April 11, 2017

RECEIVED
4-11-17
SWRCB Clerk

VIA ELECTRONIC MAIL
Jeanine Townsend, Clerk to the Board
State Water Resources Control Board
1001 I Street, 24th Floor, Sacramento, CA 95814

Dear Ms. Townsend:

Subject: Comment Letter— Incorporation of Stakeholder-Developed Groundwater Quality Control Measures for Salt and Nutrients in the Raymond Basin in Los Angeles County

I respectfully offer the following comments regarding the Amendment to the Water Quality Control Plan for the Los Angeles Region to Incorporate a Program of Implementation Consisting of Stakeholder-Developed Groundwater Quality Management Measures for Salts and Nutrients in the Raymond Groundwater Basin (Basin Plan Amendment). I regrettably did not raise my comments before the Los Angeles Water Board In December 2016 because I attempted to first get clarification from the City of Pasadena regarding the Raymond Basin Salt and Nutrient Management Plan (SNMP) rationale for the assumption that only 10 percent of the TDS in recycled water would reach the groundwater table.[1] Pasadena Water and Power responded to my request by memorandum dated December 14, 2016 (copy attached). The memorandum was not received in time to address the issues at the December 8, 2016 Los Angeles Water Board hearing.

1. The SNMP and Draft Substitute Environmental Document (SED) that are the basis for the Basin Plan Amendment <u>substantially</u> underestimate the amount of TDS that will return to the groundwater table as a result of irrigation with recycled water.

<u>The SED addresses the fate of salts (emphasis added)</u>:[2]

> *"Once salts are in the soil and vadose zone, there are* ***three possible fates: remain where they are, wick upward to the surface with water, leach downward with water****. For simplicity in the following discussion, all references to soil apply equally to the vadose zone (unsaturated zone between the soil and groundwater).* ***On a landscape scale, salts remain in the soil, or they move to surface waters, or to aquifers****.*
>
> *"Salts will remain at the same relative depth if the balance of water applied plus precipitation approximately equals atmospheric demand through evaporation from soil surfaces and transpiration from plant leaves.*
>
> ***"Salts will move downward if the balance of water applied plus precipitation exceeds atmospheric demand through evaporation from soil surfaces and transpiration from plant leaves.***
>
> *"Salts will move upward if the balance of water applied plus precipitation approximately is less than atmospheric demand through evaporation from soil surfaces and transpiration from plant leaves. This situation is enhanced in the case of water tables within 4 to 6 feet of the soil surface, depending upon texture of the soils. Finer-textured soils (silts, loams, and clays) promote upward capillary*

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[1] See SNMP, p. 73

[2] See SED, p. 23

> *movement of water in greater quantity, and from greater depths, resulting in greater salt accumulation at the surface than occurs on coarse-textured soils (sands and sandy loams).*
>
> ***"If sufficient water is added to the surface (precipitation and/or irrigation and/or water spreading) to move water through the soil to the groundwater table and aquifer, the salts reach the groundwater and aquifer, as well. Once in the aquifer, the salts remain there unless removed from the aquifer through groundwater pumping or outflow from one basin to another, if a hydraulic connection between aquifers exists."***

When high-salinity water is used for landscape irrigation, a common irrigation practice is to apply extra water to assure that the salts do not wick upward and harm plant growth.[3] As a result, the salts will either stay in suspension or move downward to the groundwater as stated above. Ultimately, repeated irrigation and precipitation will flush the suspended salts into the groundwater table and virtually all salts in applied irrigation will reach the groundwater table. (Regional Water Control Board regulations restrict surface runoff of irrigation with recycled water and such fate would be *de minimis*.[4])

<u>The SNMP says (emphasis added)</u>:[5]

> *"Pasadena Water and Power has proposed the Pasadena Non-Potable Water Project which involves the installation of a new non-potable water distribution system to deliver recycled water and local stream water for direct use to customers within the Monk Hill and Pasadena subareas. Pasadena Water and Power has estimated that upon full buildout, there will be a recycled water demand of 2,700 ac-ft/yr for direct use irrigation between the Monk Hill and Pasadena subareas.* ***Assuming that 10 percent of irrigated recycled water percolates to the groundwater table, approximately 270 ac-ft/yr may contribute to loading in the Raymond Basin****, which should fall within the Policy's recommendation for a single project to utilize less than 10 percent of the available assimilative capacity."*

This discussion is inconsistent with the SED's discussion of the fate of salts in irrigation water and no citations to studies or research are provided by the SNMP or SED to support the 10 percent assumption or explain the fate of the residual 90 percent of TDS.

<u>Analyses by other agencies</u>:

Other California water agencies have addressed the issue of the fate of TDS in irrigation with recycled water in the development of salt management plans:

> The Santa Clara Valley Water District concluded that "*Water vapor that evaporates from Irrigation water at the soil surface or that is transpired by plants is essentially distilled water with no salt content. Although plants take up some minerals from the soil, their roots actively exclude most salts. Thus,* ***nearly all of the mineral content (TDS) of the irrigation source water remains in the soil…***

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[3] GROWING Points: Irrigation Efficiency for Turfgrass Managers (UC Davis, Spring 1998, Vol. 1, No. 2, p.2); copy attached

[4] State Water Resources Control Board Order WQ 2016-0068-DDW: "Water Reclamation Requirements for Recycled Water Use", Paragraph 29.

[5] See SNMP, p. 73

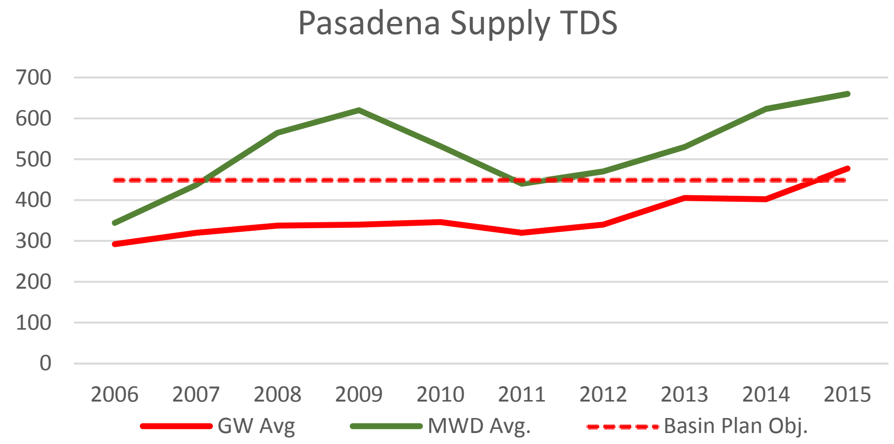
> *Accordingly, **all of the TDS associated with the source irrigation water is assumed to percolate to groundwater**.*"[6]
>
> The Zone 7 Water Agency concluded that "Perhaps **the most important simplifying assumption is that all salts applied through irrigation eventually make their way to the underlying groundwater** (while in actuality vadose zone processes can delay salt transport for decades)."[7]

Conclusion: The estimate of salt loading relies on a simplistic and unsubstantiated assumption regarding the fate of TDS in recycled water. The amount of salt that will be introduced to the groundwater by Pasadena's Non-Potable Water Project will likely be 10 times that estimated by the SNMP.

