Salt/Nutrient Management Plan for the Los Osos Groundwater Basin

January 9, 2018

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- Board of Directors, Los Osos Basin Management Committee
- San Luis Obispo County (County)
- Los Osos Community Services District (LOCSD)
- Golden State Water Company (GSWC),
- S&T Mutual Water Company (S&T)
- Central Coast Regional Water Quality Control Board (CCRWQCB)
- Cleath-Harris Geologist

Thank you for your contribution of time, data, and expertise.

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µg/L	Micrograms per liter
AF	Acre-feet
AFY	Acre-feet Per year
Agricultural Order	Conditional Waiver of Waste Discharge Requirements for Discharges from Irrigated Lands
Basin	Los Osos Groundwater Basin
Basin Plan	Central Coast Basin Water Quality Control Plan
BBMR	Basin Boundary Modification Request
BMC	Basin Management Committee
BMP	Best Management Practices

CA-NL	California State National Level
CASGEM	California Statewide Groundwater Elevation Monitoring
CASQA	California Stormwater Quality Association
CCR	California Code of Regulations
CCRWQCB	Central Coast Regional Water Quality Control Board
CDP	Coastal Development Permit
CDPH	California Department of Public Health
CEC	Constituent of Emerging Concern
Central Coast RWQCB	Central Coast Regional Water Quality Control Board
Central Coast Basin Plan	Central Coast Water Quality Control Plan
cfs	Cubic feet per second
CIMIS	California Irrigation Management Information System
Cl	Chloride
Coastal Commission	California Coastal Commission
County	San Luis Obispo County
CPUC	California Public Utilities Commission
DDW	SWRCB's Division of Drinking Water
District	San Luis Obispo County Flood Control and Water Conservation District
DWR	Department of Water Resources
EC	Electrical conductance
EFH	Equivalent Freshwater Head
EIR	Environmental Impact Report
EMP	Environmental Monitoring Program
EPA	U.S. Environmental Protection Agency
ES	Executive Summary
ETo	Evapotranspiration
GAMA	Groundwater Ambient Monitoring and Assessment
gpd/ft^2	Gallons per day per square foot
GPM	Gallons per minute
GSP	Groundwater Sustainability Plan
GSWC	Golden State Water Company
Guidance Document	A Strategic Approach to Planning for and Assessing the Effectiveness of Stormwater Programs Report
ILRP	Irrigated Lands Regulatory Program
IRWM	Integrated Regional Water Management
kg/yr	Kilograms per year
LAMP	Local Agency Management Program
lb/yr	Pounds per year
lbs N/acre	Pounds nitrogen per acre
LID	Low Impact Development
LOBP	Los Osos Basin Plan
LOCP	Los Osos Community Plan
LOCSD	Los Osos Community Services District

LOHCP	Los Osos Habitat Conservation Plan
LOSNMP	Los Osos Salt Nutrient Management Plan
LOWRF	Los Osos Water Recycling Facility
LOWWP	Los Osos Wastewater Project
MBNEP	Morro Bay National Estuary Program
MBWSL	Morro Bay Water Science Lab
MCL	Maximum Contaminant Level
MEP	Maximum extent practicable
mg/L	Milligrams per liter
mgd	Million gallons per day
MRP	Monitoring and Reporting Program
MS4	Municipal Separate Storm Sewer Systems
msl	Mean sea level
N	Nitrogen
NAS	National Academy of Sciences
NO_3-N	Nitrate-nitrogen
NPDES	National Pollutant Discharge Elimination System
NTU	Nephelometric Turbidity Unit
OWTS	Onsite Wastewater Treatment System
Panel	Science Advisory Panel
Parties	LOCSD, GSWC, S&T, and County
QA/QC	Quality Assurance and Quality Control
QAPP	Quality Assurance Project Plan
RWMP	Recycled Water Management Plan
Regional Water Board	Regional Water Quality Control Board
S&T	S&T Mutual Water Company
SAR	Sodium adsorption ratio
SGMA	Sustainable Groundwater Management Act
SNMP	Salt and Nutrient Management Plan
SNMP Monitoring Program	SNMP Groundwater Quality Monitoring Program
SWAMP	Surface Water Ambient Monitoring Program
SWMP	Stormwater Management Program
SWRCB and State Water Board	State Water Resources Control Board
TDS	Total Dissolved Solids
TMDL	Total Maximum Daily Load
USGS	United States Geological Survey
WDR Order	Waste Discharge/Recycled Water Requirement Order R3-2011-0001
WQO	Water Quality Objective
WRC	Water Recycling Criteria

Salt and Nutrient Management Plan for Los Osos Groundwater Basin
Executive Summary

The State Water Resources Control Board (State Water Board) adopted the Recycled Water Policy (Policy) in 2009 which requires that salt and nutrient management plans be developed to manage salts, nutrients, and other significant chemical compounds on a watershed- or basin/subbasin-wide basis. The plans are intended to help streamline permitting of new recycled water projects while ensuring compliance with water quality objectives and protection of beneficial uses. In accordance with the Policy, the County of San Luis Obispo (County), with technical support from Cleath-Harris Geologists Inc. (Cleath-Harris Geologists or CHG), prepared the Salt and Nutrient Management Plan for the Los Osos Groundwater Basin (Los Osos SNMP). The groundwater basin area for the Los Osos SNMP (Basin) is based on the area subject to the Stipulated Judgment and the Updated Basin Plan for the Los Osos Groundwater Basin incorporated therein (Basin Plan or LOBP) approved by the San Luis Obispo Superior Court on October 14, 2015 (Basin Plan Area).

The Los Osos SNMP presents a baseline picture of groundwater quality and establishes a framework under which salt and nutrient issues can be monitored and managed. The Policy encourages increased use of recycled water and local stormwater capture, reuse, and requires the following elements to be addressed in the Los Osos SNMP:

- A monitoring plan that includes an appropriate network of monitoring locations.
- A provision for monitoring constituents of emerging concern (CECs) consistent with recommendations by California Department of Public Health (now the Division of Drinking Water under the State Water Board).
- Water recycling and stormwater recharge/use goals and objectives.
- Salt and nutrient source identification, assimilative capacity and loading estimates, together with fate and transport of salts and nutrients.
- Implementation measures to manage salt and nutrient loading in the Basin on a sustainable basis.
- An anti-degradation analysis demonstrating that the projects included within the Los Osos SNMP will, collectively, satisfy the requirements of the State Water Board's *Statement of Policy with Respect to Maintaining High Quality of Waters in California* (also referred to as Resolution No. 68-16).

The Los Osos SNMP has been developed in a cooperative and collaborative manner among water purveyors, regulators, and other salt and nutrient stakeholders. The plan will be utilized by the Central Coast Regional Water Quality Control Board (Regional Water Board) and local agencies to aid in the management of Basin groundwater quality.

ES-1 Introduction

The Basin is impacted from excess nitrate concentrations in the upper aquifer and seawater intrusion in the lower Basin (western edge of the aquifer). Groundwater is currently the only water resource for Los Osos Valley. Excessive concentrations of salts and nutrients can damage Basin resources and can have various direct and indirect impacts on the community and surrounding region, such as potentially threatening public health, crop productivity, and access to this valuable resource, and requiring additional treatment of groundwater prior to use.

In 1983, the Regional Water Board determined that the community's use of septic systems was at least partially responsible for the nitrate contamination exceeding the State standards that occurred in the Basin (upper aquifer). Therefore, in January 1988, the State Water Board approved an amendment to the *Water Quality Control Plan, Central Coast Basin* (Central Coast Basin Plan) that contained a discharge moratorium established by the Regional Water Board for a portion of Los Osos known as the "Prohibition

Zone." The moratorium effectively halted new construction or major expansion of existing development until the water pollution is dealt with.

To help remediate the situation of seawater intrusion and excess nitrate concentration, the County has completed construction of the Los Osos Water Recycling Facility (LOWRF). In March 2016, residents located in the Prohibition Zone began to decommission their septic systems and connect to the wastewater service lines. The LOWRF receives and treats wastewater from these areas using a tertiary treatment system. Recycled water from LOWRF meets the Waste Discharge/Recycled Water Requirement Order R3-2011-2001 (WDR Order) prior to being discharged to land at community leach fields. Recycled water reuse will be available for beneficial use at permitted locations in the Basin, expected to start in early 2018. As such, it is anticipated that the County will apply for the Notice of Intent for the General Order WQ 2016-0068-DDW in early 2018.

In mid-2018, the County will likely seek a Basin Boundary Modification Request with the California Department of Water Resources (DWR), which would not modify the main Basin (Basin Plan Area), but only sections (known as "fringe areas") outside of the Basin Plan Area. Recycled water is not permitted for beneficial use in the fringe areas, per the WDR Order. These fringe areas would likely either be removed or recategorized as a subbasin by DWR. Any modified Basin boundaries will be noted in the Los Osos SNMP monitoring report due every three years to the Regional Water Board.

ES-2 Outreach

The Los Osos SNMP was developed in a collaborative setting with input from stakeholders and interested parties. The Los Osos SNMP utilized the existing stakeholder infrastructure set up by the Los Osos Basin Management Committee (BMC) Board of Directors established under the Stipulated Judgment for outreach, public meetings, and to receive input. The primary method for engaging the Los Osos SNMP stakeholders was through the BMC meetings, the County's BMC webpage, and email notifications. The Los Osos SNMP was discussed at three public meetings of the BMC between September 2016 and May 2017, and at the County Board of Supervisors meeting in January 2018.

Participants in the Los Osos SNMP development and/or review process included:

- Water purveyors: Los Osos Community Services District (LOCSD), Golden State Water Company (GSWC), and S&T Mutual Water Company (S&T)
- Environmental resource groups: Morro Bay National Estuary Program (MBNEP)
- Agricultural interests: individual farm owners
- Regulatory/government agencies: County and Regional Water Board
- Others: private well owners

ES-3 Basin Characterization

The objectives of the Basin characterization were to:

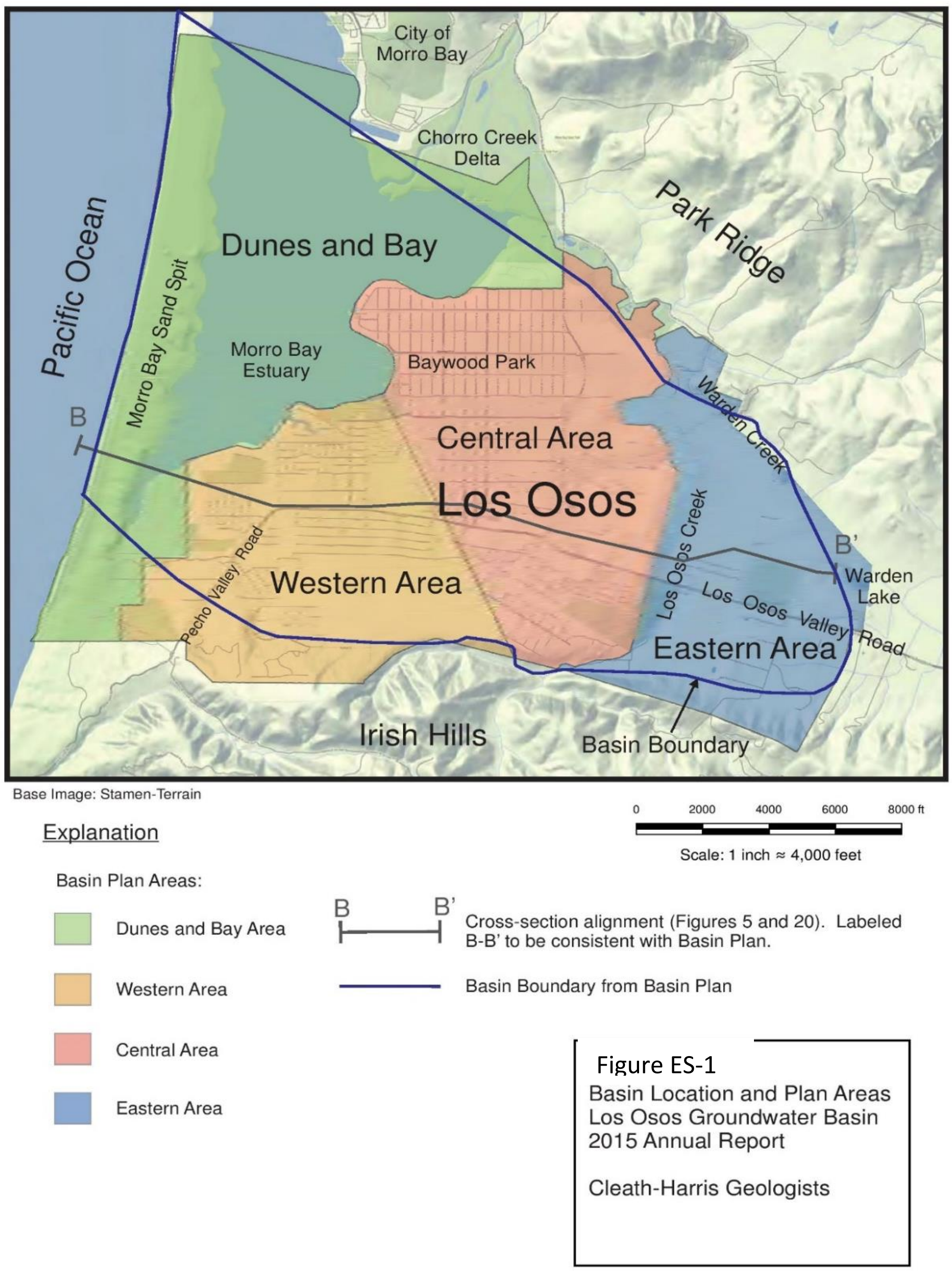
1. Review and collect data necessary to quantify, characterize, and describe the setting, land use, climate, hydrology, geology, and hydrogeology of the Basin.
2. Discuss baseline conditions (i.e., current spatial distributions) for each of the water quality constituents to be discussed in the Los Osos SNMP.
3. Discuss the water balance for the study areas of the Basin.

Groundwater Basin Setting

This Basin is formally recognized by DWR as part of the Basin No. 3-8 in Bulletin 118, *California's Groundwater*. The Basin area for purposes of the Los Osos SNMP is the same as the Basin Plan Area established by the Stipulated Judgment (Exhibit ES-1), and is approximately 7,530 acres, of which 80 percent (5,985 acres) are on land and the remaining 20 percent are underwater beneath Morro Bay (ISJ Group, 2015).

Figure ES-1 depicts the Basin Plan Area separated into individual sections, which are utilized in calculations for a technical analysis, as discussed in sections ES-4 and ES-5 of this Executive Summary.

Figure ES-1. Basin Location and Plan Areas



Source: CHG & Wallace Group, 2016

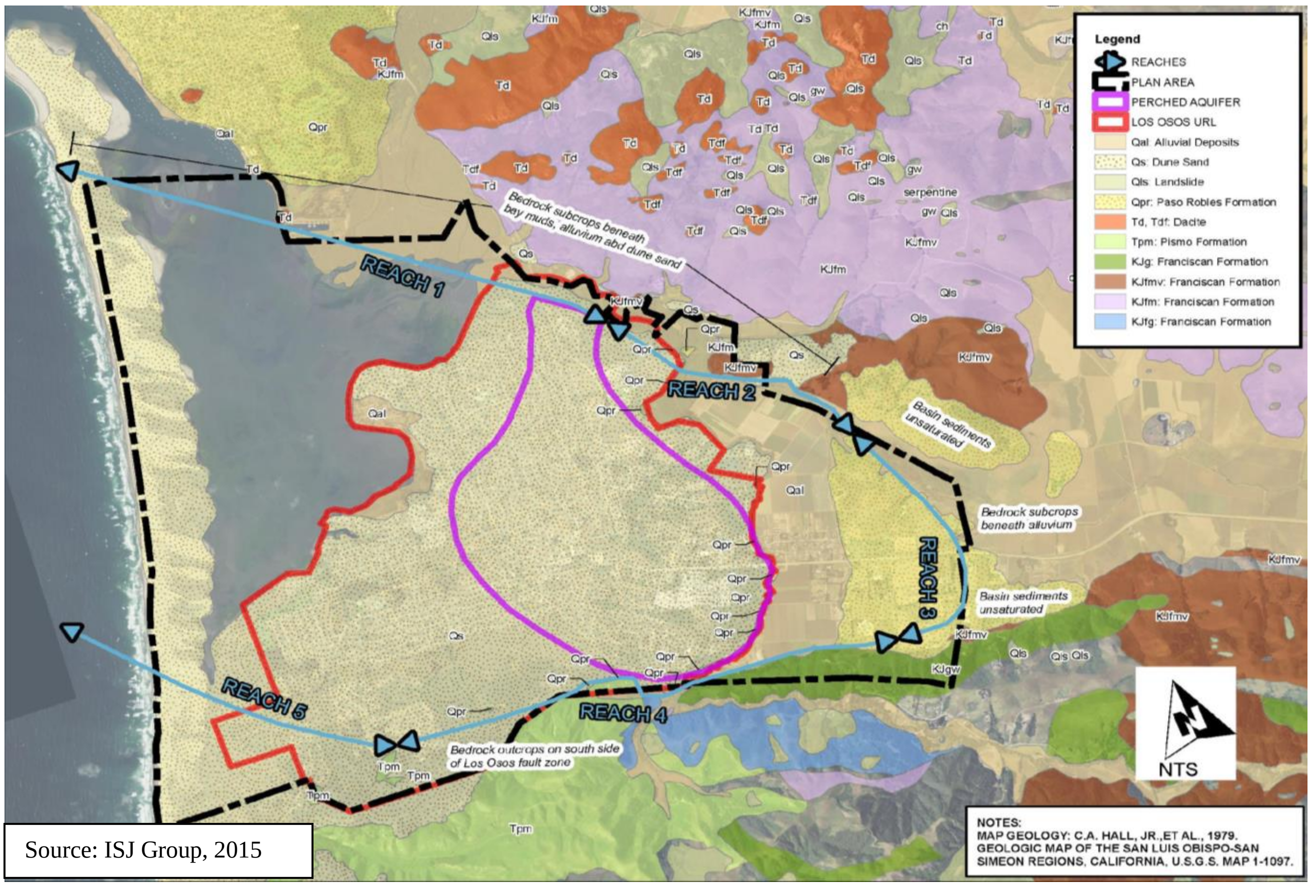
Surface Waters

The main streamflow in the Basin comes from Los Osos Creek and its tributaries. Water use in the creek valley has been estimated at 800 acre-feet per year (AFY) for irrigation and 75 AFY for rural residential use. Recharge to the aquifers underlying the creek valley comes mainly from streamflow seepage, which is estimated at 600 AFY during normal years (CHG, 2009).

Basin Geology

Figure ES-2 shows a map displaying the Basin and surficial geology. The Basin boundaries were originally defined by DWR (1958), and the Basin was refined by Cleath-Harris Geologists using information from well logs, geologic maps and cross-sections, water levels, water quality data, and fault investigations (ISJ Group, 2015; CHG, 2016).

Figure ES-2. Surficial Geology and Boundaries



Source: ISJ Group, 2015

Cleath-Harris Geologists developed six geologic cross-sections to characterize the Basin. The cross-sections include several sub-horizontal aquifer layers, which are discussed in Chapter 3. These cross-sections depict the Paso Robles Formation as the major water bearing unit in the Basin.

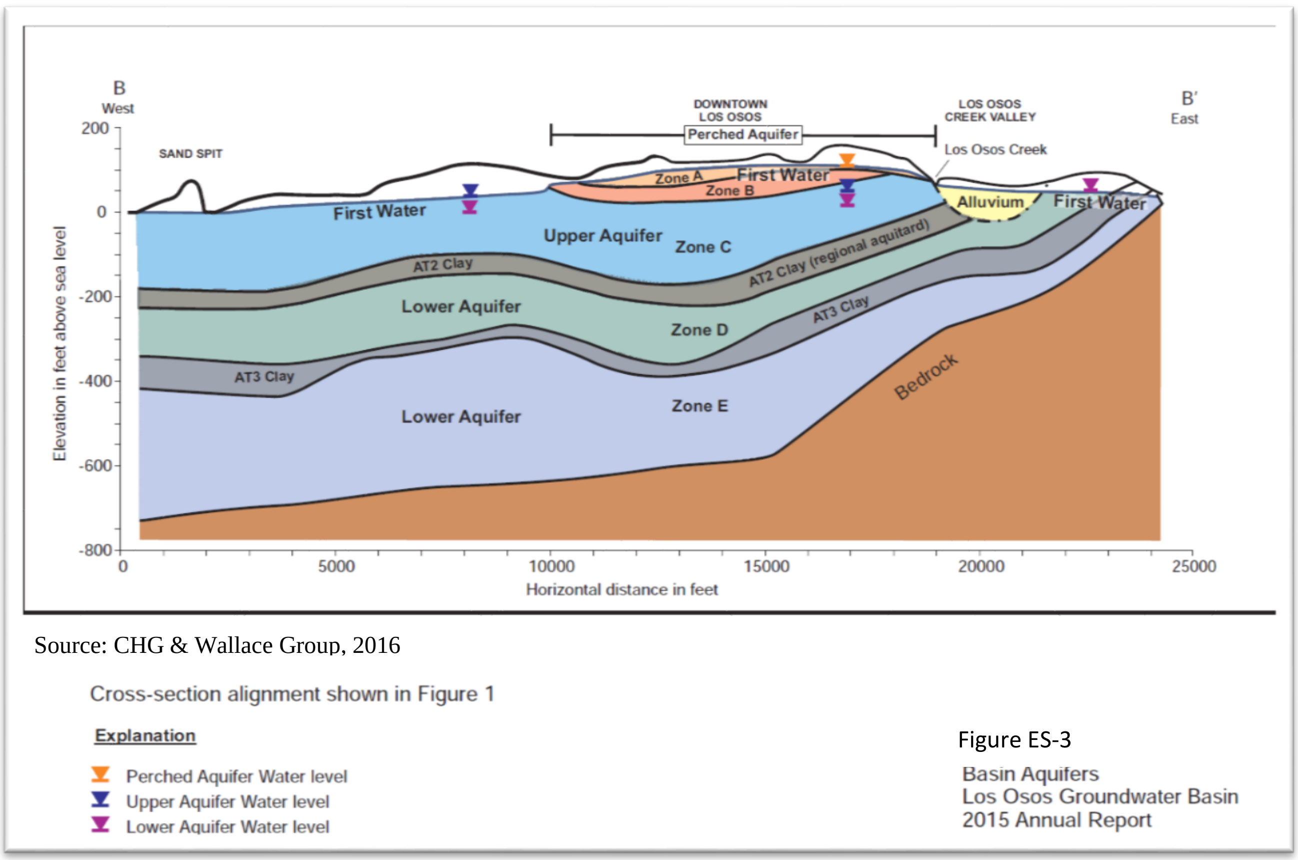
Aquifer Zone Characterization

The Basin is made up of several sub-horizontal stacked aquifer layers, each of which has distinct characteristics. The aquifer layers are designated as Zones A through E, an alluvial aquifer, and a regional aquitard (Figure ES-3):

- Zone A – perched aquifer;
- Zone B – perched aquifer (transitional upper aquifer);
- Zone C – Upper Aquifer;
- Regional aquitard (clay) – separates the upper and lower aquifers; and
- Zones D and E – Lower Aquifer.

First Water is depicted on ES-3 as the first 50 feet of water above sea level, while Zone C will be referred to as Upper Aquifer and Zone D/E will be referred to as Lower Aquifer in the rest of the Executive Summary and report. As shown in Figure ES-1, these aquifer layers are divided into the Western, Eastern, and Central areas to further delineate the storage volumes in each aquifer layer.

Figure ES-3. Aquifer Zone Characterization



Source: CHG & Wallace Group, 2016

Hydrogeology

The hydrogeology of the Basin and water balance is based on Basin models and conceptual models. The Basin groundwater flow model was developed in MODFLOW utilizing various support models, such as the United States Geological Survey's SEAWAT program. Results from the MODFLOW model include (ISJ Group, 2015):

- Evaluation of seawater intrusion, sustainable yield, and hydrologic budget information;
- Total dissolved solids (TDS) isoconcentration maps to compare impacts on seawater intrusion and sustainable yield;
- Input parameters for individual model scenarios; and
- Steady-state model scenarios run using the SEAWAT program.

The Los Osos SNMP technical analysis in Chapter 5 was based on a conceptual model which used a collection and interpretation of available information for the physical system being modeled. The conceptual model includes a characterization of the Basin structure, boundary conditions, aquifer geometry, physical parameters, and components of inflow and outflow developed through a network of geologic cross-sections with deep well control points to contour elevations on the base of four layers in the model. The physical parameters for Basin sediments include hydraulic conductivity, porosity, specific yield, and storativity, which are based on field tests or adjusted through calibration within a plausible range of values.

The conceptual model includes the three following scenarios for the Los Osos SNMP:

1. 2012 Baseline scenario - pre-LOWRF construction with no implementation of projects/programs;
2. No Further Development scenario - no further development in terms of the population served by community purveyors; includes the operation of the LOWRF; and implementation of projects/programs by various entities (such as the Urban Water Use Efficiency Program, Urban Water Reinvestment Program, and Basin Infrastructure Program); and
3. Population Buildout scenario - population size increases to buildout, the operation of the LOWRF project, and the implementation of project/programs from the No Further Development scenario with implementation of additional projects/programs by various entities (such as the Agricultural Water Reinvestment Program and additional Basin Infrastructure Program).

