC-1 and REC-2 occurs when excess algal biomass results in unpleasant odors and scum.

Numeric targets for algae, scum/foam, and odor are not readily definable. The specific quantity of algal biomass that produces scum and odors varies with many factors including algal type, season, consumption by other organisms, and other factors not widely measured or quantified. There is literature from other parts of the U.S. to suggest a target for nuisance algae at 100 to 200 mg/m^2 for chlorophyll a (Biggs, 2000, Dodds and Welch, 2000); Dodds et al., 1997). No such data relating chlorophyll-a concentrations to nuisance conditions are known for the Los Angeles River, and the relevance of values reported in other parts of the U.S. is unknown.

Because data are not sufficient to develop and implement a target for algae in this TMDL, algal biomass and DO concentrations will be measured as part of the TMDL monitoring plan, and observations will be recorded of odors and scum during monitoring. It is anticipated that reductions in nitrogen compounds implemented as part of this TMDL will reduce algal biomass. If those measures serve to ameliorate problems with scums and odors, then the impairment will be considered to be removed. That approach is a reasonable alternative to a specific numeric target in this case.

4 SOURCE ASSESSMENT

Pollutant sources include two categories: point sources and nonpoint sources. Point sources typically include discharges for which there are defined outfalls such as wastewater treatment plants and industrial discharges. These discharges are regulated through a permit such as the federal National Pollution Discharge Elimination System (NPDES) permit or the State of California issued Waste Discharge Requirements (WDRs). Stormwater runoff in the Los Angeles River watershed is regulated as a point source under the municipal separate stormwater sewer system (MS4) permit. Nonpoint sources include pollutants that reach waters from a number of land uses and source activities, but that are not conveyed through a storm sewer system. During dry weather, nitrogen sources conveyed to the Los Angeles River through the stormwater system can also be significant.

Urban runoff in Los Angeles County is regulated under two stormwater NPDES permits. The first is the Los Angeles County Municipal Storm Water NPDES permit which the Regional Board has recently renewed. There are 86 co-permittees covered under this permit including 85 cities and the County of Los Angeles. The second is a separate storm water permit for the California Department of Transportation (Caltrans). Runoff from industrial facilities is subject to a statewide NPDES permit for industry. The permitting process defines these discharges as point sources because the storm water discharges from the end of a storm water conveyance system. Because stormwater discharges are permitted under NPDES permits, they are treated as point sources in this TMDL. Data from the stormwater programs are used, to the extent possible, to estimate loadings associated with urban runoff. There are also a large number of small industrial wastewater dischargers with NPDES and WDR permits throughout the watershed. These are individual point sources, but together make up such a small proportion of the total load of nitrogen compounds that they are considered here in the aggregate as a single source category.

4.1 POINT SOURCES

The Regional Board's Characterization of the Los Angeles River Watershed (LARWQCB, 1998) identified six major point source discharges and 145 minor point source discharges permitted under the National Pollutant Discharges Elimination System (NPDES). There are six wastewater reclamation plants that either discharge, or have the potential to discharge into the Los Angeles River or its tributaries. Five are POTWs: Donald C. Tillman Water Reclamation Plant (WRP), Los Angeles-Glendale WRP, Burbank WRP, Tapia Water Reclamation Facility (TWRF), and Whittier Narrows WRP. The other is a wastewater reclamation plant located at the Los Angeles Zoo and operated by the City of Los Angeles Department of Parks.

4.1.1 Major nitrogen sources

The three largest POTWs (Donald C. Tillman Water Reclamation Plant, Los Angeles-Glendale Water Reclamation Plant, and Burbank Water Treatment Plant) constitute the major sources of nitrogen in the watershed.

- Donald C. Tillman is a tertiary treatment plant with a design capacity of 80 mgd. Most of the flow is discharged directly into the Los Angeles River. However, a portion of the flow goes into a recreation lake, which then drains into Bull Creek and Hayvenhurst Channel and back into the Los Angeles River. Another portion of the flow goes to a wildlife lake, which then drains into Haskel Channel and ultimately back into the Los Angeles River. The Donald C. Tillman plant discharges around 53 mgd to the Los Angeles River.
- Burbank has a design capacity of 9 mgd. Around 4 mgd is discharged directly into the Burbank Western Channel. The City of Burbank and CalTrans reclaim a portion of the effluent for irrigation (freeway landscapes, golf courses, parks etc.). Treated water from the plant is also used as cooling water for the Burbank Steam Power Plant.
- The Los Angeles-Glendale POTW is a 20 mgd plant that discharges around 13 mgd directly into the Los Angeles River in the Glendale Narrows. Around 4 mgd of the treated wastewater is used for irrigation and industrial uses.

Table 14 summarizes nitrogen loading from the major POTWs. The loads from the Donald C. Tillman, Burbank and Glendale POTWs were estimated using monthly flow and effluent concentration data provided as part of the annual self monitoring reports (City of Los Angeles, 2000a, 2000b, 1999a, 1999b, 1998a, 1998b, 1997a, 1997b, 1996a, 1996b, 1995a, 1995b; City of Burbank, 2000, 1999, 1998, 1997, 1996, 1995). The total annual nitrogen load from these three POTWs was 2,140 MT/yr in 2000. The total nitrogen load averaged 2,243 MT/yr from 1995 – 2000.

TABLE 14. NITROGEN LOADINGS FROM MAJOR POINT SOURCES (MT/YR).

Source	Constituent	1995	1996	1997	1998	1999	2000
Donald C. Tillman POTW	Ammonia-N	1426	1191	1401	1421	1134	1530
	Nitrate-N	190	278	152	95	81	33
	Nitrite-N	47	53	63	62	28	50
	Organic-N	177	212	200	179	149	141
	TOTAL-N	**1840**	**1734**	**1817**	**1758**	**1392**	**1754**
Burbank POTW	Ammonia-N	169	92	126	144	117	115
	Nitrate-N +Nitrite-N	20	46	29	19	16	24
	Organic-N	34	39	35	15	13	43
	TOTAL-N	**223**	**178**	**190**	**178**	**147**	**181**
Los Angeles - Glendale POTW	Ammonia-N	286	296	333	300	161	137
	Nitrate-N	45	79	53	37	25	29
	Nitrite-N	15	11	12	9	11	11
	Organic-N	40	39	39	52	31	28
	TOTAL –N	**386**	**426**	**436**	**397**	**228**	**205**
TOTAL POTW	**TOTAL-N**	**2449**	**2338**	**2433**	**2333**	**1767**	**2140**

4.1.2 Minor nitrogen sources

Minor nitrogen sources include other POTWs, permitted dischargers, tributaries and urban runoff. Three POTWs listed below are considered minor sources of nitrogen compounds:

- Tapia Water Reclamation Facility: Most of the effluent from the Tapia WRF is either reclaimed or discharged into Malibu Creek. However, due to a discharge prohibition in Malibu Creek from April 15 to November 15, the permittee is allowed to discharge up to 2 mgd of wastewater to the Los Angeles River. However, this discharge is infrequent. Because the permitted flow from Tapia is less than 2% of the mean flows from the major POTWs discharging to the Los Angeles River, the nitrogen compound loads are considered minor.

- Whittier Narrows WRP: Treated wastewater from this WRP discharges to the Rio Hondo above the Whittier Narrows Dam, into spreading grounds where most of the effluent enters the groundwater. It has been estimated that less than 1% (0.1mgd) of Whittier Narrows WRP effluent remains in the channel downstream of the spreading grounds. Further, the Whittier Narrows WRP has implemented nitrification and denitrification and nitrogen compound loadings from this facility are considered minor.
- Los Angeles Zoo WRP: The Los Angeles Zoo WRP has a 1.8 million-gallon retention basin, and discharges into the Los Angeles River near the Glendale Narrows only during wet weather when the retention capacity is exceeded. Consequently, the nitrogen compound loads are considered minor during critical conditions for this TMDL.

The contribution of these plants to the overall nitrogen loadings in the Los Angeles River is minimal, so the quantification of sources addresses the loadings of the major largest POTWs. The Monitoring program of this TMDL will include data collection to quantify loadings from these sources, if necessary.

