Attachment A to Resolution No. R16-0XX

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 Basin

Table of Contents

I. Salt and Nutrient Management Plans

II. Basin-Specific Salt and Nutrient Management Plans

E. Raymond Basin

Adopted by the California Regional Water Quality Control Board, Los Angeles Region on December 8, 2016.

Approved by:

The State Water Resources Control Board on [Insert Date].
The Office of Administrative Law on [Insert Date].

The program of implementation[1] described below is based on the Salt and Nutrient Management Plan for the Raymond Groundwater Basin developed by the Raymond Basin Management Board in consultation with the Metropolitan Water District of Southern California, the Los Angeles County Sanitation Districts, the Los Angeles County Department of Public Works, and other basin stakeholders. The Salt and Nutrient Management Plan and this program of implementation satisfy the Recycled Water Policy requirements for Salt and Nutrient Management Plans.

The following summarizes the essential elements of the Salt and Nutrient Management Plan for the Raymond Groundwater Basin. Further details may be found in the full document at: http://www.waterboards.ca.gov/losangeles/water_issues/programs/salt_and_nutrient_management/index.shtml

Background

The Raymond Groundwater Basin underlies the north westerly portion of the San Gabriel Valley in Los Angeles County. It is bounded on the north by the San Gabriel Mountains, on the west by the San Rafael Hills and on the southeast by the Raymond Fault, which separates the basin from the downgradient Main San Gabriel Basin. Raymond Basin has a surface area of approximately 40.9 square miles and consists of three sub-units: (i) the Monk Hill Subarea, which underlies the City of La Canada Flintridge and the northwestern portion of the City of

[1] The Recycled Water Policy refers to "revised implementation plans" for adoption into regional basin plans pursuant to Water Code section 13242. Water Code section 13242 uses the term "program of implementation." Pursuant to Water Code section 13242, "[t]he program of implementation for achieving water quality objectives shall include, but not be limited to:
(a) A description of the nature of actions which are necessary to achieve the objectives, including recommendations for appropriate action by any entity, public or private.
(b) A time schedule for the actions to be taken.
(c) A description of surveillance to be undertaken to determine compliance with objectives."

Pasadena, (ii) the Pasadena Subarea, which underlies most of the City of Pasadena and the unincorporated county area of Altadena, and (iii) the Santa Anita Subarea, which underlies the Cities of Arcadia and Sierra Madre (Figure 8.5-1). The land area overlying the Raymond Basin is largely urbanized with little agricultural land.

The principal streams overlying the basin are (i) the Arroyo Seco, which drains the Monk Hill Subarea and part of the Pasadena Subarea to the Los Angeles River, (ii) Eaton Wash, which drains the Pasadena Subarea and flows to the Rio Hondo, and (iii) Santa Anita Wash, which drains the Santa Anita Subarea and flows into the Rio Hondo.

The Raymond Basin is a structural basin filled with permeable alluvial deposits, which is underlain and surrounded by relatively impermeable rock. The Basin aquifer is stratified in some areas by confining or semi-confining layers consisting of impermeable or less-permeable materials such as clay or silt. The Basin aquifer is generally classified as an unconfined to semi-confined aquifer system because the semi-confining or confining layers are not continuous across the Basin. The base of the water bearing zones is considered bedrock with elevations ranging from approximately 500 feet below sea level to 2,000 feet above mean sea level. Depth to bedrock ranges from 450 to 750 feet below ground surface (bgs) in the Monk Hill and Santa Anita subareas to more than 1,200 feet bgs in the Pasadena subarea. Groundwater generally flows southeast from the Monk Hill Subarea in the northwest to the Raymond fault in the southeast.

Natural recharge to the basin consists of direct rainfall, percolation of streamflow from the northern and western sides, underflow from the Verdugo Basin and mountain front recharge. Artificial recharge of the Raymond Basin occurs via infiltration of stormwater runoff in all three subareas and, to a lesser degree, injection of treated imported water in the Monk Hill and Pasadena subareas.

Groundwater supplies fifty percent of the potable water demands for water suppliers in the basin. The balance of the demand has historically been met through the purchase of treated imported water from the Metropolitan Water District's Weymouth Treatment Plant (along with a groundwater impaction/withdrawal program historically conducted by the Valley Water Company in the Monk Hill Subarea).