2. The SNMP analysis does not use the most-recent water quality data and over-estimates assimilative capacity as a result.

The Recycled Water Policy states that "*the available assimilative capacity of a basin/subbasin shall be calculated by comparing the mineral water quality objective [Basin Plan objective] with the average concentration of the basin/sub-basin [background basin water quality conditions], either over the **most recent five years of data available** or using a data set approved by the Regional Water Board Executive Officer.*"[8] (emphasis added)

The 2016 SNMP analyses use data prior to mid-2012.[9] An examination of annual Consumer Confidence Reports prepared by the City of Pasadena[10] - a groundwater producer in the Raymond Basin - indicate that beginning in 2013, TDS in groundwater began rising dramatically:



To put this in perspective, Pasadena's pumping from the Monk Hill and Pasadena sub-basins is about half of the total pumping from those sub-basins. The TDS in Pasadena's groundwater increased from 340

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[6] Draft Technical Memorandum 2 - Future Salt and Nutrient Groundwater Quality and Assimilative Capacity for Llagas Subbasin - Salt and Nutrient Management Plan (Valley Water District), p. 30 (excerpt attached)

[7] Zone 7 Salt Management Plan, p. 5-2 (excerpt attached)

[8] See SNMP, p. 47

[9] See SNMP, p. 7

[10] See http://www.cityofpasadena.net/waterandpower/waterquality/#WQPastReports; excerpts attached for 2013 thru 2015

mg/l in 2012 to 477 mg/l in 2015 - a 40% increase - and the TDS level in 2015 was 27 mg/l higher than the basin plan objective.

Conclusion: The increase in Pasadena's groundwater TDS since 2012 has a significant negative impact on the assimilative capacity. No action to introduce TDS loading from new supply sources into the Raymond Basin should be approved without first implementing actions that can be shown to reduce TDS in the groundwater from 2015 levels.

3. The SNMP uses incorrect data for TDS level in Metropolitan Water District's imported supply for 2011.

The SNMP modeling uses 380 mg/l for MWD Weymouth WRP supply TDS in 2011[11] but a much higher value of 440 mg/l has been widely reported in Raymond Basin water agency Consumer Confidence Reports. Use of the higher value would result in a reduction in calculated assimilative capacity.

Thank you for the opportunity to comment on this important matter.

Yours truly,

Ken Kules, Pasadena Resident

Attachments

cc: Dr. Ginachi Amah, California Regional Water Quality Control Board, Los Angeles Region
Mr. Gurcharan Bawa, General Manager, Pasadena Water and Power

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[11] See SNMP, Table III.4d and Appendix W

PASADENA WATER AND POWER

MEMORANDUM

December 14, 2016

To: Gurcharan S. Bawa
Interim General Manager

From: Shan Kwan
Assistant General Manager

12/15/2016

Subject: **Compliance of the Non-Potable Water Project with the Raymond Basin Salt and Nutrient Management Plan**

Summary

Upon buildout, Pasadena's Non-Potable Water Project (NPWP) will deliver up to 3,100 AFY of recycled water for landscape irrigation and industrial uses. Recognizing the potential for salts and nutrients from the irrigation water to percolate to the groundwater table, an analysis was performed to evaluate the volume of new water that can be added to the deep aquifer without degrading the water quality of the basin as allowed by the State Water Resources Control Board (SWRCB).

The mechanism for the analysis was the Raymond Basin Salt and Nutrient Management Plan (SNMP), a document prepared by the Raymond Basin Management Board (RBMB) and submitted to the SWRCB as a requirement of its 2009 Recycled Water Policy. The analysis demonstrates that there is available capacity in the Raymond Basin for receiving additional constituents of concern from recycled water without degrading the groundwater quality beyond the basin objectives.

Regulatory Background

In 2009, the SWRCB approved the Recycled Water Policy with the goal of increasing the use of recycled water as a safe, local, drought proof, and reliable alternative source of water supply. Recognizing the potential for an increase in salt and nutrient loading in the groundwater as a result of increased recycled water use, the Policy also required that local stakeholders develop a SNMP that assesses all major sources of these constituents in the groundwater basins. Because of the many factors that contribute to the water quality of a basin, the SWRCB determined that the development of a regional SNMP was the appropriate way to address salt and nutrient issues in groundwater basins rather than impose requirements solely on individual recycled water projects.

Pasadena's NPWP overlies both the Monk Hill and Pasadena subareas of the Raymond Groundwater Basin. Water quality objectives (WQOs) that apply to the Raymond Basin are defined in the Los Angeles Regional Board's Basin Plan, and represent a standard that must be attained to protect the basin's designated beneficial uses. The SNMP prepared for the Raymond Basin analyzes the maximum annual amount of new water allowed to recharge each subarea before exceeding the WQOs. This ability of the groundwater basin to accept additional water of a quality similar to that of recycled water before significant degradation would occur is called assimilative capacity (AC). The AC compares the existing average concentration of the groundwater and the

WQOs for various constituents of concern. Further, the SWRCB has determined that no single project shall exceed 10% of a basin's available AC.

Pasadena Non-Potable Water Project

The Raymond Basin SNMP determined that the AC for the Monk Hill and Pasadena subareas equates to 225 AFY and 405 AFY, respectively. The analysis in the SNMP shows that up to 2,250 AFY of recycled water can be used for irrigation over the Monk Hill subarea before exceeding its 225 AFY assimilative capacity. Similarly, up to 4,050 AFY can be applied to the Pasadena subarea before exceeding the allowable limit of 405 AFY for salts and nutrients from new water introduced by a single project.

The Raymond Basin SNMP uses a 10% percolation rate in its anti-degradation analysis. This rate accounts for leaching of salts and nutrients from recycled water used for irrigation into the groundwater table, primarily through precipitation. The rate is consistent with USGS studies on deep percolation and has been used for other calibrations of groundwater models in the San Gabriel Valley.

The NPWP with all six phases completed through the year 2038 will deliver a total of 3,100 AFY of recycled water to PWP's service area. Of this total, 2,700 AFY will be used for irrigation. About 400 AFY will be used for irrigation in the Monk Hill subarea, and 2,300 AFY will be applied in the Pasadena subarea.