Other minor sources of nitrogen are storm water and urban runoff from municipal separate storm sewer systems (MS4s) and 145 minor dischargers listed with NPDES or WDR permits in the Los Angeles River Watershed Characterization Report (LARWQCB, 1998), including:

- 63 permits to discharge miscellaneous wastes. These include waste from dewatering, recreational lake overflow, swimming pool wastes, water ride wastewater, ground water seepage, and others
- 34 permits to discharge treated contaminated ground water with hazardous materials
- 23 permits to discharge non-contact cooling water
- 12 permits to discharge stormwater
- 5 permits to discharge contaminated ground water

- 3 permits to discharge contact cooling water
- 2 permits to discharge process waste water
- 2 permits to discharge product wash water waste
- 1 permit to discharge filter backwash brine waters

These permitted discharges are not considered major sources of nitrogen to the Los Angeles River for the following reasons. First, the discharge flows associated with these permits are generally small. More than half of these permitted discharges are for design flows of less than 0.1 mgd. Second, many of these permits are for episodic discharges rather than continuous flows, so the total annual flow is much less than the permitted design flow. Finally, although there are limited monitoring data to characterize these discharges, none of these are of types that may be expected to contain large loads or high concentrations of nitrogen. The expected small role of these discharges is supported by mass balance approximations described in the Summary to this section. The Monitoring program of this TMDL will include data collection to quantify loadings from these sources, and concentration based wasteload allocations based on water quality objectives will be established for these sources.

4.1.3 Dry-weather loading assessment

During low flow periods the three major POTWs typically account for 60% to 80% of the total volume of discharge in the river. The remaining 20% to 40% of the dry weather flow represents a combination of tributary flows, flows from other permitted NPDES/WDRs discharges within the watershed, and urban dry weather runoff.

To estimate the relative magnitude of loads from these sources during non-storm periods, recent data from the LADPW mass emission station in the LA River as well as previous estimates of stormwater loadings from the Regional Board (Corado, 1998) and from SCCWRP (Characterization of Water Quality in the Los Angeles River, Ackerman, D., SCCWRP, 2000) were evaluated. Additionally, monitoring was undertaken for this TMDL. The monitoring consisted of synoptic sampling within a single day of flow from the three POTWs, the headwaters of the tributaries, and more than 60 storm drains on September 11, 2000. The goal of the monitoring was to quantify the relative contributions from storm drains in dry weather to support the model. This was followed up by another synoptic survey in July 2001 to validate the model. The monitoring reflects one of the most complete efforts to identify and quantify dry weather flows from storm drains in Southern California. The data collected during the two surveys were consistent in terms of flows and nitrogen compound concentrations. The data were also consistent with data collected by LADPW as part of their on-going dry weather monitoring studies and appear to be representative of the dry-weather contributions from storm drains. Results are shown in Table 15.

TABLE 15. RELATIVE LOADING (%) OF NITROGEN FROM MAJOR POTWS, TRIBUTARIES, AND STORM DRAINS TO THE LOS ANGELES RIVER DURING DRY WEATER CONDITIONS (CHARACTERIZATION OF WATER QUALITY IN THE LOS ANGELES RIVER, ACKERMAN, D., **SCCWRP, 2000).**

Constituent	Total load (kg/day)	Percent Loading (%)		
		Major POTWs	Tributaries	Storm Drains
Ammonia-N	3357	85	14	0
Nitrate-N	361	32	35	34
Total Organic Nitrogen	4066	82	17	2

The data also show that about 43% of the total dry weather nitrogen load is ammonia, 4.6% of the total dry weather nitrogen load is oxidized nitrogen, and 52% of the total dry weather nitrogen load is total organic nitrogen. The major POTWs contribute 84.1% of the total nitrogen load. The stormwater system contributes a significant portion of the oxidized nitrogen load, 45MT/yr (123 kg/day). Because these estimates are based on a single sampling event, additional monitoring to estimate dry weather inputs from tributaries and the stormwater system may be justified if wasteload allocations to point sources do not succeed in removing the impairments to the listed waterbodies.

4.1.4 Loading assessment from runoff for wet and dry weather

The sources of nitrogen compounds, assimilative capacity of the Los Angeles River, and impairment by related effects can be strongly affected by variations between wet and dry weather. More specifically, high-volume flows during storm events (which are typically concentrated in the wet weather season) are very different in character than non-storm flows, which may occur in the wet season as well as the dry season. The nitrogen sources most strongly affected by wet and dry weather variations are runoff from land surfaces. In the Los Angeles River watershed, most of the runoff is conveyed to the Los Angeles River and its tributaries is conveyed through the municipal separate storm systems and are regulated under NPDES permits. Consequently, nitrogen loads conveyed through these systems are considered point sources. This section addresses sources of nitrogen from runoff .

The source assessment from runoff is based on land use data and nitrogen export coefficients. Runoff from various parts of the watershed may vary according to land use type. The Regional Board (1998) estimated total source loadings for total nitrogen to the Los Angeles River watershed, using watershed nitrogen export coefficients for waterbodies in the western United States. Table 16 summarizes results by source type, and shows the estimated total annual loading was 404 metric tons of nitrogen. This analysis suggested that 78% of the loads from the storm drain system was associated with urban runoff, 315 MT/yr. This load includes both dry and wet weather.

TABLE 16. ESTIMATES OF ANNUAL NITROGEN LOADINGS FROM RUNOFF IN THE LOS ANGELES RIVER WATERSHED BY LAND USE (LARWQCB, 1998)

Land Use	Area (sq miles)	Unit area loads (g/m2/y)	Annual Nitrogen Load (Mt/yr)
Urban	487	0.25	315
Rural/Agricultural	2	0.2	1
Forest	324	0.1	84
Atmosphere (receiving water)	2	1	4
Estimated total nitrogen annual load			404

A second study yielded similar results. SCCWRP (Characterization of Water Quality in the Los Angeles River, Ackerman, D., SCCWRP 2000) estimated nitrogen loads using export coefficients developed specifically for Southern California. That study also used more specific land use designations, and finer resolution for the watershed boundaries. Table 17 shows results, with a comparable estimated total annual load of 417 MT/yr. The study indicated urban sources in the lower part of the watershed, including residential, commercial, and industrial land uses, are the major contributor of the nitrogen loads from stormwater runoff.

TABLE 17. ESTIMATES OF NITROGEN LOADING (MT/YR) IN THE LOS ANGELES RIVER WATERSHED BY LAND USE (CHARACTERIZATION OF WATER QUALITY IN THE LOS ANGELES RIVER, ACKERMAN, D., **SCCWRP, 2000**)

Land Use	NH_3-N	NO_3-N	NO_2-N
Agriculture	0.5	3.0	0.0
Commercial	20.6	60.9	3.2
Industrial	14.8	72.6	2.6
Open	0.9	28.5	0.2
Residential	27.7	173.6	6.2
Other	0.3	1.6	0.1
TOTAL	64.9	340.1	12.2

More than one thousand industrial facilities in the Los Angeles River watershed are enrolled under the statewide NPDES general industrial stormwater permit. Those facilities are required to sample runoff and report monitoring data twice annually, but the data collected under this program are not of sufficient frequency or quality to be used to estimate loadings (Duke et al., 1998). Therefore those discharges are not quantified individually, but are included among the land use categorizations above. The analysis shows those activities are not major sources of nitrogen to the Los Angeles River and an aggregate assessment of total load is adequate based on review of previous estimates, assessment of dry weather storm system sources, and synoptic surveys.

The Los Angeles County Department of Public Works (LACDPW) estimated nitrogen loads to the Los Angeles River as part of its stormwater monitoring program (LACDPW, 2000). Nitrogen concentrations in samples collected from the Los Angeles River downstream of the POTWs during storm events were used to estimate the annual nitrogen load from 1996-2000 (LADPW, 2000). Table 18 summarizes the annual nitrogen loadings in metric tons (MT) per year that range from 75 MT/yr to 1900 MT/yr (LADPW, 2000). The annual nitrogen load estimate is a function of the total rainfall and runoff in a given year. Therefore, these estimates are subject to verification through continued monitoring and source assessment.

TABLE 18. ANNUAL NITROGEN LOADINGS (MT/YR).

Constituent	96-97	97-98	98-99	99-00
NH_3-N	38.5	332.7	10.8	3.1
NO_3-N	101.8	242.3	30.6	17.9
NO_2-N	8.0	41.5	17.0	2.9
TKN	339.5	1609.0	181.4	54.1
TOTAL	449.3	1892.8	220	74.9

Total nitrogen is equal to TKN + Nitrate + Nitrite; TKN = Total Kjeldahl Nitrogen

The effect of storm water loadings on in-stream concentrations of ammonia, nitrate and nitrite during storm discharge may be evaluated using storm water concentration data collected by the Los Angeles Department of Public Works over the five year period 1994 through 1999. Table 19 summarizes those data. The data were collected in storm runoff from a number of monitoring stations at relatively small catchments in Los Angeles selected to represent various types of land uses in the city.

TABLE 19. SUMMARY OF CONCENTRATION OF NITROGEN COMPOUNDS IN STORMWATER RUNOFF BY LAND USE TYPES.