Basin Management

From 1913 through the 1930s, over-pumping of the Raymond Basin caused significant groundwater level declines. To remedy the problem, the courts adjudicated the basin in 1943 and set a limit on allowable groundwater production. At the time, the State Department of Water Resources was appointed as the Watermaster. However, in 1984 the judgement was amended to form the Raymond Basin Management Board (RBMB), which now serves as Watermaster. The Management Board consists of ten representatives appointed by the water purveyors within the basin. The RBMB is presently composed of members from the City of Pasadena, the Lincoln Avenue Water Company, Rubio Canon Land and Water, the City of Alhambra, the City of

Arcadia, California-American Water, Kinneloa Irrigation District, San Gabriel County Water District, City of Sierra Madre and Sunny Slope Water Company. The RBMB is charged with the powers and responsibilities of managing the Raymond Basin and protecting the long-term quantity and quality of the groundwater supply.

Basin management measures that the RBMB is involved with include:

- Management and control of the withdrawal and replenishment of water supplies in the Basin.
- Implementation of the annual Operating Safe Yield (the amount of groundwater that can safely be extracted) for the succeeding fiscal year, and notification of the pumpers regarding production totals on a monthly basis.
- Coordination of spreading and storage activities.
- Coordination of local involvement in efforts to preserve and restore the quality of groundwater in the Basin.
- Assistance with enforcement of water quality regulations affecting the Basin.
- Collection of production, water quality, and other relevant data from producers.
- Preparation of an annual report of Watermaster activities, including financial activities, and summary reports of pumping and diversion.
- Participation on the Greater Los Angeles County Integrated Water Resource Management Leadership Committee, as a Groundwater Representative.

