Total Maximum Daily Load for Nutrients in Elizabeth Lake, Munz Lake, and Lake Hughes in the Santa Clara River Watershed

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I. Introduction

Elizabeth Lake, Munz Lake, and Lake Hughes (Santa Clara River Lakes) are located in the Santa Clara River watershed. Elizabeth Lake was initially listed on the 1996 Federal Clean Water Act (CWA) Section 303(d) List (303(d) list) for eutrophic conditions, pH, and low dissolved oxygen. On the 1998 303(d) list, it was also listed for organic enrichment. Munz Lake was initially listed on the 1996 303(d) list for eutrophic conditions. Lake Hughes was initially listed on the 1996 303(d) list for algae, eutrophic conditions, fish kills, and odor. Generally, waterbodies that are identified as impaired on the 303(d) list require the development of a total maximum daily load (TMDL) to establish the amount of pollutants a waterbody can receive without exceeding water quality standards and allocate this pollutant load across point and nonpoint sources. The Santa Clara River Lakes impairments are caused by excessive loading of nutrients, including nitrogen and phosphorus, to each of the lakes. The largest portion of this loading is coming from internal recycling of nutrients that have accumulated within the lakes and lake bottom sediments over time. Lake restoration projects can effectively address excess nutrient loading from internal recycling of nutrients within lakes and restore the recreational uses and ecological functions of lakes.

A. Regulatory Background

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

The elements of a TMDL are described in 40 CFR 130.2 and 130.7 and Section 303(d) of the CWA, as well as in U.S. Environmental Protection Agency guidance (U.S. EPA, 2000). A TMDL is defined as the “sum of the individual waste load allocations for point sources and load allocations for nonpoint sources and natural background” (40 CFR 130.2) such that the capacity of the waterbody to assimilate pollutant loadings (the Loading Capacity) is not exceeded. TMDLs are also required to account for seasonal variations, and include a margin of safety to address uncertainty in the analysis.

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

B. Elements of a TMDL

There are seven elements of a TMDL. The attached document, "Nutrient TMDL Support for Santa Clara River Watershed Lakes: Elizabeth Lake, Munz Lake, and Lake Hughes" prepared by Tetra Tech includes the basis for five elements: Problem Identification (titled "Nutrient Related Impairments" in the Tetra Tech document), Numeric Targets, Source Assessment, Linkage Analysis, and Waste Load and Load Allocations (titled "TMDL Summary" in the Tetra Tech document). This staff report summarizes the elements in the Tetra Tech document in addition to including other background information and implementation and monitoring sections.

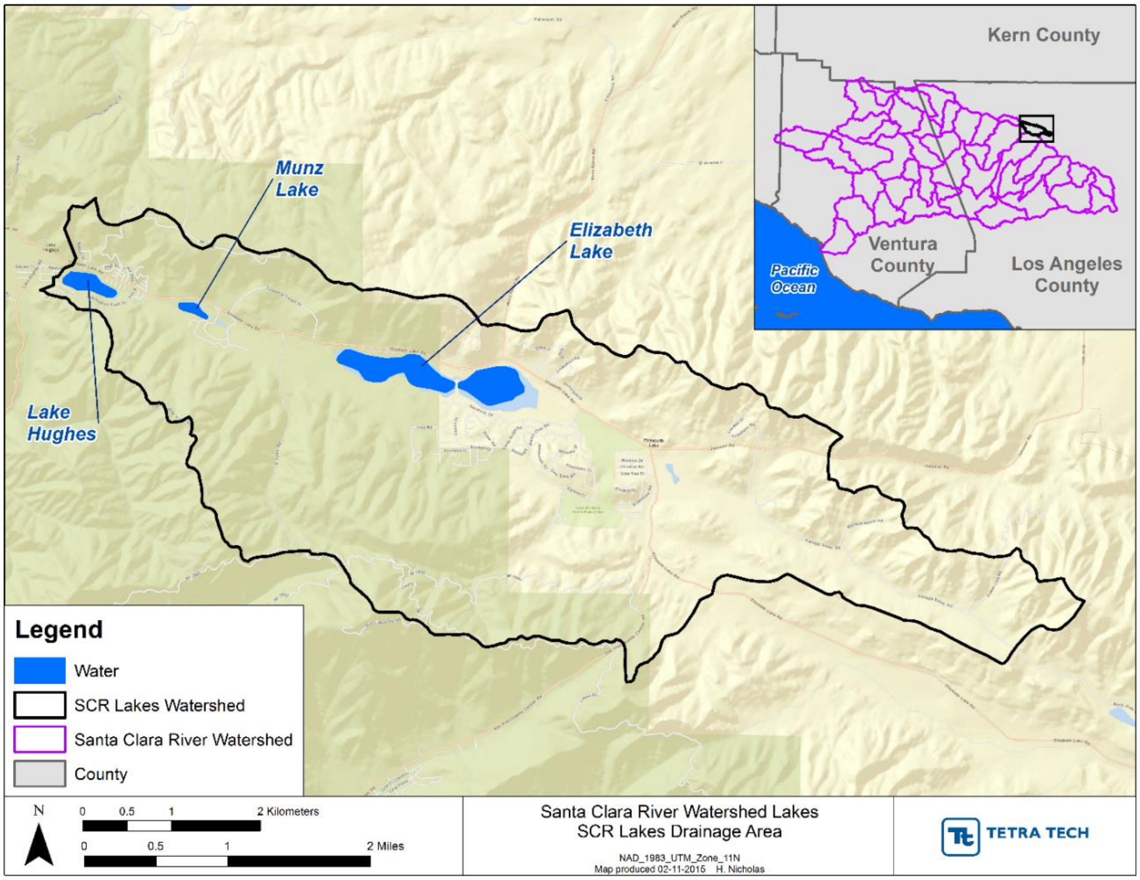
C. Environmental Setting

Elizabeth Lake is surrounded by the unincorporated town of Elizabeth Lake. The eastern half of the lake and a portion of the western half is private property, while the remainder of the western shore is encompassed by the U.S. Forest Service (USFS) within the Angeles National Forest.

Munz Lake is a privately owned, man-made lake which hosts The Painted Turtle, a camp for children with serious and/or terminal illnesses. Water in the lake comes from rain and runoff, and overflow from Elizabeth Lake during the wet season. It is possible that supplemental water is added to Munz Lake, but no information is available to evaluate this as a potential source of nutrients or to explain why Munz Lake is deeper than Elizabeth Lake and Lake Hughes

Lake Hughes is surrounded by the unincorporated community of Lake Hughes. The lake is surrounded by private homes with direct backyard access to the lake on the north and southwestern shores, while the rest of the lake edges are vegetated. Lake Hughes is fed partially by groundwater, rainfall and runoff, and infrequent overflow water from Munz Lake and Elizabeth Lake.

Figure 1. Location of Elizabeth Lake, Munz Lake, and Lake Hughes



II. Problem Statement

A. Santa Clara River Lakes

The Santa Clara River Lakes have been impacted by water quality problems stemming from both eutrophication and trash. The water quality impairments due to trash are being addressed through the Elizabeth Lake, Munz Lake, and Lake Hughes Trash TMDL adopted by the Regional Board, which became effective on March 18, 2008. The eutrophic condition is due to excess nutrients (nitrogen and phosphorus) in the lakes. The nutrient enrichment results in high algal productivity and macrophyte growth. Algal respiration and decay depletes oxygen from the water column creating an adverse aquatic environment. Likewise, the decay of algal blooms and other eutrophic-related impairments can create offensive odors leading to an unpleasant environment. The alteration of the ecosystem degrades habitat and affects the water contact recreation (REC1), non-contact water recreation (REC2), warm freshwater habitat (WARM), and wildlife habitat (WILD) beneficial uses of all three Santa Clara River Lakes. In addition, elevated nutrient levels also affect the rare/threatened/endangered species (RARE) beneficial use of Elizabeth Lake, and the groundwater recharge (GWR) beneficial use of Munz Lake.

B. Nutrient-Related Impairments

Eutrophication and nutrient enrichment problems rank as the most widespread water quality problems for lakes nationwide; more lake acres are affected by nutrients than any other pollutant or stressor (EPA 2000). Eutrophication is defined by increased nutrient loading to a waterbody and the resulting increased growth of biota, phytoplankton and other aquatic plants. Phosphorus and nitrogen are recognized as key nutrients for phytoplankton growth in lakes and are responsible for the eutrophication of surface waters.