Land Use	NH_3-N	NO_3-N	NO_2-N
Vacant land	0.2 (0.4)	0.1 (0.4)	1.0 (1.6)
Education	0.4 (0.7)	0.4 (0.7)	0.4 (0.9)
High Density Residential	0.3 (1.2)	0.3 (1.2)	0.7 (0.6)
Light Industrial	0.5 (0.9)	0.4 (0.9)	0.9 (1.0)
Retail/Commercial	1.2 (0.5)	1.0 (0.5)	0.6 (1.3)
Transportation	0.3 (1.2)	0.2 (1.2)	0.6 (0.8)
Multi-family Residential	0.6 (0.8)	0.5 (0.8)	0.9 (0.8)
Mixed Residential	0.6 (1.0)	0.5 (1.0)	0.4 (1.0)

Note: Values in tables are in mg/L, showing flow-weighted means and coefficient of variations (in parentheses) of multiple samples over five years.

These data suggest that the concentrations of ammonia, nitrate and nitrite in stormwater runoff from urban land uses are low relative to water quality objectives. The data also suggest that the largest contribution of nitrogen from runoff sources is residential. The MS4 permitees are currently undertaking special studies to address these loadings through Best Management Practices. Although the total load of nitrogen in stormwater discharge might be substantial, the load occurs entirely during periods of storm runoff when the large volume of water greatly increases assimilative capacity. To verify this assumption, additional analyses are required to measure the concentration of nitrogen compounds during storm events. However, since it is known that storm runoff strongly dominates flow during storm periods, and since the above data show concentration in the storm runoff is routinely well below the WQOs, it is reasonable to assume that the WQO is not exceeded during storm discharge in the Los Angeles River or its tributaries.

The relative load of oxidized nitrogen contributed from groundwater flow to surface water should be considered in Verdugo Basin. Groundwater data show the nitrate concentrations in this area exceed the numeric target of 45 mg-NO_3/L. Based on the estimated total flow of rising water at Gage F57C-R at 3900 acre-feet (1999-00 to 2000-01) with concentration ranging from 17 to 53 mg-NO_3/L, the oxidized nitrogen load from groundwater was estimated at 16.8 tons. The implementation plan addresses this source with special studies to assess if groundwater discharge is responsible for the elevation of the surface water nitrate concentrations.

4.2 NONPOINT SOURCES

As discussed in Section 4.1.4, the nitrogen contributions from runoff are mostly conveyed to the Los Angeles River and it's tributaries through the municipal separate storm sewer system and are considered point sources. The magnitude of the nonpoint source nitrogen contributions to the Los Angeles River is minimal.

4.3 SOURCE ASSESSMENT OVERVIEW AND SUMMARY

The three major POTWs comprise the largest source of nitrogen to the Los Angeles River, providing an average of 2,243 MT/yr in total nitrogen loadings. Urban runoff contributes a smaller fraction of the total nitrogen loadings. Although estimates to the Los Angeles River vary greatly between years (LADPW, 2000), the nitrogen loadings from the storm drain system in a typical rainfall year appear to be less than 500 MT/yr (LARWQCB, 1998; Characterization of Water Quality in the Los Angeles River, Ackerman, D., SCCWRP, 2000).

5 LINKAGE ANALYSIS

Information on sources of pollutants provides one part of the TMDL equation. To determine the effects of these sources on groundwater quality, it is also necessary to determine the carrying capacity of the receiving water, in this case the waterbody's ability to assimilate nitrogen loadings. This section describes the use of a hydrodynamic and water quality model to assess the effects of nitrogen loadings in the Los Angeles River on water quality.

The goal was to develop a model that can link sources of pollutants to in-stream water quality concentrations and impacts. This model will be used to establish the relationship between pollutant loads and the in-stream water quality targets for the listed reaches. The Environmental Fluid Dynamics Code 1-D (EFDC1D) was used to model the hydrodynamic characteristics of the river. The Water Quality Analysis Simulation Program (WASP) was used to model water quality.

5.1 MODEL DEVELOPMENT

To support the model development a comprehensive set of in-stream hydrodynamic and water quality data were collected over a two-day period in the late summer of 2000 (September 11-12) by SCCWRP. These data were reflective of low flow/dry weather conditions in the Los Angeles River Basin. This sampling effort was part of an overall program that was to include two additional sampling efforts under low flow conditions. This series of measurements was to be utilized to provide dynamic simulation of dry-weather conditions over a period of 30 to 60- days. Following the first sampling event, weather conditions changed and rain events made further dry weather sampling impossible. Therefore, the model calibrations presented herein were based on comparison of the model to the relatively steady state conditions that existed over the two-day period. These calibrations represent the critical condition for nitrogen related impairments is during the dry weather season.

Two special studies were also conducted in September 2000 to evaluate key processes. The first was a time of travel to evaluate the rate with which water flows through the system (Ackerman et al., In Prep). The second study evaluated the nutrient uptake rates by the algae *Rhizoclonium spp.* (Kamer, In Prep). *Rhizoclonium* was identified as the dominant algal species in the LA River. Studies were undertaken in 2000 and 2001 to quantify the algal biomass at certain locations to support the model. A more extensive monitoring effort was conducted in July 2001 to better understand the distribution and biomass of the algae in various parts of the watershed. The monitoring program recommendations for future studies to better define algae impairments and the relationships between algal biomass and environmental conditions.

The development and calibration of the model system is presented in detail in a report entitled "Modeling Approach and Calibration Report for the Los Angeles River Basin Nutrient and Fecal Coliform TMDLs" (Tetra Tech, 2002). The linkage analysis is briefly summarized below.

The hydrodynamic model (EFDC) was utilized to simulate the flow and temperature within the 303(d) listed segments of the Los Angeles River and tributaries (Table 20) under dry-weather conditions. EFDC1D is a one dimensional variable cross-section model for flow and transport in surface water systems.

TABLE 20. LOS ANGELES RIVER SEGMENTS MODELED FOR LINKAGE ANALYSIS

Los Angeles River Mainstem	Los Angeles River Tributaries
Reach 6: above Sepulveda Flood Control Basin	Bell Creek
Reach 5: within Sepulveda Basin	Tujunga Wash
Reach 4: Sepulveda Dam to Sepulveda Dr	Burbank Western Channel
Reach 3: Riverside Drive to Figueroa St	Verdugo Wash
Reach 2: Figueroa St to Carson St	Arroyo Seco
Reach 1: Carson St to Estuary	Rio Hondo River
	Compton Creek

The river system was divided into a total of 302 grid cells averaging 600 meters in length. Detailed cross-sections of the 303(d) listed rivers and tributaries were input into the model. Typical measured flows at the downstream end of the Los Angeles River range from 100 to 125 ft^3/sec. The point source discharges contribute approximately 80 to 100 ft^3/sec. For the purpose of the model a non-WRP base flow was established to account for flows from headwaters, storm drains, groundwater discharge near the Glendale Narrows and other unknown sources.

Figures 3-13 and 3-14 in Attachment 1 present comparisons of the measured versus simulated flows at four stations locations along the main stem of the Los Angeles River for the 2000 and 2001 low flow period (April to September). The simulated and measured flows ranged from 15 to 110 ft^3/sec at the upper most station to 165 to 200 ft^3/sec at the lowest station. The lowest station (designated F319-R) is below the confluence of all tributaries within the Los Angeles River and all simulated point source discharges (Figure 3-4 of Attachment 1). This station reflects the total water "mass balance" within the system under the relatively steady low flow condition. Comparison of the simulated flows shows that the model is simulating the flows relatively well. Above the Arroyo Seco, significant deviations between the model and measured flow values were observed (overestimates as high as 20%, underestimates of 30% not uncommon). It is noted that flow differences on the order of 20% to 30% are not uncommon in water quality models. Some of the factors contributing to accurate flow measurements include stream flow gauges that have large errors at low flow. In general the model predicts the peak flows fairly well.

The EFDC hydrodynamic model was calibrated to the September 2000 data set for flow and velocity. The values utilized for the non-WRP base flows were determined from measurements made throughout the system on September 10-11, 2000 for tributaries and storm drains. The flow data were validated using the July 2001 data set.

For simulation of the water quality within the Los Angeles River, the EFDC model was linked to the Water Quality Analysis Simulation Program (WASP5). Nutrient cycling and algal growth were simulated using the EUTRO5 component of the WASP5 model system which simulates the transport and transformation of the nitrate/nitrite, ammonia, organic nitrogen, organic phosphorus, orthophosphate, carbonaceous oxygen demand, attached algae, and dissolved oxygen. The model considers four interacting systems, algal kinetics (attached algae), the phosphorus cycle, the nitrogen cycle, and the dissolved oxygen balance. Inputs from point sources (mainly POTWs) were obtained directly from the POTWs measurements. Table 21 summarizes in part the parameters used in the model.