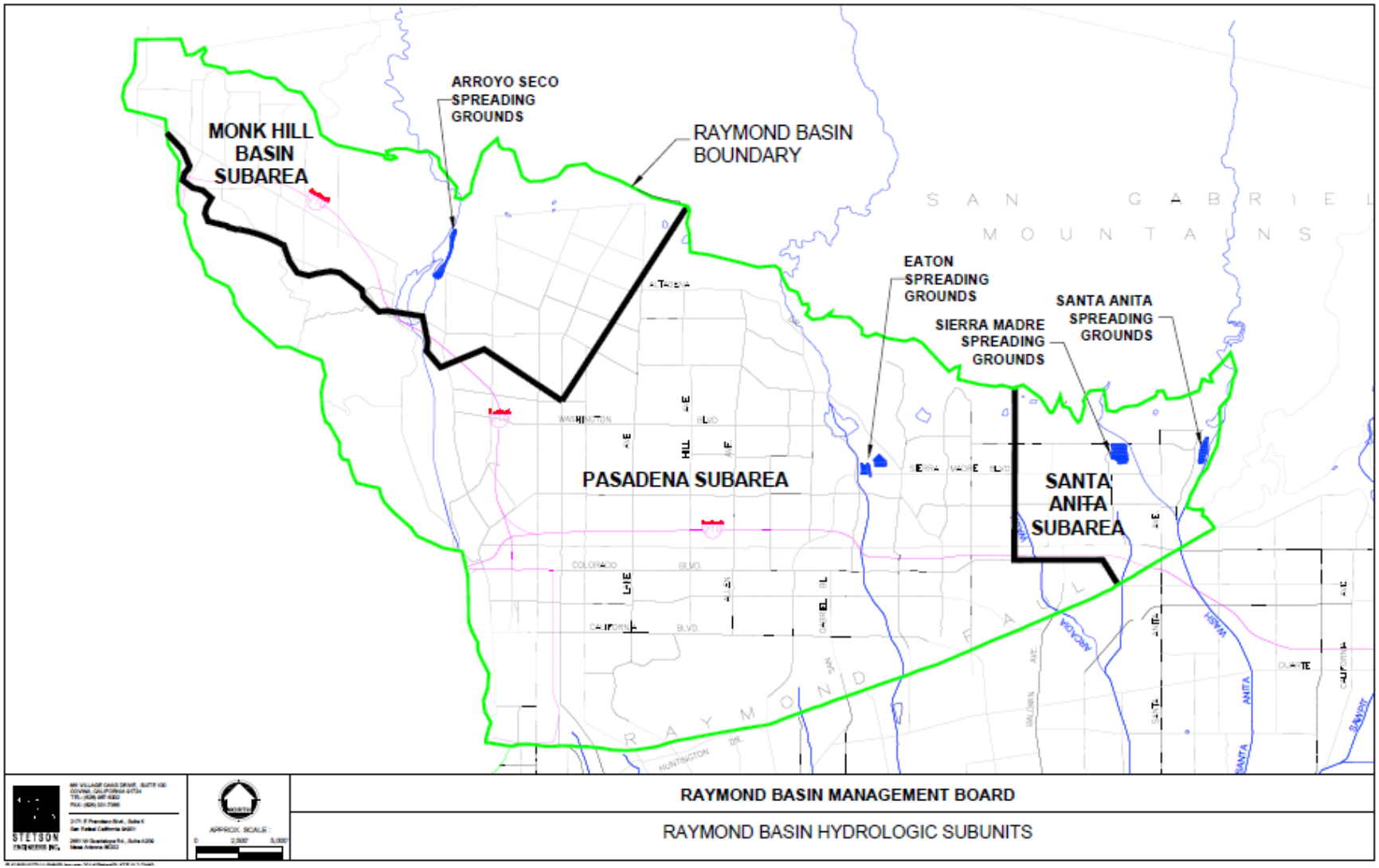

Figure 8.5-1: Raymond Basin's Salt and Nutrient Management Plan Area

Participating Agencies

The Raymond Basin Management Board (RBMB) is the lead agency for the development of the SNMP for the Basin (Raymond Basin SNMP) in conjunction with local salt/nutrient contributing stakeholders, including: the Los Angeles County Sanitation Districts (LACSD); the County of Los Angeles Department of Public Works (LACDPW), who is responsible for stormwater recharge; and the Metropolitan Water District of Southern California (MWD), who is responsible for the delivery of imported water in the Raymond Basin.

Sources of Water in the Raymond Basin

Sources of water supply in the Raymond Basin area include local groundwater and treated imported water from the Weymouth Treatment Planted operated by MWD. Return flow from these sources recharges the Raymond Basin. Other major sources of basin recharge include precipitation and mountain front recharge.

TABLE 8.5-1: CONTRIBUTIONS OF SOURCE WATERS TO THE RAYMOND BASIN

TYPE	SOURCE	CONTRIBUTION TO GROUNDWATER
Surface water	Arroyo Seco	Diverted to spreading grounds for basin recharge
Imported Water	Metropolitan Water District – blend of State Water Project and Colorado River Water	Water supply within the Raymond Basin area Storage and extraction in the Monk Hill Subarea
Groundwater	Extracted from the Raymond Basin	Water supply in the Raymond Basin area
	Subsurface flow from the Verdugo Basin	Recharge of the Raymond Basin
Stormwater	Precipitation from overlying areas	Active capture and recharge through stormwater retention and spreading basins. Infiltration of precipitation directly into the alluvium where land is not covered with impervious surfaces. Additionally, infiltration of precipitation from upland areas in the form of groundwater recharge at the basin's margins.

Groundwater outflow from the Raymond Basin includes pumping and subsurface outflow to other basins.

Salt and Nutrient Loading to the Raymond Basin

The mass balances (inputs and outflows) for total dissolved solids (TDS), chloride, nitrate-N, and sulfate from the various sources of water are presented below for the Raymond Basin. These values represent a baseline period from Water Years 2002-03 to 2012-13. Loads from the imported water, while not specifically listed, are reflected in the loads from return flow.

TABLE 8.5-2A: SALT AND NUTRIENT BALANCE IN MONK HILL SUBAREA (2002/03 THROUGH 2011/12)

Source Water	TDS		Chloride		Nitrate		Sulfate	
	tons	%	tons	%	tons	%	tons	%
Precipitation	31.3	30.2	179	22.1	31.3	30.2	269.5	29.6
Return Flow	24.7	23.9	161	19.9	24.7	23.9	311.0	19.4
Direct Spreading and Injection	25.5	24.6	291.5	36.0	25.5	24.6	491.0	29.1
Underflow from Verdugo Basin	22.1	21.4	179	28.7	22.1	21.4	282	27.3
Total Inflow	**103.6**	**100**	**810.5**	**100**	**103.6**	**100**	**1353.5**	**100**
Groundwater Production	42.6	44.5	250	44.2	42.6	44.5	433.5	44.5
Underflow to Pasadena Subarea	53.2	55.5	310	55.8	53.2	55.5	547.5	55.5
Total Outflow	**95.8**	**100.0**	**560**	**100**	**95.8**	**100**	**981**	**100**
Annual Change in Mass	7.8		250		7.8		372.5	

TABLE 8.5-2B: SALT AND NUTRIENT BALANCE IN THE PASADENA SUBAREA (2002/03 THROUGH 2011/12)