The water balance for the No Further Development and Population Buildout scenarios includes the potential recycled water areas summarized in Table ES-1. This table includes the maximum permitted distribution allocation in the Basin.[1]

Table ES-1. Urban Water Reinvestment Program Recycled Water Uses

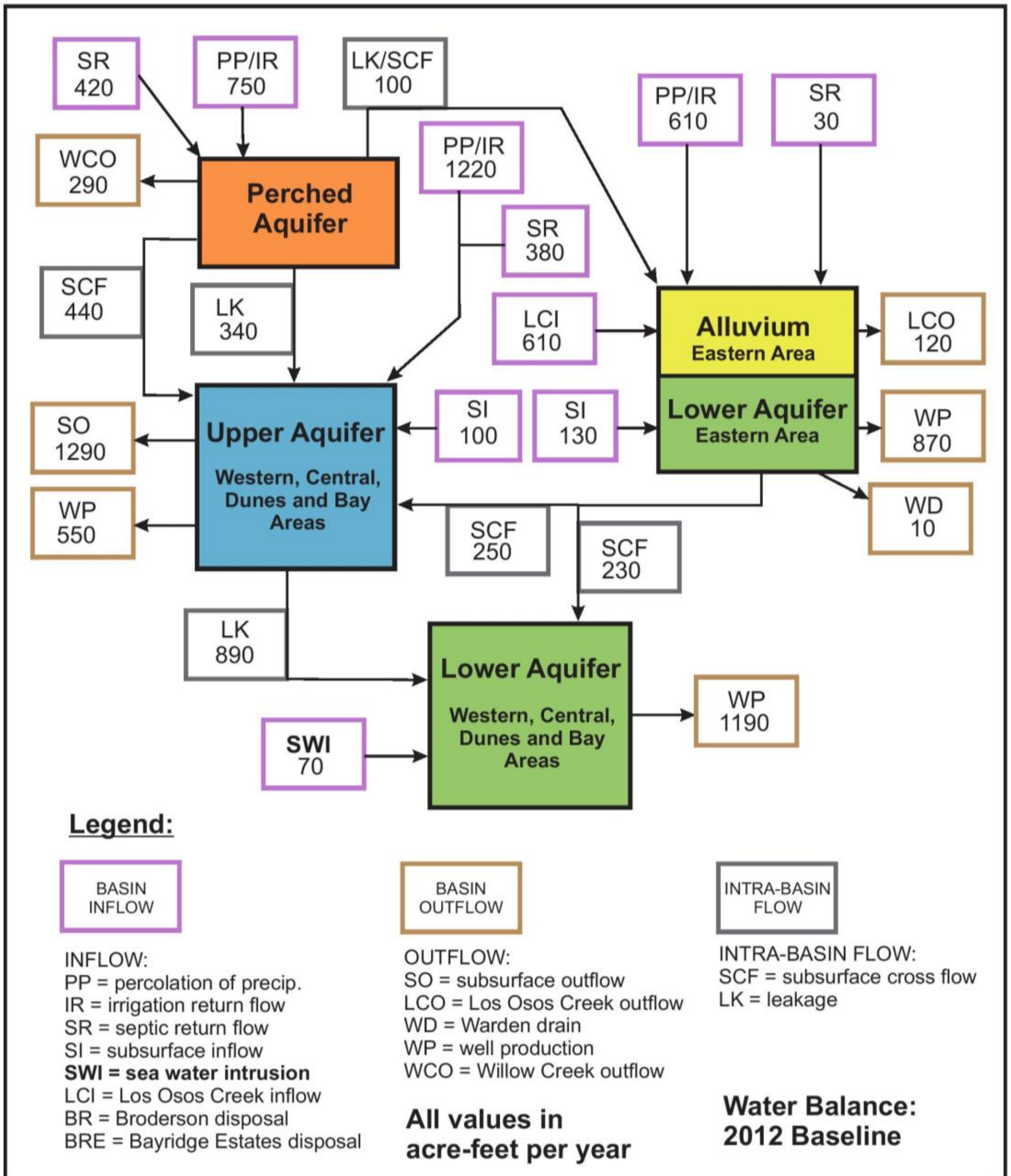
Potential Use	Quantity (AFY)	Percent of Total
Broderson Leachfields (disposal site)	448	40
Bayridge Estate Leachfields (disposal site)	33	2.9
Urban Reuse (irrigation)	63	5.6
Sea Pines Golf Course (irrigation)	40	3.6
Los Osos Valley Memorial Park (irrigation)	50	4.5
Agricultural Reuse (irrigation)[1]	486	43.4
Total	1,120	100

Source: ISJ Group, 2015
Abbreviations: acre-feet per year
Notes:
[1]Agricultural reuse - No Further Development scenario = up to 146 AFY

As an example, Figures ES-4 shows the water balance components of inflow and outflow from each of the Basin compartments for the 2012 Baseline scenario. The other two scenarios for water balance are discussed in Chapter 4.

[1] The No Further Development scenario distribution allocation for agricultural reuse is up to 146 AFY and the Population Buildout scenario distribution allocation for agricultural reuse is up to 486 AFY.

Figure ES-4. Water Balance: 2012 Baseline



SOURCE: 2015 LOBP

Figure 4-5

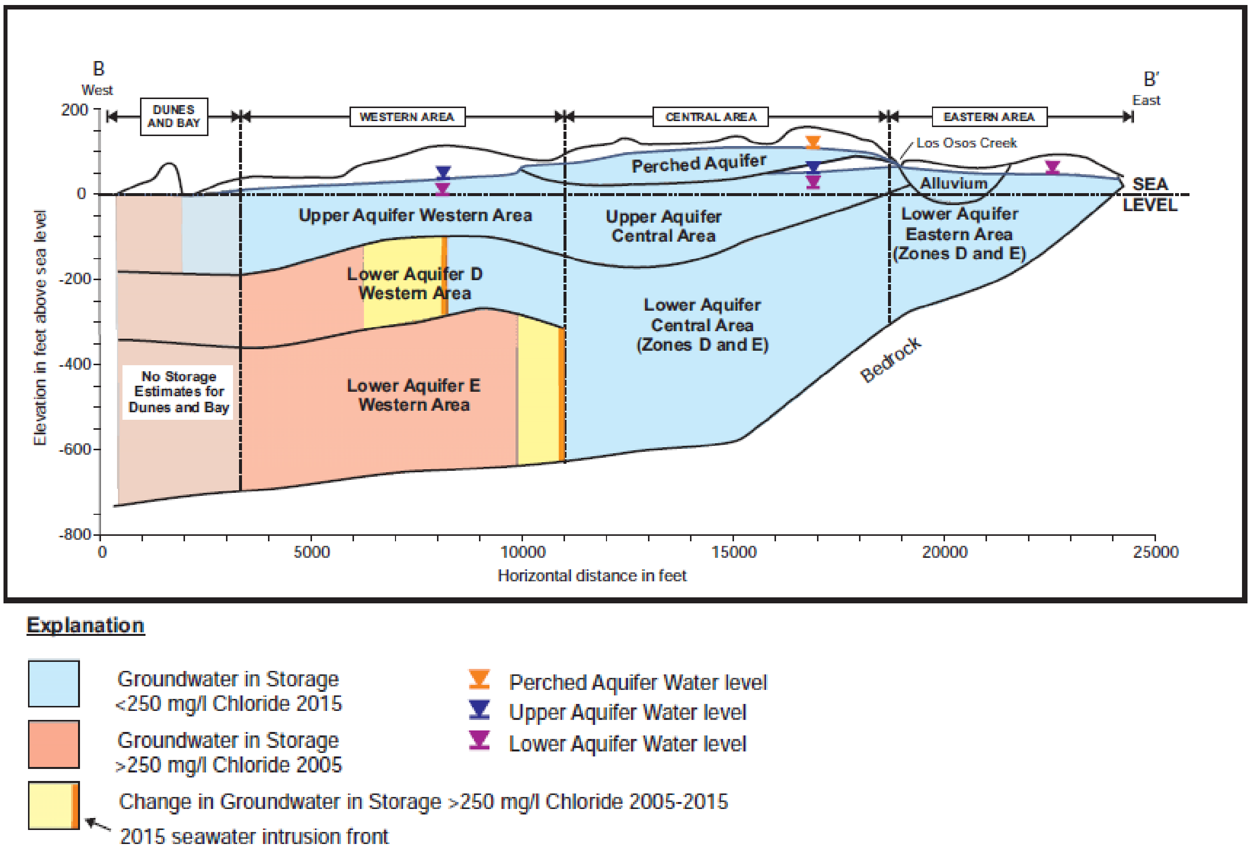
Water Balance: 2012 Baseline

Los Osos Groundwater Basin
Assimilation Capacity and
Antidegradation Analysis
County of San Luis Obispo

Cleath-Harris Geologists

The Basin reaches depths of several hundred feet below sea level and holds approximately 120,000 acre-feet, with approximately 15,000 acre-feet above sea level, excluding the Dunes and Bay area due to seawater intrusion (CHG & Wallace Group, 2016).[2] Groundwater storage for the Basin is estimated through a systematic approach of water level contouring, boundary definition, volume calculations, geology, and aquifer property estimation. Reported groundwater storage values may represent different types of storage or aquifer areas as defined by water quality or location (Figure ES-5). The total groundwater production in 2015 was approximately 2,170 acre-feet and the sustainable yield was estimated as 2,450 AFY (CHG & Wallace Group, 2016).

Figure ES-5. Basin Storage Compartments for Los Osos Groundwater Basin



Source: CHG & Wallace Group, 2016

Figure ES-5 shows the Basin divided into storage components. The Lower Aquifer (Zone D and Zone E) in the Western Area was further divided into the volume by seawater/brackish water intrusion front. Zone E in the Western Area is mostly seawater, while Zone D is mostly groundwater. Seawater volumes in the Lower Aquifer with chloride concentration of 250 mg/L or greater were removed from the Los Osos SNMP technical analysis due to water quality.

[2] Seawater intrusion is not included in the groundwater volume and water quality estimates because it is a non-potable water resource and would not reflect the average groundwater quality of the Basin.

The total decline in Basin storage between 2005 and 2015 is estimated at approximately 4,600 acre-feet, or 460 AFY on average, which includes a decline in potable groundwater storage (with less than 250 mg/L of chloride) of approximately 2,700 acre-feet, or 270 AFY. By comparison, Basin production between 2005 and 2015 averaged 2,760 AFY. Some of the storage decline is likely due to Basin pumping exceeding the safe yield, and some due to the drought conditions. (CHG & Wallace Group, 2016)

Water Quality

Constituents considered in the Los Osos SNMP were identified from the BMC's annual monitoring report for the Basin Plan and previous Basin studies that discussed known water quality issues with seawater intrusion and return flow from high-density residential septic systems. The three water quality constituents that are addressed in the Los Osos SNMP are TDS, chloride, and nitrate (as N). These constituents are defined as "indicator constituents" in the Los Osos SNMP. The Basin characterization established the baseline conditions for these constituents using water quality data from historical and current groundwater reports. The water quality analysis started with the review of Regional Water Board water quality objectives, EPA drinking water standards, LOWRF Title 22 permit requirements, BMC metrics, water quality databases used in the analysis, historical trends, and then estimated average constituent concentrations for each study area for the three indicator constituents.

Primary and secondary drinking water standards for TDS, nitrate (as N), and chloride, as established by the CDPH, Code of Regulations, Title 22, are presented for reference in Table ES-2. The Primary Maximum Contaminant Levels (MCL) are set to be protective of human health. Secondary MCLs address aesthetic issues related to taste, odor, or appearance of the water and are not related to health effects, although elevated TDS and chloride concentrations in water can damage crops, affect plant growth, and damage equipment.

The BMC metric for chloride is 100 mg/L and for nitrate is 10 mg/L. TDS is not included as a Basin metric. These metrics are discussed in the annual monitoring report for the Basin Plan.

Table ES-2. Title 22 Drinking Water Standards for Nitrate (as N), Chloride, and TDS

Water Quality Constituent	Primary Drinking Water Standard Recommended MCL (mg/L)	Secondary Drinking Water Standard Recommended MCL (mg/L)	Secondary Drinking Water Standard Upper Limit (mg/L)	Secondary Drinking Water Standard Short Term (mg/L)
Nitrate (as N)	10	--	--	--
Chloride	--	250	500	600
TDS	--	500	1,000	1,500

Abbreviations: Maximum Contaminant Levels (MCL) and milligrams per liter (mg/L)

The Regional Water Board has the authority to enforce the LOWRF WDR Order. The effluent requirements from the LOWRF will meet the WDR Order requirements, including:

- Total Nitrogen Monthly Average limit of 7 mg/L;
- Total Nitrogen Maximum Day limit of 10 mg/L; and
- California Code of Regulations for Title 22 standards for tertiary recycled water.

ES-4 Salt and Nutrient Loading Analysis

The salt and nutrient loading analysis considers the existing salt and nutrient mass in groundwater storage and the source water volumes of key inflows and outflows and their associated identified constituents. Salt and nutrient loading takes place at variable rates across the Basin. Every year, salts and nutrients leach into the groundwater system from various sources, including natural, agricultural, residential, and animal sources. Loading factors can be expressed as the amount of salt or nutrient added to the groundwater system over time. The mass associated with each loading factor is dissolved and transported into the groundwater system by recharge and return flows. There are four Basin compartments, or mixing cells, delineated for salt and nutrient loading calculations: the Perched Aquifer; the Upper Aquifer; the Western and Central Area Lower Aquifer; and the Eastern Area Alluvial and Lower Aquifer.

Simulating salt and nutrient loading for each mixing cell involves a mass balance spreadsheet model, which converts salt and nutrient loads to inflow concentrations, distributes flows according to the water balance, and provides for repeated cycles of loading. The model also allows salt and nutrient load calibration using Basin water quality data. The calibration process provides a rigorous approach to mass balance by evaluating the Basin-specific salt and nutrient loads for key sources, against known sources.

Identification of Salts and Nutrients

The primary identification of salt and nutrient indicators of mass loading are chloride and nitrate-nitrogen. These two constituents will be modeled and total dissolved solids will also be modeled as it is an indicator of total salt loading to the Basin. In addition, the Los Osos SNMP must consider all salt and nutrient constituents/parameters contained within the Central Coast Basin Plan with prescribed water quality objectives (WQOs) in the initial assessment (CCRWQCB, 2014). The initial assessment of other major dissolved ions potentially included in recycled water that reflect its salinity and nutrient content are many and varied, such as sodium, calcium, sulfate, chloride, nitrate, iron, boron and manganese.

To initially assess salt and nutrient constituents/parameters mentioned, the County analyzed the water quality data and constituent's chemical characteristics to further identify constituents for the Basin, see Chapter 4 for details. From this initial assessment, the constituents that meet the methodology criteria for additional modeling are chloride, nitrates and total dissolved solids. The other constituents will still be monitored and referenced in the Los Osos SNMP groundwater monitoring report, as appropriate.

Source Analysis

Natural systems, agricultural practices, residential sites, and animal waste are the principal sources of salt and nutrient loading in the Basin under the 2012 Baseline (pre-LOWRF construction) conditions. With LOWRF operation, recycled water reuse and disposal becomes another source of loading. Salt and nutrient mass loading factors for various sources are presented in Tables ES-3 and ES-4.

Table ES-3. Nitrates – Nitrogen (NO_3-N) Loading Factors (Source: CHG, 2017)

Source	Total Units (Baseline)	NO_3-N (lb/year)		
		Per unit (lb/year)	Attenuation (loss)	Total (lb/year)
Natural (Basin wide)[1]	4,000 acres	3.1	(incorporated)	12,400
Septic Tank Discharge[2]	830 acre-feet	152	41%	74,500
Agriculture/Turf Fertilizer[3]	400 acres	150	68%	19,200
Residential Landscape/Turf Fertilizer[3]	370 acres	45	80%	3,300
Animal Waste[4]	200 Horses	110	79%	4,600
	4,400 Dogs	2.9	92%	1,000
	6,600 Cats	1.4	92%	700

NOTES: [1] calibrated to pre-development conditions.
[2] influent quality to LOWRF, calibrated to baseline conditions.
[3] Viers et al. (2012) and M&E (1995)
[4] M&E (1995)

Table ES-4. Inflow Source Water Quality (Source: CHG, 2017)			
Source	**TDS (mg/L)**	**Chloride (mg/L)**	**NO_3-N (mg/L)**
Septic / LOWRF Influent (initial)[1]	790	200	56 [2]
Septic / LOWRF Influent (transient)[1]	WS+352	WS+115	56 [2]
Recycled Water (initial)[3]	713	200	6.6
Recycled Water (transient)[3]	IW-77	IW	6.6
Landscape Irrigation Return Flow[4]	WS*3.4+N load	WS*3.4	WS+N load
Agricultural Irrigation Return Flow[4]	WS*3.4+N load	WS*3.4	WS+N load
Perc. of Precip. with natural/animal[5]	146	36	3
Subsurface Bedrock Inflow[6]	493	50	0.2
Los Osos Creek Inflow[6]	540	53	0.2

NOTES: WS = domestic/irrigation water quality; IW = influent wastewater quality (same as septic discharge)
[1] based on initial water supply quality and LOWRF raw influent data (Appendix C, Table C14)
[2] mostly as ammonia-nitrogen (Appendix C, Table C14)
[3] based on LOWRF treated effluent data (Appendix C, Table C14)
[4] 3.4 evaporative enrichment factor calibrated to baseline conditions (Chapter 4, Section 4.3)
[5] natural loading calibrated to pre-development conditions (Chapter 4, Section 4.3 and Appendix D)
[6] based on water quality data (Appendix C, Table C10)

ES-5 Assimilative Capacity and Anti-Degradation Analysis

The Policy requires an assimilative capacity and anti-degradation analysis for recycled water use on basins and subbasins. The anti-degradation analysis evaluates the impacts of recycled water use and future Basin development on groundwater quality from various sources of salt and nutrient loading. The assimilative capacity analysis compares current groundwater Basin water quality data with WQOs.

Methodology

The methodology used to simulate salt and nutrient loading involves a mass balance spreadsheet model, which converts salt and nutrient loads to inflow concentrations, distributes flows according to the water balance, and provides for repeated cycles of loading. The spreadsheet model also allows salt and nutrient load calibration using Basin water quality data. The calibration process provides a rigorous approach to mass balance by evaluating the Basin-specific salt and nutrient loads for key sources, including natural sources and the evaporative enrichment of salts beneath agricultural fields.

For the anti-degradation and assimilative capacity analyses, the Basin has been divided into mass balance compartments, or mixing cells, that correspond to the aquifers and plan areas used for water balance and water quality. This data created an average value used in the anti-degradation and assimilative capacity analyses for water quality, as summarized below. To see details on storage volumes, water quality, anti-degradation and assimilative capacity analyses for each mixing cell refer to Chapter 5.

Assimilative Capacity

The Regional Water Board defines assimilative capacity as:

> *The capacity of a natural body of water to receive (a) wastewaters, without deleterious effects, (b) toxic materials, without damage to aquatic life or humans who consume the water, (c) Biochemical oxygen demand (BOD)[3], within prescribed dissolved oxygen limits.*

[3] BOD is the amount of dissolved oxygen needed by aerobic biological organisms to break down organic material present in a given water sample at certain temperature over a specific time period.

Based on the above definition, the assimilative capacity of a groundwater basin to receive recycled water and return flows from irrigation would be the difference between ambient (current) concentrations of a selected water quality constituent in groundwater and the maximum concentration (or water quality objective, if specified) of the constituent that would preclude deleterious effects.

The Regional Water Board has not published water quality data for median groundwater objectives for the Basin. The median groundwater objectives used for the assimilative capacity analysis are based on the Central Coast Basin Plan's highest existing median objectives for the Estero Bay Area: 1,000 mg/L TDS, 250 mg/L chloride, and 10 mg/L NO_3-N.

The resulting assimilative capacity for salt and nutrient loading is summarized in Table ES-5.

Table ES-5. Assimilative Capacity - Los Osos Groundwater Basin

Loading Constituent	Allowable[1] (mg/L)	Current[2] (mg/L)	Assimilative Capacity[3] (mg/L)	10% Assimilative Capacity (mg/L)	20% Assimilative Capacity (mg/L)
TDS	1000	440	560	56	112
Chloride	250	81	169	17	34
NO_3-N	10	6	4	0.4	0.8

Source: CHG, 2017

NOTES: [1]Allowable concentration equal to maximum existing median objective for Estero Bay planning area based on the Central Coast Basin Plan.
[2]Basin averages are weighted averages by volume for mixing cells, see Chapter 5 for additional mixing cell water quality data
[3] Formula: Allowable - Current = Assimilative Capacity

Anti-degradation Assessment

The anti-degradation analysis evaluates potential impacts to water quality under various scenarios as discussed in ES-3, the 2012 Baseline (pre-construction of LOWRF) scenario and the No Further Development and Population Buildout scenarios (construction of LOWRF with recycled water reuse), and compares those impacts to the current assimilative capacity of the Basin. The analysis is required under the Policy (State Water Board Resolution No. 2013-0003) for operating the LOWRF, which mandates compliance with State Water Board Resolution 68-16 (*Statement of Policy with Respect to Maintaining High Quality of Waters in California*). This anti-degradation analysis has been prepared to satisfy both the Los Osos SNMP requirements and operating permit requirements of the LOWRF. Results from the mass balance spreadsheet model and graphs of water quality trends for individual mixing cells are included in Appendix E and F.

Results of the antidegradation analysis indicate LOWRF operation over a 25-year period with No Further Development uses less than 2% of the assimilative capacity of the Basin for TDS and chloride, while providing a net gain in Basin assimilative capacity for NO_3-N. LOWRF operation over a 25-year period with Population Buildout (cumulative projects) uses less than 4 % of the assimilative capacity of the Basin for TDS and chloride, while providing a net gain in Basin assimilative capacity for NO_3-N. These results show compliance with antidegradation thresholds established by the State Water Board. Table ES-6 summarizes the antidegradation analysis.

Table ES-6. Basin Antidegradation Analysis - Los Osos Valley Groundwater Basin									
Constituent	**Assimilative Capacity [mg/L]**	**Assimilative Capacity Used (+lost -gained)[1]**							
		No Further Development (E+AC+U)				**Population Buildout (E+ABC+UG)**			
		10 Years		**25 Years**		**10 Years**		**25 Years**	
		mg/L	**%**	**mg/L**	**%**	**mg/L**	**%**	**mg/L**	**%**
TDS	560	1.7	0.3	7.0	1.3	7.8	1.4	20.7	3.7
Chloride	169	0.1	0.1	0.6	0.4	2.1	1.2	5.2	3.1
NO_3-N	4	-0.7	-18.7	-1.1	-26.5	-0.6	-15.4	-0.8	-20.1

(Source: CHG, 2017)
Note:

(1) Positive values of assimilative capacity use (in red) indicate a reduction in basin assimilative capacity, while negative values of use (in blue) indicate a gain, or improvement, in capacity.

(2) LOBP Projects and Programs includes: E = Urban Water Use Efficiency Program, U = Urban Water Reinvestment Program, A= Basin Infrastructure Program (designed to increase groundwater production in the upper aquifer), C - Basin Infrastructure Program (shift groundwater in lower aquifer production in the Western Area to the Central Area), G= Agricultural Water Reinvestment Program, B = Basin Infrastructure Program (maximize groundwater production from the Upper Aquifer)

The anti-degradation analysis for TDS, chloride, and nitrates demonstrated that the LOWRF Project satisfied the policy requirements for the State Water Board's Resolution No. 68-16.. Results show that the operations of the LOWRF, removal of septic systems in the wastewater service area, and programs implemented (e.g., water conservation) from the LOBP will improve groundwater quality over time with respect to nitrates. Also, with the operation of the LOWRF, pumping is reduced in the Basin due to the in lieu use of recycled water used for irrigation. Reduced pumping could infer a greater groundwater pressure head with the potential to reduce seawater intrusion in the Basin.

The Los Osos SNMP technical analyses indicate that the overall groundwater quality baseline would have continued to degrade (over the 25 year planning horizon) without the construction and operation of the LOWRF and removal of septic systems within the wastewater service area.

ES-6 SNMP Goals & Objectives

Groundwater basin management goals and objectives are summarized in the following governing mission statement for the County's recycled water facility:

> *To evaluate and develop a wastewater treatment system for Los Osos, in cooperation with the community water purveyors, to solve the Level III water resource shortage and groundwater pollution, in an environmentally sustainable and cost effective manner, while respecting community preferences and promoting participatory government, and addressing individual affordability challenges to the greatest extent possible.*

Basin management goals and objectives will aid in managing salt and nutrient loading to groundwater. Basin management practices with recycled water reuse will support in maintaining sustainable groundwater quality for the Basin. No new best management practices (BMPs) are therefore recommended as part of this Los Osos SNMP process. Goals and objectives will be updated in the Los Osos SNMP Monitoring Report when plans or BMPs are developed or revised in the future. However, one future anticipated document being prepared by the County Planning Department is the countywide Onsite Wastewater

Treatment Systems (OWTS) Local Agency Management Program (LAMP), which will outline the management of the septic systems outside the wastewater service area in the Basin (CCRWQCB, 2011a).

Basin Management Goals and Objectives

The Basin management goals and objectives were identified, developed and vetted during the development of the Basin Plan and updated or monitored in the Basin Plan 2015 Annual Groundwater Monitoring Report. The immediate goals are designed to balance supplies and demands in the Basin, and continuing goals will be implemented over time to promote and maintain the long-term balance and health of the Basin. The primary goals are to halt, and to the extent possible, reverse seawater intrusion into the Basin and to provide sustainable water supplies for existing and future residential, commercial, institutional, recreational and agricultural development within Los Osos. In addition to evaluating and tracking the status of groundwater quality and the impact of the Basin Plan programs in the Basin with objective, numerical metrics, management of the Basin will involve balancing economic, environmental, and social interests. Criteria for sustainable use of the Basin, as defined in the Basin Plan, is outlined in Chapter 6.

ES-7 Implementation Measures

Implementation of programs and measures will continue to support Basin management efforts toward reducing salt and nutrient loading and creating long-term sustainability for beneficial uses. Existing groundwater quality BMPs or measures already in place will continue. New implementation measures or BMPs developed in the future will be incorporated into the Los Osos SNMP, as appropriate, as part of the adaptive management strategies. Adaptive management strategies will be implemented in the Los Osos SNMP after securing all necessary approvals. The adaptive management approach will allow for modifications of the Los Osos SNMP over time in response to project monitoring to protect and enhance groundwater resources. This approach will allow flexibility to respond to changing conditions in the Basin.

Existing implementation programs and measures from the Basin Plan in the Basin are listed below and described in Chapter 7. Table ES-7 summarizes implementation or potential measures by the County and/or other agencies.

- Adaptive Management Plan
- Basin Metrics Implementation
- Groundwater Monitoring Program
- Urban Water Use Efficiency Program
- Urban and Agricultural Water Reinvestment Program
- Basin Infrastructure Programs A and C
- Wellhead Protection Program
- Nitrate Level Metric
- Water Level Metric
- Chloride Level Metric

Table ES-7. Potential and In Progress Implementation Measures for the SNMP			
Implementation Measures – Water Supply			
Status	**Specific Measure**	**Description**	**Effect**
Potential future measure	Softening of Groundwater Supplies	Advanced treatment to soften community water supplies	Reduces the need for self-regenerating water softeners. Fewer self-regenerating water softeners will reduce the salt load in residential wastewater stream
Implementation Measures – Recharge/Return Flow			
Status	**Specific Measure**	**Description**	**Effect**
In Progress[2]	Evaluate Study/ Recharge Projects using Recycled Water in creeks	Evaluate/optimize discharge to improve efficiency at reducing/reversing seawater intrusion	Increases freshwater head to limit seawater intrusion by reducing pumping in the Lower Aquifer
In Progress[3]	Improve Stormwater Capture	Identify and consider new projects for additional capture/infiltration of stormwater	Increases recharge of low salt/nutrient concentration water
In Progress[4]	Agricultural Grower Education and Outreach	Optimize fertilization/irrigation techniques to minimize nitrate loading and improve irrigation efficiency	Reduce fertilizer use (nitrate loading), reduce water use and associated concentration of salts in soil
Potential future measure	Expand LOWRF Collection Area	Expand LOWRF connections to septic systems within Basin but outside current collection area	Reduces nitrate loading from septic discharges
Implementation Measures – Wastewater			
Status	**Specific Measure**	**Description**	**Effect**
Potential future measure	Source Control-Chloride	Education/outreach/regulation to reduce the number of self-regenerating water softeners	Fewer self-regenerating water softeners will reduce the salt load in residential wastewater
Potential future measure	Regulatory	Ordinance regulating or banning discharge of saltwater or brine from commercial or industrial activities	Reduces salt loading in wastewater stream
Potential future measure	Regulatory	Ordinance limiting or banning self-regenerating water softeners from discharging to the sanitary sewer	Reduces salt loading in wastewater stream
Potential future measure	Regulatory	Ordinance for management of the septic systems outside the wastewater service area	Reduce nutrient loading to groundwater

Source: CHG, 2017
NOTES: [1] Discharge to Los Osos Creek being evaluated
[2] Septic tank repurposing program in progress
[3] Regional Water Board Irrigated Lands Regulatory Program

Implementation actions for salt and nutrient management in the Basin include monitoring and evaluation, prevention, and planning activities to continue active management of the Basin for the long-term beneficial uses of the stakeholders. These activities have been developed to continue providing the data needed to base decisions on sound, scientific data and to provide short-term and long-term prevention and planning activities appropriate for the current and anticipated future salt and nutrient conditions in the Basin. The Los Osos SNMP will incorporate additional implementations for the OWTS LAMP in the future.