TABLE 21. CONCENTRATIONS AND FLOW FOR POINT SOURCE DISCHARGES LOADED INTO THE MODEL

Point Source Discharge	Flows (mgd)	NH_3-N (mg/L)	NO_3-N+NO_2-N (mg/L)	Organic-N (mg/L)	Ortho-phosphate (mg/L)	Organic Phosphorous (mg/L)
Donald C. Tillman POTW						
Direct Discharge	34.4	13.40	0.10	1.80	1.56	0.15
Japanese Gardens	4.8	12.50	0.90	3.10	1.59	0.15
Recreation Lake	17.4	4.35	7.55	4.30	0.96	0.15
Wildlife Lake	5.9	12.50	0.90	3.10	1.59	0.15
Glendale POTW	9.3	3.67	2.69	1.00	1.62	0.01
Burbank POTW	9.2	19.00	0.50	2.00	0.50	0.50

In-stream concentrations and boundary conditions were collected during a field survey. The dry weather water quality model was calibrated using field measurements collected on September 10 and 11, 2000. The storm drain flows and concentration data used in the model are summarized in the Tetra Tech report (Attachment 1.). Table 22 summarizes the nitrogen and phosphorous concentrations and flows for the Los Angeles River tributaries used in the model. The values presented for each of the tributaries reflect the data that was collected in September 2000 to support the model calibration. These data reflect the critical condition of dry weather flows and reflect the concentration within the ranges shown in Tables 3 and 5, except for the Burbank Western Channel, which has implemented nitrification/denitrification and reduced ammonia concentrations discharged.

TABLE 22. CONCENTRATIONS AND FLOW FOR EACH TRIBUTARY LOADED INTO THE MODEL

Tributary	Flows (mgd)	NH_3-N	NO_3-N+NO_2-N	Organic-N	Total P
Bell Creek	6.7	0.2	2.4	3.3	0.46
Tujunga Wash	1.0	0	0	2.2	0.27

Burbank Western Channel	2.2	16.3	1.5	2.0	0.94
Verdugo Wash	4.4	0.2	1.4	0.9	0.70
Arroyo Seco	5.8	0.2	2.8	2.3	0.66
Compton Creek	4.8	0.4	0.3	1.5	1.06

For the main stem of the Los Angeles River the model shows that total nitrogen increases sharply at Donald C. Tillman plant then decreases slowly downstream with a slight increase in the area near Burbank Western Channel (3-34, Attachment 1). Most of the nitrogen is in the form of ammonia. Ammonia concentrations gradually decreased downstream of the treatment plants to values less than 1 mg/L (Figure 3-31, Attachment 1). The linkage analysis suggests that this is largely due to nitrification (*i.e.* the conversion of ammonia to nitrate) and volatilization of un-ionized ammonia. NO_3-N + NO_2-N concentrations increase at Donald C. Tillman from less than 1 mg/L to around 3 mg/L and continue to increase gradually downstream as a result of nitrification to a maximum concentration of 7 mg/L (Figure 3-32, Attachment 1).

The model predictions of in-stream chemistry can be compared to the range of values (indicated on the charts in Attachment 1 by triangle symbols) measured at the seven in-stream locations (Figures 3-31 through 3-38, Attachment 1). The model is capturing the general pattern but tending to over predict the actual measured concentrations. The range in values from three composite samples collected within an hour of each other also provides perspective on the short-term variability associated with the field measurements. Compared to the maximum concentrations for ammonia, nitrate and nitrite, the model underestimates the levels of ammonia in the Los Angeles River. However, compared to the concentration range, the model generally predicts higher concentrations than were measured in the field and the concentrations predicted by the model are consistent with the values typical of the main stem of the Los Angeles River. The monitoring data collected in September 2000 and July 2001 appear representative data of dry weather conditions.

The modeled concentrations of the different nitrogen species in the river are generally low in the tributaries and similar to the mean concentrations presented in Table 4. The predicted concentrations for Bell Creek, Tujunga Wash, Verdugo Wash, Arroyo Seco and

Compton Creek were low relative to the water quality objectives. Concentrations in Burbank Western Channel were high relative to the targets due to the influence of the Burbank POTW. Rio Hondo was not modeled in the analysis because almost all of the dry-weather flow is diverted to the spreading grounds and there was no measurable flow during the field survey

Total phosphorous concentrations in the Los Angeles River are low upstream of Donald C. Tillman (around 0.2 to 0.3 mg/L). Downstream of Donald C. Tillman, the concentrations increase to around 1.3 mg/L and are relatively stable along the river. The model results are similar to the measured concentrations from the calibration data set with the exception of the lower portion of the River below Rio Hondo where the model appears to be over predicting the actual concentration.

Algal biomass predicted by the model ranged from 40 to around 80 g/m2. The model does not reflect the very patchy distribution of algae in the river. The model shows a general relationship between algal biomass and nutrient concentrations. However, this relationship is difficult to quantify because nutrient concentrations exceed what is generally considered limiting for algae species. There did not appear to be any relationship between algal biomass and nutrient concentrations (total nitrogen or total phosphorous) in either the Los Angeles River of the Burbank Western Channel. The inability of the model to accurately predict algal biomass reflects the limitations in our understanding of the physical and biological processes that control algal biomass in the Los Angeles River and the complexity of other characteristics such as canopy cover, temperature, substrate availability, or turbidity have in controlling algae growth. It is also possible that the reductions in ammonia and phosphate concentrations in the lower portion of the river may be controlled by biological processes that are not well quantified (*e.g.*, bacterial uptake).

The model generally reflects the general patterns and approximates the actual concentration of the different nitrogen compounds in the Los Angeles River and listed tributaries. Recognizing the inherent uncertainties in any water quality model, and the combination of other characteristics in controlling algae growth, the model was used to assess the effectiveness of various load reduction strategies to meet numeric targets for ammonia and nitrate + nitrite. The model allocation scenarios and the process for selecting the preferred allocation scenario used in this TMDL are discussed in the next section.

5.2 VALIDATION OF THE MODEL

The linkage analysis was validated by comparing simulation results to measured data. For the low flow simulations the comparisons included the flow rate throughout the system (1997 and 2000), time of travel (2000), and in-stream nitrogen concentrations (2000).

General results of the model comparison verify the model accuracy for hydrodynamics, and flow velocity. The water quality comparison shows that the simulated values are generally greater than the average measured results in the Los Angeles River main stem and tributaries, except for organic nitrogen in the Western Burbank Channel. The simulation adds a degree of conservatism to the load allocation scheme. The implementation plan includes further validation of the model as additional data is collected.

5.3 EVALUATION OF POTENTIAL REMEDIES

The model was used to evaluate four potential management options for reducing nitrogen loadings to the system. The first option (Scenario 1) involves nitrification and denitrification (N/DN) at the three major POTWs. Scenario 2 is based on the N/DN of Scenario 1, but evaluates the effect of 10 mgd of water reclamation at the Donald C. Tillman POTW to further reduce nitrogen loadings. Scenario 3 also involves N/DN at the major POTWs, but evaluates the effect treating 30 mgd of effluent through a constructed wetland at the Donald C. Tillman POTW. Scenario 4 is the same as scenario

3 (N/DN at the three POTWs with 30 mgd of constructed wetlands treatment)and also assumes 10 mgd of water reclamation at the Donald C. Tillman POTW.

The flow estimates are based on a reduction of plant capacity by 13% for N/DN facilities. The effluent quality for the N/DN process was based on estimates from pilot testing at the Los Angeles-Glendale POTW provided by the City of Los Angeles. The effluent quality represents water quality that can be met on a monthly average. These concentrations were applied in the model to all three POTWs.

The predicted in-stream concentrations are presented for each of the segments of the river modeled (Table 23). The scenario evaluation assumed an effluent concentration of 2 mg/L for ammonia and 2.2 mg/L for nitrate. It is noted that the scenario evaluation utilized an ammonia load in the POTW effluent that may exceed the ammonia target for the Donald C. Tillman POTW. All four scenarios result in substantial reduction in ammonia, nitrate-nitrite and total nitrogen for the main stem and Burbank Western Channel. Under Scenario 1, total nitrogen loadings would be reduced by approximately 50% (from 4,375 kg/d to 2419 kg/d) over the existing condition and there would be an almost five-fold reduction of ammonia loads (from 3,328 kg/d to 722 kg/d). The 10-mgd of water reclamation would remove an additional 253 kg/d of total nitrogen from the system and the wetland option would remove an additional 602 kg/d of total nitrogen from the system.

The predicted water quality concentrations were evaluated to determine the effectiveness of each management scenario to meet the water quality objectives for ammonia and nitrate-nitrite in the Los Angeles River and tributaries along the entire length of the Los Angeles River. The model also provides output to evaluate changes in total nitrogen, phosphate, and algal biomass.