In general, a pollutant loaded into a waterbody is often discharged to that waterbody from an external source (i.e. external loading); in the case of nutrients, typical external sources are wastewater treatment facilities, septic systems, and urban stormwater and dry-weather runoff. However, in lakes it is also common for pollutants, particularly nutrients, to be recycled within the lake. The key processes for internal nutrient recycling (internal loading) is the exchange of phosphorus across the sediment-water interface. The exchange of phosphorus between the sediments and the water is a major part of the phosphorus cycle in lakes. The rate at which phosphorus sinks into the sediments and the rate at which sediment processes function to regenerate the phosphorus back to the water column depends upon many physical, chemical, and biological factors. Phosphorus transport to the sediments can occur by various processes such as (1) sedimentation of phosphorus minerals imported from the surrounding watershed, (2) sedimentation with organic matter, and (3) phosphorus adsorption or precipitation with inorganic compounds (Wetzel, 2001). Once the phosphorus is in the lake sediments, numerous processes (e.g. desorption and/or microbiological activities) operate, often simultaneously, to mobilize phosphorus from particulate storage to phosphorus dissolved in the sediment pore water. Once in the dissolved state residing in the sediment interstitial water, phosphorus can be easily transported into the water column where it is available again for biological activities such as algae growth. These transport mechanisms also work to release nitrogen from the sediments into the water.

Figure 2 shows the conceptual transport of nutrients from the various sediment layers to the water column. The mechanisms to transport the phosphorus from the sediment pore water to the overlying water column include diffusion, wind-induced turbulence, which can resuspend sediment particles, and sediment disturbance caused by bottom feeding fishes (Wetzel, 2001). During periods when external loading is reduced, such as the dry season, the internal recycling of nutrients is very important for phytoplankton growth and general lake water quality.

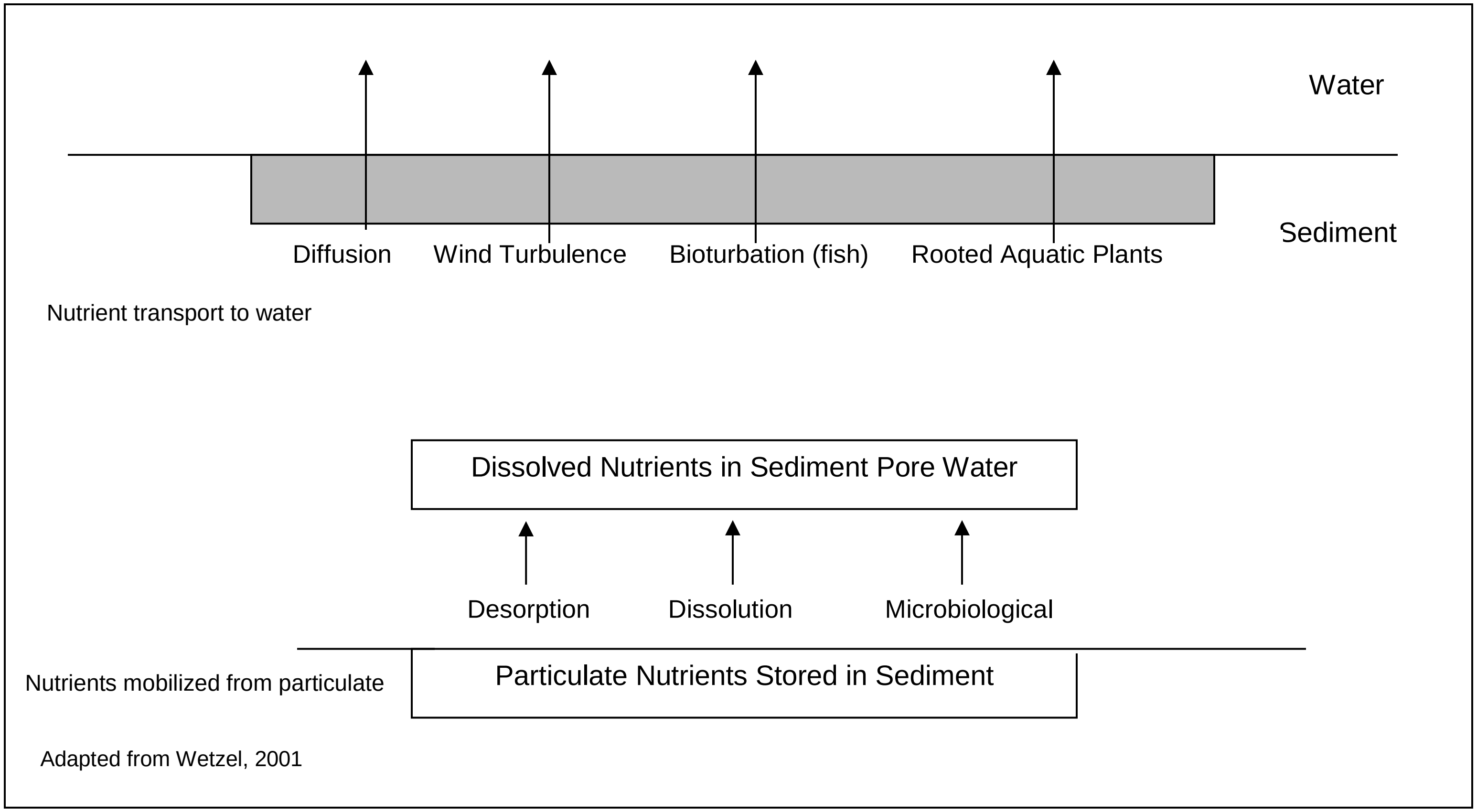
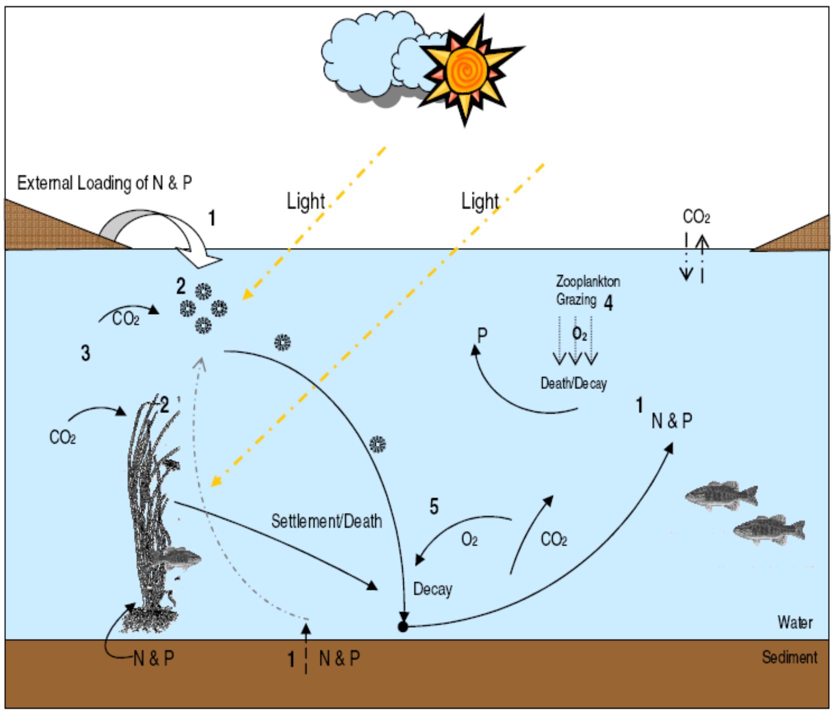


Figure 2. Example processes to mobilize and transport nutrients from sediments to water column

There are many biological responses to nutrients (nitrogen and phosphorus) in lakes. The following conceptual model (Figure 3) outlines the basics of nutrient cycling in lakes. The biologically available nutrients and light will stimulate phytoplankton and or macrophyte growth. As these plants grow, they provide food and habitat for other organisms such as zooplankton and fish. When the aquatic plants die, they release nutrients (ammonia and phosphorus) back into the water through decomposition. The decomposition of plant material consumes oxygen from the water column; in addition, the recycled nutrients are available to stimulate additional plant growth. Physical properties such as light, temperature, residence time, and wind mixing also play integral roles throughout the pathways described.