Source Water	TDS		Chloride		Nitrate		Sulfate	
	tons	%	tons	%	tons	%	tons	%
Precipitation	471.5	7.9	115.0	12.7	15.5	13.4	165.0	10.2
Return Flow	3479.5	58.4	308.0	34.1	53.1	45.8	544.5	33.5
Direct Spreading and Injection	1544.5	25.9	380.0	42.1	33.3	28.8	747.0	46.0
Underflow from Monk Hill Subarea	461.5	9.5	99.0	11.0	14.0	12.1	167.5	17.6
Total Inflow	5957.0	100	902.0	100	115.9	100	1623.5	100
Groundwater Production	2603.0	53.3	271.0	54.0	56.0	53.4	508.0	53.3
Underflow to Santa Anita Subarea	2277.0	46.7	230.5	46.0	48.7	46.4	445.5	46.7
Underflow to Main San Gabriel Basin	4880.0	100	501.5	100	104.8	100	953.5	100
Total Outflow	**1077.5**		**400.5**		**11.2**	**13.4**	**670.0**	
Annual Change in	471.5	7.9	115.0	12.7	15.5		165.0	10.2

Source Water	TDS		Chloride		Nitrate		Sulfate	
	tons	%	tons	%	tons	%	tons	%
Mass								

TABLE 8.5-2C: SALT AND NUTRIENT BALANCE IN THE SANTA ANITA SUBAREA (2002/03 THROUGH 2011/12)

Source Water	TDS		Chloride		Nitrate		Sulfate	
	tons	%	tons	%	tons	%	tons	%
Precipitation	772.0	34.4	28.0	25.5	9.8	30.5	101.5	32.4
Return Flow	424.5	18.9	41.0	37.3	9.0	28.1	83.0	26.5
Direct Spreading	371.5	16.5	17.0	15.5	4.4	13.7	39.0	12.5
Underflow from Pasadena Subarea	678.0	26.0	24.0	21.8	8.9	27.7	89.5	29.9
Total Inflow	**2245.5**	**100**	**110.0**	**100**	**32.2**	**100**	**313.0**	**100**
Groundwater Production	2385.0	91.3	132.5	91.4	35.7	90.8	268.0	89.5
Underflow to Main San Gabriel Basin	227.5	8.7	12.0	8.3	3.6	9.2	31.0	10.4
Total Outflow	**2612.0**	**100**	**145.0**	**100**	**39.3**	**100**	**299.5**	**100**
Annual Change in Mass	-366.5		-35.0		-7.1		13.5	

Groundwater Quality and Assimilative Capacity in the Raymond Basin

Groundwater quality data was available from the existing State Water Resources Control Board Department of Drinking Water's Title 22 monitoring program, which requires "General Mineral" compliance sampling that includes nitrate, chloride, sulfate, and Total Dissolved Solids (TDS). Sampling for TDS, chloride and sulfate is conducted every three years, while sampling for nitrate is conducted annually. A data set from 2002 through 2011 was used to assess current water quality conditions. Mean annual constituent concentrations were calculated as the arithmetic average concentration of all available water quality data at the production wells within each subarea. The average TDS, chloride, sulfate and nitrate-N concentrations for each of the subareas were compared to the applicable basin water quality objectives to determine the existing available assimilative capacity (Table 8.5-3). Assimilative capacity is estimated as the difference between the water quality objectives and the existing groundwater quality for each subarea.

TABLE 8.5-3: AVERAGE GROUNDWATER QUALITY AND AVAILABLE ASSIMILATIVE CAPACITY IN RAYMOND BASIN

Raymond Basin Subarea	Water Quality Objective (mg/l)	Current Water Quality (mg/l)	Available Assimilative Capacity (mg/l)
Total Dissolved Solids (TDS)			
Monk Hill	450	411.0	39.0
Pasadena		363.0	87.0
Santa Anita		268.0	182
Nitrate - N			
Monk Hill	10	8.1	1.9
Pasadena		7.5	2.5
Santa Anita		4.1	5.9
Chlorides			
Monk Hill	100	43.0	**57.0**
Pasadena		**34.0**	**66.0**
Santa Anita		**15.0**	**85.0**
Sulfates			
Monk Hill	100	**66.0**	**34.0**
Pasadena		**73.0**	**27.0**
Santa Anita		**35.0**	**65.0**

On average, groundwater quality in each subarea is currently below Basin Plan objectives for TDS, chlorides, sulfates, and nitrate, and assimilative capacity is available for all constituents. However, review of available data suggests an increasing trend for TDS, chloride, and sulfate concentrations in the Monk Hill and Pasadena subareas. Also, there is considerable annual variation in water quality for each constituent. Generally, water quality concentrations vary with many environmental factors, including the volume of groundwater in storage. The water quality concentrations in the

Raymond Basin appear to be inversely related to groundwater in storage, increasing as groundwater levels decrease, and vice versa.