ES-8 Groundwater Quality Monitoring

A Los Osos SNMP Groundwater Quality Monitoring Program (SNMP Monitoring Program) is required for the LOWRF WDR Order as part of the Policy and is built on existing Basin monitoring programs. The SNMP Monitoring Program includes descriptions of the groundwater sampling locations, sampling frequency, constituents monitored, sampling protocols and associated quality assurance and quality control

(QA/QC) procedures, data analysis, evaluation criteria, and reporting procedures. The SNMP Monitoring Program includes a report with the above data for groundwater, as well as supplemental data for surface water and stormwater, as appropriate. The County will coordinate the data collection with the BMC and other stakeholders, and prepare the required SNMP Monitoring Report for the Regional Water Board every three years.

Constituents of Emerging Concern

As part of the SNMP Monitoring Program, the Policy requires that the Los Osos SNMP include "….a provision for annual monitoring of Constituents of Emerging Concern (CEC) consistent with recommendations by *California Department of Public Health* (CDPH) and consistent with any actions by the State Water Board…." CECs generally have no established water quality standards. These chemicals may be present in waters at very low concentrations and are now detectable as the result of more sensitive analytical methods. Information regarding their health significance is evolving with the development of acceptable daily intake levels and drinking water equivalent levels; however, information is lacking on the full spectrum of potential CECs and their health significance. CECs include several types of chemicals such as pesticides, pharmaceuticals and ingredients in personal care products, veterinary medicines, and endocrine disruptors. The Policy states, "each salt and nutrient management plan shall include [a] provision for annual monitoring of Emerging Constituents/Constituents of Emerging Concern consistent with recommendations by CDPH and consistent with any actions by the State Water Board taken pursuant to paragraph 10(b) of this Policy."

As the County is applying for the 2016 *General Water Reclamation Requirements for Recycled Water Use* (Order WQ 2016-0068-DDW) in 2018, this Order includes Policy requirements for the Los Osos SNMP including "...monitoring requirements for CECs for the use of recycled water for groundwater recharge by surface and subsurface application methods. The monitoring requirements and criteria for evaluating monitoring results in the Recycled Water Policy are based on recommendations from a Science Advisory Panel. Because this General Order is limited to non-potable uses and does not authorize groundwater replenishment activities, monitoring for CECs is not required." Because the LOWRF recycled water is for non-potable uses and is not injected into the Basin for recharge, monitoring for CECs in groundwater in the Basin is not required under the General Water Reclamation Requirements for Recycled Water Use (Order WQ 2016-0068-DDW). However, the LOWRF will test for CECs annually with an annual grab sample from the effluent of the water recycling facility under the Monitoring and Reporting Program WDR Order No. R3-2011-0001 (CCRWQCB, 2011a).

Existing Groundwater Quality and Level Monitoring Programs

The Los Osos SNMP monitoring requirements will be satisfied through existing groundwater monitoring programs implemented across the Basin area by the County, BMC, and other stakeholders. The data will be coordinated with key basin monitoring programs, including the LOWRF Monitoring and Reporting Program (MRP), Monitoring Program in the Recycled Water Management Plan (RWMP) for the California Coastal Commission Coastal Development Permit, the Basin Plan Annual Groundwater Monitoring Report for the BMC, California Statewide Groundwater Elevation Monitoring (CASGEM), and other monitoring programs, as appropriate.

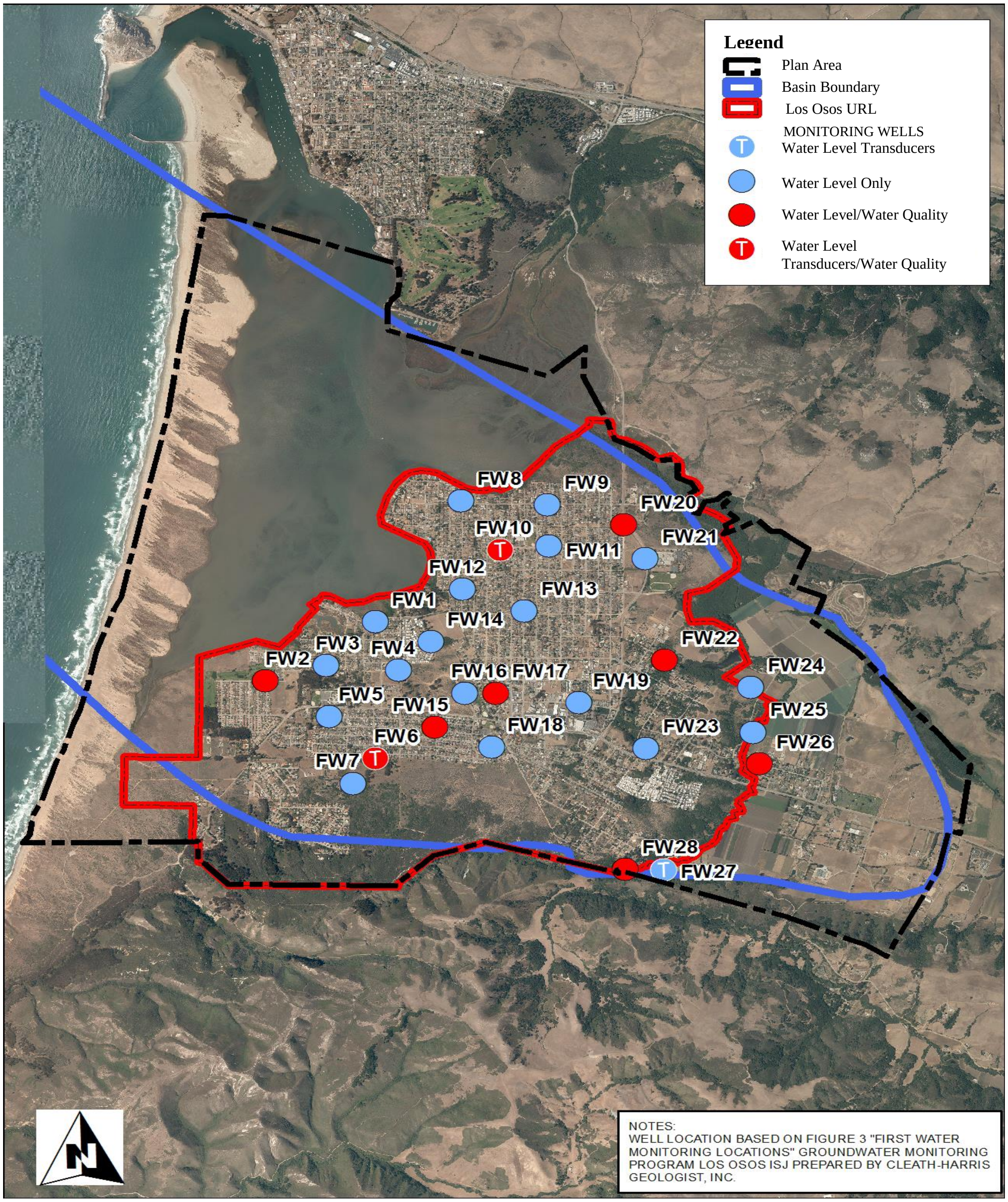
SNMP Groundwater Monitoring Network

The Los Osos SNMP will use the network monitoring locations from the BMC (73 wells) and the County LOWRF MRP (26 monitoring wells). Using the existing monitoring network locations will provide a reasonable, cost-effective means of monitoring the concentrations of salt, nutrients and other constituents of concern. Figures ES-6, ES-7, and ES-8 show the monitoring locations for each aquifer group (First Water, Upper Aquifer, and Lower Aquifer) from the Basin Plan. The current monitoring network provides a reference for identifying future wells that may be incorporated into the SNMP Monitoring Program.

Additionally, the "key wells" selected for the LOWRF MRP (Figure ES-9) will be used to optimize groundwater quality characterization.

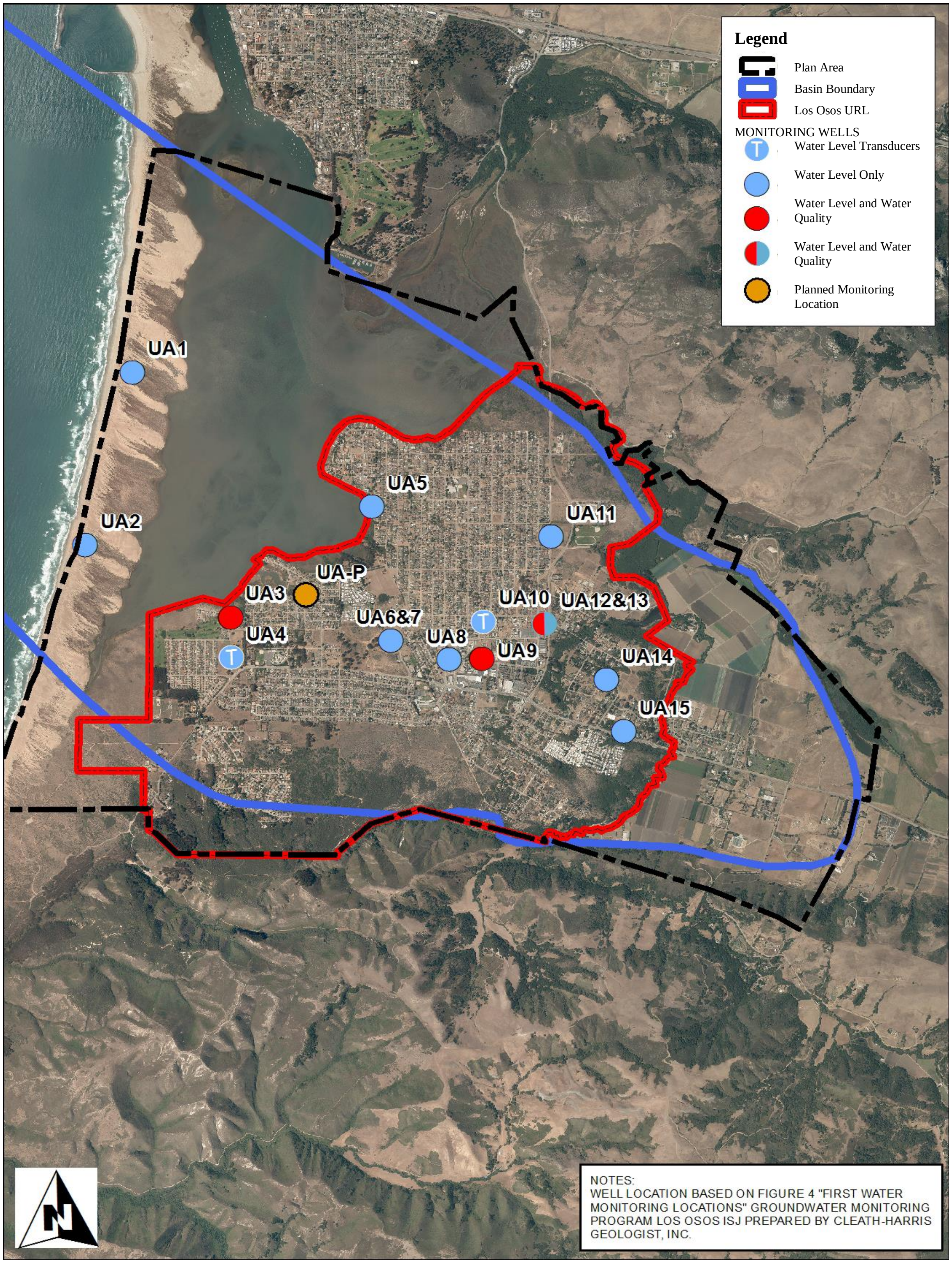
Recycled water will be discharged to the Broderson and Bayridge leachfields disposal sites (Figure ES-9). In preparation for groundwater monitoring during operations of the LOWRF, the County installed five vadose zone monitoring locations down-slope of the Broderson leachfield disposal site (Figure ES-10). These wells will be used to monitor groundwater conditions at the leachfields.

Figure ES-6. LOBP First Water Monitoring Network



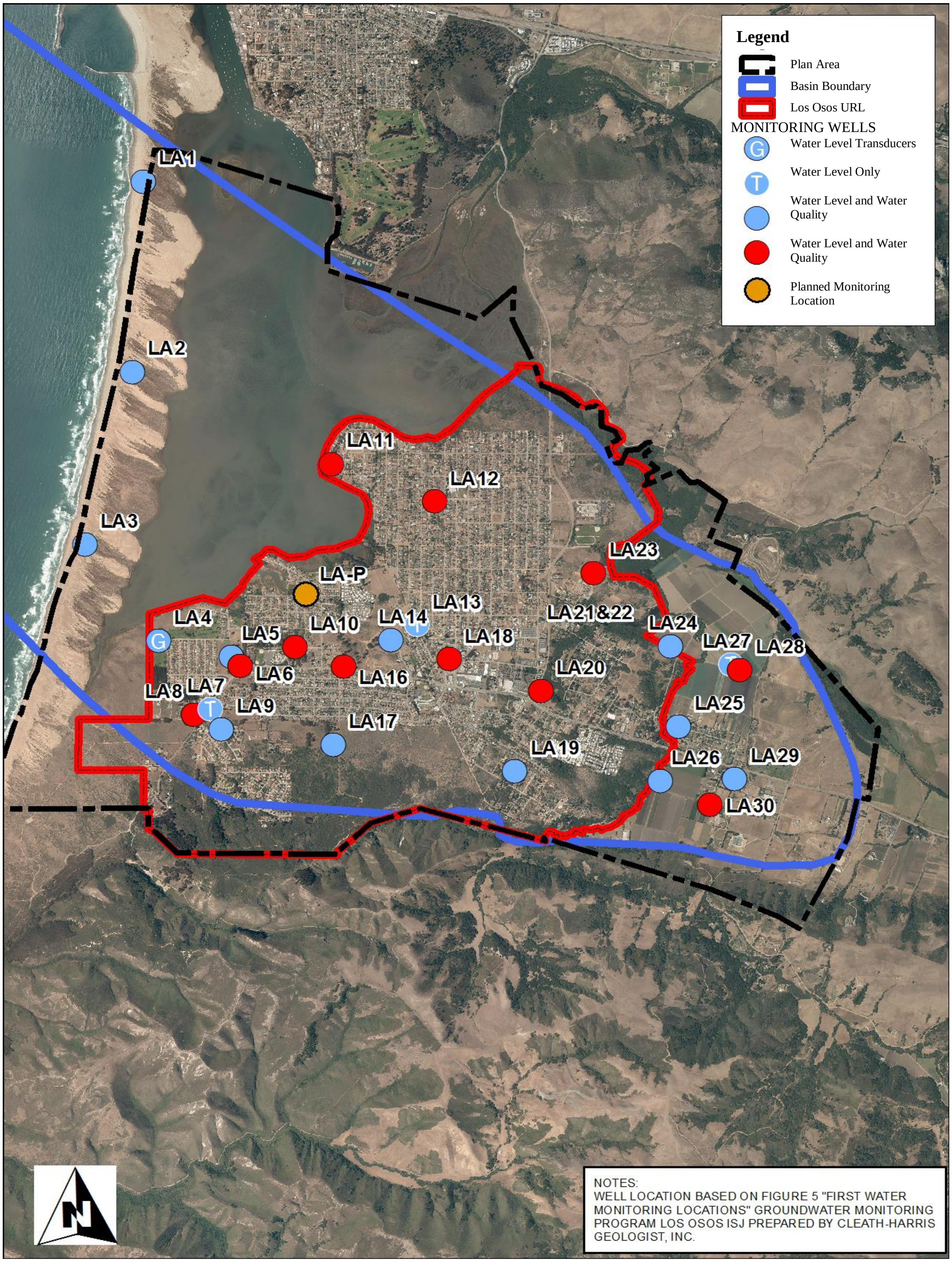
Source: ISJ Group, 2015

Figure ES-7. LOBP Upper Aquifer Monitoring Network



Source: ISJ Group, 2015

Figure ES-8. LOBP Lower Aquifer Monitoring Network



Source: ISJ Group, 2015

Figure ES-9. LOWRF Monitoring and Reporting Program Wells (Source: CCRWQCB, 2011a)

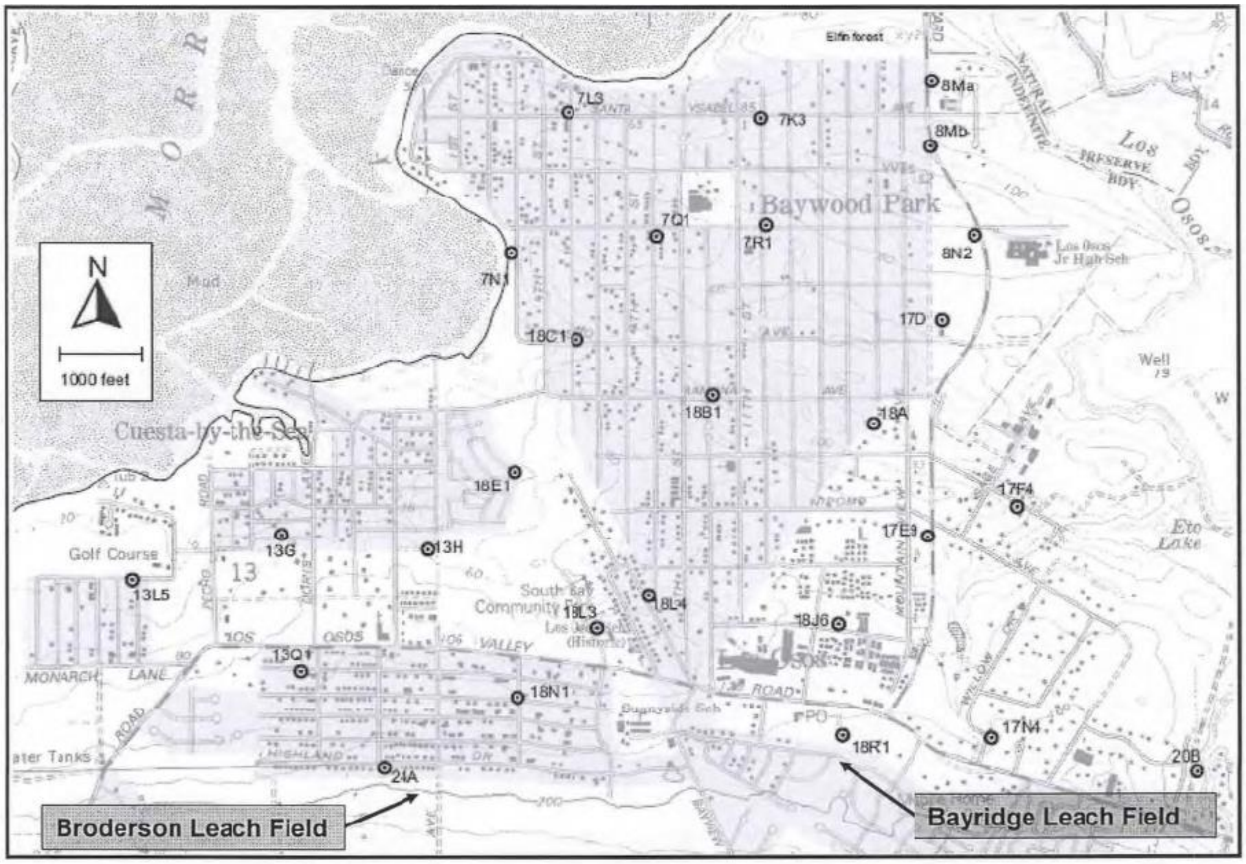
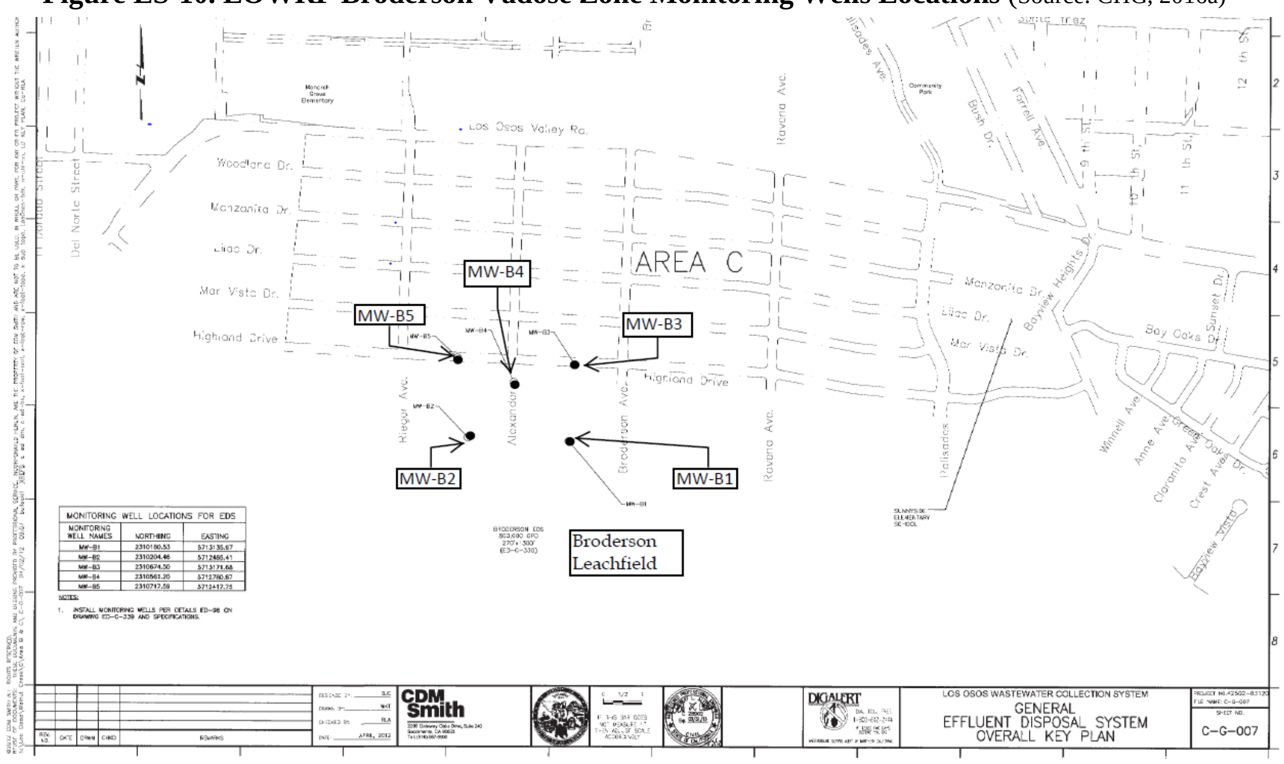


Figure ES-10. LOWRF Broderson Vadose Zone Monitoring Wells Locations (Source: CHG, 2016a)



SNMP Groundwater Quality Monitoring

Groundwater monitoring and reporting is essential for addressing many issues related to groundwater resources in the Basin, including determination of the groundwater level, water quality, sustainable yield, seawater intrusion, nitrate contamination, and future dynamic changes to the Basin. The Los Osos SNMP will also examine Basin water quality near water supply wells and areas proximate to large water recycling projects.

The monitoring report will include descriptions of the groundwater sampling locations, sampling frequency, constituents monitored, sampling protocols and associated quality assurance and quality control (QA/QC) procedures, data analysis, evaluation criteria, and reporting procedures. The Los Osos SNMP will combine information with the appropriate data from the Basin Plan annual groundwater monitoring report, LOWRF MRP, and other monitoring programs, if necessary.

The Los Osos SNMP will utilize historical total dissolved solids, chloride, and nitrate data from the County baseline water quality requirements for the LOWRF WDR Order (collected from 2012 to 2016), as well as the BMC constituents listed in their 2015 Annual Groundwater Monitoring Report. Other constituents collected by the County and BMC that will support the Los Osos SNMP include:

- Carbonate Alkalinity (BMC)
- Bicarbonate Alkalinity (BMC)
- Total Alkalinity (as $CaCO_3$) (BMC)
- Total dissolved solids (BMC, LOWRF)
- Ammonia as Nitrogen (LOWRF)
- Total Kjeldahl Nitrogen (LOWRF)
- Nitrite as Nitrogen (LOWRF)
- Nitrate as Nitrogen (LOWRF)
- Organic Nitrogen (BMC, LOWRF)
- Total Nitrogen (LOWRF)
- Boron (BMC, LOWRF)
- Calcium (BMC)
- Potassium (BMC)
- Sodium (BMC, LOWRF)
- Magnesium (BMC)
- Sulfate (BMC, LOWRF)
- Chloride (BMC, LOWRF)
- Electrical conductance (BMC, LOWRF)
- Temperature (BMC, LOWRF)
- pH (BMC, LOWRF)

Groundwater quality data should be evaluated on a regular basis for trends and exceedances of water quality objectives as discussed in ES-3. The Los Osos SNMP shall also report data collected from surface water and stormwater programs, as appropriate.

A Quality Assurance Project Plan (QAPP) was prepared to establish a general standard for sample collection procedures. This includes sampling that is conducted in accordance with industry accepted standard sampling protocols and analyses that are conducted by California-certified laboratories (see Appendix G).

ES-9 EXECUTIVE SUMMARY CONCLUSION

The County has prepared the Los Osos SNMP in accordance with the Policy. The objective of the Los Osos SNMP is to manage salts and nutrients within the Basin in a manner that ensures attainment of water quality objectives and protection of beneficial uses. The Basin area for the Los Osos SNMP is based on the court-approved Basin Plan Area established pursuant to the Stipulated Judgment approved by the San Luis Obispo Superior Court on October 15, 2015. The Basin Plan Area is part of the Los Osos Valley Groundwater Basin, the California Department of Water Resources (DWR), Bulletin 118 Basin No. 3-8. Known issues in the Basin include seawater intrusion and elevated nitrate concentrations from septic systems.

Indicator constituents for the Los Osos SNMP include chlorides, TDS, and nitrates. These constituents were analyzed in the anti-degradation analysis, which demonstrated that the LOWRF satisfies the requirements of the State Water Board’s Resolution No. 68-16 - *Statement of Policy with Respect to*

Maintaining High Quality of Waters in California. The antidegradation analysis evaluated the potential impacts to water quality from the Basin Plan project's three scenarios, which included 2012 Baseline (no LOWRF), No Further Development, and Population Buildout. Results show that the operations of the LOWRF with removal of septic systems from the wastewater service area and implementing management programs (e.g. water conservation) from the Basin Plan will increase groundwater quality overtime with respect to nitrates. Additionally, the operation of the LOWRF will reduce groundwater pumping within the Basin, which infers that a greater pressure head can be created to reduce seawater intrusion in the Basin.

The SNMP Monitoring Program identified stakeholders responsible for conducting, compiling, and reporting the monitoring data. The County will coordinate with the BMC and other stakeholders to collect the required data and prepare a report for the Regional Water Board at least every three years. Groundwater monitoring locations for the Los Osos SNMP will be the same as those used in existing monitoring programs; specifically, the Basin Plan Annual Report and the LOWRF Annual Groundwater Monitoring and Reporting Program for the WDR Permit Order. The County and/or appropriate purveyors could implement adaptive management in the Basin to address issues that may develop.