1. Nutrients (N and P) enter the lake through external loading from the surrounding watershed and internal recycling processes
2. Nutrients and light stimulate the growth of phytoplankton and macrophytes (aquatic plants)
3. Aquatic plants consume carbon dioxide and increase the pH of the lake
4. Zooplankton (aquatic invertebrates) graze the phytoplankton population
5. Aquatic plants break down and/or die and consume oxygen as part of decomposition and recycle ammonia, phosphorus, and carbon dioxide into the water and the sediments

Adapted from EPA 1999

Figure 3. Conceptual Model of Lake Processes

These typical biological processes can become over-stimulated by the addition of excess nutrients to the lake and create a situation in which water quality becomes degraded and beneficial uses are impaired. Excessive nutrient loading, from either external or internal processes, will lead to excessive phytoplankton and macrophyte growth. This excessive plant biomass may cause increased turbidity, altered planktonic food chains, algal blooms, reduced dissolved oxygen concentrations, and increased nutrient recycling. These changes can lead to a cascade of biological responses culminating in impaired beneficial uses.

Particularly in shallow lakes, like the Santa Clara River Lakes, the combination of available nutrients and greater light intensity throughout the water column results in rapid plant growth. In addition, light can penetrate to the lake bottom promoting macrophyte growth. In comparison, in deep lakes a greater portion of the water column is not able to support photosynthesis as a majority of the water column is below is the light penetration depth. Thus, the impacts of nutrient loading and the biological response of algal blooms and dominant macrophytes is often very apparent in shallow lakes.

Plant growth can lead to increased pH in the lake due to rapid consumption of carbon dioxide. The elevated pH creates a harmful environment for organisms and can increase the toxicity of ammonia, potentially leading to direct toxicity to fish and other organisms. As these large phytoplankton populations and macrophytes die or break apart, the decomposition process will consume oxygen and dramatically reduce the oxygen levels found in the lake. Low dissolved oxygen levels can cause significant stress to fish and other organisms and may lead to fish kills. Moreover, as the plant material is decomposed, the nutrients are released and will recycle through the system. Shallow lakes tend to have increased biological productivity because it is likely that the photosynthetic zone and decomposition zone of the water column overlap, creating the situation in which, as materials are decomposed and the nutrients released, they are also immediately available for photosynthesis and plant growth continuing to drive ongoing impairments.

III. Numeric Targets

The Tetra Tech report describes how the numeric targets were derived, including the translation of the narrative water quality objectives for biostimulatory substances (i.e., nutrients) contained in the Water Quality Control Plan for the Los Angeles Region (Basin Plan) using the nutrient numeric endpoint (NNE) framework. The NNE framework establishes a suite of biologically-based numeric thresholds (e.g., algal biomass) and links these thresholds to numeric nutrient endpoints (nutrient concentrations or loads) to address eutrophication. The linkage between the biological thresholds and numeric nutrient endpoints relies upon established load response relationships among nutrients, risk cofactors and biological response indicators (e.g., chlorophyll *a*) and water quality models. The water quality models allow the derivation of site-specific nutrient allocations on the basis of site-specific conditions. For this TMDL, the chlorophyll *a* target is set at 20 µg/L in order to fully support beneficial uses. The numeric targets for total nitrogen and total phosphorus are set to meet this chlorophyll *a* concentration using the NNE BATHTUB modeling tool. Because recent data indicate that Munz Lake is close to meeting the chlorophyll *a* target and because the BATHTUB model could not be calibrated to the extremely high nutrient concentrations in Elizabeth Lake and Lake Hughes, Munz Lake was used as a reference for acceptable conditions in Elizabeth Lake and Lake Hughes. The BATHTUB tool was applied to Munz Lake to set numeric targets for total nitrogen and total phosphorus in all three lakes. This is a technically sound approach based on the best available information. If subsequent data are collected that will allow for full calibration of the BATHTUB model for all three lakes, then the TMDL may be revised. Tables 1 through 3 below identify the numeric targets for the Santa Clara River Lakes. All three lakes have the same targets for chlorophyll *a*, total nitrogen, and total phosphorus. Elizabeth Lake has additional targets for dissolved oxygen and pH, and Lake Hughes has additional targets for dissolved oxygen and ammonia.

Table 1. Nutrient-Related Numeric Targets for Elizabeth Lake

Parameter	Numeric Target	Notes
Chlorophyll *a*	≤20 μg/L summer average (May – September) and annual average	
Dissolved Oxygen	≥7 mg/L minimum mean annual ≥5 mg/L single sample minimum	
pH	The pH of inland surface waters shall not be depressed below 6.5 or raised above 8.5 as a result of waste discharges. Ambient pH levels shall not be changed more than 0.5 units from natural conditions as a result of waste discharge.	
Total Nitrogen	≤1.13 mg-N/L summer average (May – September) and annual average	Based on simulation of allowable concentrations from the Munz Lake BATHTUB model
Total Phosphorous	≤0.113 mg-P/L summer average (May – September) and annual average	Based on simulation of allowable concentrations from the Munz Lake BATHTUB model

Table 2. Nutrient-Related Numeric Targets for Munz Lake

Parameter	Numeric Target	Notes
Chlorophyll *a*	≤20 μg/L summer average (May – September) and annual average	
Total Nitrogen	≤1.13 mg-N/L summer average (May – September) and annual average	Based on simulation of allowable concentrations from the BATHTUB model
Total Phosphorous	≤0.113 mg-P/L summer average (May – September) and annual average	Based on simulation of allowable concentrations from the BATHTUB model

Table 3. Nutrient-Related Numeric Targets for Lake Hughes

Parameter	Numeric Target	Notes
Ammonia[1]	≤1.56 mg/L acute (one-hour) ≤1.41 mg/L four-day average ≤0.56 mg/L chronic (30-day average)	Based on median temperature and 95th percentile pH
Chlorophyll *a*	≤20 µg/L summer average (May – September) and annual average	
Dissolved Oxygen	≥7 mg/L minimum mean annual concentration ≥5 mg/L single sample minimum	
Total Nitrogen	≤1.13 mg-N/L summer average (May – September) and annual average	Based on simulation of allowable concentrations from the Munz Lake BATHTUB model
Total Phosphorous	≤0.113 mg-P/L summer average (May – September) and annual average	Based on simulation of allowable concentrations from the Munz Lake BATHTUB model

[1] The median temperature and 95th percentile pH values were calculated from the observed data and used in the calculation of the acute and chronic targets. These are presented as example calculations since the actual target varies with the values determined during sample collection.

IV. Source Assessment

Pollutants can enter surface waters from both point and nonpoint sources. Point sources include discharges from discrete human-engineered outfalls, including municipal separate storm sewer systems (MS4s) within the watershed, which are regulated through National Pollutant Discharge Elimination System (NPDES) permits. Pollutants from nonpoint sources come from many diffuse sources and, in contrast to point sources, are conveyed to surface waters through more diffuse pathways such as overland sheet flow and groundwater.

The only point sources in the Santa Clara River Lakes watershed are discharges from storm drains, including discharges from the MS4. Limited data were available on stormwater systems in the watershed. Los Angeles County maintains one storm drain and six catch basins in the area of Elizabeth Lake. Other storm drains are likely to exist in the watershed. Locations of storm inlets to the lakes were approximated using field observations and information from Los Angeles County.

Nonpoint sources in the Santa Clara River Lakes watershed include internal loading from the sediments at the bottom of the lakes, sheet flow from the land surrounding the lakes, atmospheric deposition[1], onsite wastewater treatment systems (OWTS) and the Lake Hughes Community Wastewater Treatment Facility (WWTF). (The Elizabeth Lake Golf and Ranch Club appears to have been closed since 2010, although, according to the County of Los Angeles, they have recently applied for a permit to begin operation in the future.) OWTS and the Lake Hughes Community WWTF are considered nonpoint sources because they discharge to the ground, and therefore are not regulated by NPDES permits.

The source assessment for the Santa Clara River Lakes includes estimates for internal nutrient loading from the lake sediments, and external nutrient loading from (1) wastewater effluent from the Lake Hughes Community WWTF (via spray irrigation), (2) wastewater effluent from OWTS (or "septic systems"), (3) wet-weather and dry-weather runoff from the surrounding watershed (via storm drains and nonpoint source sheet flow), and (4) direct atmospheric deposition. Estimates of the annual loads of nitrogen and phosphorus from each of these sources to each of the lakes are provided in Appendices A, B, and C of the Tetra Tech report.