Salt and Nutrient Management Measures in the Raymond Basin

Existing salt and nutrient management measures in the Raymond Basin include: actions/programs that are intended to sustain groundwater recharge, monitor water quality conditions, and control salinity in waters imported into the basin. Potential management measures include increasing groundwater recharge and promoting onsite stormwater capture and retention. These management measures are summarized in Table 8.5-4.

TABLE 8.5-4: EXISTING AND POTENTIAL SALT AND NUTRIENT MANAGEMENT MEASURES IN THE RAYMOND BASIN

Category	Program/Project	Description
Groundwater Management and Adaptation	Basin Adjudication (Existing)	Focus on protecting the long-term quantity and quality of the groundwater supply.
Water Quality Monitoring/Management	Title 22 Water Quality Monitoring Program (Existing)	Title 22 Monitoring requirements to track mineral water quality (along with other parameters). Monitoring results dictate actions to be taken (e.g. groundwater treatment facilities, water quality blending plans) to maintain production from wells.
	SNMP Monitoring Program (Planned)	RBMB will implement a proposed monitoring plan as required by the Recycled Water Policy. Water quality data will be reported to the LARWQCB at least every three years. The sampling frequency for salts and nutrients will be periodically evaluated and adjusted accordingly as necessary.
Groundwater Replenishment	Maintain Existing Spreading Grounds	LACDPW maintains a complex system of dams, retention basins, storm channels and off-stream spreading grounds to control stormwater runoff and to maximize replenishment of the stormwater flow. The existing spreading grounds are operated to enable stormwater runoff to be replenished into each of the subareas in an efficient and effective manner. A lesser source of replenishment is injection of treated imported water into the Monk Hill subarea. Local stormwater replenished in these facilities typically has the lowest concentrations of TDS, nitrate, sulfate, and chloride of the various sources contributing to loading. Artificial recharge of stormwater runoff occurs in off-stream spreading grounds located off the Arroyo Seco, Eaton Wash, and Santa Anita Wash. The stormwater augments naturally occurring groundwater replenishment from precipitation. Replenishment of high quality stormwater contributes to the long-term enhancement of groundwater quality.
	Develop new spreading facilities (Potential)	The RBMB and LACDPW continually investigate opportunities to expand the network of spreading

Category	Program/Project	Description
		grounds. Potential new sites include existing debris basins.
Improve Imported Water Quality	Imported Water - Regional Salinity Control (Existing)	The MWD is responsible for all treated imported water used in the Raymond Basin and that water is from the Weymouth Treatment Plant. MWD has a goal to maintain the TDS concentrations at or below 500 mg/l. This is done through blending SWP water with Colorado River water.
Stormwater Capture and Runoff Management	Reduce Stormwater Runoff (Planned)	Cities within the Raymond Basin are co-permittees under the Los Angeles County MS4 Permit. As such, cities are directed to take proactive steps, both individually and collectively, to implement stormwater Best Management Practices (BMPs) to reduce or eliminate stormwater runoff from facilities and consequently reduce flow in storm channels. These practices may result in increased stormwater replenishment.

Projected Impacts of Future Projects on Water Quality (Assimilative Capacity Use)

A mass balance spreadsheet model was developed as an assimilative capacity assessment tool to calculate the impacts of additional future salt and nutrient loadings on existing assimilative capacity in the basin. In the absence of actual planned recycled water projects, a hypothetical groundwater replenishment project with water quality similar to other local recycled water projects was evaluated. The analysis determined the maximum annual recharge of water from this project that could occur in each subarea (Monk Hill, Pasadena, and Santa Anita) of the Raymond Basin before exceeding 10 percent of the assimilative capacity for any of the salt and nutrient parameters. Results of this analysis are presented in Table 8.5-5.