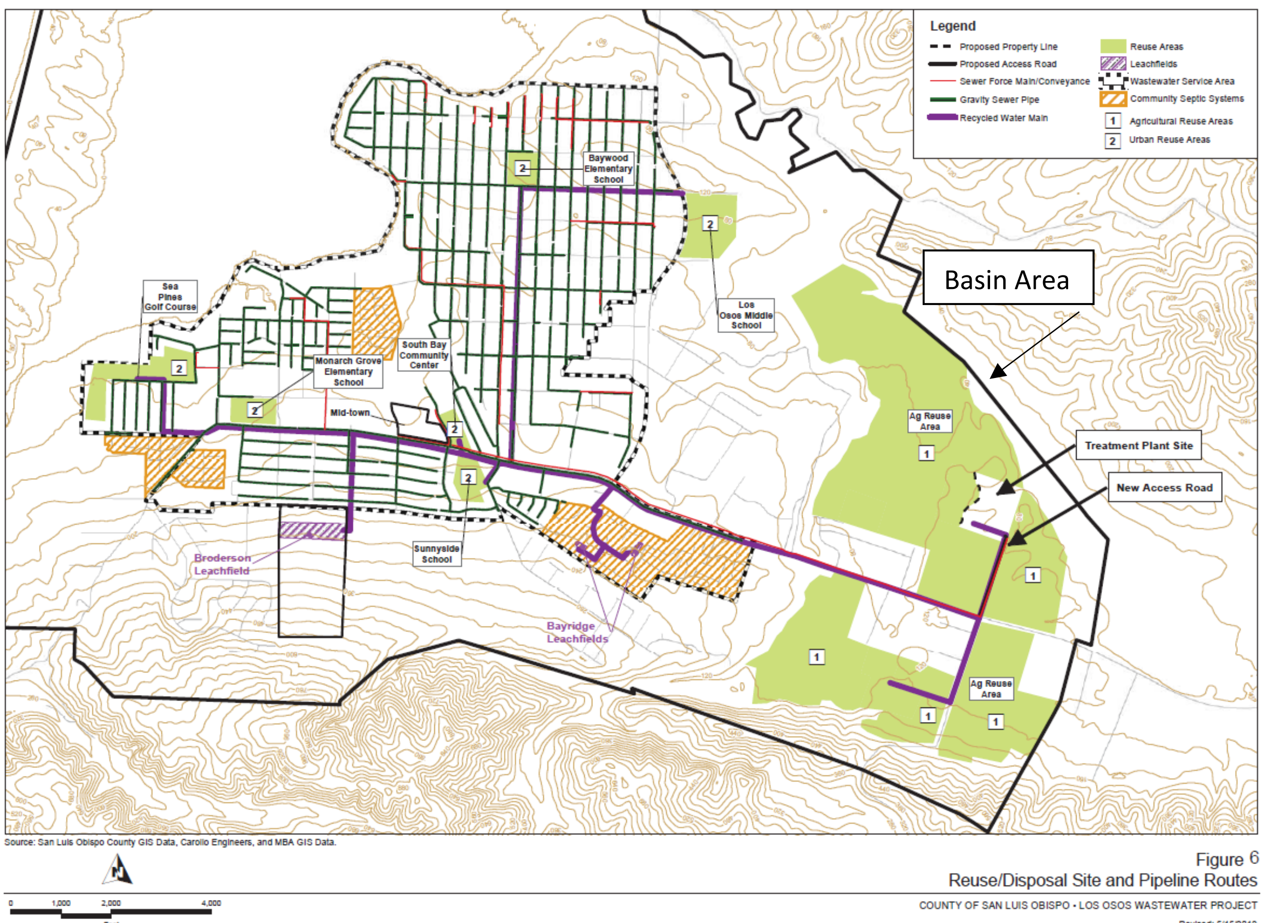
The operation of the LOWRF, implementation of the SNMP Monitoring Program, along with the continuation of the Basin Plan programs will continue to improve the Basin water quality for beneficial uses. Storage capacity will be increased by reducing groundwater pumping. Nitrate loading will be reduced by the removal of septic systems in the wastewater service zone. Seawater intrusion will decline due to the increase in pressure head in the Basin from the reduced pumping. These programs take critical steps towards sustainability in the Basin.

Chapter 1 INTRODUCTION

The Salt and Nutrient Management Plan (SNMP) for the Los Osos Groundwater Basin (Los Osos SNMP) was prepared by County of San Luis Obispo (County) with assistance from Cleath-Harris Geologists (Consultant), as well as the Los Osos Community Services District (LOCSD), Golden State Water Company (GSWC), S&T Mutual Water Company (S&T) and Central Coast Regional Water Quality Control Board (Regional Water Board). These agencies (except for the Regional Water Board) provide water and/or wastewater services in the Los Osos Valley Groundwater Basin.

The Los Osos SNMP will be implemented within the area subject to the Stipulated Judgment, as more specifically defined in the order signed by the San Luis Obispo Superior Court on October 14, 2015. The community's recycled water project area is located within the adjudicated basin area as shown in Figure 1-1. This basin area is part of the Los Osos Valley Groundwater Basin, the California Department of Water Resources (DWR), Bulletin 118 Basin No. 3-8.

Figure 1-1. Recycled Water Facility Location in Los Osos Basin



(Source: Carollo, 2013)

This basin area has been studied extensively and will be referred to as the Basin for the rest of the report. The County, along with local water purveyors and basin stakeholders, has been actively managing local water resources through practices such as developing and implementing local monitoring programs, investigating local hydrogeology, determining the basin's water balance, cooperative planning, and ongoing public outreach.

1.1 LOS OSOS BACKGROUND

The community of Los Osos is an unincorporated community of approximately 14,500 residents situated about mid-way on the coastline of San Luis Obispo County, south of the Morro Bay National Estuary and State Marine Reserve. The community's permanent population grew steadily during the 1970s and into the mid-1980s. Until recently, the community's sanitation needs have been primarily addressed through individual septic systems with septic pits, leachfields and similar methods.

Drinking water is obtained by means of groundwater extraction from the Basin, a multi-aquifer Basin that underlies the community. The Basin is comprised of an upper and lower aquifer separated by a thick layer of clay[1], which thereby restricts the vertical movement of groundwater.

The Regional Water Board (Region 3) determined in 1983 that the community's use of septic systems was at least partially responsible for the nitrate contamination in excess of the State standards that occurred in the groundwater Basin (upper aquifer). Therefore, in January 1988, the State Water Resources Control Board (State Water Board) approved an amendment to the *Water Quality Control Plan, Central Coast Basin* (also known as the Central Coast Basin Plan). The amendment contained a discharge moratorium established by the Regional Water Board for a portion of the Los Osos area known as the "Prohibition Zone." This zone prohibited discharge from additional individual and community sewage disposal systems, the moratorium effectively halted new construction or major expansions of existing development until the water pollution was dealt with.

Since the establishment of the Prohibition Zone, there have been prior unsuccessful attempts to rectify the situation through construction of a centralized wastewater treatment project by both the County and LOCSD. In 2007, special legislation was authored and passed under Assembly Bill 2701 to authorize transfer of wastewater authority from the LOCSD to the County. On June 11, 2010, the County received the Coastal Development Permit (CDP) A-3-SLO-09-055/069 from the California Coastal Commission. The Coastal Commission has authority and regulatory requirements for coastal communities, including Los Osos, CA. The CDP is for the construction and operation of a community sewer system, including a treatment plant, collection, disposal, and reuse facilities, and all associated development and infrastructure.

In 2016, the County completed the construction of the Los Osos Water Recycling Facility (LOWRF), see Section 1.3 for details.

1.1.1 Stipulated Judgement and Los Osos Basin Management Committee

On October 14, 2015, Judge Martin J. Tangeman of the San Luis Obispo Superior Court signed an order approving the Stipulated Judgment and the Updated Basin Management Plan for the Los Osos Groundwater Basin (also referred to as *Los Osos Basin Plan* (LOBP)). The Stipulated Judgment formed the Los Osos Groundwater Basin Management Committee (BMC), composed of representatives from the LOCSD, GSWC, S&T, and the County (collectively, the Parties).

The area covered by the LOBP includes the unincorporated communities of Los Osos, Baywood Park and Cuesta-by-the-Sea in San Luis Obispo County, California. The Los Osos SNMP references the LOBP and the LOBP annual groundwater monitoring reports (2015 Annual Basin Report), which contain technical information, management strategies, and goals for the Basin.

[1] Clay consist of low permeability, which is unable to transmit fluid from pore to pore and therefore has limited water flow within/ through the aquitard.

1.2 REGULATIONS

1.2.1 Recycled Water Policy

In February 2009, the State Water Board adopted Resolution No. 2009-011 which established a statewide Recycled Water Policy. The policy encourages and provides guidance for the use of recycled water and reuse. It also requires local wastewater and water purveyors, together with local salt- and nutrient-contributing stakeholders, to develop a SNMP for the Basin. The SNMP is intended to help streamline the permitting of new recycled water and stormwater projects while ensuring compliance with water quality objectives.

Central to this policy is the requirement that local water and wastewater entities, together with stakeholders, develop a SNMP for groundwater basins in California in which recycled water is to be used. In addition, the Regional Water Board provided a supplemental document *Water Board Support of Regional Salt & Nutrient Management Planning Effort; Transmittal of Informational Document*, dated March 3, 2014. This document provides additional guidance for the assimilative capacity and antidegradation studies uniquely associated to the Central Coast Region, which the County used to support their analyses.

The County has prepared this SNMP in accordance with the Recycled Water Policy. The required elements of an SNMP are as follows:

- A monitoring plan that includes an appropriate network of monitoring locations.
- A provision for annual monitoring of constituents of emerging concern (CECs).
- Goals for the use of recycled water and stormwater, existing and proposed implementation measures and volunteer efforts underway within the groundwater Basin, and the process of implementing the SNMP.
- Characterization of salt and nutrient sources, methodology and results of the loading analyses.
- Assimilative capacity and fate and transport of salts and nutrients.
- Implementation measures to manage salt and nutrient loading in the basin on a sustainable basis.
- An antidegradation analysis demonstrating that the operation of the LOWRF will satisfy the requirements of the SWRCB’s Resolution No. 68-16 - *Statement of Policy with Respect to Maintaining High Quality of Waters in California*

1.2.1.1 Los Osos Basin SNMP

Excessive concentrations of salts and nutrients in groundwater can damage the Basin resources and impact the region’s economy. Groundwater is the currently the only water resource available in the Los Osos Valley. The groundwater is used to meet residential, commercial, open space, and agricultural water demands throughout Los Osos Valley. Poor groundwater quality could threaten the ability to use this valuable resource, potentially impact public health, impact crop productivity, and require additional treatment of groundwater prior to use.

The objective of this SNMP is to manage salts and nutrients within the Basin area in a manner that ensures attainment of water quality objectives and protection of beneficial uses. As mentioned in the introduction, the Los Osos SNMP planning area is consistent with the Basin area, as shown in Figure 1-2, in order to best align to groundwater management efforts.

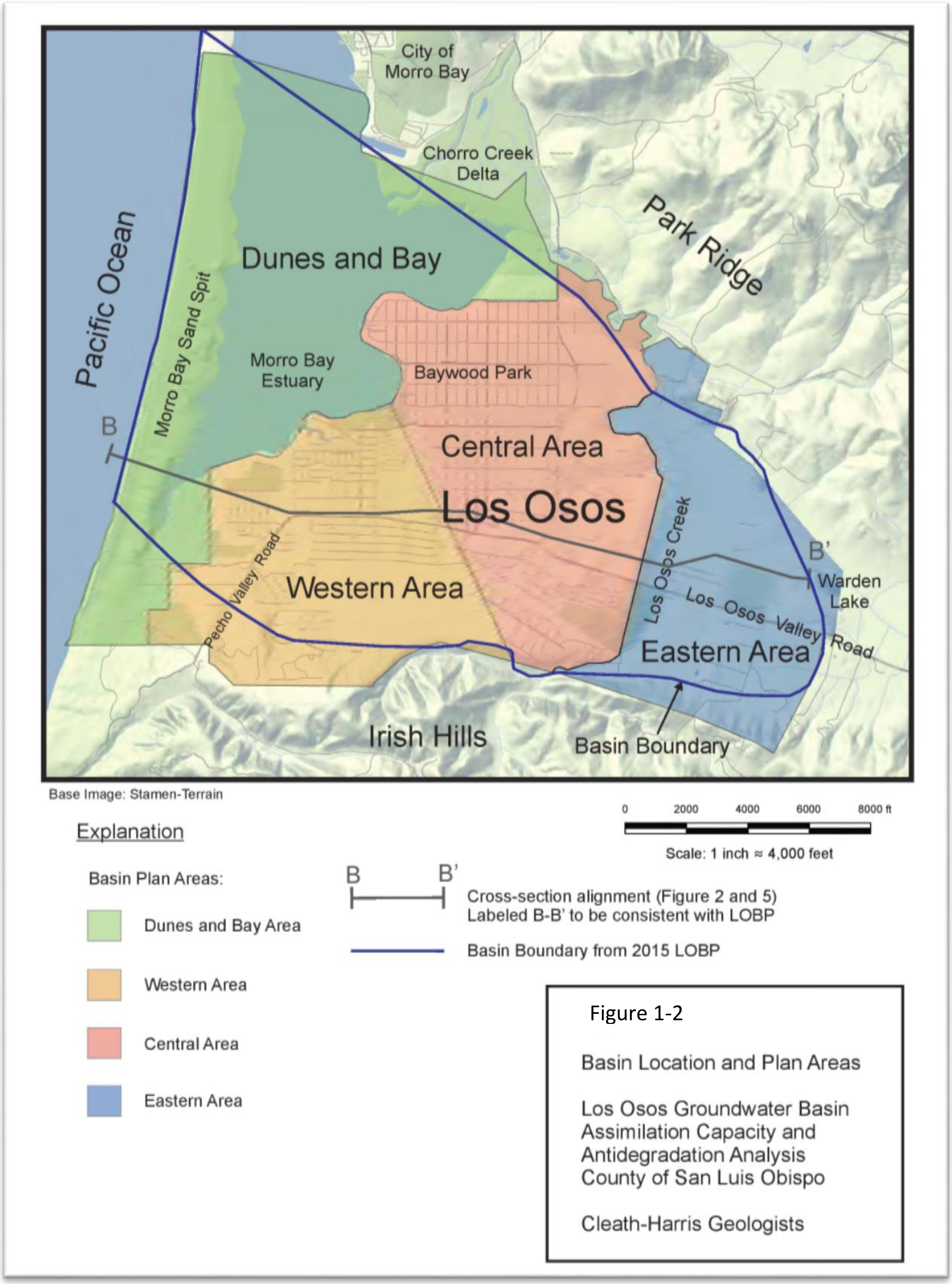


Figure 1-2

Basin Location and Plan Areas

Los Osos Groundwater Basin
Assimilation Capacity and
Antidegradation Analysis
County of San Luis Obispo

Cleath-Harris Geologists

Source (CHG, 20172016)

The SNMP summarizes groundwater quality data and discusses the established framework under which salt and nutrient issues can be managed. Known issues in the Basin include seawater intrusion and increasing nitrate concentrations. Seawater intrusion has been encroaching into the Basin over the past four decades, and nitrate concentrations have been increasing in the upper aquifer of the Basin since the 1950s. These issues and others will be discussed throughout this report.

This SNMP builds upon the LOBP and 2015 Annual Basin Report, which provides a comprehensive understanding of the groundwater system and conceptual groundwater model/model simulating the system [2]. These reports document water quality conditions and groundwater quality in the Basin, identify sources of salt and nutrient loading and describe actions and best management practices (BMPs). Other Basin hydrogeology and groundwater quality reports were also referenced during the preparation of this SNMP.

1.2.2 SGMA in Los Osos Basin Non-Adjudicated Fringe Areas

The Sustainable Groundwater Management Act (Water Code §§ 10720 *et seq.*) (SGMA) took effect on January 1, 2015, and requires local sustainable groundwater management in high and medium priority basins (as designated by DWR). DWR designated the Los Osos Valley Groundwater Basin as a high priority basin subject to critical conditions of overdraft. SGMA does not apply to the portion of the adjudicated Basin area, provided that certain requirements are met (Water Code Section 10720.8[3]); however, DWR's 2016 Bulletin 118 Interim Update defines the basin boundary as extending outside of the adjudicated Basin area ("fringe areas"). These "fringe areas" are required to comply with SGMA requirements, including formation of Groundwater Sustainability Agencies (GSAs), and development and implementation of Groundwater Sustainability Plans (GSPs).

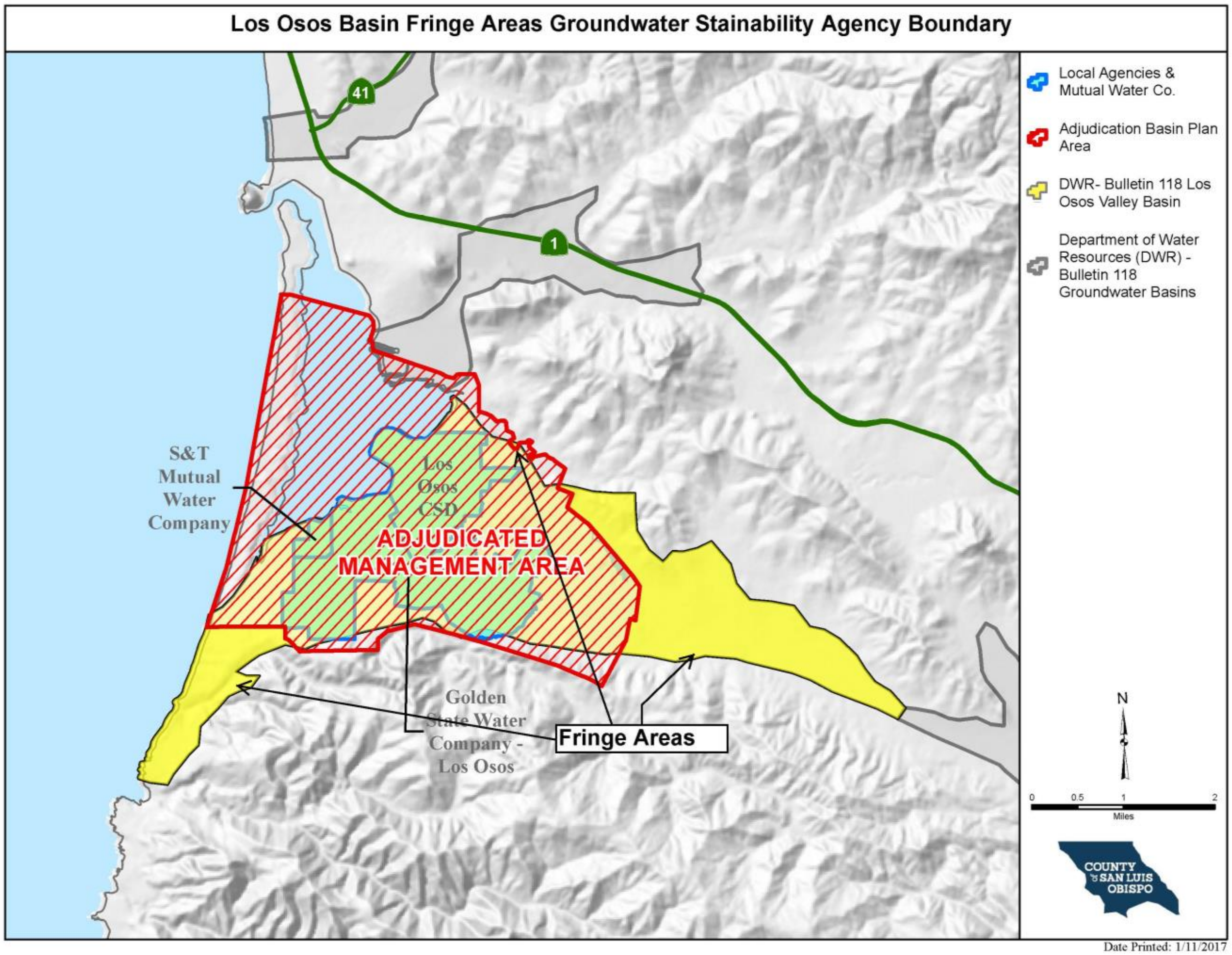
On April 4, 2017, the County Board of Supervisors took action to approve formation of a GSA over the fringe areas (covering approximately 40 parcels). Figure 1-3 shows the GSA's intended coverage areas, adjacent to the adjudicated Basin area. In June 2017, the GSA started a technical study to characterize conditions in the fringe areas. The GSA expects to use results of this study to develop a basin boundary modification request (BBMR) to be submitted to DWR for consideration in 2018. Any subsequent changes DWR approves to the groundwater basin boundary will be described in the Los Osos SNMP Groundwater Quality Monitoring Report (due every three years).

If any fringe areas still exist after DWR's 2018 BBMR approval process, the GSA would be required to develop and adopt a GSP by January 31, 2020. However, management already exists in the fringe areas through programs like the State Water Board's Irrigated Lands Regulatory Program (ILRP). The ILRP regulates discharges from irrigated agricultural lands and prevents agricultural discharges from impairing the waters that receive these discharges. The ILRP is discussed in Chapter 8.

[2] The Model utilizes United States Geological Survey's (USGS) SEAWAT program, which was developed to simulate three-dimensional, variable-density, transient groundwater flow in porous media. SEAWAT combines MODFLOW (modular flow) and MT3D (mass transport) code, and adds variable fluid density capability for seawater intrusion simulations. (Gou and Langevin, 2002)

[3] Pursuant to Water Code 10720.8(d), SGMA does not apply to the areas of the Los Osos Groundwater Basin at issue in Los Osos Community Services District v. Southern California Water Company [Golden State Water Company] et al. subject to certain requirements (Court adopted order approving Stipulated Judgment on October 14, 2015).

Figure 1-3. Groundwater Management Areas for the Los Osos Basin



Source: (County, 2017)

1.3 LOS OSOS WATER RECYCLING FACILITY PROJECT

As discussed in Section 1.1, the LOWRF project is required by the Regional Water Board as a result of septic discharges and degradation of water quality. The project is a critical first-step toward solving the community's water supply and groundwater management deficiencies and, therefore, maximizes long-term sustainable integrated water management benefits. The LOWRF serves about 90% of the population of the community, while the lower density areas remain on individual septic systems. A collection system conveys raw wastewater to a centralized treatment facility which produces disinfected tertiary recycled water. All recycled water is reused within the Basin area. Despite startup of the LOWRF, development restrictions, in place since 1988, will remain until other resource issues such as water supply and habitat conservation are addressed.

The primary local and state agencies regulating the use of recycled water are the Division of Drinking Water for the State Water Board (formerly the California Department of Public Health), State Water Board, Regional Water Board, California Coastal Commission (Coastal Commission), and the San Luis Obispo County Department of Environmental Health Services. The Regional Water Board is the lead agency for issuing permits for water recycling projects.

The LOWRF will meet permit requirements in the Waste Discharge/Recycled Water Requirement (WDR) Order R3-2011-0001, dated May 11, 2011. The purpose of this WDR Order is to prescribe waste discharge and recycled water requirements for the LOWRF. The County is updating to the most current permit by applying for the Notice of Intent for the General Order WQ 2016-0068-DDW in early 2018.

The LOWRF construction was completed in March 2016. The system treatment and collection system have been tested and the commissioning phase was completed in September 2016. Sewer connections by landowners were phased over a period which commenced on March 2016 and is expected to be completed in 2018. To-date, not all the properties have complied with the mandatory sewer connection. As of September 1, 2017, the percent of sewer connections made is about 93%. The County continues to work with property owners toward full compliance. Since the completion of the LOWRF in March 2016, all treated water is being transported and discharged to leach fields until agreements are completed for irrigation at permitted locations (i.e., schools, parks, golf course, and various agricultural areas) within the Basin.

Chapter 2 SNMP OUTREACH

The Los Osos SNMP was developed in a collaborative setting with input from stakeholders and interested parties. The SNMP utilized the existing stakeholder infrastructure set up by the Los Osos Basin Management Committee (BMC) Board of Directors for outreach, public meetings, and input on technical analysis. The meetings and regulatory coordination elements of the process are outlined below.

2.1 STAKEHOLDER GROUP

The SNMP preparation was coordinated through the efforts of the BMC's existing stakeholder groups. The primary method for engaging the Los Osos SNMP stakeholders was through the BMC monthly meetings, County webpage, and emails. Stakeholders that participated in this SNMP process included:

- Water purveyors: LOCSD, GSWC, and S&T
- Resource groups: Morro Bay National Estuary Program
- Agricultural interests: individual farm owners
- Others: community residents, local businesses, and private well owners
- Regulatory/government agencies: The County and Regional Water Board

Other stakeholders were identified through past groundwater management planning efforts for the Basin. Stakeholders and interested parties was continually updated through meetings who expressed interest.

The primary method for engaging the Los Osos SNMP stakeholders was through meetings. Draft SNMP, meeting announcements, meeting material, and other Los Osos SNMP-related information were emailed and uploaded to the County and Los Osos BMC website to keep basin users informed throughout the process.

2.2 PUBLIC MEETINGS

Four public meetings were held between September 2016 and January 2018, including a meeting with the County Board of Supervisors (BOS) to review the Final SNMP. Public meeting contents are outlined below, and meeting presentations and staff reports are included in Appendix A.

2.2.1 BMC Meetings

BMC meetings on the Los Osos SNMP were held on September 21, 2016; March 15, 2017; and May 17, 2017 at the South Bay Community Center in Los Osos, California. The September 2016 and May 2017 meeting utilized PowerPoint slides to facilitate discussion, while an update was given at the March 2017 meeting. A number of stakeholders attended the meetings and provided input on the plan process.

The September 21, 2016 meeting provided an overview of the requirements for the Los Osos SNMP development, proposed process, and source identification. The May 17, 2017 meeting reviewed the Draft SNMP.

Presentations by the County included:

- Introductions
- Background on the Recycled Water Policy
- Salt and Nutrient Management Plan requirements
- Approach for Plan development
- Technical analysis
- Constituents to be addressed
- Overview of salt and nutrient sources
- Plan development schedule and future public meetings

The May 17, 2017 presentation also included:

- Assimilative capacity and anti-degradation analyses results
- Goals and implementations
- Other monitoring programs
- Los Osos SNMP Groundwater Quality Monitoring Program

2.2.2 County Board of Supervisors Meeting

The Los Osos SNMP was submitted to the County Board of Supervisors and included a resolution approving the SNMP for the Los Osos Groundwater Basin; authorizing the County to submit the plan to the Regional Water Board and to take actions necessary to implement monitoring and reporting. A County staff report summarized the importance, results, and requirements of the Los Osos SNMP. The County Board meeting was held on January 23, 2018.

Chapter 3 BASIN CHARACTERIZATION

This chapter provides a Basin characterization and summary of groundwater quality for the Los Osos SNMP and includes the following:

1. Discussion of data used to characterize and describe the setting, land use, climate, hydrology, and geology.
2. Discussion of the established baseline conditions (i.e., current spatial distributions) for each of the water quality constituents to be reviewed in this SNMP.
3. Discussion of the estimated water balance within the Basin for use in the assimilative capacity and antidegradation analyses to be discussed in Chapter 5.