A. Internal Loading

Internal loading is the release of stored nutrients from bed sediments to the water column. Elevated nutrient concentrations have been observed in all three lakes since the early 1990s. Sources of nutrient loading during this time period might have included discharges from OWTS, effluent from the Lake Hughes WWTF, discharges from storm drains, and surface runoff from undeveloped areas, as described below. Sediments within all three lakes have likely accumulated nutrients from these sources over time. Nutrients stored in sediments can be released into the water column by multiple processes including anoxic conditions, wind perturbation, and the movement of fish and macroinvertebrates (see Figure 2). Internal loading

[1] Atmospheric deposition is typically classified as either direct or indirect deposition, where direct deposition is what is deposited on the surface of the waterbody and indirect deposition is what is deposited on the land draining to the waterbody. From a regulatory standpoint, direct deposition is considered a nonpoint source. Indirect deposition may be considered either a point source or a nonpoint source depending on how the pollutants are conveyed to the waterbody once they have been deposited on the land surface.

from bed sediments is the most significant source of nutrients to Elizabeth Lake and Lake Hughes, comprising over 99% of the nutrient loading.

B. External Loading

1. Lake Hughes Community Wastewater Treatment Facility

The Los Angeles Regional Water Quality Control Board (Regional Water Board) established a septic system discharge prohibition (Order No. 80-24) in the Lake Hughes community in 1980, after the County of Los Angeles Department of Health Services notified the Regional Water Board about a serious health hazard resulting from failing private sewage disposal systems due to high groundwater. Section 13243 of the California Water Code (CWC) provides that a Regional Board, in a water quality control plan or in waste discharge requirements, may specify certain conditions or areas where the discharge of waste, or certain types of waste, will not be permitted. Order No. 80-24 prohibited the construction of any new private sewage disposal systems in the Lake Hughes community as well as the continued use of existing systems six months after a wastewater treatment facility was constructed.

After Order No. 80-24 was established, the County of Los Angeles proposed to construct a wastewater collection, treatment, and disposal system in the Lake Hughes area where the discharge prohibition was established. Due to complications with funding, it took many years for the facility to be built.

The Lake Hughes Community WWTF was constructed in 1990 to protect Lake Hughes from contamination due to malfunctioning septic systems. The County of Los Angeles Department of Public Works operates the facility for the Community Development Commission. The Lake Hughes Community WWTF has a design capacity of 93,000 gallons per day (gpd). The daily average dry weather inflow during 1994 was approximately 50,000 gpd. The treated wastewater is pumped to a 2.2-million gallon above-ground holding tank for storage, and then discharged via 15 spray nozzles for irrigation in an area approximately 2,000 feet east of Lake Hughes. (LARWQCB, 1995) The average nutrient concentrations in the facility's effluent, prior to discharge to the spray irrigation fields, are 5.1 mg/L total nitrogen and 3.01 mg/L phosphate as phosphorus. The average nutrient concentrations in the groundwater wells downgradient of the spray irrigation field are 7.24 mg/L total nitrogen and 0.06 mg/L phosphate as phosphorus.

2. Onsite Wastewater Treatment Systems

An OWTS consists of a septic tank and a soil absorption field that allows effluent to infiltrate through soil. Septic systems can be significant sources of nutrients to subsurface and surface waters when they are not properly sited or functioning. Wastewater with high concentrations of nitrogen and phosphorus may seep into shallow groundwater and eventually enter surface waters. Nitrogen is particularly mobile in groundwater, while phosphorus has a tendency to be absorbed by the soils.

Prior to construction of the Lake Hughes Community WWTF described above, the areas surrounding Lake Hughes operated on septic systems. Most of the occupied parcels within the Lake Hughes watershed are assumed to be serviced by the Lake Hughes Community WWTF. Parcel counts and a review of aerial photographs indicate that there are approximately 12 OWTS remaining within the Lake Hughes watershed.

For Munz Lake, parcel counts and a review of aerial photographs indicate five OWTS in the watershed. Parcel counts and census data indicate that there are approximately 830 OWTS in the Elizabeth Lake watershed.

3. Runoff from Surrounding Areas

Wet-weather runoff contributes to nutrient loading of the lakes via sheet flow from surrounding areas or discharges from storm drains during storm events. Dry-weather runoff from irrigation also has the potential to deliver nutrients to the lakes through the same pathways.

4. Atmospheric Deposition

Atmospheric deposition of nutrients directly to lake surfaces is considered a source of loading. Atmospheric deposition may occur as either wet deposition (associated with precipitation), or dry deposition (associated with particulates). There are two major pathways for pollutants from atmospheric deposition to enter waterbodies. One is direct deposition (pollutants fall directly on the water surface) and the other is indirect deposition, in which pollutants are deposited in the surrounding watershed and washed into the waterbody during a storm event. The nutrient load from indirect atmospheric deposition is accounted for in the estimates of runoff from the watershed. The direct deposition is small, because of the relatively small sizes of the lakes.

C. Summary of Source Assessment

A summary of the nutrient loading to the Santa Clara River Lakes is presented in Table 4. Wet-weather and dry-weather runoff that drain the areas surrounding the lakes via sheet flow and storm drains and atmospheric deposition are sources of nutrient loading to all of the Santa Clara River Lakes. Internal loading is the largest source of nutrient loading to Elizabeth Lake and Lake Hughes. In addition, OWTS are possible sources of nutrient loading to groundwater affecting both Elizabeth Lake and Lake Hughes. The Lake Hughes Community WWTF is also a source of nutrient loading to Lake Hughes through groundwater.

Table 4. Summary of Nutrient Loading to the Santa Clara River Lakes

Input	Flow (ac-ft/yr)	Total Phosphorus (lb-P/yr) (percent of total load)	Total Nitrogen (lb-N/yr) (percent of total load)
Elizabeth Lake			
Discharges from County of Los Angeles storm drains	323	537 (0.07)	3,165 (0.07)
Nonpoint source runoff from drainage area within County of Los Angeles	42	48 (0.01)	448 (0.01)
Nonpoint source runoff from drainage area encompassed by Angeles National Forest	24	27 (<0.01)	239 (<0.01)
Onsite wastewater treatment systems	38	160 (0.02)	961 (0.02)
Atmospheric deposition (to the lake surface)	83	N/A	36 (<0.01)
Internal loading (in-lake sediments)*	N/A	760,000 (99.90)	42,470,000 (99.90)
Total	**509**	**760,773**	**42,474,848**
Munz Lake			
Discharges from storm drains	18.6	33 (45.50)	184 (35.94)
Nonpoint source runoff from drainage area encompassed by Angeles National Forest	28.6	38 (53.12)	320 (62.52)
Onsite wastewater treatment systems	0.2	1 (1.38)	6 (1.17)
Atmospheric deposition (to the lake surface)	4.4	N/A	2 (0.37)
Total	**51.8**	**72**	**512**
Lake Hughes			
Discharges from storm drains	64.9	110 (0.20)	657 (0.01)
Nonpoint source runoff from	3.3	4 (0.01)	35 (<0.01)

Input	Flow (ac-ft/yr)	Total Phosphorus (lb-P/yr) (percent of total load)	Total Nitrogen (lb-N/yr) (percent of total load)
drainage area encompassed by Angeles National Forest			
Lake Hughes Community Wastewater Treatment Facility	8.8	1 (<0.01)	174 (<0.01)
Onsite wastewater treatment systems	5.0	2 (<0.01)	14 (<0.01)
Atmospheric deposition (to the lake surface)	14.4	N/A	6 (<0.01)
Internal loading (in-lake sediments)*	N/A	54,819 (99.79)	8,244,612 (99.99)
Total	**92**	**54,936**	**8,245,498**

*Mass of nutrients that flux between the sediment and water annually.

V. Allocations

The Tetra Tech report describes how the loading capacity, or allowable load, and allocations were derived. The NNE BATHTUB modeling tool was used to calculate an allowable total nitrogen and total phosphorus load that would meet the chlorophyll *a* target of 20 µg/L for each lake. The BATHTUB model was calibrated to the conditions in Munz Lake and then the calibrated model was applied to all three lakes.

For Munz Lake, the loading capacities for total nitrogen and total phosphorus are 395 lb-N/yr and 63.9 lb-P/yr, respectively. This will require a 22.8% and 11.7% reduction of the existing total nitrogen load and total phosphorus load, respectively.[2] WLAs and LAs were developed assuming equal percent reductions in all sources.