TABLE 23. COMPARISON OF FLOWS, NITROGEN CONCENTRATIONS, AND NITROGEN LOADINGS FOR FOUR MANAGEMENT SCENARIOS TO EXISTING CONDITION

Existing condition	Flow (mgd)	Concentrations (mg/L)				Loading (kg/d)			
Donald C. Tillman		NH_3	NO_3-NO_2	Org-N	Total N	NH_3	NO_3-NO_2	Org-N	Total N
Direct Discharge	34.4	13.4	0.1	1.8	15.3	1745	13	234	1992
Japanese Gardens	4.8	12.5	0.9	3.1	16.5	227	16	56	300
Recreation Lake	17.4	4.4	7.6	4.3	16.2	286	497	283	1067
Wildlife Lake	5.9	12.5	0.9	3.1	16.5	279	20	69	368
Glendale POTW	9.3	3.7	2.7	1.0	7.4	129	95	35	259
Burbank POTW	9.2	19.0	0.5	2.0	21.5	662	17	70	749
	81.0					3328	659	748	4735
Scenario 1	Flow (mgd)	Concentrations (mg/L)				Loadings (kg/d)			
		NH_3	NO_3-NO_2	Org-N	Total N	NH_3	NO_3-NO_2	Org-N	Total N
Donald C. Tillman	70.0	2.0	2.7	2.0	6.7	530	715	530	1775
Burbank	8.0	2.0	2.7	2.0	6.7	61	82	61	203
Glendale	17.4	2.0	2.7	2.0	6.7	132	178	132	441
	95.4					722	975	722	2419
Scenario 2	Flow (mgd)	Concentrations (mg/L)				Loadings (kg/d)			
		NH_3	NO_3-NO_2	Org-N	Total N	NH_3	NO_3-NO_2	Org-N	Total N
Donald C. Tillman	60.0	2.0	2.7	2.0	6.7	454	613	454	1522
Burbank	8.0	2.0	2.7	2.0	6.7	61	82	61	203
Glendale	17.4	2.0	2.7	2.0	6.7	132	178	132	441
	85.4					646	873	646	2166
Scenario 3	Flow (mgd)	Concentrations (mg/L)				Loadings (kg/d)			
		NH_3	NO_3-NO_2	Org-N	Total N	NH_3	NO_3-NO_2	Org-N	Total N)
Donald C. Tillman	40.0	2.0	2.7	2.0	6.7	303	409	303	1014
Tillman Wetland	30.0	1.6	2.0	0.1	1.4	182	227	11	159
Burbank	8.0	2.0	2.7	2.0	6.7	61	82	61	203
Glendale	17.4	2.0	2.7	2.0	6.7	132	178	132	441
	95.4					677	895	506	1817
Scenario 4	Flow (mgd)	Concentrations (mg/L)				Loadings (kg/d)			
		NH_3	NO_3-NO_2	Org-N	Total N	NH_3	NO_3-NO_2	Org-N	Total N
Donald C. Tillman	30.0	2.0	2.7	2.0	6.7	227	307	227	761
Tillman Wetland	30.0	1.6	2.0	0.1	1.4	182	227	11	159
Burbank	8.0	2.0	2.7	2.0	6.7	61	82	61	203
Glendale	17.4	2.0	2.7	2.0	6.7	132	178	132	441
	85.4					601	793	431	1564

Table 24 presents a summary of the modeling results in terms of the extent of the ammonia plume concentration downstream of the Tillman WRP as a function of the ammonia as nitrogen concentration. The model indicates that the maximum instream ammonia concentration is 1.8 mg/L based on a discharge of 2.0 mg/L.

TABLE 24. MAGNITUDE (MG/L) AND EXTENT (MILES) OF AMMONIA SIGNAL DOWNSTREAM OF DONALD C. TILLMAN WRP UNDER FOUR NITROGEN REDUCTION SCENARIOS

NH3-N concentration (mg/L)	Scenario 1	Scenario 2	Scenario 3	Scenario 4
1.8	0	0	0	0
1.7	1.88	0.75	0	0
1.6	5.26	4.13	0	0
1.5	9.37	7.52	3.75	1.88
1.4	10.81	10.11	7.89	5.26
1.3	14.37	13.27	10.86	9.75
1.2	16.57	16.20	14.73	12.62
1.1	18.41	17.51	16.94	16.20
1.0	19.14	19.14	18.77	18.04

In the model, algal biomass in the Los Angeles River was not sensitive to nitrogen reduction scenarios. There was only a slight reduction in algal biomass in Burbank Western Channel. This is consistent with special studies performed by SCCWRP (Kamer, In Prep) that suggest that nitrogen may not be limiting algae in the Los Angeles River. A sensitivity analysis was run to estimate the concentration at which phosphorous became limiting in the model. Phosphorous was not limiting at concentrations as low as 0.3 mg/L. This analysis suggests that algal biomass in the Los Angeles River may be controlled by other processes, such as flow, substrate, turbidity, canopy cover, phosphorous and temperature, in addition to nitrogen concentrations.

Further research is needed to determine whether nitrogen compounds are controlling algal biomass in the river and if so what levels of reductions would be necessary to limit algal biomass. Due to this uncertainty, the implementation plan includes monitoring to observe changes in algae mass. If algal growth is not sufficiently reduced to meet targets, further analysis will be conducted to revise this TMDL for nitrogen compounds and include other pollutants that affect algal growth.

6 ALLOCATIONS

In this section, wasteload allocations for nitrogen compounds from point sources, and allocations for nitrogen compounds from nonpoint sources to the Los Angeles River are developed. The wasteload allocations discussed below are based on Scenario 2, which was selected by stakeholders as the preferred scenario.

6.1 WASTELOAD ALLOCATIONS

U.S. EPA regulations require that a TMDL include wasteload allocations (WLAs), which identify the portion of the loading capacity allocated to existing and future point sources (40 CFR 130.2(h)). It is not necessary that every individual point source have a portion of the allocation of pollutant loading capacity. It is necessary, however, to allocate the loading capacity among individual point sources as necessary to meet the water quality objective.

This TMDL defines ammonia WLAs in accordance with Resolution No. 2002-11 and the Policy for Implementation of Toxics Objectives for Inland Surface Waters, Enclosed Bays, and Estuaries. The ammonia Waste Load Allocation for this TMDL is equivalent to the Effluent Concentration Allowance (ECA) as defined in the Policy for Implementation of Toxics Objectives. The ECA is based on the ammonia WQOs and provides the basis, along with an analysis of the variability in POTW denitrification performance, for determining effluent limits for ammonia in NPDES permits. Because the dischargers have not yet implemented nitrification at the major POTWs, it is difficult to quantify the variability in nitrification performance that is necessary to determine the ammonia effluent limits. Consequently, the POTW effluent limits for ammonia necessary to implement the WLAs for this TMDL will be specified in the NPDES permit.

6.1.1 Wasteload Allocations for Major Point Sources

WLAs have been developed for the Donald C. Tillman, Los Angeles-Glendale and Burbank POTWs because they represent approximately 85% of the total nitrogen loadings to the system. Wasteload allocations for Donald C. Tillman, Los Angeles-Glendale and Burbank POTWs are based on concentrations needed to meet in-stream water quality objectives for ammonia, nitrate-N + nitrite-N, nitrate, and nitrite. The WLAs are set at levels necessary to attain and maintain the applicable narrative and numerical water quality objectives. A 20 percent explicit margin of safety has been included for nitrate, nitrite, and nitrate + nitrite to account for any lack of knowledge concerning the relationships between effluent limitations and water quality.

WLAs for ammonia are based on Resolution No. 2002-11 which establishes the relationship between water quality objectives and the beneficial uses of inland waterbodies. Since most of Los Angeles River listed segments are not designated in the Basin Plan as "COLD," "MIGR," and "SPWN," it is assumed that salmonids are absent and early life stages are not present in Los Angles River. WLAs for ammonia (NH_3) include one-hour and thirty day averages and are based on the pH and temperature data downstream from the POTWs for the past five years. The 90th percentile of pH data is used to establish the one-hour average WLA, and the medians of pH and temperature data are used to establish the thirty-day average WLA. WLAs for Donald C. Tillman, Los Angeles-Glendale, and Burbank POTWs are provided in Table 25. The ammonia WLA for the Donald C. Tillman WRP has been modified to account for increased assimilative capacity from discharge into the Los Angeles River that passes through the Wildlife and Recreational Lakes where ammonia is converted to oxidized nitrogen. The magnitude of the increased assimilative capacity is based on the product of a ratio of the total effluent to the effluent directly discharged through the Lakes (80 MGD/63 MGD) and an estimate of the magnitude of ammonia conversion from 2001 monitoring data. The estimate of ammonia conversion is based on the average ammonia concentration in the effluent to the average concentration in the Wildlife Lake Receiving Water Station W-3 (16.2 mg/L and 14.7 mg/L, respectively), i.e. 9% conversion. Therefore, WLA for ammonia at the Tillman WRP is adjusted by a factor of 1.05. If the water effect ratio study results in a revised ammonia objective, this TMDL will be revised to reflect the new ammonia target and correspondent WLA.