Based on the 10% percolation rate, the NPWP will contribute 40 AFY and 230 AFY to the groundwater tables in the Monk Hill and Pasadena subareas, respectively. Since the projected recycled water recharge from the NPWP is less than Raymond Basin's AC, the NPWP satisfies the requirements of the Basin Plan and the policies set forth by the SWRCB.

Table 1 provides a summary of the quantitative analysis as described above.

Table 1 – Summary Analysis of NPWP and the Raymond Basin Assimilative Capacity

Raymond Basin	NPWP Irrigation Water (AFY)	NPWP Percolation to GW table (AFY)	Available AC (project goal) (AFY)
Monk Hill subarea	400	40	225
Pasadena subarea	2,300	230	405
Total	2,700	270	630

Timeline

Pasadena Water and Power has been engaged in discussions with the RBMB on the subject of the SNMP as it relates to the NPWP since at least 2013 when a technical memorandum was prepared informing them of the proposed project. Since then, the RBMB has reviewed and commented on the draft Environmental Impact Report for the NPWP. As recently as July 2016, PWP, RBMB, and its consultants met to discuss the SNMP. The conclusion of this meeting was that full buildout of the NPWP will not degrade the groundwater basin.

Next Steps

Following the Los Angeles Regional Water Quality Control Board's (LARWQCB) direction in 2011 for RBMB to proceed with the development of the SNMP, RBMB held numerous stakeholder meetings and coordinated with the LARWQCB resulting in the preparation and submittal to the SWRCB of the final draft of the Raymond Basin SNMP. On December 8, 2016, the LARWQCB unanimously adopted the Raymond Basin SNMP. With its approval, RBMB has primary responsibility for implementing the SNMP, which includes a monitoring program for water quality. It should be noted that the planning horizon for the SNMP is the year 2025, and as conditions change, including impacts of drought and climate change, and where results from the SNMP Monitoring Program indicate modifications are warranted, the SNMP will be updated.

The formal approval of the Pasadena NPWP, including the proposed management practices to protect the basin water quality, will require an application to the SWRCB to be regulated under a Water Reclamation Requirement for Recycled Water Use (General Order). The General Order requires proposed recycled water uses to comply with Basin Plan requirements. Therefore, determination of the NPWP's compliance with the Basin Plan and its WQOs is part of the application process.

Volume 2, Number 2, Page 1 Spring, 1998

GROWINGPoints

Department of Environmental Horticulture • University of California, Davis

Irrigation Efficiency for Turfgrass Managers

By Ali Harivandi, UC Cooperative Extension Area Advisor
Alameda, Contra Costa and Santa Clara Counties

Turfgrasses need water from their seedling stage though maturity. Almost every physiological reaction requires water; without it, metabolism ceases and the turfgrass plant dies. Water also is essential for proper plant nutrition. Mineral elements must dissolve in the soil solution before they can be absorbed by roots. Irrigation provides this "solution" which is absorbed by roots and translocated through the turfgrass plant, providing a constant supply of food for healthy growth.

Turfgrasses absorb water primarily through their root systems, and, after using a minute amount, release most of it through transpiration. If for any reason and to any degree water transpired exceeds water absorbed, growth is retarded. Transpiration in turf is determined almost entirely by temperature, humidity, wind and light. Thus, the need for water over a given period of time also depends on these factors. The turfgrass manager must consider these environmental factors when planning an efficient irrigation program.

Inefficient irrigation programs, in addition to being wasteful, increase the incidence of diseases and weeds in turf. They also reduce the effectiveness of other turfgrass management practices such as fertilization, mowing, thatch and pest control. Due to the diversity of soil and climatic factors, however, a single set of recommendations defining irrigation efficiency cannot be given. In what follows, primary factors affecting irrigation efficiency are discussed with the hope that a thorough understanding of them will enable the turfgrass manager to develop an efficient irrigation program tailored to his/her individual conditions.

Climatic Conditions. A thorough knowledge of climatic conditions is essential for maximum turfgrass irrigation efficiency. Water loss from turf is influenced primarily by climatic conditions. In general, water applied to turf is used/lost through (a) deep percolation due to gravitational force, b) runoff, caused primarily by improper application rates, c) evaporation from soil and/or leaf surfaces and d) metabolism and/or transpiration of the turf plant. Deep percolation and runoff can be reduced by applying the right amount of water at the proper rate. Evaporation and transpiration (the combination of which is known as "evapotranspiration" or ET) are influenced by temperature, humidity, wind, and, to some extent, by solar radiation. ET increases as temperature, wind and radiation increase and humidity decreases.

Recent studies also show that ET from a specific turfed site varies among turf species. Under similar climatic conditions evapotranspiration from sites planted to cool season turfgrasses is generally higher than those planted to warm season turfgrasses. In other words, cool season turfgrasses generally use more water than warm season turfgrasses.

Most turf specialists recommend water application equal to the ET at a given site. In studies by researchers at the University of California, Riverside, however, cool season turfgrasses such as Kentucky bluegrass, perennial ryegrass and tall fescue showed no significant difference in quality when sprinkler irrigation equaled 100 and 80 percent ET. Warm season turfgrasses (seashore paspalum, hybrid bermudagrass, and zoysiagrass) exhibited no significant difference in quality when sprinkler irrigation equaled 100, 80 and 60 percent irrigation. These results indicate that water savings of 20 percent for cool season and 40 percent for warm season turfgrasses can be realized without significantly affecting turf qual-

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ity. ET can be measured with several types of evaporation pans, such as the U.S. Weather Bureau Class A aboveground pan, or by weather stations designed to measure a site's ET for irrigation purposes. Turfgrass managers interested in more site-specific knowledge of daily turfgrass water use can get such information from the California Irrigation Management Information system (CIMIS), a free service to the public offered by the California Department of Water Resources. For more information on CIMIS, visit their website at wwwdpla.water.ca.gov/cgi-bin/cimis/cimis/hq/main.pl or contact DWR staff at (530) 327-1653.

Soil Water-Holding Capacity. Water-holding capacity depends on soil texture. The more clay a soil contains, the higher its water-holding capacity.

All soils have three water fractions when saturated. The first, "gravitational water," is that fraction which is lost through gravity to deep percolation and is unavailable to turfgrasses. Once this water fraction has drained, soil is described as at "field capacity" (FC). A second fraction of soil water, also unavailable to turfgrasses, is "hygroscopic water" and is very tightly held by soil particles. All water present in soil below the "wilting point" (WP) belongs to this fraction. The third water fraction, that which the turfgrass plant can absorb, is known as "available water." All plant present in the soil between the WP and FC falls in this category. The proportion of available to unavailable water differs among soil textures.