For Elizabeth Lake, the loading capacities for total nitrogen and total phosphorus are 14,929 lb-N/yr and 2,794 lb-P/yr, respectively. This will require a 99.96% and a 99.63% reduction of the existing total nitrogen load and total phosphorus load, respectively. For Lake Hughes, the loading capacities for total nitrogen and total phosphorus are 1,669 lb-N/yr and 311 lb-P/yr, respectively. This will require a 99.98% and a 99.43% reduction of the existing total nitrogen load and total phosphorus load, respectively.

[2] For total phosphorus, the model over-predicts the existing phosphorus concentration in the lake because the calibration factor for the net phosphorus sedimentation rates would need to be set higher than the recommended maximum value in BATHTUB. This over-estimation provides a conservative estimate of the required load reduction, which is applied to the margin of safety.

Equal percent reductions for all sources were not appropriate for Elizabeth Lake and Lake Hughes because, unlike for Munz Lake, there are explicit internal loading sources in addition to the external loading sources. Because the internal loading contribution is so large for Elizabeth Lake and Lake Hughes, an equal percent reduction approach would require that the external sources be reduced significantly lower than background conditions. Instead, the allowable external nutrient loading to Lake Hughes and Elizabeth Lake was set based on the allowable inflow concentration of nutrients to Munz Lake. Based on this approach, external sources need to be reduced by 19.8% for total nitrogen and 18.7% for total phosphorus in Elizabeth Lake and 20.7% for total nitrogen and 3.2% for total phosphorus in Lake Hughes. The required reduction of the internal load in Elizabeth Lake and Lake Hughes was then calculated by subtracting the required external load reductions from the total allowable loads.

A. Waste Load Allocations

The point sources of nutrients into the Santa Clara River Lakes are discharges from storm drains, including discharges from the municipal separate storm sewer system (MS4). The Waste Load Allocations (WLAs) for total phosphorus and total nitrogen are assigned to discharges from storm drains discharging to the lakes.

Table 5. Waste Load Allocations Assigned to Storm Drain Discharges to the Santa Clara River Lakes

Lake	Total Phosphorus (lb-P/yr)			Total Nitrogen (lb-N/yr)		
	Existing	Allocation	% Reduction	Existing	Allocation	% Reduction
Munz Lake	33.0	29.1	11.7%	184.1	142.1	22.8%
Elizabeth Lake	536.9	436.7	18.7%	3,164.8	2536.8	19.8%
Lake Hughes	110.10	106.6	3.2%	656.7	520.8	20.7%

B. Load Allocations

The major nonpoint source of nutrients to Lake Hughes and Elizabeth Lake is internal nutrient loading (nutrient flux from sediments). Inputs from OWTS and atmospheric deposition are also nonpoint sources of nutrients. Load allocations are assigned for nonpoint source discharges to the Santa Clara River Lakes. Special studies may be conducted to further evaluate sources.

Table 6. Load Allocations Assigned to Nutrient Inputs for Nutrient Loading to Munz Lake

MUNZ LAKE

Input	Total Phosphorus (lb-P/yr)		Total Nitrogen (lb-N/yr)	
	Allocation	% Reduction	Allocation	% Reduction
Nonpoint source runoff from drainage area encompassed by Angeles National Forest	33.96	11.7%	247.2	22.8%
Onsite wastewater treatment systems	0.88	11.7%	4.6	22.8
Atmospheric deposition (to the lake surface)	NA	NA	1.5	22.8%
Total	**34.8**	**11.7%**	**253.3**	**22.8%**

Table 7. Load Allocations Assigned to Nutrient Inputs for Nutrient Loading to Elizabeth Lake

ELIZABETH LAKE				
Input	Total Phosphorus (lb-P/yr)		Total Nitrogen (lb-N/yr)	
	Allocation	% Reduction	Allocation	% Reduction
Nonpoint source runoff from drainage area encompassed by Angeles National Forest	22.1	18.7%	191.4	19.8%
Nonpoint source runoff from drainage area within County of Los Angeles	39.4	18.7%	359.0	19.8%
Onsite wastewater treatment systems	130.1	18.7%	770.3	19.8%
Internal loading (in-lake sediments)	2,166.0	99.7%	11,042.2	99.97%
Atmospheric deposition (to the lake surface)	NA	NA	28.9	19.8%
Total	**2,357.6**	**99.7%**	**12,391.8**	**99.97%**

Table 8. Load Allocations Assigned to Nutrient Inputs for Nutrient Loading to Lake Hughes

LAKE HUGHES				
Input	Total Phosphorus (lb-P/yr)		Total Nitrogen (lb-N/yr)	
	Allocation	% Reduction	Allocation	% Reduction
Nonpoint source runoff from drainage area encompassed by Angeles National Forest	3.6	3.2%	27.6	20.7%
Lake Hughes Community Wastewater Treatment Facility	1.4	3.2%	138.2	20.7%
Onsite wastewater treatment systems	1.9	3.2%	11.1	20.7%
Internal loading (in-lake sediments)	197.3	99.6%	956.4	99.99%

LAKE HUGHES				
	Total Phosphorus (lb-P/yr)		Total Nitrogen (lb-N/yr)	
Input	Allocation	% Reduction	Allocation	% Reduction
Atmospheric deposition (to the lake surface)	NA	NA	5.0	20.7%
Total	204.3	99.6%	1,138.4	99.99%

VI. Implementation

This section describes the regulatory mechanisms that will be used to implement the TMDL, how compliance with WLAs and LAs will be determined, implementation measures that could be used to attain WLAs and LAs, and an implementation schedule. This section also includes a discussion of monitoring requirements, special studies that may be conducted to evaluate assumptions in the TMDL, and a consideration of costs of the reasonably foreseeable methods of compliance with the TMDL.

A. Implementation of Waste Load Allocations

The regulatory mechanism used to implement the WLAs for storm drain discharges within the Santa Clara River Lakes watershed is the Los Angeles County MS4 Permit; or for additional responsible entities in the future, MS4 permits under Phase II of the US EPA Stormwater Permitting Program; or the residual designation authority of the state under CWA section 402(p)(2)(E), and other applicable regulatory programs. WLAs shall be incorporated into MS4 permits as water quality-based effluent limitations (WQBELs). MS4 Permittees may be deemed in compliance with WQBELs if they demonstrate that: (1) there are no violations of the WQBEL at the Permittee’s applicable MS4 outfall(s); (2) there are no exceedances of the numeric targets in the lake downstream of the Permittee’s outfalls; or (3) there is no direct or indirect discharge from the Permittee’s MS4 to the lake.

The WLAs for storm drain discharges shall be achieved 15 years after the effective date of the TMDL.

B. Implementation of Load Allocations

Two primary federal statutes establish a framework in California for addressing nonpoint source water pollution: Section 319 of the CWA of 1987 and Section 6217 of the Coastal Zone Act

Reauthorization Amendments of 1990 (CZARA). In accordance with these statutes, the state assesses water quality associated with nonpoint sources of pollution and develops programs to address nonpoint sources. The *Plan for California's Nonpoint Source Pollution Control Program* (NPS Program Plan), which became effective in 2000, provides a coordinated statewide approach to dealing with nonpoint source pollution. Federal approval of the NPS Program Plan required the State Water Resources Control Board (SWRCB) to provide assurances that it has the legal authority to implement and enforce the NPS Program Plan. In 2004, the SWRCB adopted the Nonpoint Source Implementation and Enforcement Policy. This policy specified that the regional boards have the administrative permitting authorities to regulate nonpoint sources of pollution through Basin Plan discharge prohibitions, waste discharge requirements (WDRs), and waivers of WDRs. The NPS Program Plan was updated in 2015 with the 2014 - 2020 California Nonpoint Source Program Implementation Plan. The updated plan continues to stress cooperation and local stewardship to resolve nonpoint source problems, while using applicable State regulatory authorities to protect and restore water quality.