TABLE 25. AMMONIA (NH_3) WASTELOAD ALLOCATION FOR MAJOR POTWS IN LOS ANGELES RIVER WATERSHED

POTWS	One-hour average WLA (mg/L)	Thirty-day average WLA (mg/L)
Donald C. Tillman WRP	4.2	1.4
Los Angeles-Glendale WRP	7.8	2.2
Burbank WRP	9.1	2.1

Table 26 shows the WLAs for nitrate-nitrogen (NO_3-N), nitrite-nitrogen (NO_2-N), and nitrate-nitrogen plus nitrite-nitrogen (NO_3-N + NO_2-N) for major POTWs in the Los Angeles River watershed.

TABLE 26. NITRATE-NITROGEN, NITRITE-NITROGEN, AND NITRATE-NITROGEN + NITRITE-NITROGEN WASTELOAD ALLOCATIONS FOR MAJOR POTWS

POTWs	Thirty-day Average WLA* (mg/L)		
	NitrateNO_3-N	NitriteNO_2-N	NitrateNO_3-N +NitriteNO_2-N
Donald C. Tillman WRP	7.2	0.9	7.2
Los Angeles-Glendale WRP	7.2	0.9	7.2
Burbank WRP	7.2	0.9	7.2

*Receiving water monitoring is required on a weekly basis to ensure compliance with the water quality objective

These limits will be sufficient to meet the water quality objectives. This assertion is based on two key findings from the Source Analysis and Linkage Analysis. The first finding is that there are no other point sources with sufficient loads to increase nitrogen compound concentrations above the WQO. This finding is reasonable warranted based on the Source Analysis, however it is conceivable that this could change in the future. For this reason it may be prudent to develop wasteload allocations for the minor NPDES dischargers. This will require development of improved monitoring programs to establish the baseline from these sources. The second finding is that there are no sinks in the system that would allow for the accumulation of nitrogen. This also appears to be warranted since most of the river is channelized and sediments that may accumulate in these channels are likely to be flushed out during major storms. The one possible exception would be in the vicinity of the Glendale Narrows where willow trees and other vegetation have taken root. This area is a relatively small portion of the river and the overall effect on the nitrogen budget for the river is probably negligible.

6.1.2 Wasteload Allocations for Minor Point Sources

Ammonia WLAs for minor point sources will be set at levels necessary to maintain the applicable water quality objective. WLAs for minor point sources will be established in accordance to the reach into which a minor point source discharges based on instream pH and temperature of the last five years data set. Ammonia WLAs for minor point source discharges are listed in Table 27.

TABLE 27. AMMONIA WASTE LOAD ALLOCATIONS FOR MINOR POINT SOURCES IN LOS ANGELES WATERSHED

Water Body	One-hour average WLA (mg/L)	Thirty-day average WLA (mg/L)
Los Angeles River above Los Angeles-Glendale WRP	4.7	1.6
Los Angeles River below Los Angeles-Glendale WRP	8.7	2.4
Los Angeles River Tributaries	10.1	2.3

WLAs for nitrate-nitrogen, nitrite-nitrogen, and nitrate-nitrogen plus nitrite-nitrogen are set equal to numeric targets as listed in Table 28. Monitoring requirements will be placed on minor NPDES and WDR dischargers to refine the estimates of nitrogen loadings. Wasteload allocations for these minor point sources will be revised and in the future if monitoring data indicates that loads are greater than assumed in this assessment and the prescribed wasteload allocations do not result in attainment of water quality objectives.

TABLE 28. NO_3-N, NO_2-N, AND NO_3-N + NO_2-N WASTE LOAD ALLOCATIONS FOR MINOR POINT SOURCES IN LOS ANGELES WATERSHED

Constituent	Thirty-day Average Wasteload allocation
NO_3-N	8 mg/L
NO_2-N	1 mg/L
NO_3-N + NO_2-N	8 mg/L

6.1.3 WLA for municipal storm water and urban runoff from municipal separate storm sewer systems (MS4s)

As discussed in Section 4, Source Assessment, the concentrations of ammonia, nitrate and nitrite in runoff from land uses objectives during both dry and wet weather are low relative to water quality. Table 17 indicates no significant loads of ammonia from runoff sources in the watershed. The dry-weather flows measured from individual storm drains represent 7 to 15% of total nitrogen loadings to the Los Angeles River. It is believed that WLAs for the POTWs, which represent 85% of the total nitrogen loadings and 97% of the ammonia loadings, will result in the attainment of water quality objectives. This assumes that nitrogen loadings estimate associated with runoff flows are accurate and that they will not increase over time. Based on the 1998 Regional Board Staff Report, the estimated annual nitrogen load is 315 MT/year from run off through the stormwater system. The WLAs for ammonia, nitrate, nitrite, and nitrate + nitrite are based on the numeric targets and are listed as WLAs for minor point sources in Tables 27 and 28. Additional source monitoring information is needed to refine the estimates of nitrogen contributions from urban runoff and determine the sources. Measures should also be taken by MS4 permittees to ensure that loadings from nuisance flows do not increase in the future. This might involve best management practices (BMPs) to address dry weather runoff from residential areas (e.g., runoff of fertilizers from lawns). Waste load allocations for MS4s may be revised in the future if monitoring data indicate that loads are higher than assumed in this assessment and the prescribed WLAs for POTWs do not result in attainment.

6.2 LOAD ALLOCATIONS

The Source Assessment indicates that nitrogen loads from nonpoint sources are not significant relative to the loads from point sources. Consequently, load allocations will not be developed at this time. Load allocations may be developed if it is determined they are necessary after load reductions are effected through implementation of the wasteload allocations.

6.3 CRITICAL CONDITIONS AND SEASONALITY

The critical condition for this TMDL is low flow (dry weather) during summer. Summer reflects the critical condition for nitrogen compounds because the ammonia toxicity objective is lower at higher temperatures. In addition, the combination of warmer temperatures and stable low-flow conditions in the summer is also likely to create conditions conducive for algal growth and the build up of mats in certain portions of the river. The assessment of critical conditions for this TMDL is based on analysis of long-term data reflecting river flow and in-stream measurements of temperature and pH.

During low flow periods wastewater treatment plants make up most of the baseflow to the system (typically 80%) and contribute most of the nitrogen loadings (roughly 85%). Consequently there is minimal dilution during this critical period. Storms may increase total loadings to the system but these periods are not considered to be critical for the following reasons: 1) the magnitude of storm-water contribution is small relative to annual loadings from point sources; 2) there is ample dilution during storm events; and stormwater is rapidly moved through and exported out of the river system.

The major and minor point sources are all expected to be relatively constant throughout the year, so the critical period for impacts on the Los Angeles River and tributaries is times when storm runoff is absent or small because low flow in the river allows less assimilative capacity for pollutants. Periods of low flow are not restricted to a particular season, such as months commonly defined as “dry weather” in southern

California, when virtually no storm runoff occurs for an entire season. The low-flow conditions described in this dry weather mass balance can also occur during months when monthly average rainfall and runoff may be substantial, because low flow commonly occurs at periods between storms in wet seasons.

6.4 MARGIN OF SAFETY

The statute and regulations require that a TMDL include a margin of safety to account for any lack of knowledge concerning the relationships between effluent limitations and water quality, and uncertainty in the source and linkage analyses. The margin of safety is largely based on the following factors:

- Use of modified design flows rather than actual flows in the model. Average flows from Donald C. Tillman are around 53 mgd or 76% of the modified design flows (70 mgd). Average flows from Glendale are 13 mgd or 75% of the design flow of 17.4 mgd. Average flows at Burbank were 5 mgd or 63% of the modified design flow of 8 mgd.

- An explicit margin of safety of 10 percent is included for NH_3, NO_3-N, NO_2-N, and NO_3-N + NO_2-N WLAs provided in Tables 25 and 26 to address uncertainty in the sources and linkage analyses. The target for these nitrogen compounds is based on the WQOs for the Los Angeles River.

6.5 SUMMARY OF TMDL

This TMDL sets wasteload allocations for ammonia, nitrite and nitrate + nitrite for the Donald C. Tillman WRP, Los Angeles-Glendale WRP and the Burbank WRP. The WLAs are designed to ensure compliance with the water quality objectives for ammonia based on both the chronic and acute criteria and nitrite and nitrate + nitrite. Under this TMDL the monthly ammonia loadings will be reduced from around 143,500 kg/month to around 19,700 kg/month. This represents an 86% reduction in the total ammonia loads.