Table 1 shows the appropriate amount of water available under various soil textures at field capacity. Note that a fine-textured soil, such as clay, holds about twice as much water as coarse, sandy soil.

So, the heavier the soil, the higher its water-holding capacity and, thus, the more water necessary to wet it to a given depth (compared to a sandy soil). As **Figure 1** indicates, almost 1.5 inches of water are required to wet loam soil to a depth of 12 inches. The same amount of water wets clay soil to a depth of 7 inches and a sandy soil to a depth of 24 inches.

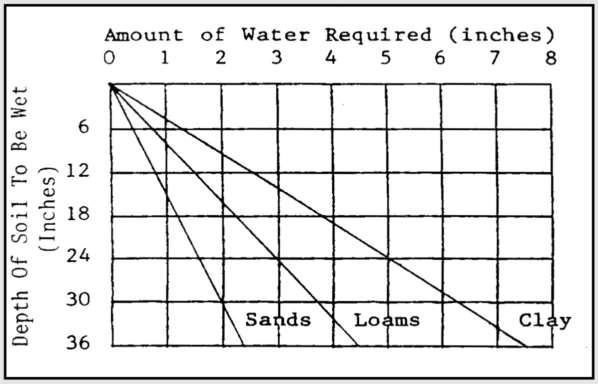


Figure 1. *Relative inches of water required to wet soils to given depths (assuming no runoff)*

Soil Texture	Available	Unavailable
	(inches per foot)	
Sand	0.4 - 1.0	0.2 - 0.8
Sandy Loam	0.9 - 1.3	0.9 - 1.4
Loam	1.3 - 2.0	1.4 - 2.0
Silt Loam	2.0 - 2.1	2.0 - 2.4
Clay Loam	1.8 - 2.1	2.4 - 2.7
Clay	1.8 - 1.9	2.7 - 2.9

Table 1. *Available and unavailable water per foot of soil*

Grass Species	Root Depth
Annual bluegrass Creeping bentgrass Colonial bentgrass Perennial ryegrass Creeping red fescue Kentucky bluegrass	Shallow
Tall fescue	Intermediate
St. Augustinegrass Zoysiagrass Bermudagrass	Deep

Table 2. *Relative turfgrass root depth under normal use conditions*

Once a soil is wetted to the desired depth, the amount of water applied in subsequent irrigations depends upon the rate of plant water use. A proper application will return the soil to 100 percent of its water-holding capacity. Under certain conditions, a little extra water may be applied to leach salts. Obviously, if more water is applied than the amount which can be stored by the soil, some water will be lost through deep percolation. Sandy soils are especially prone to deep percolation. Likewise, if water application rates exceed a given soil's absorption and percolation rates, water is lost through runoff. Heavy and/or compacted soils are especially prone to runoff.

Root Depth. Turfgrass species differ in their rooting abilities. Some species have deep root systems, others shallow ones. Approximate rooting depths of common turfgrasses are given in **Table 2**. As the table shows, warm season turfgrasses generally produce deep root systems, while almost all cool season turfgrasses have shallow root systems. (Tall fescue, with an intermediate root system, is an exception.) Since it is the objective of an efficient irrigation program to supply water throughout the root zone, rooting depth as well as soil texture should be considered when determining the rate and amount of water applied.

Although the rooting depth of each turfgrass species is genetically controlled, environmental factors also affect it considerably. Roots, for example, can penetrate deeper in sandy than in clay soils, are generally deeper in fall and spring than in summer and winter, and are deeper when the grass is mowed higher. Other environmental factors affecting turfgrass root depth are irrigation, fertilization, soil compaction, and shade. The best way to determine turfgrass rooting depth in a specific location is physical inspection. A soil probe or a shovel can be used.

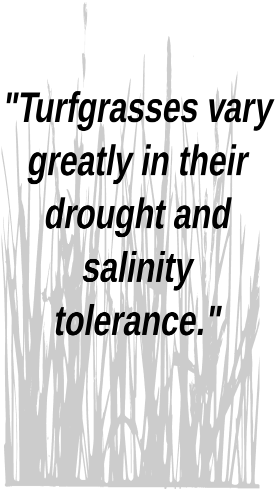
Drought Tolerance. Turfgrass species vary greatly in their tolerances of drought stress. Commonly grown turfgrasses are ranked according to their drought tolerance in **Table 3**. Use of the more drought-tolerant turfgrasses should be considered when it is known before turf establishment that an area either will not be irrigated at all or only on a limited basis. It should be noted that although drought tolerance depends in large part on a turf species' genetic characteristics, several environmental factors also contribute to such tolerance. Generally, deep-rooted grasses growing in a deep soil with good subsoil moisture remain green for extended periods, despite lack of irrigation. Once soil moisture in the root zone is depleted, however, the turfgrass cannot survive for long. Deep-rooted turfgrasses, such as the tall and hard fescues, growing in dry areas where rain or

High	Seashore paspalum
	Weeping alkaligrass
	Hybrid bermudagrass
	Zoysiagrass
	St. Augustinegrass
	Common bermudagrass
	Buffalograss
	Kikuyugrass
	Creeping bentgrass
	Tall Fescue
	Perennial ryegrass
	Kentucky bluegrass
	Red fescue
	Hard fescue
	Highland bentgrass
	Colonial bentgrass
Low	Dichondra

Table 3. *Relative drought tolerance of turfgrasses*

High	Hybrid bermudagrass
	Buffalograss
	Zoysiagrass
	Common bermudagrass
	Seashore paspalum
	St. Augustinegrass
	Kikuyugrass
	Tall fescue
	Hard fescue
	Red fescue
	Kentucky bluegrass
	Perennial ryegrass
	Highland bentgrass
	Creeping bentgrass
	Colonial bentgrass
	Weeping alkaligrass
Low	Dichondra

Table 4. *Relative salinity tolerance of turfgrasses*



"Turfgrasses vary greatly in their drought and salinity tolerance."

irrigation may wet only the top few inches of soil, may not exhibit as much drought tolerance as the same grasses growing in a soil with adequate subsoil moisture but infrequent rain and/or irrigation.

It is important to note that a "drought tolerant" turfgrass does not necessarily provide a lush green turf under limited irrigation. Most drought tolerant turfgrasses go dormant, lose color, and stop growth under drought situations. They do, however, have the capability to resume growth when moisture becomes available. Non-drought tolerant turfgrasses have a much shorter drought-induced dormancy period before they die than do drought-tolerant species.