The features of the Basin described in this report are consistent with the list of groundwater basin characteristics suggested by the Regional Water Board for inclusion in the SNMP. Data used to characterize this Basin area were collected from sampling events and various reports from local and state agencies. Portions of text in this chapter are excerpted from the *Los Osos Basin Plan* (2015), *Los Osos 2015 Annual Groundwater Monitoring Report* (2016), and *Los Osos Basin Boundary Technical Memorandum* (2016).

3.1 GROUNDWATER BASIN SETTING

As discussed in Chapter 1, the Basin characterization and groundwater quality analysis for this SNMP is based on the court approved adjudicated Basin area from the October 15, 2015 Stipulated Judgment that is applicable to the recycled water treatment project area. This Basin area is part of the Los Osos Valley Groundwater Basin, designated as Basin No. 3-8 in DWR's Bulletin 118. The Basin is situated in the Los Osos Valley, west of San Luis Obispo County (Figure 3-1). The plan area overlying this Basin is approximately 7,530 acres, of which 80 percent (5,985 acres) are on land and the remaining 20 percent are underwater beneath Morro Bay (ISJ Group, 2015). The Basin area is bounded on the north by Park Ridge, on the south by the Irish Hills, and on the west by the Pacific Ocean. The Los Osos fault zone trends east to west near the southern boundary of the Basin area. Annual precipitation ranges from 15 to 21 inches (DWR, 2004).

The Basin is made up of five stratigraphic unit layers in one aquifer, these layers are commonly referred to as the Upper Aquifer and Lower Aquifer. This Basin has been the focus of numerous studies to understand the hydrogeology and water quality. The primary constraint on water availability in this groundwater Basin is deteriorating water quality from seawater intrusion and nitrate contamination. The excessive levels of nitrate in the Upper Aquifer of the Basin and seawater intrusion in the Lower Aquifer have been attributed partly to the high density of individual septic systems of the Upper Aquifer and pumping of the Lower Aquifer.

The County of San Luis Obispo Planning Department has determined that the Basin is currently at a certified Level III severity rating (resource capacity has been met or exceeded) due to seawater intrusion (Carollo Engineers et al., 2012). Through the development of the Los Osos Basin Plan, the Los Osos BMC, in coordination with the County's LOWRF project, has evaluated and identified management strategies for implementation to improve conditions in the Basin.

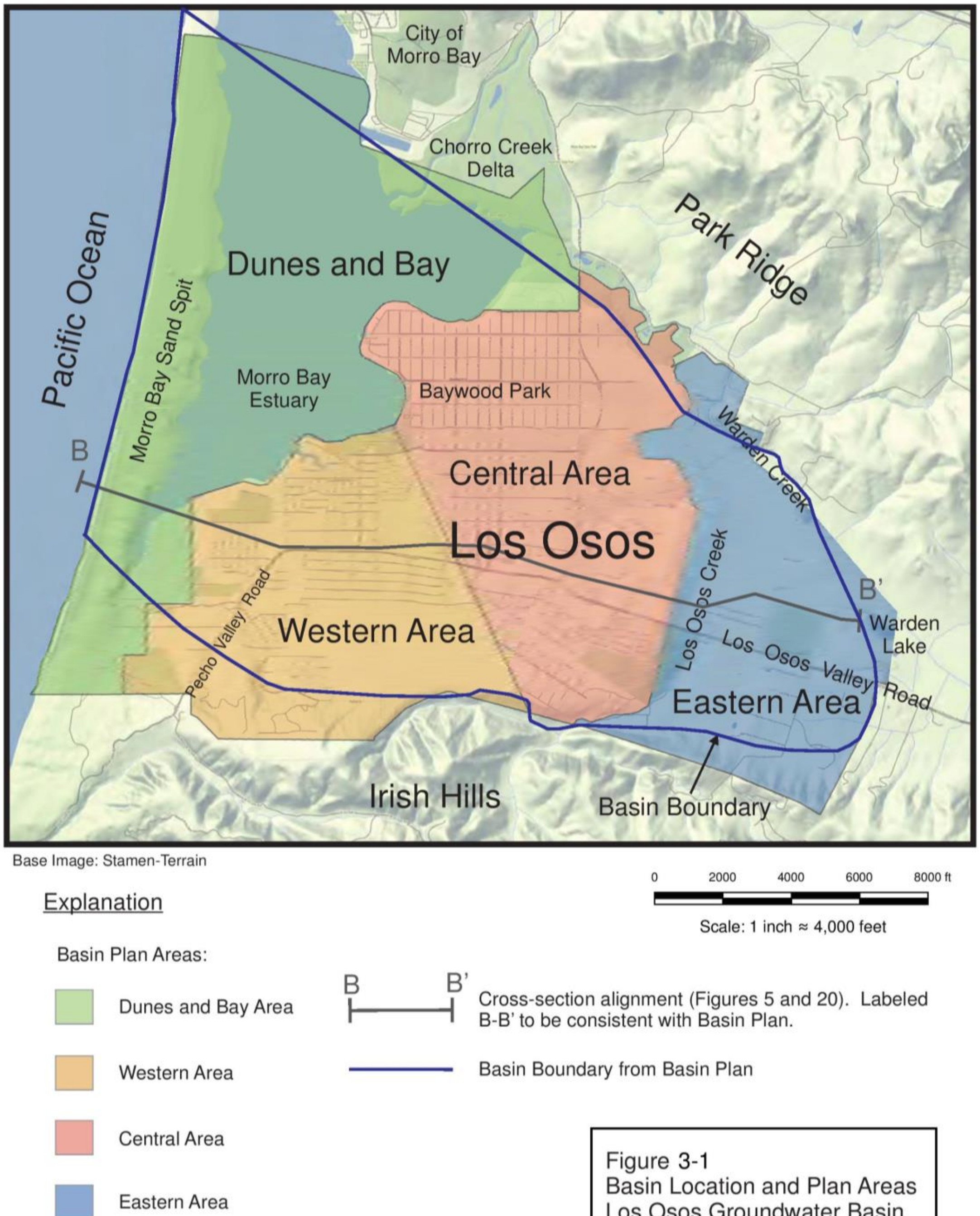


Figure 3-1
Basin Location and Plan Areas
Los Osos Groundwater Basin
2015 Annual Report

Cleath-Harris Geologists

Source: CHG & Wallace Group, 2016

3.2 LAND USE AND WATER USE

Los Osos is an unincorporated community located in San Luis Obispo County, California. Los Osos land use categories and associated acreage in the Basin area are listed in Table 3-1. The overall distribution of land use in the Basin area includes residential, open space, agriculture crops, commercial, and community facilities at about 50, 27, 18, 3, and 2 percent, respectively (ISJ Group, 2015).

Table 3-1. Land Use Categories in the Plan Area

Name	Abbreviation	Acreage
Agriculture	AG	1,089.1
Commercial Retail	CR	92.2
Commercial Service	CS	27.4
Industrial	IN	0.0
Office and Professional	OP	31.6
Open Space	OS	378.1
Recreation	RC	1,123.4
Residential Rural	RR	148.5
Residential Multi-Family	RM	135.1
Residential Single-Family	RF	1,640.0
Residential Suburban	RS	1,086.8
Rural Lands	RL	0.0
Public Facilities	PF	121.7
Uncategorized	UN	109.7
Waterbody	WA	1,545.0
Total		7,528.6

Source: ISJ Group, 2015

Groundwater in the Basin is extracted by water purveyors (i.e., GSWC, S&T, and LOCSD) and overlying private well users. Table 3-2 shows overall groundwater use percentage, respectively. Figure 3-2 shows the approximate locations of the groundwater use areas in the Basin.

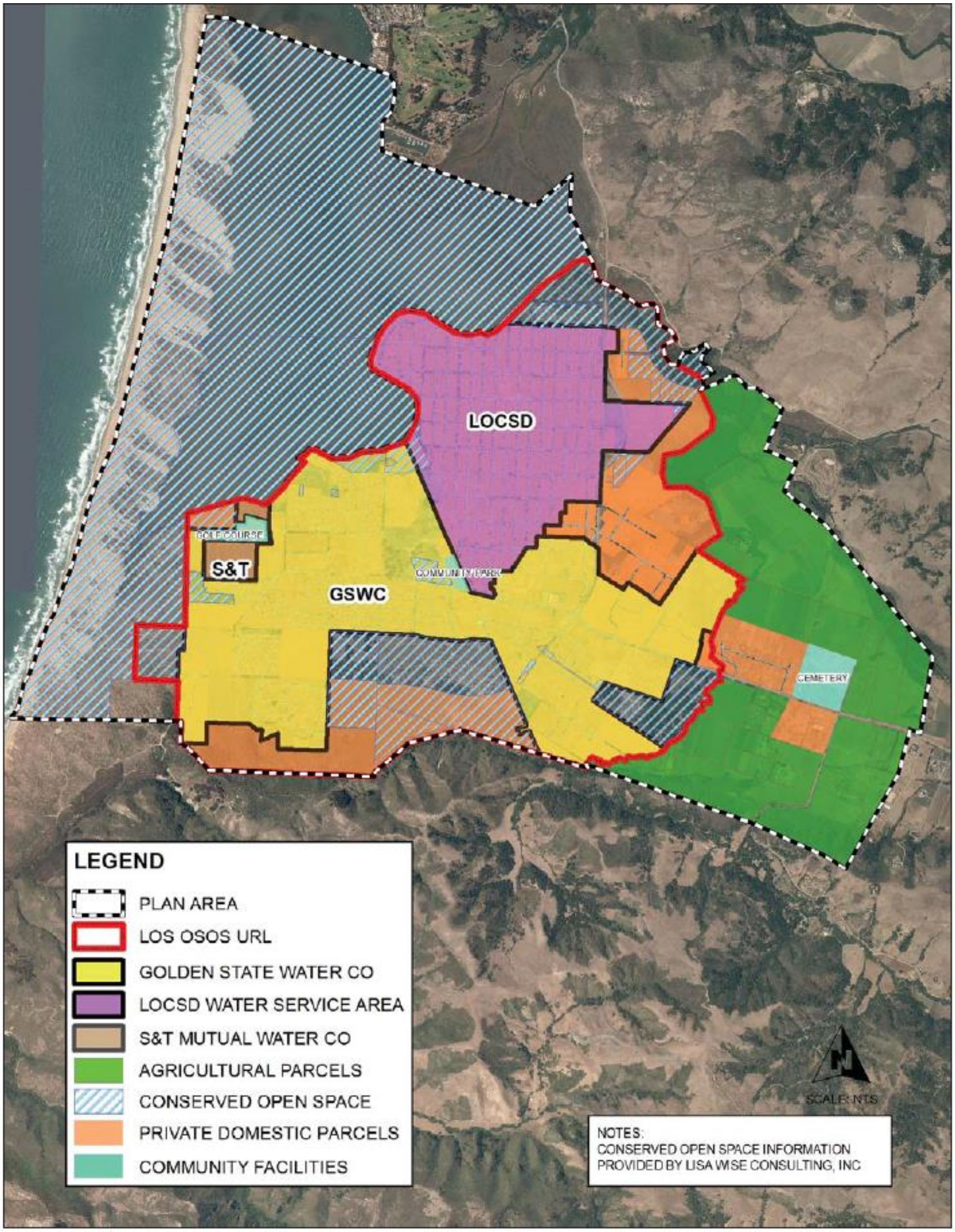
Table 3-2. Categories of Groundwater Use

Category	Area (acres)	Share of Total Area
Purveyors	2,365	52%
Private Domestic Wells	968	22%
Community Facilities	84	2%
Agriculture	1,090	24%
Total	4,507	100%

Source: ISJ Group, 2015

In 2017, recycled water reuse was discharged for land disposal at the Broderson and Bayridge Estates leach fields. Recycled water will be available at permitted urban and agriculture irrigation locations, pending completion of all necessary contractual negotiations in 2018.

Figure 3-2. Groundwater Use Areas



Source: ISJ Group, 2015

3.3 CLIMATE AND HYDROLOGY

The climate of the Los Osos Basin area is dominated by the Pacific Ocean and characterized by small daily and seasonal temperature changes. The maritime influence decreases with distance from the ocean, resulting in greater daily and seasonal temperature ranges and lower relative humidity. The Central Coast region, in general, has a Mediterranean climate characterized by mild, wet winters and dry summers. Los Osos summers are cool, with the average high and average temperatures in July ranging between 68°F to 55°F, and September is the warmest month with temperatures ranging between 71°F to 55°F, respectively (The Weather Channel, 2016).

Average monthly and annual precipitation data were collected from the County of San Luis Obispo Public Works database and City of Morro Bay Fire Department (Table 3-3). Average annual precipitation (2005 to 2016) in the Basin is 14.7 inches per year (in/yr) at the Los Osos Landfill Rain Station (No. 727). Precipitation for the July 2015 to June 2016 rainfall year was reported at 16.15 inches. However, four years prior to July 2015 were drought years with a precipitation average value of 8.41 in/yr from July 2011 to June 2015 (CHG & Wallace Group, 2016).

Table 3-3. Average Monthly Precipitation

Average Monthly Precipitation - Los Osos Landfill Rain Station (No. 727) (inches) 2005 to 2016												
Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	**Total**
0.18	0.03	0.08	1.01	0.81	3.07	3.31	2.78	1.95	1.06	0.37	0.15	14.67
Average Monthly Precipitation - City of Morro Bay Fire Department (inches) 1981 to 2010												
Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	**Total**
0.01	0.05	0.24	0.82	1.4	2.72	3.57	3.77	3.29	1.1	0.43	0.08	17.48

Source: County Water Resources Division of Public Works (2005-2016) and City of Morro Bay Fire Department (1981-2010)

The Los Osos Landfill (gage #727) has only been operating since 2005, and is not considered representative of long-term climatic conditions. The City of Morro Bay Fire Department shows results for the average precipitation between 1981 and 2010. This data provides long-term climatic conditions with over 30 years' worth of precipitation data with an average total of 17.48 inches.

On average, at least 85 percent of annual precipitation occurs from October through April. Average monthly reference evapotranspiration (ETo) data were collected from the California Irrigation Management Information System (CIMIS) weather station located in San Luis Obispo West (Station No. 160) and is presented in Table 3-4. Monthly ETo ranges from 4.02 inches in October 2015 to 4.97 inches in September 2016, with an annual average of 51.41 inches.

Table 3-4. Average Monthly Reference Evapotranspiration at CIMIS Station #160

Evapotranspiration (inches)												**Total**
Dec 2016	Jan 2017	Feb 2017	Mar 2017	Apr 2017	May 2017	Jun 2017	Jul 2017	Aug 2017	Sep 2017	Oct 2017	Nov 2017	
4.02	2.98	2.01	1.72	3.57	3.82	5.02	5.01	6.46	6.51	5.29	4.97	51.41

Source: CIMIS, 2016

3.3.1 Surface Water Sources

The main streamflow in the Basin study area is Los Osos Creek and its tributaries. Other creeks in the Basin area include Willow Creek and Warden Creek, which flows through Warden Lake, a marshy depression located just outside the Basin boundary to the east, as shown on Figure 3-3. Los Osos Creek originates in the Irish Hills to the south of the Basin, and flows through and drains Clark Valley watershed, a small alluvial valley, before emerging in the Basin area. Los Osos Creek flows northeast and then northwest into Morro Bay. Subsequently, Willow Creek is a short watercourse that starts in the Basin, flows through the dune sands, and drains into Eto Lake and then Los Osos Creek (ISJ Group, 2015).

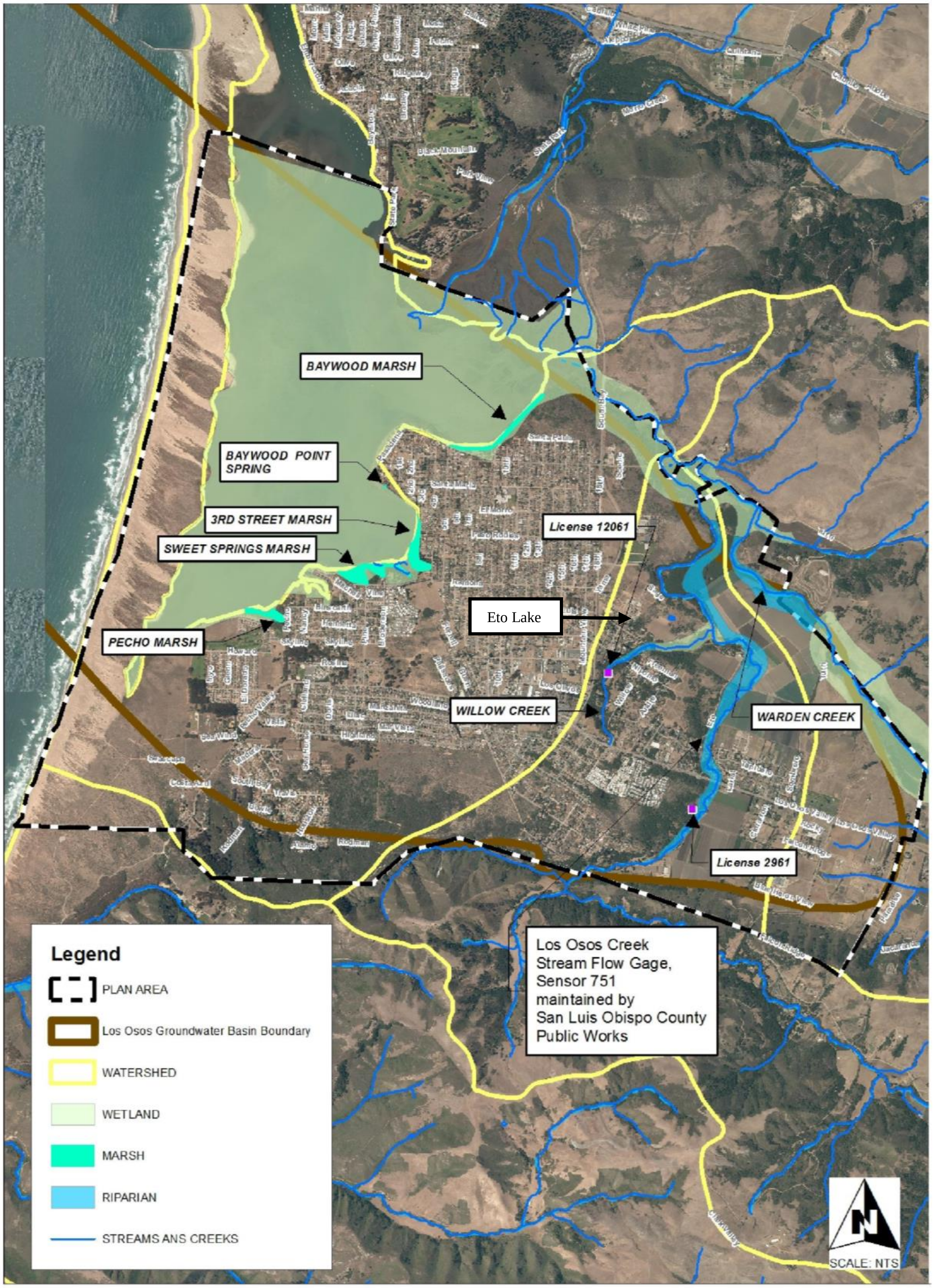
Significant sources of recharge for the Basin are direct percolation from precipitation and percolation from surface runoff, such as streams and tributaries. The stormwater runoff from the hills into the creek is highly variable by season. Peak flows from the Los Osos Creek can be as high as 1,000 cubic feet per second (cfs) and subsiding to less than 40 cfs within a few days (ISJ Group, 2015). This seasonal creek dries up in the summer and fall between Clark Valley and Eto Lake.

3.3.1.1 Streamflow Data

Streamflow data for Los Osos Creek is monitored by a County gauge (Sensor 751) at the Los Osos Valley Road bridge, as shown on Figure 3-3. There is minimal surface water runoff into the stream channels from the surrounding land area due to high infiltration rates from the permeable sandy soil. Runoff from the surrounding land area does not contribute to streams recharge in the Basin, but precipitation that falls on this land area recharges the Basin both directly and indirectly from local drainage areas or natural depressions within the dune sands (CHG & Wallace Group, 2016).

As shown in Table 3-5, the average flow of Los Osos Creek at the gauge (drainage area of 7.6 square miles) was 3,769 acre-feet per year (AFY) between 1976 and 2001. Water use in the creek valley has been estimated at 800 AFY for irrigation and 75 AFY for rural residential use (CHG, 2009). Recharge to the aquifers underlying the creek valley comes mainly from streamflow seepage. The estimated stream seepage during normal years is 600 AFY. The 2008 Equivalent Freshwater Head (EFH) basin model estimated stream seepage under current conditions at 665 AFY, while the SEAWAT model estimated stream seepage under current conditions at 640 AFY (CHG, 2009). These Basin models are discussed in Section 3.6.1.

Figure 3-3. Surface Water Resources of the Basin



Source: ISJ Group, 2015

Table 3-5. Historical Streamflow & Stream Gauge Summary - 1976 to 2001

Stream Gage Name: **Los Osos Creek (#6)**
Water Planning Area: **3**

Water Year†	Annual Stream Flow (acre-feet)		Water Year†	Annual Stream Flow (acre-feet)	
1976	110	1	1990		9
1977	0		1991		10
1978	8,810		1992		11
1979	1,240		1993		12
1980	3,890	2	1994	497	
1981	1,630		1995	19,270	
1982	2,390	3	1996	1,740	
1983		4	1997	3,020	
1984	2,110		1998	7,340	
1985	1,920		1999	505	
1986	11,850	5	2000	2,540	
1987		6	2001	2,470	
1988		7	2002	0	
1989		8	2003	NA	13

[1] gage put into operation in February
[2] missing data for one day in February
[3] missing data for various days in February, March, and April
[4] only visual observations were available for this year
[5] missing data for the end of February and beginning of March

From Annual Stream Flow Records	
Average Flow:	3,769 AFY
Median Flow:	2,110 AFY
Minimum Flow (2002):	0 AFY
Maximum Flow (1995):	19,270 AFY

Source: CHG, 2009

Recent streamflow data from stream gauge station #751 is presented in Table 3-6. The maximum stream stage was recorded during the 2015 water year (drought year).

Table 3-6. Maximum Stream Stage for Los Osos Creek, 2015 Water Year

Date	Maximum Stream Stage County Sensor 751 (feet)	Daily Precipitation County Station #727 (inches)
12/11/14	2.25	1.22
12/12/14	0.69	1.22
12/15/14	0.40	0.71
12/16/14	2.68	0.71
12/17/14	2.24	0.08
3/1/15	2.60	0.43
7/19/15	2.54	1.69
7/20/15	2.36	0.24

Source: CHG & Wallace Group, 2016
Note: There is no rating curve to correlate the data between the rain and stream gage reading, reference only. A rating curve should be developed in the future by the County of San Luis Obispo.

3.3.2 Climate Change Projections for North Coast Sub-Region

The *2014 San Luis Obispo Integrated Regional Water Management (IRWM) Region, Climate Change Analysis (Appendix R)* is based on historical and future projected monthly data sets. Climate change analyses for the three San Luis Obispo County sub-regions was conducted to evaluate precipitation, minimum and maximum temperature, wind speed, evapotranspiration, and runoff, as well as average annual change in growing degree days, heating degree days, and cooling degree days.[1] The following paragraphs summarize a few potential outcomes from the *Climate Change Analysis (2014).*

For the North Coast sub-region (including the Los Osos area), the mid-century (2050) projections indicated a change in precipitation cycles, with an annual increase in warming patterns and night-time temperatures, and some minor changes in wind speeds. Additionally, growing degree days were projected to increase in all seasons, which could cause an alteration in plants' water requirements, such as increasing watering frequency.

Groundwater quality/quantity: There is not enough literature on the effects of increased temperatures on groundwater quality; however, changes in solubility of geochemicals could affect water quality, such as an increase in pH (County of San Luis Obispo et al., 2014). Also, a rise in sea level would lead to an increase in salt water intrusion, impairing water quality by reducing the water available for use.

Increased Water Demand: Increased temperatures are responsible for changes in water consumption for agriculture due to changed growing cycles, crop demand and increased evapotranspiration. Under future climate change scenarios, the Los Osos Community would face increased demands in water for agriculture due to increased evapotranspiration in spring, summer, and fall. Adjustments in water budget in this community would be required in response to changing cropping needs in the area. However, plant growth is conducive to warmer temperatures, and as the climate in the region gets warmer, a potential growth in agriculture can be expected, especially for growing winter crops. Despite the restrained growth in the region, water demands of the already-existing communities can be expected to increase. This increase will be a result of greater evapotranspiration which would increase the domestic use of water used for irrigation. This increase could decrease the groundwater storage volume, if projects and/or programs are not implemented, such as the recycled water reuse. (County of San Luis Obispo et al., 2014)

Climate change can potentially impact the Basin and future water supply by affecting water demands, groundwater quality, available groundwater and surface water supply, and infrastructure. Climate change presents an uncertainty because it is unclear which of the predicted climate change scenarios, if any, will occur. Several scenarios could be (1) an increase in temperature, which would increase the water demand by increasing water use for plants and humans; (2) an increase or decrease in precipitation, which would impact the Basin's recharge rates; (3) an increase of potential frequency of flooding; and (4) an increase in sea level rise that could increase the rate or quantity of seawater intrusion into the Basin (ISJ Group, 2015). These potential impacts of climate change, if they occur, will be addressed by the continued management of the Los Osos BMC.