This TMDL places a limit and requires a reduction of ammonia and nitrite + nitrate mass discharged from the three major POTWs in the Los Angeles River watershed. Under these allocations the mass emissions for nitrate-nitrite can increase to a limited extent without causing exceedances of water quality objectives for these compounds. However, conversion of the ammonia load in POTWs effluent to nitrate + nitrite through nitrification will likely result in exceedances of nitrate + nitrite water quality objectives unless the nitrified effluent is subsequently denitrified.

The degree of ammonia, nitrate, nitrite, and nitrite + nitrate reduction specified in this TMDL is subject to modification if it is determined that additional reductions in nitrogen concentrations are required to meet algae, foam/scum, odor, pH or DO target. Presently, there are insufficient data for defining such a target.

Available data suggest that the nitrogen loadings from the minor NPDES dischargers and dry-weather nuisance flows are insignificant relative to the major NPDES dischargers. Based on available data, literature, analysis, models, and conservative assumptions built into models, the Regional Board anticipates that implementation of this TMDL will result in compliance with the water quality objectives. Additional WLAs or LAs may be developed or implemented at a future date should the monitoring data indicate non-attainment of water quality objectives or other in-stream targets.

7 IMPLEMENTATION

The WLAs established in this TMDL will be established as NPDES permit effluent limits for the three major POTWs and other NPDES dischargers. The renewal of the NPDES permits for the D.C. Tillman and Los Angeles-Glendale POTWs is tentatively scheduled for September 2003. At that time, an updated data set for pH and temperature will be available that can be considered in establishing this TMDL's WLA in the NPDES permits, upon approval by the Regional Board.

The City of Los Angeles reports that additional time is required to implement the nitrification and denitrification facilities required to meet the WLAs. This Implementation Plan provides interim limits for ammonia and nitrate during construction and start-up of nitrification/denitrification processes.

7.1 ALTERNATIVES CONSIDERED

Two alternatives were considered for developing an appropriate implementation schedule to meet the ammonia, nitrate, nitrite, nitrate + nitrite objectives. The details are discussed in section 7.2 and 7.3

- Alternative 1 – Waste load allocations would be applied to POTWs on the effective date of the TMDL
- Alternative 2 – Under this alternative, the interim waste load allocation would be considered in interim period before WLAs for nitrate-N, nitrite-N, nitrate-N + nitrite-N apply to POTWs

7.2 RECOMMENDED ALTERNATIVE

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

7.3 EVALUATION AND BASIS FOR THE IMPLEMENTATION PLAN

This TMDL provides the Regional Board discretion to establish interim wasteload allocations for ammonia + nitrite + nitrate for a period not to exceed three years beyond the effective date of the TMDL. These interim wasteload allocations will allow the dischargers to complete implementation of nitrification/denitrification facilities without increasing current ammonia, nitrate and nitrite loads. After the nitrification/denitrification facilities are in place, it is anticipated that the reductions in ammonia and nitrate loads will reduce impairments caused by nutrient effects, including algae, odor, and scum. The Implementation Plan includes the following elements:

* nitrification and denitrification process to remove ammonia and oxidized nitrogen from POTW effluent
* interim limits for POTWs implementing nitrification and denitrification processes;
* water effects ratio (WER) studies to determine site-specific objectives for ammonia;
* special studies to address issues pertaining to water quality objectives for nitrate and nitrite
* continued and additional monitoring for nutrients and their effects in Los Angeles River; implementation and evaluation of residential best management practices (BMPs) in the Los Angeles River watershed;
* implementation and evaluation of residential best management practices (BMPs) in the Los Angeles River watershed; and
* additional studies to address issues for which the data is insufficient to assess the nutrient loading from groundwater.

Table 29 provides the Implementation Schedule for this TMDL.

TABLE 29. LOS ANGELES RIVER NITROGEN TMDL IMPLEMENTATION SCHEDULE

Table 7-8.2. IMPLEMENTATION SCHEDULE **Implementation Tasks**	**Completion Date**
1. Apply interim limits for NH_3-N and NO_3-N + NO_2-N to major Publicly Owned Treatment Works (POTWs). 2. Apply Waste Load Allocations (WLAs) to minor point source dischargers and MS4 permittees. 3. Include monitoring for nitrogen compounds in NPDES permits for minor NPDES dischargers above 0.1 mgd as permits are renewed.	Effective Date of TMDL
4. Submittal of a Monitoring Work Plan by MS4 permittees to estimate ammonia and nitrogen loadings associated with runoff loads from the storm drain system for approval by the Executive Officer of the Regional Board. The Work Plan will include monitoring for ammonia, nitrate, and nitrite. The Work Plan may include a phased approach wherein the first phase is based on monitoring from the existing mass emission station in the Los Angeles River. The results will be used to calibrate the linkage analysis. The Work Plan will also contain protocol and a schedule for implementing additional monitoring if necessary. The Work Plan will also propose triggers for conducting source identification and implementing BMPs, if necessary. Source identification and BMPs will be in accordance with the requirements of MS4 permits.	1 year after the Effective Date of TMDL
5. Submittal of a Workplan by major NPDES permittees to evaluate the effectiveness of nitrogen reductions on removing impairments from algae odors, scums, and pH for approval by the Executive Officer of the Regional Board. The monitoring program will include instream monitoring of algae, foam, scum, and odors in the Los Angeles River. A key objective of these studies will be to determine the effectiveness of nitrogen reductions on removing impairments related to algae, foam, odor, scum and pH. In addition, groundwater discharge to Los Angeles River will also be analyzed for nutrients to determine the magnitude of these loadings and the need for load allocations. The Workplan will include protocol and schedule for development of appropriate numeric targets for	1 year after the Effective Date of TMDL

Table 7-8.2. IMPLEMENTATION SCHEDULE **Implementation Tasks**	**Completion Date**
nutrients and algae in the Los Angeles River. The Workplan will also contain protocol and a schedule for identification of limiting nutrients.	
6. Submission of a special studies Workplan by the City of Los Angeles to evaluate site-specific objectives for ammonia, nitrate, and nitrite, including the following issues: pH and temperature distribution downstream of the D.C. Tillman WRP to determine the point of compliance for ammonia, establishment of ammonia WLAs based on seasonality, and revision of the water quality objectives for nitrate and nitrite based on averaging of the numeric objective.	1 years after Effective Date of TMDL
7. Submission of results from water effects ratio study for ammonia and special studies by the City of Los Angeles including pH and temperature distribution downstream of D.C. Tillman WRP.	No later than 2.5 years after Effective Date of TMDL.
8. Regional Board considers site-specific objective for ammonia, nitrate, nitrite and nitrite + nitrate and revision of wasteload allocations based on results from Tasks 6 and 7. The site specific objective will consider factors including but not limited to seasonality, averaging periods, and the WER for ammonia. If a site specific objective is adopted by the Regional Board, approved by State Board and Office of Administrative Law and established by US EPA, for ammonia then the WQO are revised and as such the numeric target and waste load allocations would need to be revised to reflect the revised WQO.	No later than 3.5 years after Effective Date of TMDL.
9. Interim limits for ammonia and nitrate + nitrite expire and WLAs for ammonia, nitrate, nitrite, and nitrate + nitrite apply to POTWs.	3.5 years after Effective Date of TMDL
10. Complete evaluation of monitoring for nutrient effects and determine need for revising wasteload allocations, including but not limited to establishing new WLAs for other nutrient and related effects such as algal growth	4 years after Effective Date of TMDL
11. Regional Board considers results of Tasks 5 and 10 and revises or establishes WLAs as appropriate.	5 years after Effective Date of TMDL

7.3.1 Nitrification and Denitrification

This section provides a brief overview of the processes available for the POTWs to achieve the WLAs. Nitrification removes ammonia and a portion of organic nitrogen from wastewater treatment plant effluent by converting these nitrogen compounds to other nitrogen forms, such as nitrite and nitrate. Denitrification converts the oxidized nitrogen forms into gaseous nitrogen that is released from the effluent.

Two different categories of nitrification and denitrification processes can be implemented. The first involves converting existing facilities to provide nitrification and denitrification. The second requires the construction of new facilities for nitrification and denitrification.

Conversion of existing facilities to provide nitrogen removal involves modifying existing activated sludge processes by adjusting the amount of aeration, the types of bacteria present in the sludge, and the solids residence time. The benefit of converting existing facilities relative to constructing new nitrogen removal facilities is that it is cost effective, involves minimal new construction, and does not significantly change existing operations and maintenance costs. However, nitrogen removal processes based on conversion of existing facilities are more difficult to control than new facilities specifically designed to remove nitrogen compounds. If a large amount of ammonia enters the treatment plant unexpectedly, it is possible that the ammonia will pass through the plant without being treated. As such, meeting instantaneous maximum effluent limits with this process could be difficult. Achieving consistent levels of nitrate and nitrite significantly below 10 mg/L-N is difficult in converted facilities. And finally, this process adds some organic nitrogen to the effluent.