Soil Salt Content. Soil salt content can influence irrigation practices. Where soil salinity is a problem, over-irrigation can be helpful for leaching. As a general rule, if the amount of water applied to the soil (irrigation + natural precipitation) exceeds evapotranspiration, salt movement in the soil is downward. Conversely, salt movement is upward if evapotranspiration exceeds the amount of water applied. In the latter case, salt drawn to the soil surface gradually accumulates to levels toxic to turfgrasses. A salinity problem is best prevented by applying water in amounts greater than ET. Accumulated salt is thereby constantly leached downward through the soil profile to below the root zone. This is especially important if reclaimed effluent water which contains already soluble salts is used for irrigation. In severe cases of salinity, planting a salt-tolerant turfgrass (Table 4) also should be considered.

Summary. Irrigation efficiency is affected by many factors. The turfgrass manager interested in adopting efficient and effective irrigation techniques must acquire a thorough understanding of soil-water-turf relationships. This understanding should extend to the role of water in turfgrass growth and development, the influence of climate and soil factors on water utilization by turf, and to the genetic characteristics of turfgrass species grown.

For Your Information:

Gibeault, V.A., J.L. Meyer, V.B. Youngner, M. Mahady, and R. Strohman. 1982. *Irrigation of Turfgrasses for Water Conservation*. A report by University of California and the Metropolitan Water District.

Harivandi, M.A., 1981. Factors in Turfgrass Irrigation. *California Turfgrass Culture*. Vol. 31. No. 2.

Harivandi, M.A. 1981. The Use of Effluent Water for Turfgrass Irrigation. *California Turfgrass Culture*. Vol. 32. No. 3, 4.

Sports Turfgrass Management for Professionals

On May 18th and19th, UCCE environmental horticulture advisors and University Extension will offer a course on current techniques in the art and science of turf management.

The program is specially designed for parks and recreation site managers, athletic turf managers, school and college grounds managers, horticultural consultants, pest control advisors, and other professional turf and landscape managers.

Coordinated by Ali Harivandi, the two-day course will be taught by Steve Cockerham, agricultural operations superintendend, UC Riverside; Jim Delfino, grounds manager, 3 Com Park, San Francisco; John Deming, Enhanced Technical Services, Pacheco; Ali Harivandi, area turf, soil and water advisor, UCCE; and Rex March, vertebrate pest management specialist, UC Davis.

Course fee is $185 (includes course materials and lunches). May 11 is the enrollment deadline. For more information call (530) 757-8899.

Santa Clara Valley Water District
San Jose, California

DRAFT

Technical Memorandum 2

Future Salt and Nutrient Groundwater Quality and Assimilative Capacity

for

Llagas Subbasin

Salt and Nutrient Management Plan

June 2013

Prepared by:

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www.toddengineers.com

INTERIM DRAFT
This Technical Memorandum for the Llagas Subbasin Salt and Nutrient Management Plan is an Interim Draft. Additional information has been received since the draft was prepared but has not yet been incorporated into the document. The final version will incorporate these changes and stakeholder comments as warranted.

6.1.4.4 TDS in Irrigation Return Flow to Groundwater

Water vapor that evaporates from Irrigation water at the soil surface or that is transpired by plants is essentially distilled water with no salt content. Although plants take up some minerals from the soil, their roots actively exclude most salts. Thus, nearly all of the mineral content (TDS) of the irrigation source water remains in the soil. Flushing by winter rains or by applying enough irrigation water to create a small amount of downward percolation (rated as the ent salts from accumulating int salts from accumulating in soils. High salinity rapidly impacts plant growth, and it was assumed for this analysis that growers maintain soil salinity at a more or less constant level from year to year. Accordingly, all of the TDS associated with the source irrigation water is assumed to percolate to groundwater. This corresponds to 4.000 ton/yr in the northern Shallow Aquifer (HSU-1) and 15,700 ton/yr in the southern Shallow Aquifer (HSU-2). The additional added TDS load associated with fertilizer use is assumed to be negligible.

6.1.5 Septic System Percolation Quality

Groundwater is the source of water supply for the unincorporated areas of the subbasin relying on septic systems. A TDS increase of 200 mg/L is assumed to result from household water uses (Kaplan, 1987). There are also added salts from self-regenerating water softeners that discharge brine into the sewer or septic system. Water softeners remove calcium and magnesium from the local groundwater. During the regenerating process, a brine solution is washed through the system to remove the calcium and magnesium that builds up in the water softener. This brine is then discharged into the septic system. A 2009 District survey of over 2,000 homes in the Morgan Hill and Gilroy urban areas found that nearly 20 percent of the homes had water softeners. The added salts from water softeners reported by MWH (2009) are 77 pounds per month for timer-based systems and 28 pounds per month for meter-based systems. Based on District survey data, half of the systems are timer-based and half are meter-based (MWH, 2009). **Table 10** summarizes the concentration of TDS and nitrate-NO_3 in septic system seepage quality.

ZONE 7 WATER AGENCY
100 N. CANYONS PARKWAY
LIVERMORE, CA 94551
(925) 454-5000

Salt Management Plan

Prepared for
Zone 7 Water Agency

MAY 2004

EOA, Inc. / Zone 7—Water Resources

Chapter 5

Zone 7 Salt Balance Calculations

5.1 Introduction

Maintaining a sustainable water supply and a sustainable water quality are key components of successful groundwater basin management and stewardship. To provide a sustainable water supply, a basin must be managed to prevent overdraft. To provide sustainable water quality, a basin must be managed to have a neutral or negative salt balance. The purpose of this chapter is to describe and summarize the salt balance calculations used to monitor the loading to, and thus the sustainability of, the Main Basin groundwater quality.

A sustainable water supply has been assured through Zone 7's practice of maintaining the groundwater basin in long-term hydrologic balance. Overdraft is prevented through a combination of monitoring, detailed inventory tracking, contracts that limit pumping, education/negotiation with prospective extractors, and finally, a commitment to artificially recharge the basin as needed to maintain the basin hydrologic balance.

Attaining sustainable groundwater quality is a Zone 7 goal that has yet to be fully achieved. Zone 7 believes that this goal can be achieved through the control and adjustment of the computed salt balance of the basin. Zone 7 annually computes a basin salt balance using a fundamental salt balance equation: inflow of salts dissolved in water minus outflow of salts dissolved in water equals the change in dissolved salts in the basin.

Zone 7 computes the magnitude of components in the salt balance equation using its extensive hydrologic inventory database. Salts are added to the basin in via various sources of recharge. Natural stream recharge adds water and salt from the Arroyo Valle, Arroyo Mocho and Arroyo Las Positas. Irrigation of urban and agricultural lands adds salt dissolved in the irrigation water. Subsurface inflow from the fringe basins adds water and salts as groundwater flows into the basin. Artificial stream recharge adds water and salts dissolved in the recharge waters. Rainfall does not add salt. However it helps dilute and transport the salts added from urban and agricultural irrigation down to the water table.