TABLE 8.5-5: PROJECTED ASSIMILATIVE CAPACITY USE (%) BY FUTURE RECYCLED WATER PROJECTS (Hypothetical Scenario)

Time Period	TDS	Chloride	Sulfate	Nitrate
Percent Utilization of Assimilative Capacity (%)				
Monk Hill Maximum Annual Recharge*: 225 acre-feet per year*				
10 years	5.2	4.0	2.0	0.0
20 years	7.6	2.8	5.9	0.0
Equilibrium*	10	3.6	7.7	0.0
Pasadena Maximum Annual Recharge*: 405 acre-feet per year*				
10 years				
20 years	3.9	2.8	5.3	-1.0
Equilibrium*	7.5	4.5	10.0	-1.8
Santa Anita Maximum Annual Recharge*: 245 acre-feet per year*				
10 years				
20 years	8.0	5.6	8.3	0.7
Equilibrium*	9.7	6.8	10.0	0.8

Per the analysis, equilibrium will be reached after a period of 100 years.

The assimilative capacity assessment tool provides a valuable management tool that can be employed in decisions concerning use of new water for aquifer recharge. It is capable of identifying the mineral constituents in the water that will most limit the volume of new water that can be used for recharge without passing a defined assimilative capacity threshold, e.g., 10 percent (as in this scenario), as well as evaluate the effects of groundwater replenishment with water having different water quality characteristics.

Salt and Nutrient Load Limits

Salt and nutrient loads to the Raymond Basin will be managed with the existing and potential programs/projects discussed above. These measures are designed to protect long-term quantity and quality of the groundwater supply. Assignment of allocations for salts and nutrients is not warranted at this time. However, additional management measures will be considered where review of monitoring data indicates that it is warranted.

Monitoring Program

Groundwater monitoring for salt and nutrient management plan implementation will rely on water quality monitoring conducted as part of the State Water Resources Control Board Department of Drinking Water's Title 22 Water Quality Monitoring Program for which water samples are collected from potable supply wells throughout the basin and analyzed for a variety of parameters including TDS, chloride, sulfate and nitrate-N. This sampling program monitors groundwater quality within the basins and can be used to assess spatial and temporal changes in salt and nutrient concentrations. This monitoring may also help confirm the source/cause of increasing concentrations in the Pasadena and Monk Hill subareas and assist with identifying potential management measures to address them. Elements of the program are laid out in Table 8.5-6.

TABLE 8.5-6: MONITORING PROGRAM ELEMENTS

<table>
<tr><th>Element</th><th>Description</th></tr>
<tr><td>Responsible Agency</td><td>Raymond Basin Management Board</td></tr>
<tr><td>Program Origin</td><td>Title 22 Water Quality Monitoring Program</td></tr>
<tr><td>Parameters and Monitoring Frequency</td><td>
<table>
<tr><th>Parameter</th><th>Monitoring Frequency</th></tr>
<tr><td>Nitrate-N</td><td>Annually</td></tr>
<tr><td>Total Dissolved Solids</td><td rowspan="3">Triennially*</td></tr>
<tr><td>Chloride</td></tr>
<tr><td>Sulfate</td></tr>
</table>
</td></tr>
<tr><td>Monitoring Locations</td><td>Potable water supply wells spatially distributed throughout the Raymond Basin's three subareas.</td></tr>
<tr><td>Reporting Requirements</td><td>Triennial report of monitoring results. TDS, chloride, sulfate and nitrate-N data collected from the Title 22 Water Quality Monitoring Program will be uploaded to the State Water Board's online GeoTracker database.</td></tr>
<tr><td>Review Period</td><td>Data collected from the monitoring program will be reviewed periodically to evaluate basin water quality conditions and trends.</td></tr>
</table>

*In response to the trend of increasing TDS concentrations in the Monk Hill and Pasadena subareas, the RBMB will increase the frequency of monitoring of TDS in production wells to at least once annually to gather more annual data to evaluate future trends.

Updates to the Salt and Nutrient Management Measures

Salt and nutrient management measures will be updated (i) as necessary to reflect changing conditions in the Raymond Basin (e.g. drought conditions, changes in current or projected salt and nutrient loads to the basin, and/or changes in land use), (ii) where results from the SNMP Monitoring Program indicate that revisions/modifications are warranted, (iii) if needed to address modified or additional recycled water projects, and/or (iv) at the end of a 10-year planning horizon (i.e. 2025).

Regulatory Implications

The salt and nutrient management strategies developed by the Raymond Basin stakeholders are measures designed to provide a framework for the long-term management of salts and nutrients in the Raymond Basin, while supporting increased use of recycled water. These strategies will be applied in conjunction with already existing groundwater quality protection measures in the planning area (e.g., cleanup operations).

Where additional projects have the potential to impact salt and/or nutrient loads to the basin, consideration will be given to water quality conditions and the corresponding assimilative capacity in localized areas during the permitting process or the development of other Regional Water Board regulatory actions.