3.4 BASIN GEOLOGY

A map displaying the Basin boundaries and surficial geology is shown in Figure 3-4. The Basin boundaries were originally defined by DWR (1958), and the Basin was refined by Cleath-Harris Geologists using information from well logs, geologic maps and cross-sections, water levels, water quality data, and fault investigations (ISJ Group, 2015; CHG, 2016). As stated in the *2016 Los Osos Valley Groundwater Basin Boundary Modification Request Technical Memorandum by Cleath-Harris Geologists* (CHG, 2016):

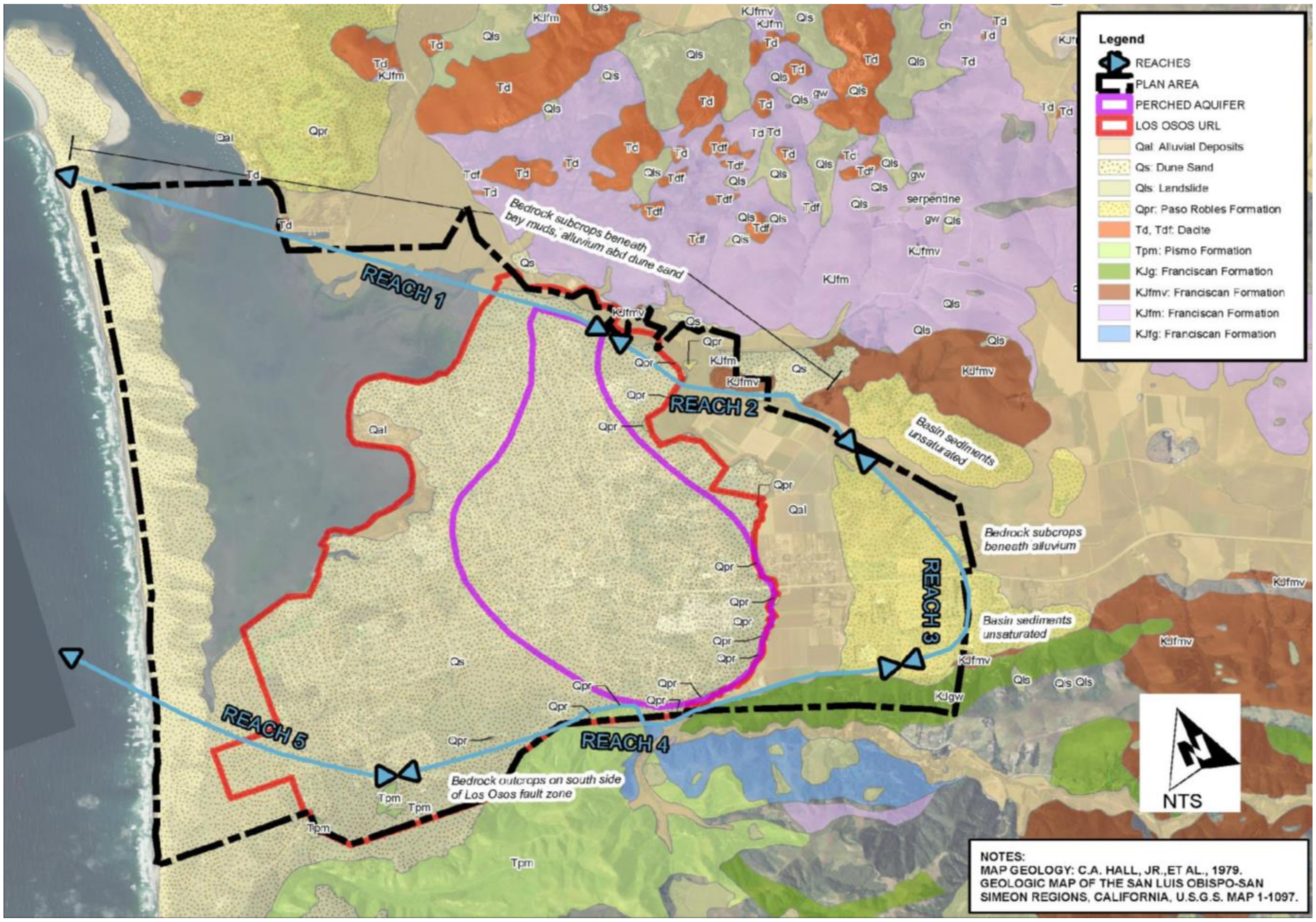
[1] Details of the climate change analysis can be reviewed at
https://slocountywater.org/site/Frequent%20Downloads/Integrated%20Regional%20Water%20Management%20Plan/seen

"In general, the proposed lateral basin boundary is the onshore extent of the contiguous area overlying the principal aquifers, with at least one pre-Holocene aquifer present. The proposed bottom of the basin is the base of permeable sediments, which is defined by the contiguous base of the stacked principal aquifers within the lateral basin boundary.

The basin boundary effectively encloses an area at ground surface beneath which the Paso Robles Formation and windblown sand deposits taper to a negligible thickness (less than about 40 feet) or pinch out entirely against basement rocks (Yates and Wiese, 1988).

The basin area excludes Holocene-age alluvial deposits and active dune sands that are directly underlain by bedrock which have a restricted subsurface hydraulic connection to the basin. The pre-Holocene aquifers include older (stabilized) dune sand deposits, the Paso Robles Formation, and the Careaga Formation."

Figure 3-4. Surficial Geology and Boundaries - Los Osos Groundwater Basin

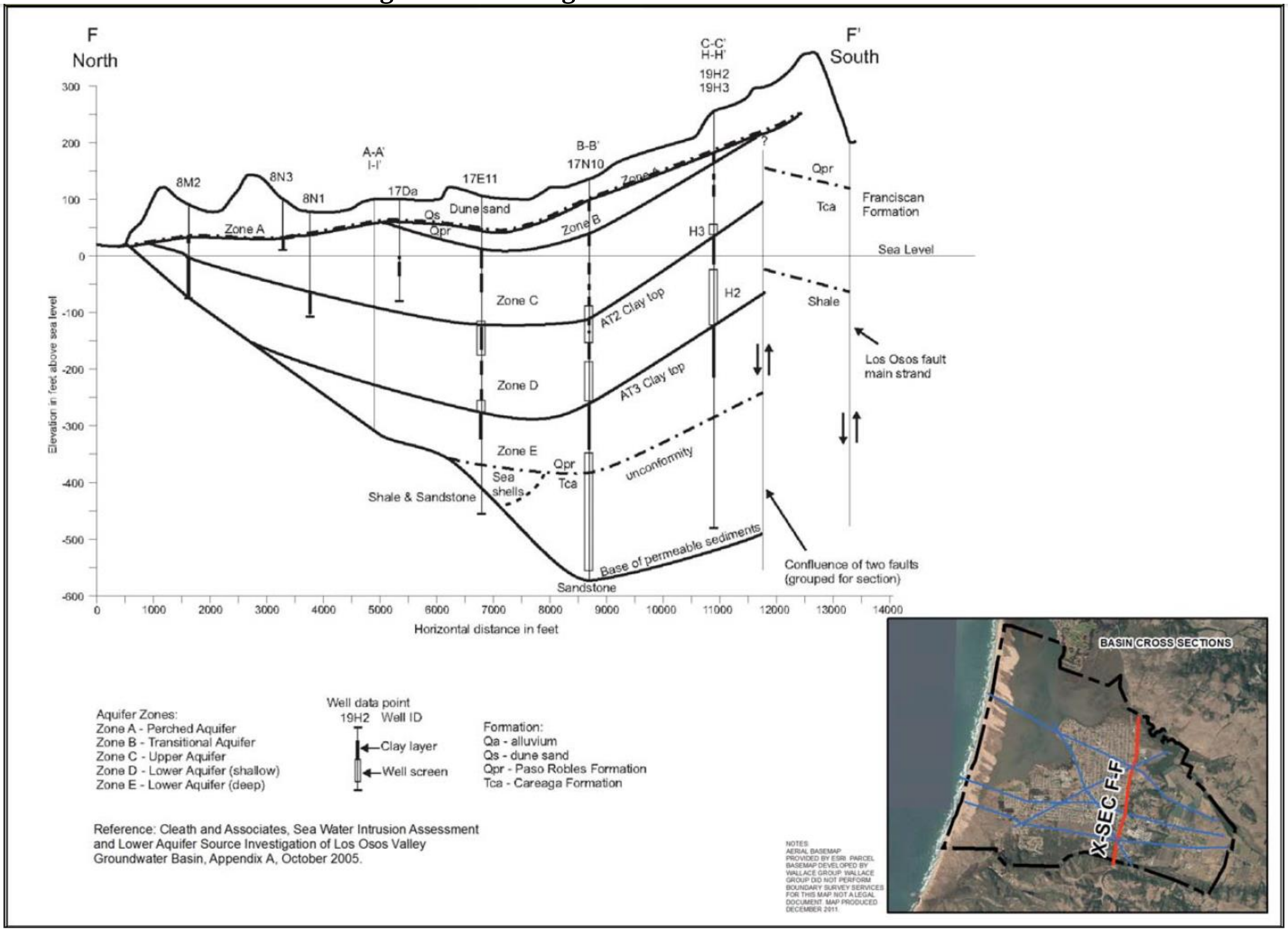


Source: ISJ Group, 2015

3.4.1 Geologic Cross-Sections

Six geologic cross-sections (i.e., cross-section A-A' to cross-section F-F') were developed by Cleath-Harris Geologists. Two cross-sections were presented in the Los Osos Basin Plan (LOBP). The first geologic cross-section, F-F', traverses from the southern to northern edge of the Basin area (Figure 3-5), and the second cross-section, B-B', traverses from the Pacific Ocean to the western edge of the Basin area (Figure 3-6). The cross-sections include the several sub-horizontal aquifer layers (Zones A through E, and the Alluvial Aquifer); the sub-layers are discussed in detail in Table 3-7.

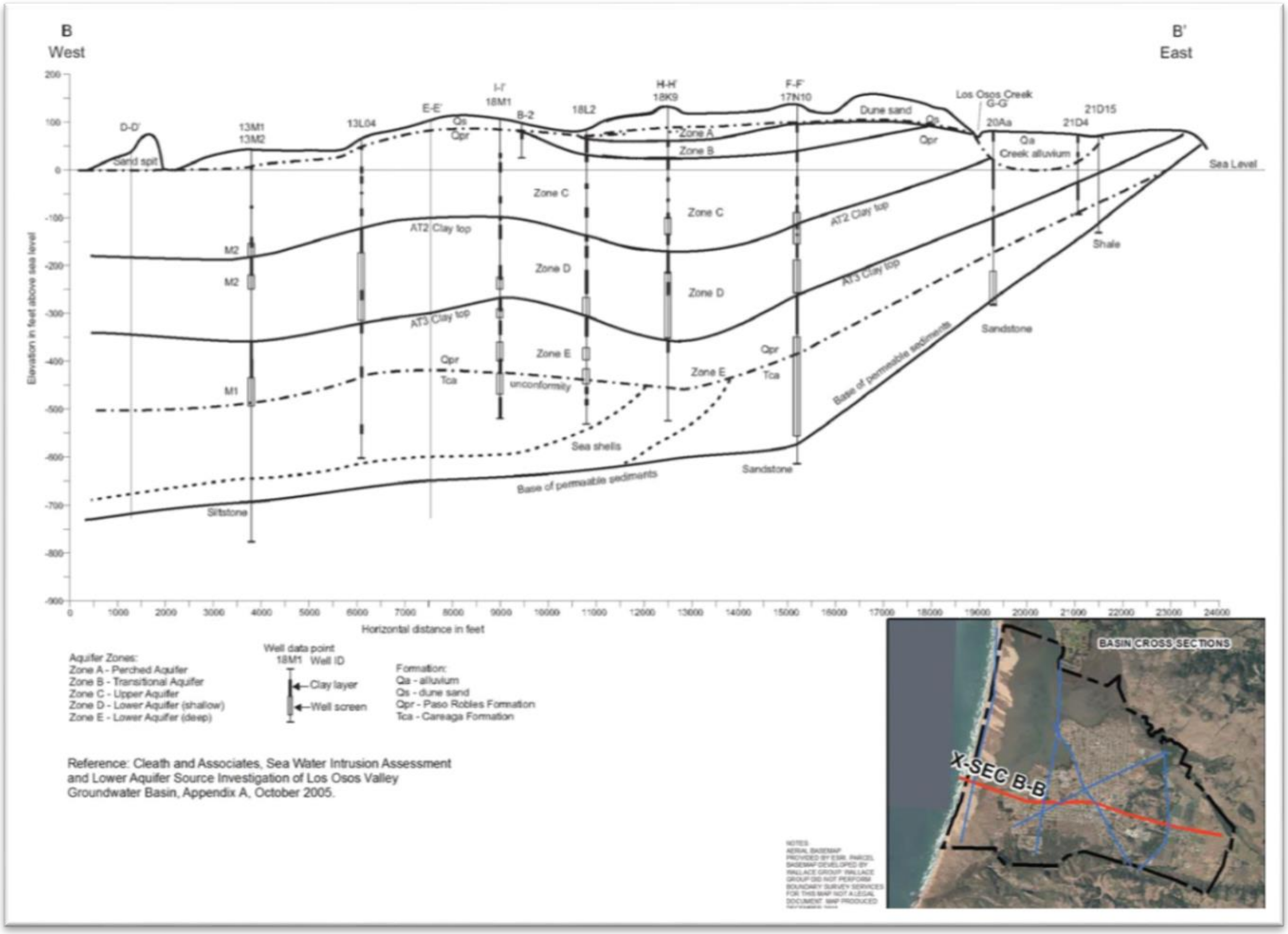
Figure 3-5. Geologic Cross Section F-F'



Source: ISJ Group, 2015

In Figures 3-5 and 3-6, the Paso Robles Formation sedimentary layers are the major water bearing sediments in the Los Osos Basin. The general production zones are identified in the Upper Aquifer Paso Robles Formation (Qpr), and Lower Aquifer in the Paso Robles Formation (Qpr) and Careaga Formation (Tca) (CHG, 2016).

Figure 3-6. Geologic Cross Section B-B'



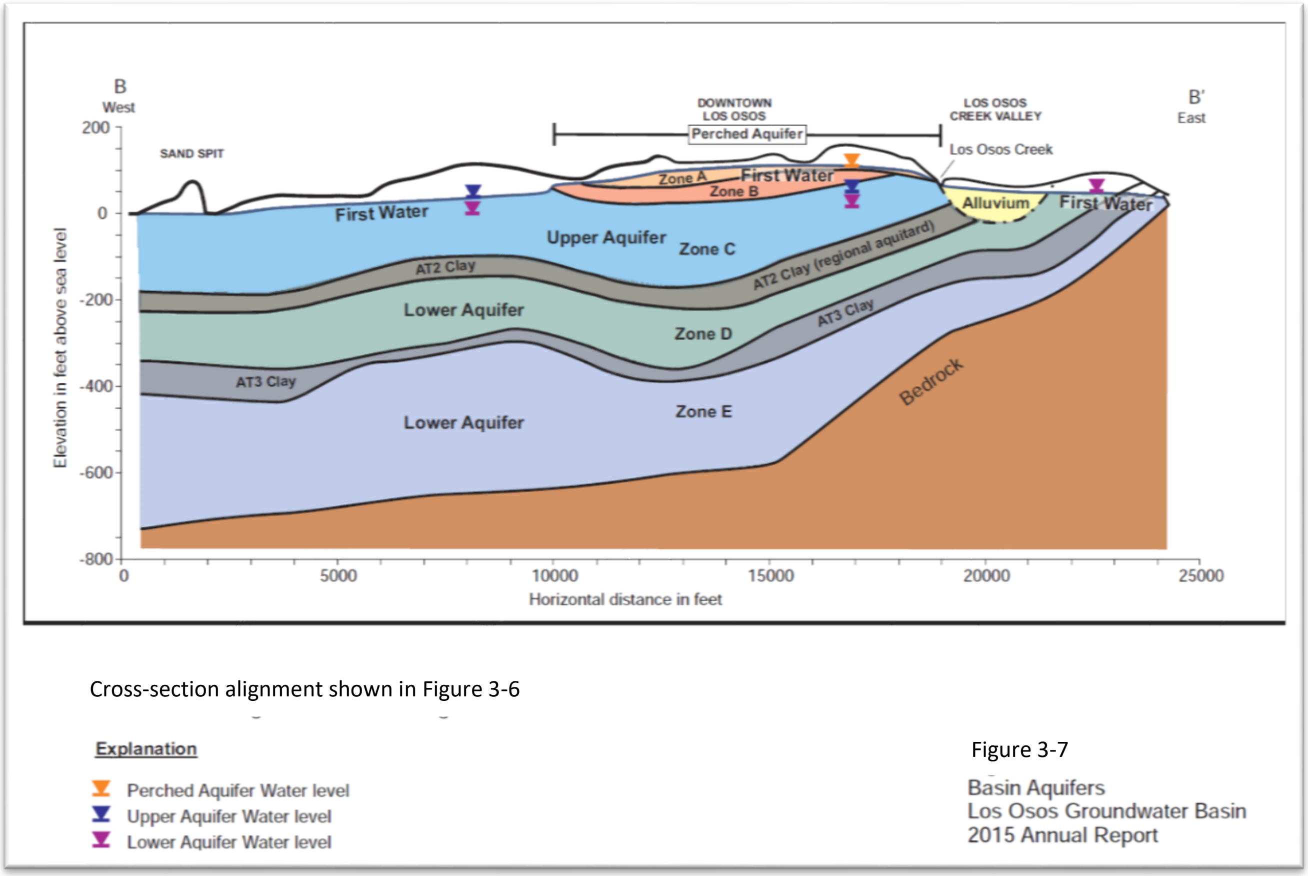
Source: ISJ Group, 2015

3.5 AQUIFER ZONE CHARACTERIZATION

The Basin is made up of several sub-horizontal stacked aquifer layers, each of which has distinct characteristics. The aquifer layers are designated as Zones A through E, an Alluvial Aquifer, and a regional aquitard, as described in Table 3-7 and shown on Figure 3-7.

- Zone A - Perched Aquifer,
- Zone B - Perched Aquifer (transitional Upper Aquifer),
- Zone C – Upper Aquifer,
- Regional aquitard (clay) - separates the Upper and Lower Aquifers, and
- Zones D and E - Lower Aquifers.

Figure 3-7. Aquifer Zone Characterization



Source: CHG & Wallace Group, 2016

In Figure 3-7, First Water refers to the shallowest groundwater zones and includes the Alluvial Aquifer, the Perched Aquifer, and the top portion of the Upper Aquifer (Zone C), which is not overlain by the alluvial or Perched Aquifer.

Table 3-7. Aquifer Zone Characterization and Groundwater Flow (Source: CHG, 2016)

Alluvial Aquifer
The Alluvial Aquifer is formed from stream channel and floodplain deposits of Los Osos Creek. Recent alluvial deposits are interpreted to overlie Paso Robles and Careaga Formation sediments in the Los Osos Creek valley. These alluvial deposits are typically close to 70 feet thick. The base of the alluvial deposits extends to approximately 40 feet below sea level where Los Osos Creek exits the Basin through a narrow in the lower creek valley. The Los Osos Creek valley alluvium typically consists of mostly clay with interbedded sand and gravel lenses. A basal sand and gravel unit is also inferred from inspection of well drilling logs, although the similarities in lithology with underlying Paso Robles Formation deposits make alluvial sediment interpretation difficult. Active irrigation or private domestic wells may tap the basal gravel in the alluvium, but typically extend into deeper aquifer zones. Groundwater in the Alluvial Aquifer of the Los Osos Creek valley moves down the valley toward the Morro Bay estuary. Recharge occurs from a variety of sources: direct percolation of precipitation; return flow from irrigation and septic system discharges; stream seepage from Los Osos Creek; and subsurface inflows across Basin boundaries.

During drought years, alluvial water levels may decline in excess of 10 feet between spring and fall, but typical seasonal fluctuations are closer to 5 feet. Many agricultural wells in the creek valley tap the Lower Aquifer below the alluvium, where water level fluctuations are greater due to seasonal production to meet irrigation demands.

Zone A – Perched Aquifer

Zone A is a Perched Aquifer that overlies a clay layer at the base of the older dune sands. Zone A is not generally used as a source of water supply for Los Osos. The Perched Aquifer is unconfined and completely within dune sands, although there are also many areas with saturated dune sands that are not specifically in Zone A. The perched clay outcrops along the banks of Los Osos Creek above an elevation of approximately 80 feet. The dune sands are wind-blown (eolian) deposits, also referred to as the Baywood fine sand. These deposits typically comprise poorly graded fine to medium-grained clean sand, and reach a maximum estimated thickness of close to 100 feet along the dune ridges in Baywood Park.

The average hydraulic conductivity of the older dune sand in Zone A is estimated to range from 70 to 230 gallons per day per square foot (gpd/ft^2). The specific yield for these shallow sands is estimated between 20 and 25 percent. Zone A receives recharge from direct percolation of precipitation and return flows from anthropogenic activities.

Groundwater movement in Zone A is within dune sand and flow directions are generally northwest to northeast, with relatively steep hydraulic gradients of up to 0.06 ft/ft between Bayview Heights and downtown (parallel to the topographic slope). Flow in Zone A drains to Willow Creek and issues from seeps in the Los Osos Oaks Preserve and along the banks of Los Osos Creek. To the north and west, the perching clay pinches out and groundwater spills into aquifer Zone C. A groundwater high between downtown Los Osos and eastern Baywood Park separates water moving to the east toward Los Osos Creek from water moving to the west toward the Morro Bay estuary.

Zone B – Transitional Aquifer

Zone B, the transitional aquifer, is composed of fine sands and silty sands with occasional clayey and gravelly lenses. Zone B is separated from Zone A by a clay and clayey sand aquitard up to 30 feet thick beneath downtown Los Osos. The piezometric head in Zone B lies between the Zone A (Perched Aquifer) and the uppermost community water supply aquifer, which is Zone C. Water levels in Zone B have been measured up to 16 feet lower than Zone A, and close to 60 feet higher than Zone C at multi-level monitoring wells. These water level differences, along with differences in general mineral water quality, led to the identification of Zone B as a separate aquifer. Subsequent lithologic correlations between downtown and wells to the north and east placed Zone B within the Paso Robles Formation. No pumping tests specific to Zone B are available. Zone B is not generally used as a source of water supply for Los Osos.

Zone C   Upper Aquifer

Zone C, which is the shallowest aquifer used as a source of water supply for the Los Osos community, overlies the regional aquitard and extends up to the water table, except where overlain by Zones A or B. Zone C is predominantly within Paso Robles Formation deposits, except at lower topographic elevations where dune sands are saturated. The Paso Robles Formation is composed of unconsolidated sands, gravels, and clays. Gravel clasts are generally derived from Franciscan Formation rocks, including cherts, metavolcanics and hard sandstone. Shales, quartz and diabase/dacite are also commonly logged. The depositional environment has included beach and near-shore marine conditions. As a result, sea shells are occasionally present in the Paso Robles Formation. West of downtown Los Osos, Zone C is generally composed of fine to medium grained sands, with relatively few clays or gravels, except one notable basal gravel. In the downtown area, Zone C sediments coarsen, with more fine gravels noted in logs, although interbedded clays are also common.

Recharge to Zone C occurs via direct percolation of precipitation, return flow from irrigation and septic system discharges, stream seepage from Los Osos Creek, subsurface inflows across Basin boundaries, and through leakage from overlying Zones A and B. Movement of groundwater in Zone C is variable, but generally flows north and west toward Morro Bay, with some easterly flow from Baywood toward Los Osos Creek. Upper Aquifer water levels have increased historically in some areas due to increased return flow from development. The hydraulic gradient in Zone C ranges from 0.004 to 0.025 (dimensionless), and averages approximately 0.009.

Specific yield for aquifer zones would be estimated based on individual lithology, and typically range from 13 to 20 percent. Where Zone C is unconfined (portions of western Basin area), specific yield estimates apply to aquifer storativity estimates. Where confined or semi-confined (beneath Morro Bay estuary and downtown Los Osos), aquifer storativity values may be several orders of magnitude lower. Pumping test conducted in downtown Los Osos indicated a storativity of 0.0001.

Regional Aquitard

Individual clay beds in the Paso Robles Formation are generally discontinuous across the Basin, with one important exception. A regional aquitard has been recognized since the early 1980s, when Brown & Caldwell (1983) noted differences in water quality above and below the clay. The regional aquitard ranges from approximately 20 to 80 feet thick, and averages 50 feet thick over 27 drilled locations. The regional aquitard is one of the most significant hydrogeologic features in the Basin and separates the Upper and Lower Aquifers. Hydraulic communication between the Upper (Zones A through C) and Lower (Zones D and E) Aquifers is restricted by the regional aquitard, although the large areal extent and vertical hydraulic gradient across this layer, along with open wellbore flows, results in several hundred acre-feet of leakage through the aquitard each year.

Zone D – Lower Aquifer (Zone D and E)

Below the regional aquitard is Lower Aquifer, Zone D. This is currently the primary source of community water supplies. Zone D is a Paso Robles Formation aquifer zone composed predominantly of sands and gravels. Gravel clast composition is Franciscan Formation sandstone, chert, and metavolcanics, along with siliceous shales and claystones. Shell fragments are noted in Zone D lithology at wells on the sand spit and in Baywood Park. The structure of Zone D is generally conformable with the overlying aquitard, except where displaced by faulting in the Bayview Heights area. The aquifer zone averages close to 100 feet thick over the central portions of the Basin, thinning toward the east. Pumping tests indicate a confined aquifer condition in Zone D. The hydraulic conductivity of Zone D is estimated to be between 129 to 140 gpd/ft^2.

Groundwater in this zone is generally moving toward downtown Los Osos from surrounding areas. Water levels have shown declining trends over time in many areas. Much of this decline took place during the 1970s and early 1980s, in concert with growing population and groundwater withdrawal.

The principal sources of freshwater recharge to the Lower Aquifer (Zones D and E) are leakage through the regional aquitard from the Upper Aquifer and Los Osos Creek stream seepage. Subsurface inflow from bedrock sources is believed to be a lesser source of recharge. Seawater intrusion is occurring in the Lower Aquifer, and has been advancing at an estimated rate of 200 to 250 feet per year in Zone D since 2005.

Zone E – Lower Aquifer (Zone D and E)

An aquitard separates Zone D from Zone E in the Lower Aquifer. This aquitard is typically thinner than the regional aquitard and possibly discontinuous. The two Lower Aquifer zones differ with respect to salinity near the coast and with respect to permeability in inland areas, warranting the hydrogeologic aquifer distinction. The contact between the Plio-Pleistocene Paso Robles Formation and the Pliocene Careaga Formation occurs in the middle of Zone E. The Careaga Formation is the lowermost Basin hydrostratigraphic unit. The base of the Careaga Formation is up to 800 feet below sea level in the southwestern portion of the Basin.

Zone E contains a mixture of sands and gravels that are associated with Paso Robles Formation and Careaga Formation. The Careaga Formation has not been mapped regionally in outcrop, and there is considerable variation in what has been tentatively identified as Careaga Formation, including coarser grained and finer grained zones. The deep Basin sediments in the western portion of the Basin include much coarser sands and gravel, compared to the finer sands and silty sands in the eastern portion of the Basin.

At wells along South Bay Boulevard, east of downtown Los Osos, the fine grained silty sandstone attributable to the Careaga Formation is estimated to have a hydraulic conductivity of approximately 7 gpd/ft^2. Adjusting for differences in permeability and screened intervals between Zone D and Zone E aquifers, the hydraulic conductivity of Zone E is in the vicinity of the Los Osos Community Park is estimated to range between 60 and 90 gpd/ft^2.