Salts are removed from the basin by several hydrologic outflow components. Salts are removed from the Main Basin as water is pumped from wells or gravel mining pits. Some of the extracted municipal pumpage and associated salt (25-30%) is returned to the basin in that portion used for irrigation over the Main Basin. The remainder of the pumpage and salts is either used inside the home and then exported as wastewater in the LAVWMA pipeline or used for irrigation in fringe basin areas where the applied salts do not impact the Main Basin. Some of the mining pumpage is returned to the Main Basin through stream recharge. However, most of this pumpage leaves the basin and valley as stream outflow. Irrigation within the basin removes water through evaporation. However, no salt is removed (the salt remains with the excess irrigation water (percolate) in the soil). Similarly, evaporation removes water from the mining ponds but leaves behind dissolved minerals.

5.2 Salt Loading Calculation Assumptions

One of Zone 7's groundwater basin management tools is the tracking and annual calculation of salt loading to the Main Basin. These salt balance calculations take into account the addition and removal of salt in the Main Basin based on annual water supply and demand. The influx of salts into the Main Basin comes from natural stream recharge, urban irrigation, agricultural irrigation, subsurface groundwater inflow, and artificial recharge. The removal of salts from the Main Basin occurs through groundwater pumpage from the basin for municipal and agricultural purposes, gravel mining related stream exports and off-haul, and groundwater basin outflow. Therefore, the salt balance presents an estimate of the overall effect of salt loading on groundwater quality in the basin based on salt loading at the surface. The final results of the salt balance are presented as annual cumulative changes in the basin-wide TDS concentration and salt loading.

The salt balance calculations include several fundamental and intentionally simplifying assumptions as part of this screening level "spreadsheet" model of the Main Basin. It is assumed that the main groundwater basin is well mixed. Supply and demand components each have associated TDS concentrations based on the given year's monitoring data, some historic data, and a few assumed (otherwise unmeasurable) values. Perhaps the most important simplifying assumption is that all salts applied through irrigation eventually make their way to the underlying groundwater (while in actuality vadose zone processes can delay salt transport for decades). Salts removed by plant uptake and by the application of fertilizers are considered negligible. Percolate quality is assumed to be primarily a function of the differing percent of applied water that recharges throughout the area due to site specific variations in soil characteristics.

Zone 7 performs salt loading calculations in two ways. The first method uses a given year's (e.g., 1998) actual rainfall and recharge volume and water quality data plus that year's land use conditions. This actual annual salt balance is computed using Zone 7's detailed hydrologic inventory data and has been calculated since 1974. The actual balance in any one year is not indicative of long-term trends since there can be substantial year to year variations in recharge and extraction components and also significant changes in basin storage. Very wet years, for example, may show a negative salt balance. A large drop in basin storage due to a drought for example will result in less water in the basin and generally a net loss of salts even though the concentration of salts may increase.

Water Quality Test Data 2013: CCR Table

PASADENA GROUNDWATER AND MWD TREATED SURFACE WATER DATA								
Parameter	MCL	PHG / MCLG / AL	DLR / MRL	Pasadena Wells		MWD Weymouth Plant		Typical Source of Contaminant
				Average	Range	Average	Range	
Primary Standard (Monitored for health concerns)								
Radiologicals (pCi/L)								
Gross Alpha Particle Activity	15	(0)	3	2.7	<DLR - 7.4	<DLR	<DLR - 3	Erosion of natural deposits
Gross Beta Particle Activity (1)	50	(0)	4	4	3 - 5	4	<DLR - 4	Decay of natural and man-made deposits
Uranium	20	0.43	1	4.6	4.2 - 5.6	2	1 - 2	Erosion of natural deposits
Volatile Organic Compounds <DLRs								
Carbon Tetrachloride (ppt) (2)	500	100	500	537	<DLR - 3191	<DLR	<DLR	Discharge from chemical plants and other industrial activities
cis-1,2-Dichloroethylene (c-1,2-DCE) (ppb) (2)	6	100	0.5	0.34	<DLR - 7.78	<DLR	<DLR	Major biodegradation by-product of TCE and PCE groundwater contamination
Tetrachloroethylene (PCE) (ppb) (2)	5	0.06	0.5	0.64	<DLR - 7.39	<DLR	<DLR	Discharge from factories, dry cleaners, and autoshops
Trichloroethylene (TCE) (ppb)	5	1.7	0.5	0.93	<DLR - 3.62	<DLR	<DLR	Discharge from metal degreasing sites and other factories
Inorganic Compounds <DLRs								
Aluminum (ppb)	1,000	600	50	<DLR	<DLR	160	95 - 220	Erosion of natural deposits
Barium (ppb)	1,000	2,000	100	<DLR	<DLR - 140	<DLR	<DLR	Erosion of natural deposits
Chromium (ppb)	50	(100)	0.2	4.0	1.6 - 7.9	<DLR	<DLR	Erosion of natural deposits
Chromium VI (ppb) (4)	n/a	0.02	0.03	3.9	1.2 - 7.3	<DLR	<DLR	Erosion of natural deposits, Industrial waste discharge
Fluoride (ppm)	2	1	0.1	0.9	0.4 - 1.5	0.8	0.7 - 1.3	Water additive for dental health, erosion of natural deposit
Nitrate as N03 (ppm) (2)	45	45	2	27	11 - 54	2	2	Runoff and leaching from fertilizer use, erosion of natural deposits
Perchlorate (ppb) (2)	6	6	2	13.5	<DLR - 45.5	<DLR	<DLR	Industrial waste discharge
Secondary Standard (Monitored for aesthetic qualities such as taste, color, odor) (3)								
Chloride (ppm)	500	n/a		46	16 - 77	88	84 - 91	Runoff and leaching from natural deposits
Color (Units)	15	n/a		8	2 - 59	1	1	Naturally-occurring organic materials
Odor (Units)	3	n/a		1	1 - 1	4	3 - 6	
Specific Conductance (µS/cm)	1600	n/a		690	450 - 928	870	850 - 890	Substances that form ions when in water
Sulfate (ppm)	500	n/a		84	48 - 143	180	170 - 190	Runoff and leaching from natural deposits
Total Dissolved Solids (ppm)	1000	n/a		405	260 - 566	530	520 - 540	
Turbidity (NTU)	5	n/a	0.1	2.3	0.22 - 17.9	<DLR	<DLR	Soil runoff
Other Parameters								
123-Trichloropropane (ppt)	n/a	n/a	5	<DLR	<DLR - 9			Industrial waste discharge
Alkalinity (ppm)	n/a	n/a		170	85 - 203	110	76 - 130	n/a
Boron (ppb)	n/a	n/a		125	100 - 150	150	150	n/a
Calcium (ppm)	n/a	n/a		76	48 - 108	58	56 - 61	n/a
Corrosivity (LSI)	n/a	n/a		0.28	-0.25 - 0.45	0.25 - 0.45	0.4	n/a
Magnesium (ppm)	n/a	n/a		20	5.5 - 35	22	21 - 23	n/a
pH (pH Units)	n/a	n/a		7.65	7.36 - 7.84	8.1	8.1	n/a
Potassium (ppm)	n/a	n/a		2.7	2.5 - 2.9	4.2	4.0 - 4.3	n/a
Sodium (ppm)	n/a	n/a		37	30 - 55	82	79 - 85	n/a
Total Hardness (ppm)	n/a	n/a		270	134 - 403	240	230 - 250	n/a