1. Internal Loading

Load allocations are assigned to internal loading in Elizabeth Lake and Lake Hughes. Cooperative parties for the lake sediment LAs are identified, not as responsible parties or as dischargers, but as landowners who have an interest in lake restoration. Cooperative parties for the lake sediment LAs include the owners of Elizabeth Lake and Lake Hughes. Internal loading LAs for total nitrogen and total phosphorus shall be attained within 15 years of the effective date of this TMDL. Load allocations for internal loading will be implemented through the following:

(1) Memorandum of Agreement (MOA), or

(2) Clean Up and Abatement Order or Other Regulatory Order

If chosen as the implementation strategy, cooperative parties shall develop and enter an MOA with the Regional Water Board within three years from the effective date of the TMDL with the purpose of implementing the load allocations. The MOA shall detail the voluntary efforts that will be undertaken to attain the load allocations for Elizabeth Lake and Lake Hughes, and meet requirements pursuant to the development of a non-regulatory implementation program as presented in the Water Quality Control Policy for Addressing Impaired Waters: Regulatory Structure and Options (State Water Board Resolution No. 2005-0050) section 2 C ii and requirements of this TMDL.

To be a valid non-regulatory implementation program adopted by the Regional Water Board, the MOA shall include the following requirements and conditions:

- The MOA shall contain conditions that require trackable progress on attaining load allocations and numeric targets. A timeline shall be included that identifies the point or points at which Regional Water Board regulatory intervention and oversight will be triggered if the pace of work lags or fails.
- The MOA shall contain a provision that it shall be revoked based upon findings by the Executive Officer that the program has not been adequately implemented, is not achieving its goals, or is no longer adequate to restore water quality.
- The MOA shall be consistent with the California Policy for Implementation and Enforcement of the Non-point Source Pollution Control Program, including but not limited to the "Key Elements of a Non-point Source Pollution Control Implementation Program".

Cooperative parties entering into an MOA with the Regional Water Board for Elizabeth Lake and Lake Hughes shall submit and implement work plans to clean up the sediments of each lake. The work plans shall be submitted within five years of the effective date of the TMDL, and must be approved by the Executive Officer and may be amended by Executive Officer approval, as necessary. The work plans shall identify implementation measures, which cooperative parties will implement, that will achieve the internal loading LAs. Additionally, the work plans shall include a Monitoring and Reporting Program (MRP) Plan and strategy to secure funds to remediate the lake sediments. The work plans shall include tasks and a clear timeline for task completion leading to the attainment of internal loading LAs. The roles of each cooperative party shall also be set forth in the work plans. The work plans shall include annual reporting requirements.

If an MOA is not established within three years of the effective date of the TMDL, or the cooperative parties do not comply with the terms of the MOA, or if the MOA and Lake Work Plans are not implemented or otherwise do not result in attainment of load allocations consistent with the provisions and schedule of the TMDL, a cleanup and abatement order pursuant to Water Code section 13304, or another appropriate regulatory order, shall be issued to implement the load allocations.

2. Nonpoint Source Runoff

The drainage area encompassed by the Angeles National Forest, and the drainage area within the County of Los Angeles are assigned load allocations for the runoff from areas surrounding the Santa Clara River Lakes. The LAs for runoff from areas that are not served by the MS4 shall be regulated by WDRs, waivers of WDRs, or other regulatory mechanisms in accordance with the Nonpoint Source Implementation and Enforcement Policy (NPS Policy). The Regional Water Board may choose to regulate the LAs for runoff under the same mechanism as the LAs for in-lake loading in order to increase efficiency. Compliance with the TMDLs for Elizabeth Lake and Lake Hughes may be based on coordinated MRPs and lake work plans for both the internal loading LAs and nonpoint source runoff LAs that set forth responsibilities for each cooperative party. In addition, recently a portion of the Elizabeth Lake shoreline and adjacent area has been approved as a mitigation bank, which will be restored and protected against future development. Restoration efforts to comply with this TMDL should be coordinated with restoration efforts for the mitigation bank. Runoff from the drainage area encompassed by the Angeles National Forest and the drainage area within the County of Los Angeles shall attain load allocations within 15 years of the effective date of the TMDL.

3. Lake Hughes Community WWTF

The Lake Hughes Community WWTF is assigned load allocations for nutrient loading to Lake Hughes. The regulatory mechanism used to implement the load allocations is the WWTF's WDRs. The LAs for the Lake Hughes Community WWTF are based on the facility's discharge to groundwater and the point of compliance is the groundwater down gradient of the spray field. Permit writers may translate the LAs into mass-based or concentration-based numeric effluent limitations consistent with the assumptions and requirements of the TMDL.

The County of Los Angeles shall conduct a special study to investigate the elevated nutrient concentrations in groundwater down gradient from the spray irrigation field by examining background concentrations and possible contributions to the nutrient loading from the facility. Implementation will be completed over two phases: (1) completion of the special study and (2) possible upgrades to the facility. The special study shall be completed within five years of the effective date of the TMDL. If the results of the special study demonstrate that the WWTF is contributing to the nutrient loading in groundwater, the facility shall complete upgrades to achieve the assigned load allocations as soon as possible, but no later than 12 years after the effective date of the TMDL. If the results of the special study indicate that the WWTF is not contributing to the nutrient loading in groundwater, the facility may continue to operate as constructed, and the TMDL will be revised.

4. OWTS

The LAs for OWTS shall be implemented through WDRs or waivers of WDRs. Commercial and multifamily OWTS are currently regulated by the Regional Water Board through WDRs. Single family residential OWTS are currently regulated by the County of Los Angeles through a memorandum of understanding (MOU) with the Regional Water Board. In addition, the State Water Board adopted a policy for siting, design, operation, and maintenance of OWTS (OWTS Policy) as Resolution No. 2012-0032 to comply with CWC sections 13290 and 13291 on June 19, 2012. The OWTS Policy became effective on May 13, 2013. The policy emphasizes local management of OWTS. The policy requires an Advanced Protection Management Program (APMP) and local agencies are authorized to implement APMPs in conjunction with their existing programs and in collaboration with the Regional Water Board.

This TMDL assigns load allocations generally to all OWTS in the watershed, but does not specify which, if any, specific OWTS must reduce discharges to meet the load allocations. The County will conduct a special study to refine the area subject to the load allocations and determine which OWTS are contributing to the nutrient loading to the lakes. Those systems will then be included in the APMP of the County's Local Agency Management Program (LAMP). Existing OWTS included in an APMP are required to be upgraded or modified to enhance their nitrogen removal or meet other requirements of the APMP. If the study determines that the total phosphorus load allocations are not being met and reductions are required, which can't be achieved by phosphorus source reduction, the TMDL may be reconsidered to adjust the allocations scenario or otherwise revise elements of the TMDL. Existing OWTS shall remain regulated by the existing MOU and LAMP until the above determination is made, the LAMP is revised, and subsequent OWTS upgrades are required.

New or replacement OWTS installations, as defined by the OWTS Policy upon its becoming effective, that are within the APMP area, shall meet the supplemental treatment requirements for nitrogen per Tier 3 of the OWTS Policy.

The Regional Water Board will evaluate existing MOUs and any future submittal of a LAMP under the OWTS Policy to determine if additional changes are needed to implement the LAs.

New or replacement OWTS dischargers, and existing OWTS dischargers within the APMP, shall achieve compliance with LAs as soon as possible, but no later than 12 years after the effective date of the TMDL. The owners of OWTS are ultimately responsible for achieving the LAs. The Regional Water Board and the County of Los Angeles will work to obtain funding for any necessary OWTS upgrades.

C. Potential Implementation Strategies and Associated Costs

The TMDL requires responsible entities and cooperative parties to attain WLAs and LAs for nutrients to prevent excessive algal growth and maintain adequate dissolved oxygen concentrations and pH values in the Santa Clara River Lakes. There are many implementation alternatives available to reduce nutrient loading. Rather than a single treatment solution, a combination of implementation measures may be required to reduce nutrients and algae to acceptable levels. The Regional Water Board cannot specify the manner of compliance that responsible entities and cooperative parties will use to comply with the TMDL. The following discussion presents several potential implementation strategies that could be used to comply with the TMDL and their associated costs.

The cost estimates for several of the reasonably foreseeable implementation actions are intended to provide the Regional Water Board with a reasonable range of potential costs of implementing this TMDL. The cost estimates are not additive. Rather, responsible entities and cooperative parties may implement individual potential treatment alternatives or a combination of alternatives and the costs would vary accordingly. The cost estimates account for a range of economic factors and require a number of assumptions regarding the extent of implementing many of the measures. In reviewing the cost estimates, it should be noted that there are multiple additional benefits associated with the implementation of these strategies. Federal and State funding is available to help reduce costs. The Water Board will help responsible entities and cooperative parties apply for and obtain funding assistance.

1. Internal Loading Implementation Alternatives

The Regional Water Board cannot specify which implementation measures must be used to implement the internal loading LAs, but cooperative parties may employ a variety of lake management strategies such as dredging, maintaining lake levels, and invasive species removal.