3.6 HYDROGEOLOGY

3.6.1 Hydrogeologic Basin Models

The hydrogeology of the Basin is based on groundwater models and conceptual models. The Basin groundwater flow model was developed in MODFLOW from various other models dating from the mid-1980s to 2010. As an example, the MODFLOW model utilizes USGS's SEAWAT program, which was developed to simulate three-dimensional, variable-density, transient groundwater flow in porous media. SEAWAT combines MODFLOW (modular flow) and MT3D (mass transport) code, and adds variable fluid density capability for seawater intrusion simulations. (ISJ Group, 2015)

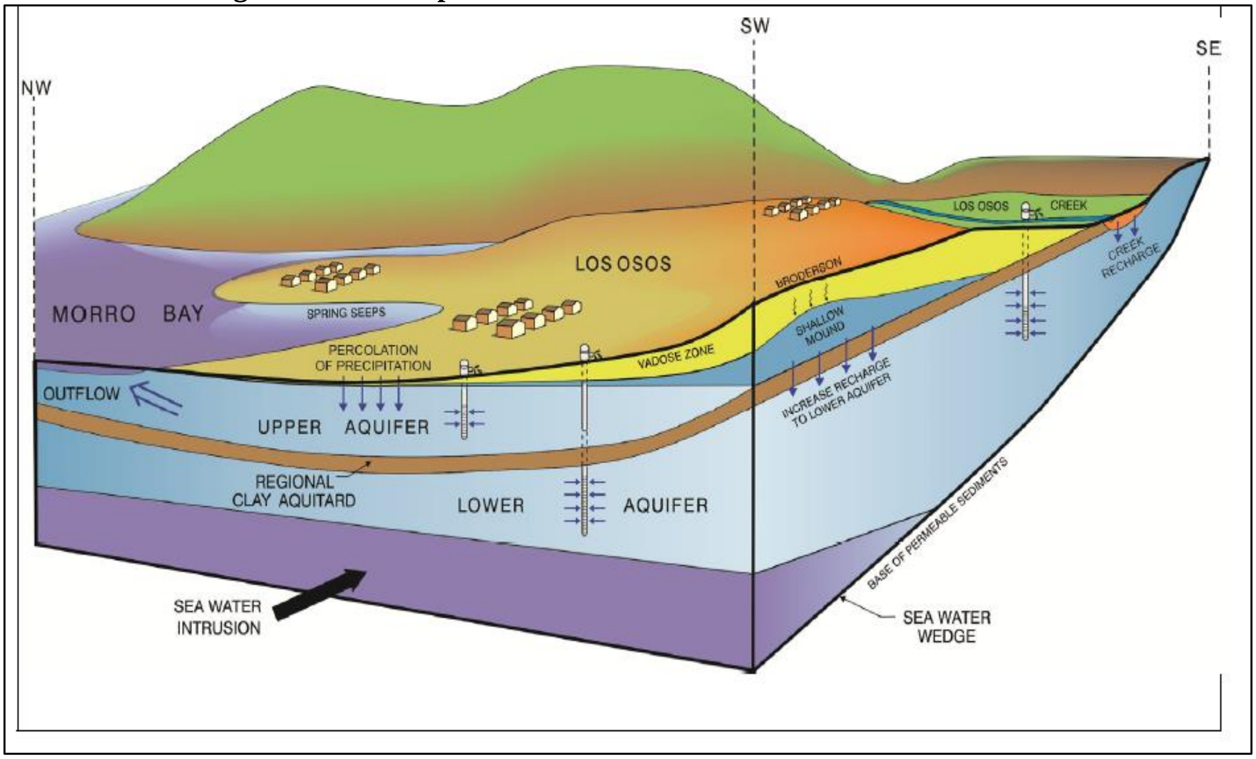
Inflow to the MODFLOW model includes percolation of precipitation, leakage from the perched aquifer (through a recharge pre-processor), stream seepage, septic return flows, irrigation return flows and subsurface inflow (including seawater intrusion). Seawater intrusion simulation and mixing with fresh groundwater is modeled by tracking total dissolved solids (TDS) concentrations within the Basin. Outflow from the MODFLOW model includes evapotranspiration (through the recharge pre-processor), well production, creek outflow and subsurface outflow. (ISJ Group, 2015)

Results of the MODFLOW model includes (ISJ Group, 2015):

- Evaluation of seawater intrusion and sustainable yield and hydrologic budget information
- TDS isoconcentration maps to compare the effects of existing and alternative groundwater pumping and wastewater disposal scenarios on seawater intrusion and sustainable yield.
- Input parameters for individual model scenarios, which include adjusting well production, septic/wastewater return flow, and Perched Aquifer leakage. Also, percolation of precipitation and sea level are also adjusted when defining climate change scenarios. Starting heads and initial salt concentrations are imported from the current condition scenario.
- Model scenarios are run in steady-state using the SEAWAT program. To achieve steady-state (Basin equilibrium), the ending heads and final concentrations of each model run are imported into the MODFLOW model as initial heads and starting concentrations for the next model run until there is no significant difference between model inflow and outflow (mass balance error approaching zero), and there is no further movement of the seawater intrusion front within the Basin.
- Information extracted from the MODFLOW model for comparison with other scenarios includes the quantity of seawater intrusion, Los Osos Creek recharge, and subsurface outflow. Other components of flow have also been extracted to create Basin hydrologic budgets.

The Los Osos SNMP technical analysis in Chapter 5, a conceptual model was used in a compilation and interpretation of available information on the physical system being modeled. For a groundwater basin, conceptual model includes a characterization of basin structure, boundary conditions, aquifer geometry, physical parameters, and components of inflow and outflow. The Basin structure and aquifer geometry for the conceptual model was developed through a network of geologic cross-sections, with deep well control points used to contour elevations on the base of four layers in the model [Upper Aquifer (Layer 1), the regional aquitard (Layer 2), and two divisions of the Lower Aquifer (Layers 3 and 4)] (ISJ Group, 2015). The physical parameters for Basin sediments (hydraulic conductivity, porosity, specific yield and storativity) are based on field tests or adjusted through calibration within a plausible range of values. Figure 3-8 shows the conceptual model of the Basin.

Figure 3-8. Conceptual Model of the Los Osos Groundwater Basin



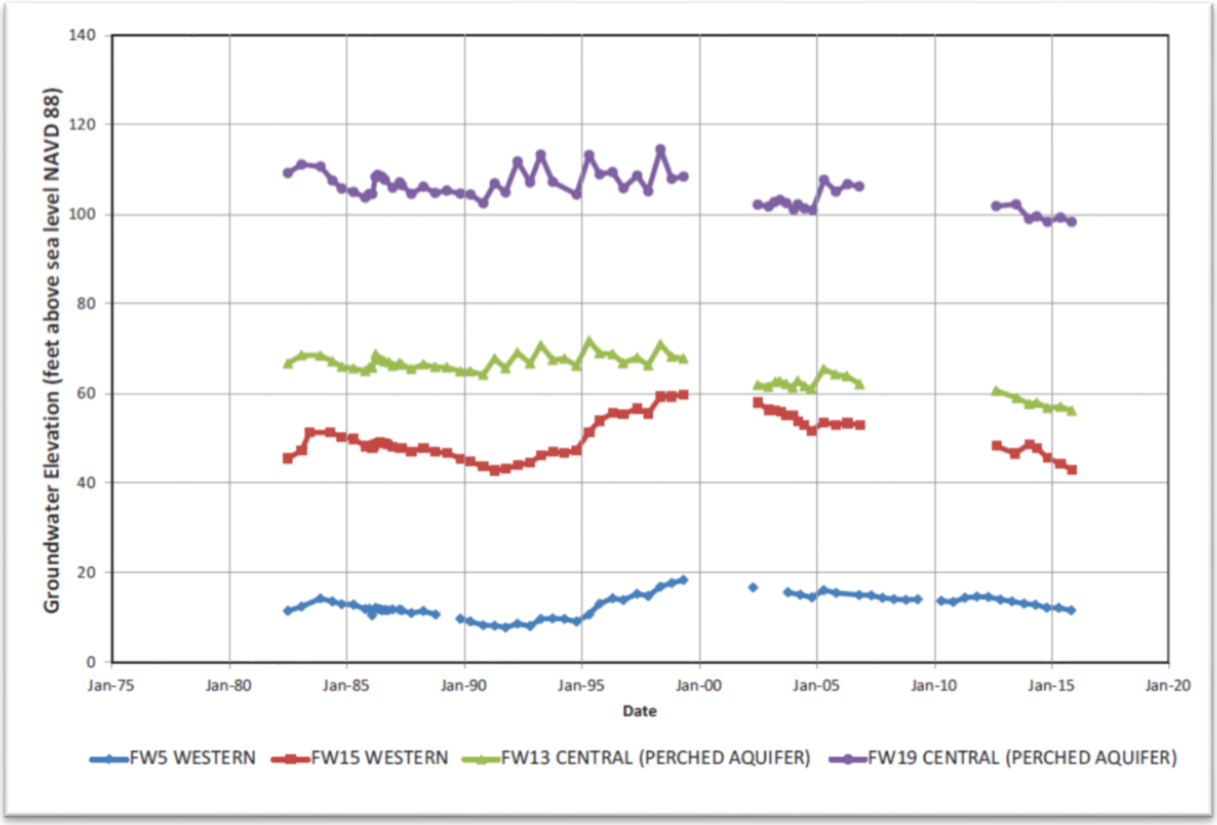
Source: ISJ Group, 2015

3.6.2 Groundwater Levels and Hydrographs

Water level hydrographs that show measured groundwater elevations over time for the Basin are illustrated in Figure 3-9 to 3-11. The hydrographs represent data from groundwater wells screened in either the First Water, Upper Aquifer, or Lower Aquifer and their Basin location as shown on Figure 3-1, such as Western, Central, and Eastern areas of the Basin. A database of wells in the Basin, along with their characteristics, such as date of construction, depth, screened intervals, owner, production and location, is maintained (confidential proprietary data); only aggregate data is published to the public**.** Groundwater elevations in wells can measure hydraulic head in an aquifer. Changes in hydraulic head, along with other parameters, are used to calculate changes in the amount of groundwater in storage within an aquifer.

Figures 3-9 to 3-11 shows hydrographs of individual groundwater wells measured approximately from 1975 to 2015. Although the wells selected for the hydrographs display different patterns of fluctuation over time, the First Water and Upper Aquifer hydrographs (Figures 3-9 and 3-10) show that groundwater elevations at most locations over the approximate 40-year period have either remained about the same (i.e., no net change) or have experienced a net decline (last 5-year drought) (CHG & Wallace Group, 2016). In contrast, the wells in the Lower Aquifer hydrograph (Figure 3-11) show an increase in groundwater elevations over the last five years.

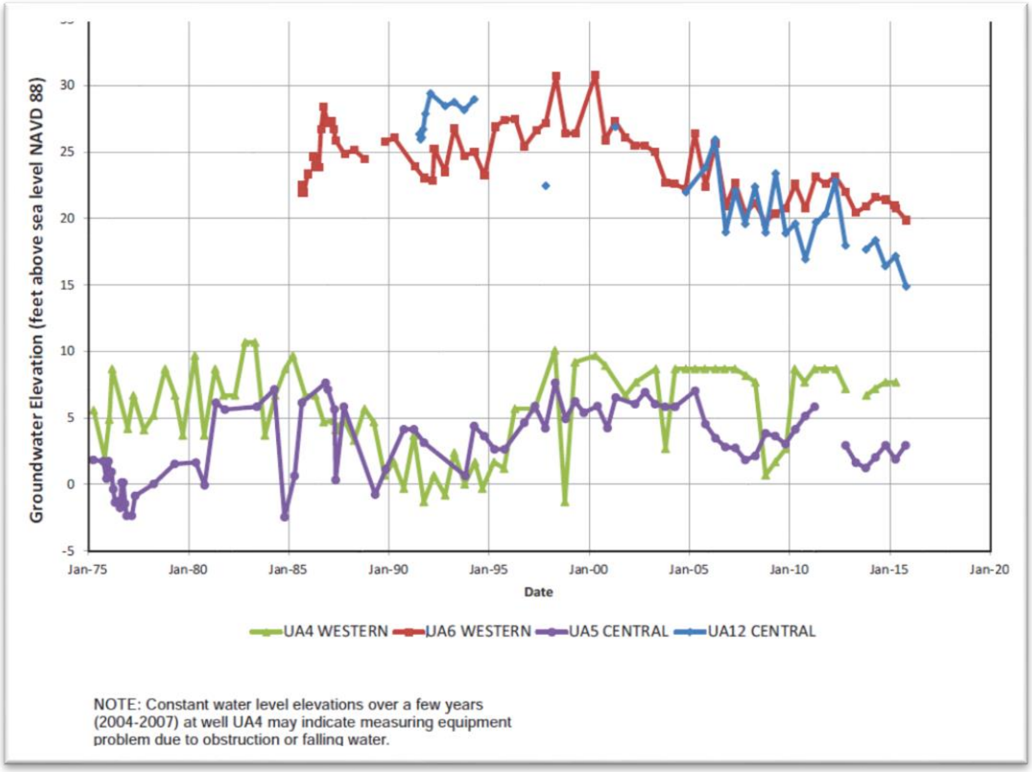
Figure 3-9. Water Level Hydrographs for Perched Aquifer/First Water



Source: CHG & Wallace Group, 2016

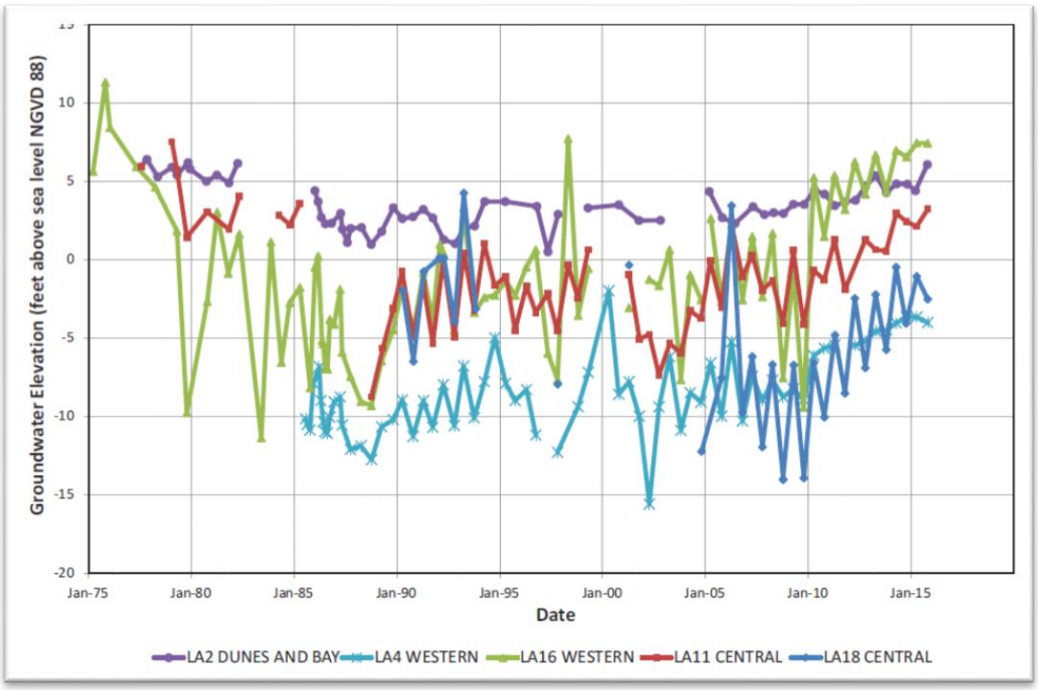
Water level trends over the last 10 years (2005 – 2015) are shown in Figures 3-9 to 3-11, average 0.7 feet of decline per year in First Water, 0.5 feet of decline per year in the Upper Aquifer, and 0.9 feet of rise in Lower Aquifer water levels. The declining water levels in First Water and Upper Aquifer wells are interpreted to be mainly in response to over 30 inches of decline in the cumulative departure from mean precipitation curve between 2005 and 2015. (CHG & Wallace Group, 2016)

Figure 3-10. Water Level Hydrographs for the Upper Aquifer



Source: CHG & Wallace Group, 2016

Figure 3-11. Water Level Hydrographs for the Lower Aquifer



Source: CHG & Wallace Group, 2016

3.6.3 Water Level Contour Maps

Water level contour maps for Spring 2015 are presented in Figures 3-12, 3-13, and 3-14 for the Perched Aquifer, Upper Aquifer with Alluvial Aquifer, and Lower Aquifer, respectively. The water level elevations are based on the kriging interpolation method, which provides a best (least-squares) estimate of values at unmeasured points based on the mapped values. Water level data available from irrigation and domestic wells were used in the development of the water level contour maps. To develop contour maps useful for groundwater storage estimates, a few wells located along the Basin boundaries were added to the monitoring network, along with additional control points in the Perched and Upper Aquifers. All groundwater elevations were adjusted to a common datum (North American Vertical Datum of 1988 (NAVD 88)) prior to contouring and groundwater storage calculations. These adjustments are approximate, pending a review of all reference point elevations by a licensed land surveyor. (CHG & Wallace Group, 2016)

3.6.3.1 Groundwater Contours

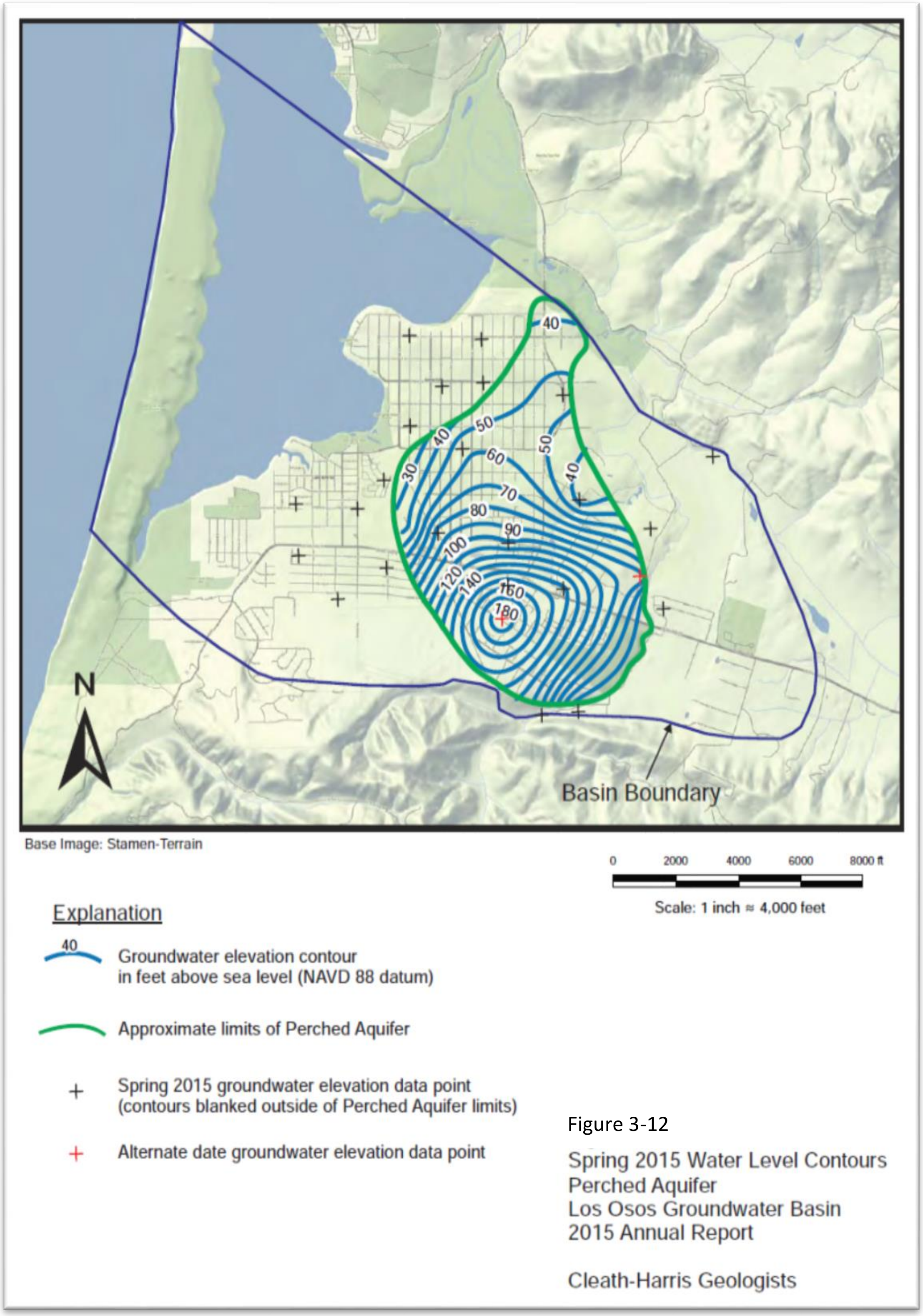
Groundwater moves in the direction of declining head, and groundwater elevation contours can be used to show the general direction of groundwater movement. Spring water level contours for the *2015 Annual Groundwater Monitoring Report* (CHG & Wallace Group, 2016) are summarized below.

- The Perched Aquifer water level contour map (Figure 3-12) shows the highest groundwater elevations at Bayridge Estates wastewater disposal field, with a radial direction of groundwater flow from the higher topographic elevations to lower elevations.

- The Upper Aquifer and Alluvial Aquifer water level contour map (Figure 3-13) shows the highest groundwater elevations at the southern edge of the Los Osos Creek valley. The general direction of groundwater flow is to the northeast along the creek valley and to the northwest toward the Morro Bay estuary. Significant features include a pumping depression interpreted to be present in the area of downtown Los Osos, and a groundwater high point interpreted to be present beneath dune sand ridges in Baywood Park.

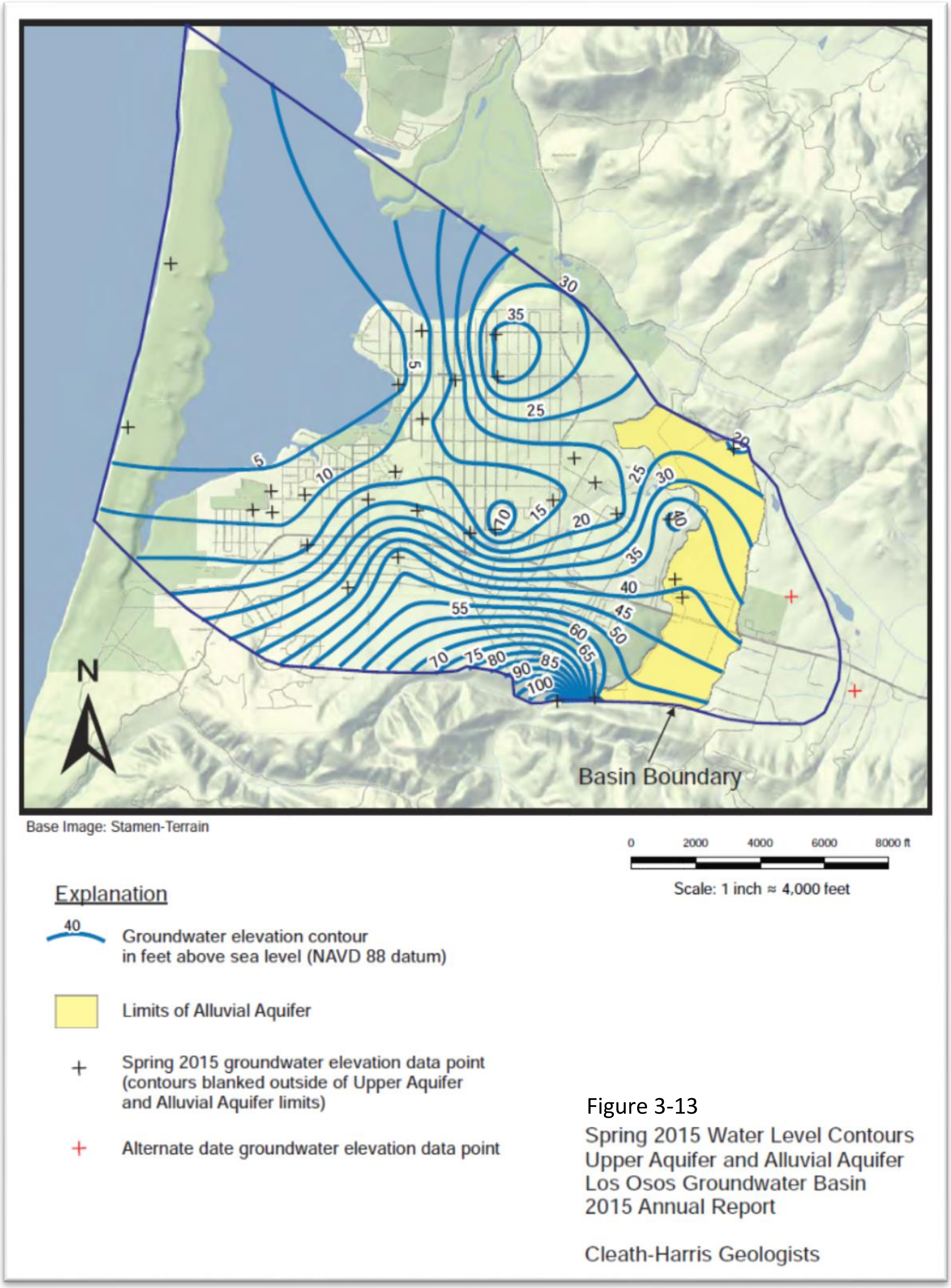
- Lower Aquifer water level contour map (Figure 3-14) shows high groundwater elevations at the southern edge of the Los Osos Creek Valley and near the eastern Basin boundary. Groundwater flow in the Lower Aquifer is generally toward Central Area pumping depressions. Lower Aquifer groundwater elevations over most of the Western and Central Areas are below sea level. One of the pumping depressions is centered around a monitoring well, which may be due to an inaccurate wellhead elevation.

Figure 3-12. Water Level Elevation Contours for the Perched Aquifer



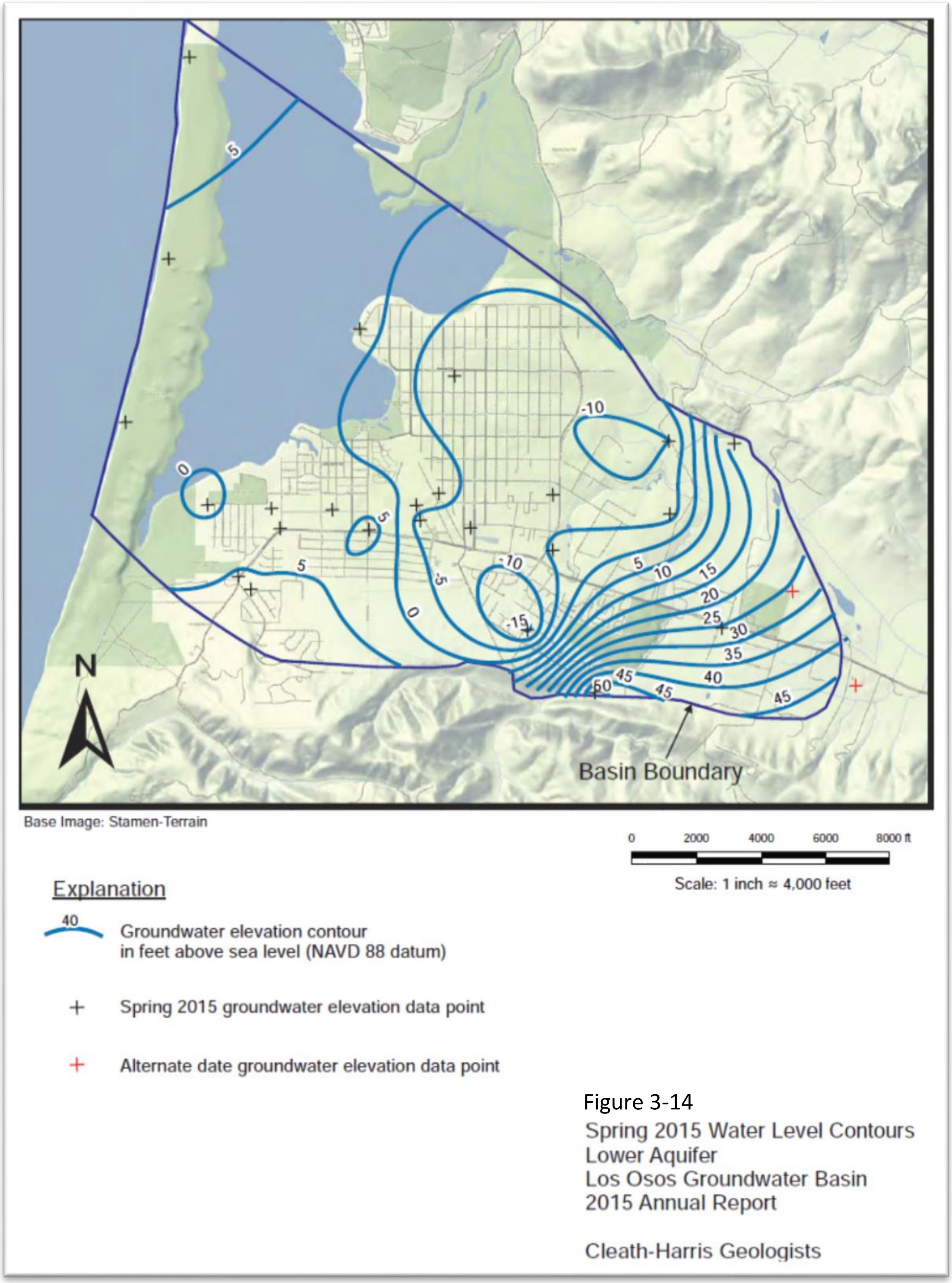
Source: CHG & Wallace Group, 2016

Figure 3-13. Water Level Elevation Contours for the Upper Aquifer and Alluvial Aquifer



Source: CHG & Wallace Group, 2016

Figure 3-14. Water Level Elevation Contours for the Lower Aquifer



Source: CHG & Wallace Group, 2016

3.6.4 Groundwater Storage

As stated in the *2015 Annual Groundwater Monitoring Report*, groundwater total production in 2015 was 2,170 acre-feet and the 2015 sustainable yield was estimated to be 2,450 acre-feet per year (CHG & Wallace Group, 2016). The Basin reaches depths of several hundred feet below sea level in the study area and holds a considerable volume of groundwater in storage. Groundwater storage has been estimated through a systematic approach of water level contouring, boundary definition, volume calculations, and aquifer property estimation. Table 3-8 summarizes the Basin groundwater storage (excluding Dunes and Bay area) of approximately 120,000 acre-feet in 2015, with approximately 15,000 acre-feet above sea level. The table shows a seasonal storage decline of approximately 300 acre-feet between Spring 2015 and Fall 2015.