City of Pasadena 2014 Groundwater and MWD Treated Surface Water Data

Parameter	MCL	PHG / MCLG / AL	DLR / MRL	Pasadena Wells		MWD Weymouth Plant		MCL Violation	Typical Source of Contaminant
				Average	Range	Average	Range		
Primary Standard (Monitored for health concerns)									
Radiologicals (pCi/L)									
Gross Alpha Particle Activity(1)	15	(0)	3	2.7	<DLR – 7.4	<DLR	<DLR – 4	No	Erosion of natural deposits
Gross Beta Particle Activity(2)	50	(0)	4	4	3 – 5	5	<DLR – 6	No	Decay of natural and man-made deposits
Uranium	20	0.43	1	15.1	9.4 – 19	3	2 – 3	No	Erosion of natural deposits
Volatile Organic Compounds									
Carbon Tetrachloride (ppt)(3)	500	100	500	750	<DLR – 2220	<DLR	<DLR	No	Discharge from chemical plants and other industrial activities
cis-1,2-Dichloroethylene (c-1,2-DCE) (ppb)	6	100	0.5	0.10	<DLR – 0.60	<DLR	<DLR	No	Major biodegradation by-product of TCE and PCE groundwater contamination
Tetrachloroethylene (PCE) (ppb)	5	0.06	0.5	0.63	<DLR – 2.86	<DLR	<DLR	No	Discharge from factories, dry cleaners, and autoshops
Trichloroethylene (TCE) (ppb)	5	1.7	0.5	1.40	<DLR – 5.24	<DLR	<DLR	No	Discharge from metal degreasing sites and other factories
Inorganic Compounds									
Aluminum (ppb)	1000	600	50	<DLR	<DLR – 41	136	70 – 230	No	Erosion of natural deposits
Barium (ppb)	1000	2000	100	75	22 – 170	112	112	No	Erosion of natural deposits
Chromium (ppb)	50	(100)	0.2	2.2	<DLR – 5.5	<DLR	<DLR	No	Erosion of natural deposits
Chromium VI (ppb)(5)	n/a	0.02	1	3.1	1.9 – 6.1	<DLR	<DLR	No	Erosion of natural deposits, industrial waste discharge
Fluoride (ppm)	2	1	0.1	0.7	0.3 – 1.5	0.8	0.6 – 1.0	No	Water additive for dental health, erosion of natural deposit
Nitrate (ppm)(3)	45	45	2	29	12 – 56	<DLR	<DLR	No	Runoff and leaching from fertilizer use, erosion of natural deposits
Perchlorate (ppb)(3)	6	6	4	10	<DLR – 27	<DLR	<DLR	No	Industrial waste discharge
Secondary Standard (Monitored for aesthetic qualities such as taste, color, odor)(4)									
Chloride (ppm)	500	n/a	n/a	49	16 – 88	89	86 – 92	No	Runoff and leaching from natural deposits
Color (Units)	15	n/a	n/a	5.7	1 – 14	1	1	No	Naturally-occurring organic materials
Odor (Units)	3	n/a	1	0.2	0 – 1	2	2	No	Naturally-occurring organic materials
Specific Conductance (μS/cm)	1600	n/a	n/a	705	432 – 986	987	964 – 1010	No	Substances that form ions when in water
Sulfate (ppm)	500	n/a	0.5	72	11 – 136	233	227 – 238	No	Runoff and leaching from natural deposits
Total Dissolved Solids (ppm)	1000	n/a	n/a	402	242 – 582	623	604 – 641	No	Runoff and leaching from natural deposits
Turbidity (NTU)	5	n/a	0.1	0.6	0.1 – 2.3	<DLR	<DLR	No	Soil runoff
Other Parameters									
123-Trichloropropane (ppt)	n/a	n/a	5	<DLR	<DLR – 10	NA	NA	No	Industrial waste discharge
Alkalinity (ppm)	n/a	n/a	n/a	166	88 – 196	128	127 – 128	No	n/a
Boron (ppb)	n/a	n/a	100	125	100 – 150	110	110	No	n/a
Calcium (ppm)	n/a	n/a	n/a	74	39 – 106	74	74	No	n/a
Corrosivity (LSI)	n/a	n/a	n/a	-0.35	-0.93 – 0.00	12.5	12.5	No	n/a
Magnesium (ppm)	n/a	n/a	n/a	21	3 – 42	25	25 – 26	No	n/a
pH (pH Units)	n/a	n/a	n/a	7.01	6.57 – 7.48	8.1	8.1	No	n/a
Potassium (ppm)	n/a	n/a	n/a	2.7	2.5 – 2.9	4.6	4.4 – 4.7	No	n/a
Sodium (ppm)	n/a	n/a	n/a	39	28 – 56	93	89 – 96	No	n/a
Total Hardness (ppm)	n/a	n/a	n/a	270	120 – 430	289	284 – 294	No	n/a

Understanding the Water Quality Chart(3)

As in previous years, the Water Quality Report compares the quality of your tap water to state drinking water standards. The report includes information on all regulated and unregulated drinking water contaminants that were detected during calendar year 2014. More than 100 regulated contaminants that were tested for, but not detected, are not included in this report. A number of regulated chemicals and other compounds do not require annual monitoring. Their most recent test results and corresponding test year are footnoted, if applicable. DDW allows us to monitor for some contaminants less than once per year because the concentrations of these contaminants do not change frequently. Some of our data, though representative, are more than one year old.

Maximum Contaminant Level (MCL): The highest level of a contaminant that is allowed in drinking water. Primary MCLs are set as close to the PHGs (or MCLGs) as is economically and technologically feasible. Secondary MCLs are set to protect the odor, taste, and appearance of drinking water.