Dredging

Dredging is the process of removing or displacing gravel, mud, sand, and/or silt along with various materials (i.e. sediment, debris, etc.) from water bodies such as rivers, lakes, streams and their corresponding shorelines and wetlands. Traditional dredging, also known as "dry dredging," is a specific type of dredging that involves the drainage of the waterbody in order to proceed with excavation and/or repositioning of the sand and gravel. This method is generally carried out with the use of bulldozers and backhoes. Once the sediments are removed, clean sediment can be applied. Since the Santa Clara River Lakes cycle through dry periods, dredging can be done while the lake beds are dry to avoid the need to drain the lakes, minimize environmental impacts, and reduce costs.

Based on the Machado Lake Eutrophic, Algae, Ammonia, and Odors (Nutrient) TMDL, a unit cost of $20 per cubic yard of dredged material is assumed, which comprises equipment delivery, operation of equipment, pumping, dewatering, sludge/sediment management, cleaning, labor, and transportation of waste. This estimate is an overestimate of the costs that would be incurred for dredging, because this estimate is based on hydraulic dredging, and the Santa Clara River Lakes may be dredged using traditional dredging when the lake beds are dry. The estimated cost for hydraulic dredging is $3,975,260 for Elizabeth Lake and $690,500 for Lake Hughes (Table 9).

Table 9. Costs of Hydraulic Dredging

Lake	Approximate Area (Acres)	Approximate Area (ft^2)	Estimated Dredge Depth (ft)	Estimated Dredge Volume (ft^3)	Estimated Dredge Volume (yd^3)	Total Cost
Elizabeth Lake	123.2	5,366,592	1	5,366,592	198,763	$3,975,260
Lake Hughes	21.4	932,184	1	932,184	34,525	$690,500

Increase and/or Maintain Lake Level

Maintaining an optimal lake level is another method to improve lake water quality. In warm climates with short wet seasons, a direct source of supplemental water with low nutrient concentrations could be used to help offset evaporative losses from the lake and increase the assimilative capacity of the lake. A supply of supplemental water could help to maintain the lake level and water quality through the hot dry season, which is considered the critical condition for the lakes. The source of supplemental water could come from a variety of sources such as potable supply, stormwater (capture and reuse), or recycled water. Any water source used to supplement the Santa Clara Lakes would be required to comply with the TMDL waste load and load allocations and all water quality objectives including the federal and statewide anti-degradation policy.

The most significant costs of implementing supplemental water are the cost of the water itself and the construction of pipelines. Costs of pipelines will be determined by the distance from the lakes to the water source. Cost of the water will vary, depending on the location of the water source and the availability of recycled water.

Floating Islands / Hydroponic Nesting Islands

Floating islands are constructed islands that provide terrestrial and aquatic habitat while at the same time reducing nutrient concentrations in the lake. The island provides nesting and resting habitat for bird species and the roots below the water provide fish habitat. Floating islands are beneficial in removing nutrients from the water column through the roots of plants that are exposed in the water column rather than rooted in the sediments of the lake. The periodic drying of the Santa Clara Lakes makes it unlikely that this TMDL implementation method is appropriate for all three lakes. However, in combination with additional implementation measures, floating islands have the potential to improve water quality in the Santa Clara River Lakes.

Most floating islands are prefabricated, and fairly economic for installation. They also require minimal maintenance. A floating island can cost $700, not including plants (CanadianPond.ca Products Ltd).

Invasive Species Removal

Terrestrial and aquatic invasive plants can affect the quality of the lake by crowding out native plants, destroying shoreline habitat, and changing runoff dynamics and water tables. Invasive terrestrial plants can consume three times more water than native plants, which, if located along a lake's shoreline, can have a significant impact on the lake's assimilative capacity. The removal of invasive species is a potential implementation alternative for the Santa Clara River Lakes.

Removal activities should be carried out in a manner which will minimize environmental impacts. Eradication efforts in nearby watersheds have been estimated to cost $663,350 (Ventura County Resource Conservation District, 2006).

2. Runoff Implementation Alternatives

Various BMPs may be implemented to prevent runoff from flowing into the Santa Clara River Lakes. Runoff conveyed through storm drains or from sheet flow can be treated through various implementation alternatives that would reduce pollutant loads entering the Santa Clara River Lakes. BMPs may include restoration of lake shorelines and buffer areas to prevent nonpoint source runoff from reaching the lakes, as well as the installation of treatment devices designed to reduce nutrient loadings in runoff from storm drains, such as vegetated swales, infiltration areas, and catch basin inserts. The LAs for internal loading, and the WLAs and LAs for point and nonpoint source runoff, respectively, may be implemented as a coordinated lake restoration effort that combines sediment remediation and shoreline buffering/runoff reduction/treatment projects.

<u>Shoreline Buffering/Filter Strips</u>

Trees, plants, and shrubs along shorelines protect lakes by acting as a buffer for runoff. These strips of vegetation retain sediment and other pollutants before they can reach the lakes. The deep root systems of the trees and shrubs also hold soil in place and absorb nutrients. In addition, buffer areas can attract birds and other wildlife and provide important habitat for aquatic animals living along the shore. Filter strips reduce runoff velocities and trap sediment and other pollutants as they settle out. The reduced velocities also result in some infiltration.

An estimate for the cost of filter strips includes the cost of seed or sod, which is approximately $0.30 per ft^2 for seed, or $0.70 per ft^2 for sod. This totals between $13,000 and $30,000 per acre of filter strip. Typical maintenance costs are approximately $350/acre/year (CASQA, 2003).

<u>Vegetated Swales</u>

Vegetated swales allow for the filtering of pollutants, and infiltration of runoff into groundwater. Swales planted with native vegetation offer higher resistance to flow and provide a better environment for filtering and trapping pollutants from runoff. Conservatively, a properly designed vegetated swale may achieve a 25 to 50 percent reduction in particulate pollutants, including sediment and sediment-attached phosphorus. Lower removal rates (less than 10 percent) can be expected for dissolved pollutants, such as soluble phosphorus and nitrate. The cost of developing a swale unit is estimated in the range of $6,000 to $17,000 or from $0.25 to $0.5 per square foot (CASQA, 2003). The maintenance cost is assessed at 5% of the construction cost annually.

Infiltration Basin

An infiltration basin is an impoundment that captures stormwater and allows it to infiltrate into the ground over a period of days. The basin temporarily stores runoff for a storm of a specific design size. The applicability of an infiltration basin is dependent on soil type, slope, depth to the water table, depth to the bedrock or impermeable layer, contributing watershed area, land use, and proximity to wells and surface waters.

Infiltration basins are relatively cost-effective practices because little infrastructure is needed when constructing them. One study estimated the total construction cost at about $2 per foot of storage for a 0.25-acre basin (CASQA, 2003).

Catch Basin Inserts

The County of Los Angeles has already installed full capture systems for trash on the catch basins draining to Elizabeth Lake. In addition to controlling discharges of trash, these full capture systems will help to capture sediment, preventing the transport of nutrients that are adsorbed onto soil particles. Catch basin inserts cost approximately $800 per insert (LARWQCB, 2007).

3. Upgrades to the Lake Hughes Community WWTF

The Lake Hughes Community WWTF's current treatment process consists of screening, comminution, and oxidation, followed by clarification and chlorination. If studies show that the facility is contributing to the nutrient loading in groundwater, the facility may need to be upgraded to include nutrient removal in order to meet the load allocations. Because it is not yet known if or how the WWTF needs to be upgraded, the costs provided in this section are estimates. The cost of a study to determine if upgrades to the facility are required could cost approximately $150,000, which includes the cost to construct approximately three groundwater wells needed to identify the flow rate, hydraulic gradient, and assimilative capacity of the groundwater basin, as well as assess any degradation of nutrients in the groundwater due to plant or bacteria uptake. If upgrades are required, the average biological nutrient removal costs for a new small system (50,000 gpd) range from $800,000 to $1.2 million for construction and $74,000 to $117,000 for operation and maintenance (U.S EPA, 2007). According to the County of Los Angeles, certain local systems cost more than this. For example, the County provided information that an upgrade to the Trancas Water Pollution Control Plant (75,000 gpd) in 2006, which included a new biological nutrient removal process for nitrogen removal to 10mg/L, cost $4.6 million. The County of Los Angeles is also currently upgrading the Malibu Mesa Wastewater Reclamation Facility (200,000 gpd), including a new biological nutrient removal/membrane bioreactor process for nitrogen removal to 10mg/L, which is estimated to cost $12million. If the study confirms the need for the 3% reductions in total phosphorus loading, the reductions could potentially be achieved through source reduction efforts to reduce the amount of total phosphorus added by users to the wastewater. Federal and State grants and loans are available to fund any necessary upgrades and potentially to fund the study to determine if the upgrades are necessary in order to minimize impacts to rate payers.