The costs for construction of new facilities for nitrification and denitrification are significantly greater than the conversion of existing facilities. However, the new facilities allow significantly more control over the nitrogen removal processes.

Additionally, the new facilities can be designed to achieve significantly more overall nitrogen removal than the converted facilities.

A monitoring program will be developed to assess compliance with in-stream targets identified in Table 13. Monitoring requirements will also be established to evaluate changes (if any) to algal biomass and the presence of scum and odors. Monitoring requirements will also be established to refine source estimates from minor NPDES dischargers, dry-weather flows from storm drains and stormflow. In addition, receiving water quality and algae should be monitored weekly. These data will be reviewed prior to the next permit cycle (5-years) to evaluate the effectiveness of this TMDL and to determine if additional WLAs or LAs are required for other constituents.

7.3.2 Interim Discharge Limit

As POTWs implement nitrification/denitrification processes to comply with the ammonia-nitrogen, nitrate-nitrogen, nitrite-nitrogen, and nitrate-nitrogen + nitrite-nitrogen objectives, implementation of nitrification/denitrification facilities requires time for planning, design, and construction. POTWs in the Los Angeles River watershed may require additional time to meet the ammonia-nitrogen, nitrate-nitrogen, nitrite-nitrogen, and nitrate-nitrogen + nitrite-nitrogen WLAs. To allow time for completion of the nitrification/denitrification facilities which are integral to this TMDL, the amendment to the Basin Plan made by this TMDL provides the authority for the Regional Board to grant compliance schedules, at the Regional Board's discretion, based on higher interim loads which translate as interim effluent limits in Tables 30 and 31 for a period not to exceed three years from the effective date of the TMDL at the discretion of the Regional Board. The thirty-day average and daily maximum interim limits for total ammonia as nitrogen are based on the 95th and 99th percentiles of effluent performance data reported by dischargers from 1998 to 2002. These interim limits will apply to NH_3-N, and NO_3-N + NO_2-N. Effluent limits for the individual compounds NH_3-N, NO_3-N, and NO_2-N are not required during the interim period.

TABLE 30. INTERIM LIMITS FOR TOTAL AMMONIA AS NITROGEN (NH_3-N)

POTWs	Daily Maximum Interim Limits (mg/l)	Monthly Average Interim Limits (mg/l)
Donald C. Tillman WRP	21.7	21.0
Los Angeles-Glendale WRP	19.4	16.5
Burbank WRP	24.1	22.7

TABLE 31. INTERIM LIMITS FOR NH_3-N + NO_3-N + NO_2-N

POTWs	Monthly Average Interim Limits (mg/l)
Donald C. Tillman WRP	8.0
Los Angeles-Glendale WRP	8.0
Burbank WRP	8.0

7.3.3 Special Studies

Special studies can be conducted by the dischargers to address concerns regarding water quality objectives, numeric targets, and wasteload allocations. Dischargers have already undertaken WER studies to address the ammonia water quality objective. This study will be augmented by a detailed profile of pH, temperature and mixing of the effluent discharge into the receiving water downstream from the Donald C. Tillman POTW. The Dischargers may also undertake studies to address issues regarding ammonia, nitrate, nitrite, and nitrate+nitrite, including compliance points and averaging periods for interpreting water quality objectives.

These studies will be conducted in accordance with Workplans submitted by the Discharger and approved by the Executive Officer. The results from the special studies will be used as the basis for a Regional Board Staff recommendation for modification of the water quality objectives and wasteload allocations. After consideration and approval by the Regional Board, a water quality objective modification or site specific objective would be established as a Basin Plan Amendment. The Implementation Plan schedules a Regional Board hearing to consider special studies 3 years after the effective date of the TMDL.

7.4 COST ANALYSIS

This section summarizes the cost analysis associated with the Los Angeles River Nitrogen TMDL. The cost analysis includes a capital cost estimate for denitrification facilities based on information provided by the City of Los Angeles.

The cost for Nitrification/Denitrification (N/DN) at Donald C. Tillman and Glendale is estimated at $21.3 M and $10.8 M respectively based on communication from the City of Los Angeles City. The cost for N/DN at Burbank is estimated to be $8.5 million. No additional cost is considered for the 10 mgd of water reclamation because significant infrastructure is in place. The total cost for Scenarios 1 and 2 is approximately $40.6 million. The cost estimates were provided by the City of Los Angeles.

Scenarios 3 and 4 require constructed wetlands at Donald C. Tillman. The cost for construction of the 30-acre wetland has been estimated at $56 million. The total cost for scenarios 3 and 4 is $96.6 million. Modeling shows that options listed under Scenario 2 (N/DN with 10 mgd reclamation at Donald C. Tillman) are sufficient to meet the in-stream water quality objectives. Monitoring of the river will be required to determine the need additional level of treatment.

It is noted that the costs for implementation of nitrification/denitrification of the POTW effluent are required by the criterion specific water quality objective for ammonia in the Basin Plan. The costs attributable to this TMDL only include the costs for monitoring and special studies in the Implementation Plan.

8 MONITORING

The details of the monitoring plan to measure the effectiveness of the TMDL will be developed by the Regional Board as part of the NPDES permitting process for the POTWs and include the following components: 1) a core compliance monitoring program designed to ensure that effluent limitations and water quality objectives are being met by the POTWs; 2) a source monitoring program to better identify sources and refine loading estimates; and 3) watershed-scale monitoring to ensure compliance at key compliance points along the river and listed tributaries for both nitrogen compounds and effects such as algae, foam, scum, odors, and pH.

8.1 COMPLIANCE MONITORING FOR WASTEWATER RECLAMATION PLANTS

Effluent monitoring requirements will be developed for the POTWs to ensure compliance with the daily and monthly limits for nitrogen species (ammonia, nitrate, and nitrite). The frequency of sampling should be on a daily basis until there is sufficient data to statistically demonstrate that some other frequency of monitoring is adequate to ensure that the daily objective is being met. Organic nitrogen should also be measured at these times to keep track of total nitrogen loadings.

Receiving water monitoring requirements should include water column measurements of temperature, pH and DO (on at least a weekly basis) ammonia, nitrate, nitrite, organic nitrogen (on at least a monthly basis) and acute and chronic toxicity (on at least a quarterly basis). Observations for the presence of scum, odors, and the presence and extent of algal mats should be recorded at the same time the receiving waters are sampled.

8.2 ADDITIONAL SOURCE MONITORING

Additional monitoring and special studies are needed to refine the source loading estimates. There are uncertainties in the assessment of source loadings from the upstream tributaries to the Los Angeles River, the minor permitted discharges and the non-permitted dry-weather flows from the stormwater system. The following recommendations are designed to address these uncertainties.

A requirement for minor NPDES dischargers above 0.1 mgd to monitor nitrogen loadings on a monthly basis will be considered as the NPDES permits are revised by the Regional Board. The loadings from these sources will be used to re-evaluate the need for additional reductions in the Wasteload Allocations at the time of permit renewal of the large POTWs.

This TMDL will include monitoring to evaluate sources of loadings associated with nonpoint sources, specifically dry weather discharges from urban sources delivered to the Los Angeles River through storm drains. A special study on groundwater in Verdugo Basin should also be conducted to assess if groundwater discharge is responsible for the elevation of the surface water nitrate concentrations in Verdugo Basin.

8.2.1 Watershed Monitoring

A watershed scale monitoring program will be implemented through major dischargers' monitoring programs. The watershed monitoring program will include key compliance points along the river and the upstream and downstream ends of the listed tributaries. Sample results should be compared to the numeric in-stream targets identified in Table 13. Data on the extent and distribution of algal mats, scum and odors should also be compiled. The data could also be used to provide further verification of the model and refine the TMDL as appropriate.

A special watershed-wide study should also be conducted to assess extent and magnitude of algae problem within the Los Angeles River Watershed. Should it be determined that algae is indeed a problem, this would trigger additional studies in the Los Angeles River Watershed in the next phase of permit renewal to: 1) define the targets for algal abundance, scum and odors; 2) address factors controlling algal abundances; and 3) develop an implementation process.

8.3 SUMMARY OF MONITORING

The TMDL monitoring program is designed to provide information that will assure that water quality objectives are being met throughout the watershed and to refine the source loading estimates. These efforts will provide information on the success of the TMDL to address the nitrogen related problems in the River and listed tributaries. Information generated by this program may be used to revise the TMDL at the next NPDES permit cycle.

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