Maximum Contaminant Level Goal (MCLG): The level of a contaminant in drinking water below which there is no known or expected risk to health. MCLGs are set by the U.S. Environmental Protection Agency.

Public Health Goal (PHG): The level of a contaminant in drinking water below which there is no known or expected risk to health. PHGs are set by the California Environmental Protection Agency.

Maximum Residual Disinfectant Level (MRDL): The highest level of a disinfectant allowed in drinking water. There is convincing evidence that addition of a disinfectant is necessary for control of microbial contaminants.

Primary Drinking Water Standard (PDWS): MCLs and MRDLs for contaminants that affect health along with their monitoring and reporting requirements, and water treatment requirements.

Maximum Residual Disinfectant Level Goal (MRDLG): The level of a drinking water disinfectant below which there is no known or expected risk to health. MRDLGs do not reflect the benefits of the use of disinfectants to control microbial contaminants.

Detection Limits for Purposes of Reporting (DLR): The DLR is a parameter that is set by regulation for each reportable analyte. It is not laboratory specific and it is independent of the analytical method used (in cases where several methods are approved). It is expected that a laboratory can achieve a Reporting Limit that is lower than or equal to the DLR set by the DDW. This is also known as the Minimum Reporting Level (MRL).

NA: Contaminant or property was not analyzed.

n/a: Not applicable.

ND: Contaminant was not detected. The contaminant is less than the DLR.

Regulatory Action Level (AL): The concentration of a contaminant which, if exceeded, triggers treatment or other requirements that a water system must follow.

Units of Measurement:

ppm = parts per million **ppb** = parts per billion
ppt = parts per trillion **pCi/L** = picocuries per liter
LSI = Langelier Saturation Index
μS/cm = microsiemens per centimeter
NTU = Nephelometric Turbidity Units.

City of Pasadena 2015 Groundwater and MWD Treated Surface Water Data

Parameter	MCL	PHG / MCLG / AL	DLR / MRL	Pasadena Wells		MWD Weymouth Plant		MCL Violation	Typical Source of Contaminant
				Average	Range	Average	Range		
Primary Standard (Monitored for health concerns)									
Radiologicals (pCi/L)									
Gross Alpha Particle Activity(1)	15	n/a	3	6.7	<DLR – 17	<DLR	<DLR – 4	No	Erosion of natural deposits
Gross Beta Particle Activity(2)	50	n/a	4	4.4	3.2 – 6.1	5	4 – 6	No	Decay of natural and man-made deposits
Uranium(1)	20	0.43	1	7.3	4.2 – 15	3	3	No	Erosion of natural deposits
Volatile Organic Compounds									
Carbon Tetrachloride (ppt)(3)	500	100	500	970.0	<DLR – 1340	<DLR	<DLR	No	Discharge from chemical plants and other industrial activities
cis-1,2-Dichloroethylene (c-1,2-DCE) (ppb)	6	100	0.5	0.7	<DLR – 1.12	<DLR	<DLR	No	Major biodegradation by-product of TCE and PCE groundwater contamination
Tetrachloroethylene (PCE) (ppb)	5	0.06	0.5	0.8	<DLR – 2.4	<DLR	<DLR	No	Discharge from factories, dry cleaners, and autoshops
Trichloroethylene (TCE) (ppb)	5	1.7	0.5	1.7	<DLR – 6.5	<DLR	<DLR	No	Discharge from metal degreasing sites and other factories
Inorganic Compounds									
Aluminum (ppb)(4)	1000	600	50	<DLR	<DLR – 41	156	88 – 200	No	Erosion of natural deposits
Barium (ppb)(4)	1000	2000	100	68.6	22 – 170	122	122	No	Erosion of natural deposits
Chromium (ppb)(4)	50	(100)	0.2	3.6	<DLR – 6.3	<DLR	<DLR	No	Erosion of natural deposits
Chromium VI (ppb)	10	0.02	1	3.4	1.1 – 7.2	<DLR	<DLR	No	Erosion of natural deposits, industrial waste discharge
Fluoride (ppm)	2	1	0.1	0.9	0.3 – 1.5	0.7	0.6 – 1.0	No	Water additive for dental health, erosion of natural deposit
Nitrate (ppm)(3)	45	45	0.4	28.4	12.9 – 55.6	<DLR	<DLR	No	Runoff and leaching from fertilizer use, erosion of natural deposits
Perchlorate (ppb)(3)	6	1	4	9.8	<DLR – 17.4	<DLR	<DLR	No	Industrial waste discharge
Secondary Standard (Monitored for aesthetic qualities such as taste, color, odor)(5)									
Chloride (ppm)	500	n/a	n/a	46.7	16.4 – 96.6	100	98 – 102	No	Runoff and leaching from natural deposits
Color (Units)	15	n/a	n/a	3.1	1 – 5	1	1	No	Naturally-occurring organic materials
Odor (Units)	3	n/a	1	0.0	0	2	2	No	Naturally-occurring organic materials
Specific Conductance (μS/cm)	1600	n/a	n/a	748.0	504 – 1087	1040	1030 – 1060	No	Substances that form ions when in water
Sulfate (ppm)	500	n/a	0.5	84.0	27.3 – 149	257	252 – 261	No	Runoff and leaching from natural deposits
Total Dissolved Solids (ppm)	1000	n/a	n/a	477.2	298 – 698	660	654 – 665	No	Runoff and leaching from natural deposits
Turbidity (NTU)	5	n/a	0.1	0.3	0.14 – 0.61	<DLR	<DLR	No	Soil runoff
Other Parameters									
123-Trichloropropane (ppt)	n/a	0.7	5	<DLR	<DLR – 7.5	NA	NA	No	Industrial waste discharge
Alkalinity (ppm)	n/a	n/a	n/a	177.8	110 – 206	126	123 – 129	No	n/a
Calcium (ppm)	n/a	n/a	n/a	79.1	43.3 – 123	78	77 – 78	No	n/a
Corrosivity (LSI)	n/a	n/a	n/a	0.08	-0.09 – 0.25	0.57	0.56 – 0.58	No	n/a
Magnesium (ppm)	n/a	n/a	n/a	23.7	10.7 – 37.8	27	26 – 28	No	n/a
pH (pH Units)	n/a	n/a	n/a	7.5	7.1 – 7.95	8.1	8.1	No	n/a
Potassium (ppm)(6)	n/a	n/a	n/a	2.7	2.5 – 2.9	4.9	4.8 – 5.0	No	n/a
Sodium (ppm)	n/a	n/a	n/a	31.3	23 – 36	100	97 – 102	No	n/a

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