4. OWTS Special Study and Upgrades

As stated in section VII.B.4, OWTS owners are ultimately responsible for attaining load allocations. Before any individual OWTS are required to be upgraded to meet the load allocations, the County of Los Angeles will conduct a special study to investigate which, if any, OWTS are contributing to nutrient loading in the Santa Clara River Lakes. The special study may use groundwater monitoring and modeling to predict the contributions of septic systems to lake water quality. The results of this study will relate groundwater quality to surface water quality, and will be used to determine which OWTS need to be upgraded in order to attain the load allocations. The County of Los Angeles shall complete the OWTS study and submit a final report to the Regional Water Board within five years of the effective date of the TMDL. A similar OWTS study for the Ventura River watershed is currently underway and is estimated to cost $242,465. The County of Ventura recently applied for and received federal CWA 319(h) grant funding to pay for this study (Ventura County, 2016).

For the OWTS that are determined to be contributing nutrient loading to the lakes, various actions may be required to reduce the loading from OWTS to attain load allocations within twelve years. These may include actions ranging from more frequent inspections and maintenance to the installation of supplemental treatment. OWTS inspection and maintenance could cost up to $5,000. If the inspection confirms the need for advanced treatment, the cost of upgraded systems could cost up to $22,000 (SWRCB, 2012). There would also be ongoing maintenance and monitoring requirements to ensure the advanced treatment is performing well. According to the County of Los Angeles, some upgrades and enhanced systems can cost more than this. For example, the County provided information on three approved OWTS enhanced systems and their cost estimates: Advantex systems ($19,000 to $48,000 depending on tank size), MicroSepTec systems (approximately $30,000), and Jett systems ($34,000 to $43,000 depending on tank size). Maintenance estimates for these three systems are between $250 and $1200 per year. Federal and State funding are available to help offset costs. The Regional Water Board encourages the County of Los Angeles to coordinate and assist homeowners in applying for funding, if upgrades are determined to be necessary.

D. Monitoring

The Santa Clara River Lakes monitoring will consist of receiving water monitoring and discharge monitoring. Monitoring is required to measure the progress of pollutant load reductions and improvements in water quality. The monitoring plan has several goals.

- Determine attainment of total phosphorus, total nitrogen, ammonia, dissolved oxygen, pH, and chlorophyll *a* numeric targets.

- Determine compliance with the waste load and load allocations for total phosphorus and total nitrogen.

- Monitor the effect of implementation actions on lake water quality

1. Receiving Water Monitoring

Responsible entities and cooperative parties for each lake in the Santa Clara River Lakes TMDL shall submit an MRP Plan. The MRP Plan for Elizabeth Lake and Lake Hughes shall be included as part of the work plans for internal loading. The MRP for Munz Lake shall be submitted separately for Executive Officer approval within five years of the effective date of the TMDL. Monitoring will begin sixty days after the Executive Officer approval of the MRP. Water samples will be collected quarterly in each lake, on a year-round basis. The time of day for sample collection will be considered when developing the sampling schedule. The lake sampling sites will be located at two sites in Elizabeth Lake and one site each in Munz Lake and Lake Hughes, in the open water portion of the lakes.

In situ measurements of water quality will be made at each of the sampling stations using a water quality probe (such as YSI or HydroLab). Parameters measured will include:

- Temperature
- Dissolved oxygen
- pH
- Electrical conductivity

The water quality probes will be calibrated immediately prior to departure to the field against known pH, EC, and DO solutions. Transparency will also be measured. Additionally, a staff gauge shall be placed in an appropriate location at the lake to measure changes in lake elevation.

Water samples will be analyzed for the following constituents.

- Total nitrogen
- Total phosphorus
- Nitrate (NO_3-N)
- Total ammonia (NH_3-N)
- Ortho-phosphorus (PO_4)
- Total Dissolved Solids
- Total Suspended Solids
- Chlorophyll *a*
- Turbidity

Detection limits shall be less than the numeric targets in this TMDL. A monitoring report will be prepared and submitted to the Regional Water Board annually within six months after the completion of the final sampling event of the year.

2. Discharge Monitoring

Discharge monitoring will assess attainment of the waste load and load allocations. Discharge monitoring shall be required through the regulatory mechanisms used to implement the waste load and load allocations. The monitoring procedures/methods, analysis, and quality assurance shall be comparable with the State Water Resources Control Board's (State Water Board) Surface Water Ambient Monitoring Program (SWAMP).

E. Schedule

The TMDL implementation schedule is designed to provide responsible entities and cooperative parties flexibility to implement appropriate BMPs and lake management strategies to address nutrient impairments at the Santa Clara River Lakes. Implementation consists of development of monitoring/management plans and work plans by responsible entities, implementation of BMPs to address external nutrient loading to the lake, and implementation of lake management activities to reduce internal sources of nutrients and water column nutrient concentrations. The schedule includes a reconsideration based on the results of any new information or data. The reconsideration will occur prior the date when load allocations and waste load allocations must be attained.

Table 10. TMDL Implementation Schedule

Task	Date
The Los Angeles Water Board will reconsider this TMDL within six years of the effective date of the TMDL to revise the LAs, WLAs, implementation schedule, and any other element of the TMDL based on the results of any new information or data.	6 years from the effective date of the TMDL
Storm Drain Discharges	
Responsible entities shall meet assigned WLAs for total nitrogen and total phosphorus.	Within 15 years of the effective date of the TMDL
Onsite Wastewater Treatment Systems	
The County of Los Angeles shall submit a work plan for a study to determine which existing OWTS are contributing to the nutrient loading to the Santa Clara River Lakes for approval by Executive Officer.	Within three years of the effective date of the TMDL
The County of Los Angeles shall complete the OWTS study and submit a final report to the Regional Water Board.	Within five years of the effective date of the TMDL

Task	Date
Complete OWTS upgrades (as necessary)	As soon as possible, but no later than 12 years after the effective date of the TMDL
Attain LAs for total nitrogen and total phosphorus for OWTS	As soon as possible, but no later than 12 years after the effective date of the TMDL
Internal Loading for Elizabeth Lake and Lake Hughes	
If chosen as the implementation strategy, cooperative parties shall develop and enter a Memorandum of Agreement (MOA) with the Regional Water Board to implement LAs.	Within 3 years of the effective date of the TMDL
The Regional Water Board shall begin development of a cleanup and abatement order or other regulatory order to implement the LAs if an MOA is not established with cooperative parties.	3 years from the effective date of the TMDL
Cooperative parties shall submit Lake Work Plans for each lake, including a MRP, for approval by the Executive Officer to comply with the MOA.	Within 5 years of the effective date of the TMDL
Cooperative parties shall submit annual monitoring reports on the progress of Lake Work Plan implementation.	Within 6 years of the effective date of the TMDL
Internal loading LAs for total nitrogen and total phosphorus shall be attained.	Within 15 years of the effective date of the TMDL
Runoff	
Nonpoint source runoff from the drainage area encompassed by the Angeles National Forest and from the drainage within the County of Los Angeles unincorporated area shall submit a MRP for Munz Lake	Within 5 years of effective date of the TMDL
Nonpoint source runoff from the drainage area encompassed by the Angeles National Forest and from the drainage within the County of Los Angeles unincorporated area shall attain LAs for total nitrogen and total phosphorus for runoff not served by storm drains.	Within 15 years of the effective date of the TMDL
Lake Hughes Community Wastewater Treatment Facility	
The Lake Hughes Community Wastewater Treatment Facility shall complete the special study and submit the final report to the Regional Board	Within 5 years of the effective date of the TMDL
Complete WWTF upgrades (as necessary)	As soon as possible, but no later than 12 years after the effective

Task	Date
	date of the TMDL
The Lake Hughes Community Wastewater Treatment Facility shall achieve LAs for total nitrogen and total phosphorus.	As soon as possible, but no later than 12 years after the effective date of the TMDL

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