Table 3-8. Spring and Fall 2015 Groundwater in Storage (<250 mg/L Chloride)

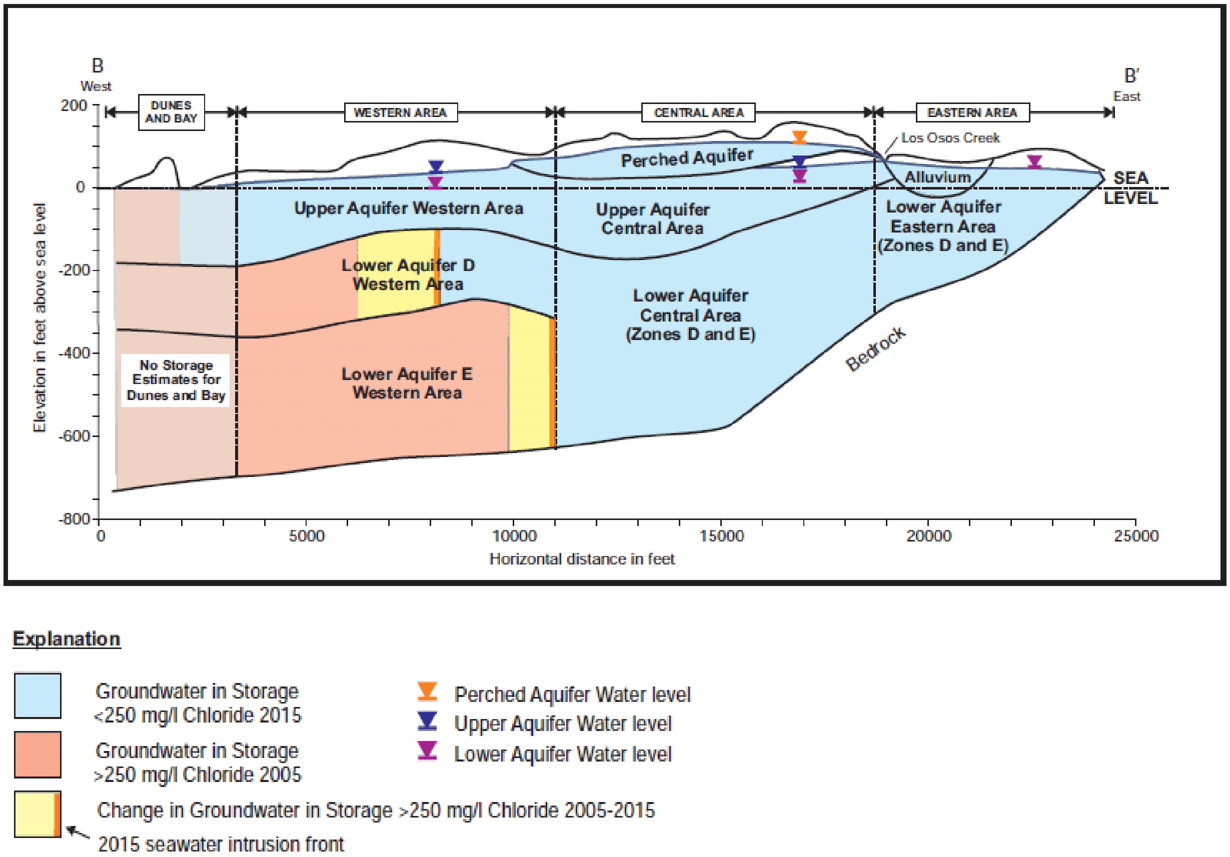
Basin Area	Aquifer	Zone	Spring 2015		Fall 2015	
			Total	Above Sea Level	Total	Above Sea Level
			ACRE-FEET			
Western and Central	Perched	A, B	4,200	4,200	4,200	4,200
	Upper	C	27,000	7,700	26,600	7,200
Western	Lower (fixed vol.)	D[1]	14,300	0	14,300	0
	Lower (confined vol.)[2]	D[1]	80	1	70	1
Central	Lower (fixed vol.)	D, E	56,100	0	56,100	0
	Lower (confined vol.)[2]	D, E	90	3	80	2
Eastern	Alluvial and Lower	Alluvial, D, E	17,900	3,400	18,000	3,500
TOTAL			119,700	15,300	119,400	14,900

NOTES:
1. Western Area (Zone E) not included due to high chloride concentrations.
2. Lower Aquifer confined volume estimates shown for comparison to fixed volumes. The fixed volume component of storage is based on the specific yield of the aquifer sediments, and is fixed because the Lower Aquifer is never dewatered in the Western and Central areas. The confined component adds a relatively small volume of transient storage associated with the aquifer pressure, and is based on the storativity of the aquifer.
3. Once the volume of saturated Basin sediments has been calculated, a porosity factor is applied to isolate the volume of pore space, which contains the actual groundwater. For the Basin, the nominal values for the various porosity factors are estimated at 0.3 total porosity, 0.2 effective porosity, and 0.1 specific yield factor. The storativity value used for the confined aquifer in the Western and Central areas is estimated at 0.0008.

Source: CHG & Wallace Group, 2016

The volume storage components in Table 3-8 shows the Lower Aquifer divided into Zone D and E. The Western Area is further divided by seawater and the non-intruded seawater volume, as shown on Figure 3-15. The seawater intrusion was defined as groundwater with a chloride concentration of 250 milligrams per liter (mg/L) or greater. Zone E in the Western Area is mostly intruded seawater with chloride concentrations above 250 mg/L (Figure 3-15) and is not shown on Table 3-8, while Zone D is mostly potable groundwater. Seawater intrusion in Zone E of the Western Area is not included in the assimilative capacity and antidegradation analysis due to the water quality results would skew the results high for chlorides and total dissolved solids, and not reflect the Basin's true water quality.

Figure 3-15. Basin Storage Compartments for Los Osos Groundwater Basin



(Source: CHG & Wallace Group, 2016)

Figure 3-15 shows the decline in storage between 2005 and 2015 is estimated at approximately 4,600 acre-feet, or 460 acre-feet per year on average. There has also been a decline in fresh groundwater storage (<250 mg/L chloride) of 2,700 acre-feet, or 270 acre-feet per year. By comparison, Basin production between 2005 and 2015 averaged 2,760 acre-feet per year. Some of the storage decline is partly due to Basin pumping in excess of the safe yield and drought conditions (CHG & Wallace Group, 2016). The history and chloride trends in the Basin are summarized in Section 3.7.4.3

3.7 WATER QUALITY

The three chemical constituents to be addressed in the Los Osos SNMP as indicators of salt and nutrient loadings to the Basin are nitrate (as Nitrogen (N)), chlorides, and TDS[2]. Recent and historic measured concentrations of nitrate (as NO_3) and chloride at different locations in the Basin were collected and used to establish the baseline conditions (i.e., estimated spatial distribution of constituent concentration representative of current conditions). The nitrate (as NO_3) data were converted to nitrate (as N) for the Los Osos SNMP. The baseline conditions for the three constituents were derived using water quality data from

[2] TDS is a measure of the combined content of all inorganic and organic substances contained in in water that can pass through a 2-micron filter and includes ionized or micro-granular (colloidal sol) suspended form, such as carbonate, biocarbonate, chloride, fluoride, sulfate, phosphate, nitrate, calcium, magnesium, sodium, and potassium. TDS is not generally considered a primary pollutant (e.g. it is not deemed to be associated with health effects) it is used as an indication of aesthetic characteristics of drinking water and as a indicator of the presence of a broad array of chemicals.

basin studies, the Los Osos Basin Plan, water quality reports from water purveyors[3], and baseline groundwater quality monitoring reports from the LOWRF (WDR Order No. R3-2011-0001), and other historical Basin studies. The maps of baseline conditions were then used to estimate average constituent concentrations in the Basin. The baseline conditions for TDS, nitrate (as N), and chloride are required for the assimilative capacity and anti-degradation analyses in the Los Osos SNMP.

The major objectives of the water quality analyses described in this section include:

1. Review of the Regional Water Board water quality objectives and drinking water standards for the Basin;
2. Description of the water quality databases used in the analysis;
3. Discussion of historical trends for the three indicator constituents and estimation of the baseline conditions for each constituent; and
4. Ranges of measured constituent concentrations and estimated average constituent concentrations for each study area.

3.7.1 Water Quality Objectives

Water Quality Objectives (WQO) provide a reference for assessing groundwater quality in the Los Osos Basin. Primary and secondary drinking water standards for TDS, nitrate (as N), and chloride, as established by the Code of Regulations, Title 22 are presented for reference in Table 3-9. The Primary Maximum Contaminant Levels (MCL) are set to be protective of human health. Secondary MCLs address aesthetic issues related to taste, odor, or appearance of the water and are not related to health effects, although elevated TDS concentrations in water can damage crops, affect plant growth, and damage municipal and industrial equipment. The U.S. Environmental Protection Agency (EPA) recommended Secondary MCL for TDS is 500 mg/L, and 250 mg/L for chloride.

The LOBP water quality metrics for chloride is 100 mg/L and for nitrate is 10 mg/L, as shown in Table 3-10. TDS is not included as a metric in the LOBP. Metrics are reported in the LOBP annual groundwater monitoring reports by the Los Osos BMC.

Table 3-9. Title 22 Drinking Water Standards for Nitrate (as N), Chloride, and TDS

Water Quality Constituent	Primary Drinking Water Standard Recommended MCL (mg/L)	Secondary Drinking Water Standard Recommended MCL (mg/L)	Secondary Drinking Water Standard Upper Limit (mg/L)	Secondary Drinking Water Standard Short Term (mg/L)
Nitrate (as N)	10	--	--	--
Chloride	--	250	500	600
Total Dissolved Solids	--	500	1,000	1,500

Abbreviations: Maximum Contaminant Levels (MCL) and milligrams per liter (mg/L)

Table 3-10. LOBP Quality Objectives

Constituent Metric	Groundwater Goal (mg/L)
Nitrate Metric	10 mg/L or lower
Chloride Level Metric	100 mg/L or Lower

Abbreviations: milligrams per liter (mg/L)
Source: ISJ Group, 2015

[3] Water Purveyors adheres to federal and state drinking water quality guidelines required by the EPA, the SWRCB's Division of Drinking Water (DDW) and the California Public Utilities Commission (CPUC).

3.7.2 Regional Water Board Water Quality Objectives for Recycled Water

The WQOs (i.e., maximum acceptable concentrations) for organic and inorganic constituents in the Basin were developed by the Regional Water Board for both water source and beneficial water use (CCRWQCB, 2016). The beneficial water uses for which water quality objectives were developed are domestic and municipal use for landscape irrigation and agricultural use. Table 3-11 shows nitrate (as N) as the applicable Regional Water Board WQOs for this Basin. Nitrate (as N) is listed in municipal/domestic water supplies and for agricultural water use (i.e., irrigation supply and livestock watering). As previously noted, the SNMP for the Basin will address TDS, nitrate (as N), and chloride as indicator constituents of salt and nutrient loadings to the Basin.

Table 3-11. Nitrate (as N) WQO for Municipal/Domestic Supply and Agricultural Water Use

Constituent	Municipal and Domestic Supply Maximum Contaminant Level (MCL) (mg/L)	Agricultural Water Use Irrigation Supply Maximum Concentration (mg/L)	Agricultural Water Use Livestock Watering Maximum Concentration (mg/L)
Nitrate (as N)	10	--	90

Abbreviations: milligrams per liter (mg/L)
Source: CCRWQCB, 2011a

The Regional Water Board has the authority to enforce the LOWRF waste discharge requirements as defined in Waste Discharge/Recycled Water Requirements (WDR) Order No. R3-2011-0001. The waste discharge requirements comply with the recycled water requirements of CDPH, California Code of Regulations - Title 22 for unrestricted use. There will be periods in the year when the LOWRF effluent is not used for irrigation and will be disposed to land in leach fields. The effluent requirements from the LOWRF will meet the WDR Order requirements, including:

- Total Nitrogen Monthly Average limit of 7 mg/L,
- Total Nitrogen Maximum Day limit of 10 mg/L, and
- California Code of Regulations for Title 22 standards for tertiary recycled water.

3.7.3 Data Sources

Recent and historic water quality measurements were collected and used to generate the baseline conditions for TDS, nitrate (as N), and chloride for this study. Drinking water quality in the Basin was extensively characterized in the LOBP and in the baseline groundwater monitoring for the LOWRF WDR Order. Numerous water samples have been collected by the Los Osos BMC for their annual report and for the LOWRF permit. The Los Osos BMC has a total of 73 wells, including 35 monitoring wells, 15 municipal wells (active and inactive) and 23 private wells (pending well owner participation) (CHG & Wallace Group, 2016), and the LOWRF baseline sampling includes 26 monitoring wells (20 LOCSD wells and 6 private wells). The Los Osos BMC and LOWRF sampling program utilize a similar set of wells for cost efficiency. The LOWRF samples for all the baseline permit requirements (collected from 2012 to 2016) are noted below, as well as the Los Osos BMC constituents listed in their 2015 Annual Groundwater Monitoring Report:

- Carbonate Alkalinity (BMC)
- Bicarbonate Alkalinity (BMC)
- Total Alkalinity (as $CaCO_3$) (BMC)
- Total Dissolved Solids (BMC, LOWRF)
- Ammonia as Nitrogen (LOWRF)
- Total Kjedahl Nitrogen (LOWRF)
- Nitrite as Nitrogen (LOWRF)
- Nitrate as Nitrogen (LOWRF)
- Boron (BMC, LOWRF)
- Calcium (BMC)
- Potassium (BMC)
- Sodium (BMC, LOWRF)
- Magnesium (BMC)
- Sulfate (BMC, LOWRF)
- Chloride (BMC, LOWRF)
- Electrical conductance (BMC, LOWRF)

- Organic Nitrogen (BMC, LOWRF)
- Total Nitrogen (LOWRF)
- Temperature (BMC, LOWRF)
- pH (BMC, LOWRF)

Temperature and pH are parameters that are routinely measured during sampling to verify that the groundwater samples represent the actual aquifer conditions. Hexavalent chromium is tested by water purveyors and submitted to the Los Osos BMC for their Annual Groundwater Monitoring Report (CHG & Wallace Group, 2016). The Los Osos BMC monitoring network for their annual report is discussed below and summarized in Chapter 8, while the LOWRF monitoring network is discussed in Chapter 8.

3.7.3.1 Los Osos BMC Monitoring Network

The Los Osos BMC monitoring network has 23 wells designated for water quality monitoring; these wells are distributed laterally and vertically across the Basin. The monitoring network of 73 wells includes 28 wells representing First Water, 15 wells representing the Upper Aquifer, and 30 wells representing the Lower Aquifer. The LOBP monitoring network is listed on Tables 3-12 to 3-14 for the First Water, Upper Aquifer, and Lower Aquifer, respectively.

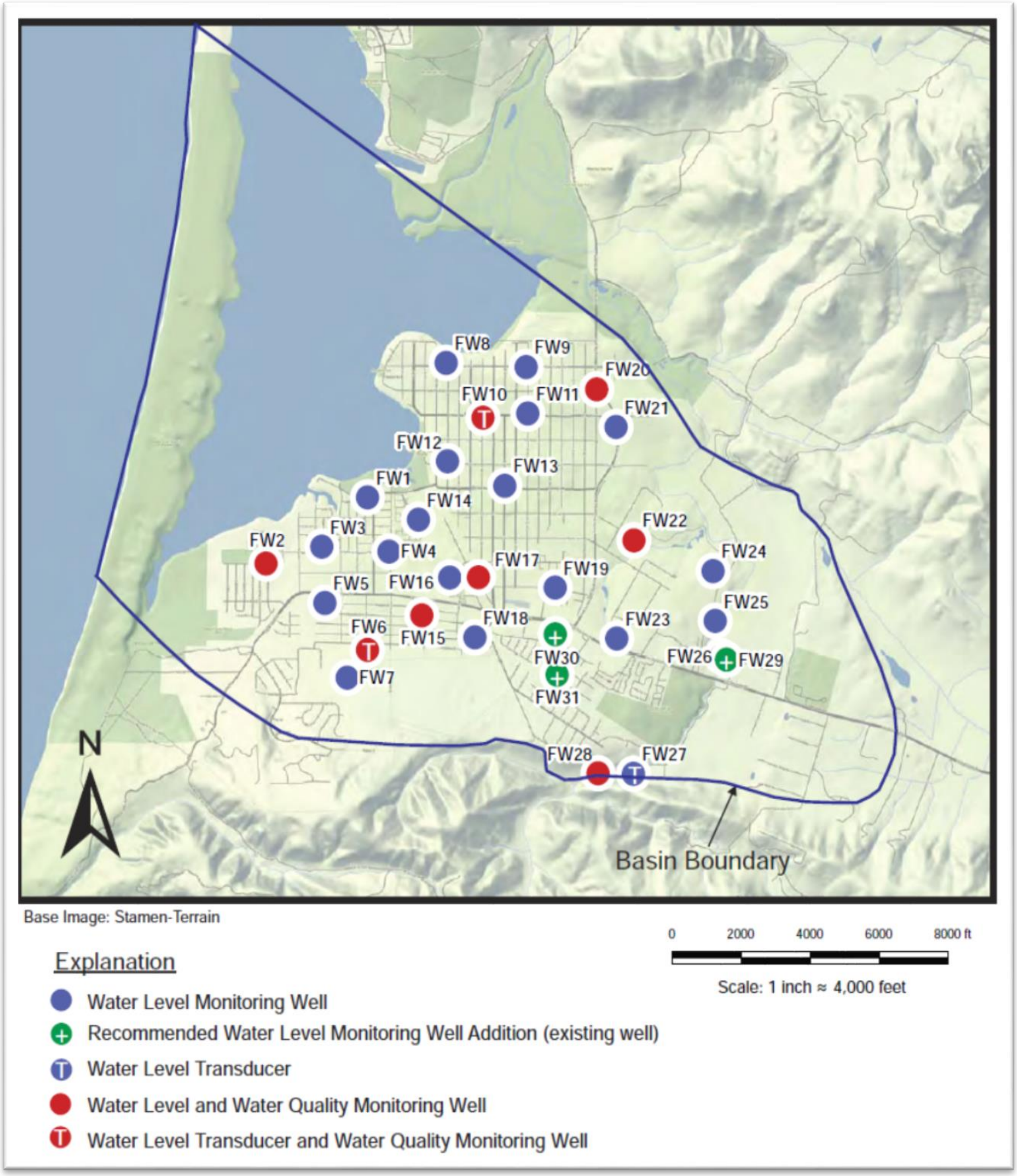
Figure 3-16 presents the monitoring network for First Water, which refers to wells screened within the first 50 feet of the water table across the Basin, regardless of the aquifer. First Water is the interface where percolating waters, including precipitation and return flows from irrigation and wastewater, mix with Basin waters. This 50-foot thick interface occurs within unconfined sediments and rises and falls seasonally with water level fluctuations, and may be present in dune sands, Paso Robles Formation deposits, or Los Osos Creek alluvium. (CHG & Wallace Group, 2016)

Figure 3-17 presents the monitoring network for the Upper Aquifer (Zone C), which refers to the non-Perched Aquifer above the regional aquitard (see Figure 3-7). As noted above, a portion of the Upper Aquifer may also be considered first water in certain Basin areas and is the main source of water for rural residential parcels.

Figure 3-18 presents the monitoring network for the Lower Aquifer (Zones D and E), which refers to water-bearing sediments below the regional aquitard. As shown in Figure 3-7, Zone D lies between the regional aquitard (AT2 clay) and a deeper aquitard (AT3 clay) and Zone E is below the AT3 clay. Zone D is one of the main water supply source for the community.

Tables from the LOBP 2015 Annual Report displaying water quality results for the constituents listed in Section 3.7.3 are presented in Appendix B.

Figure 3-16. Groundwater Monitoring Program, First Water Wells for Los Osos Basin



Source: CHG & Wallace Group, 2016

Table 3-12. First Water Monitoring Network

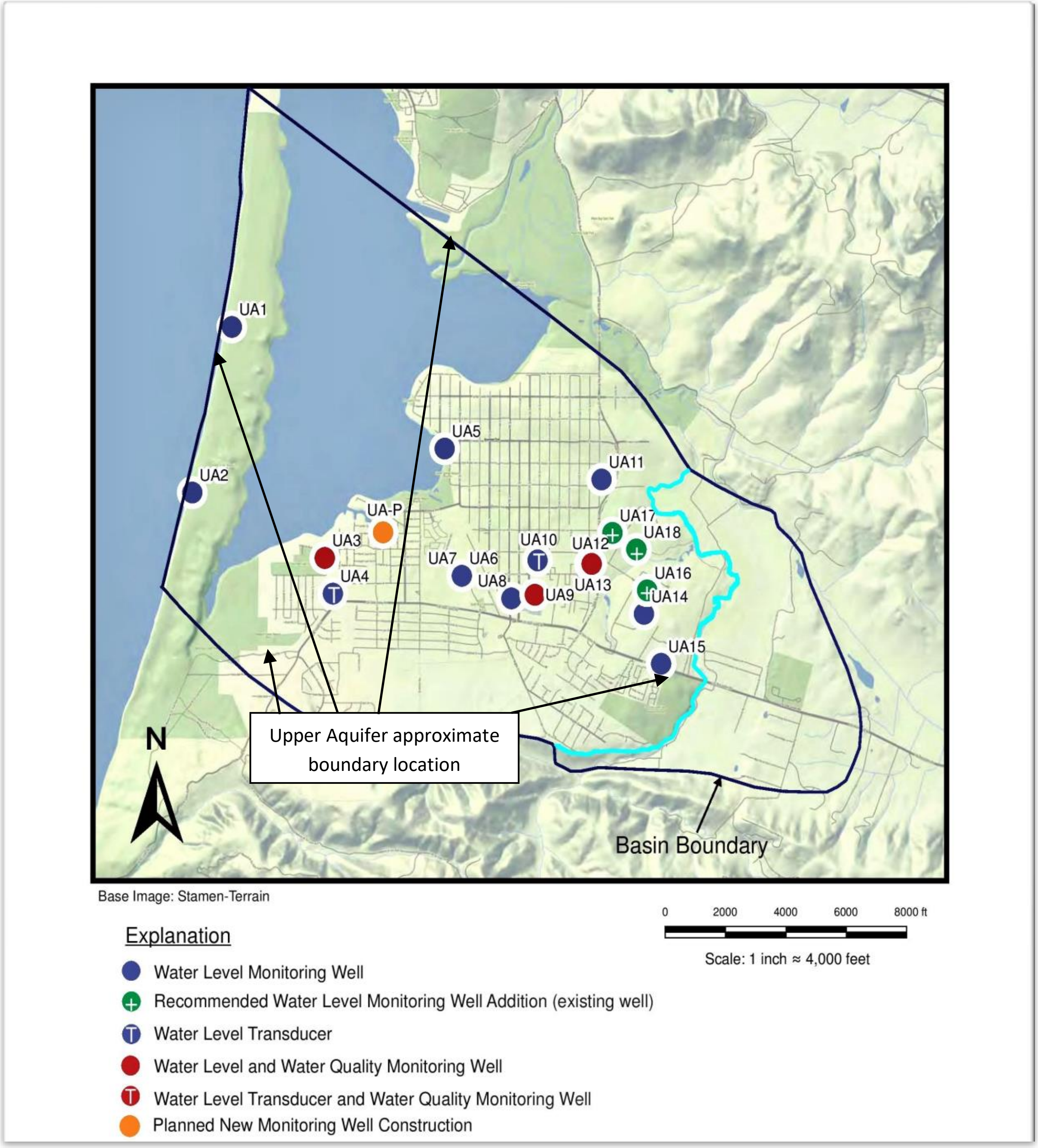
Program ID	Well Number	Basin Area	Total Well Depth (ft)	Screened Interval (ft)	Monitoring*
FW1	Private	Western	--	--	L
FW2	30S/10E-13L8	Western	37	26-36	L, G
FW3	30S/10E-13G	Western	34	47-52	L
FW4	30S/10E-13H	Western	164	154-164	L
FW5	30S/10E-13Q2	Western	105	97-100	L
FW6	30S/10E-24A	Western	164	154-164	TL, G, CEC
FW7	30S/10E-24Ab	Western	240	200-240	L
FW8	30S/11E-7L4	Central	50	40-50	L
FW9	30S/11E-7K3	Central	70	55-65	L
FW10	30S/11E-7Q1	Central	75	29-43, 54-75	TL, G
FW11	30S/11E-7R2	Central	35	25-35	L
FW12	30S/11E-18C2	Central	35	25-35	L
FW13	30S/11E-18B2	Central	35	25-35	L
FW14	Private	Western	--		L
FW15	30S/11E-18N2	Western	95	85-95	L, G
FW16	30S/11E-18L11	Western	35	25-35	L
FW17	30S/11E-18L12	Central	53	43-53	L, G
FW18	30S/11E-18P	Western	35	15-35	L
FW19	30S/11E-18J7	Central	35	25-35	L
FW20	30S/11E-8M	Central	47	37-47	L, G
FW21	30S/11E-8N4	Central	50	40-50	L
FW22	Private	Central	--	--	L, G
FW23	Private	Central	--	--	L
FW24	Private	Eastern	--	--	L
FW25	Private	Eastern	--	--	L
FW26	Private	Eastern	--	--	L, G, CEC
FW27	Private	Eastern	--	--	TL
FW28	Private	Eastern	--	--	L, G

* Legend: L = groundwater level; TL = transducer site for groundwater level;
G = groundwater quality: general mineral suite; CEC = constituents of emerging concern

Source: ISJ Group, 2015

Figure 3-17 shows the approximate Upper Aquifer horizontal extents for the Basin. In Figure 3-18, the approximate Lower Aquifer horizontal extents reaches the perimeter of the Basin (basin outline).

Figure 3-17. Groundwater Monitoring Program, Upper Aquifer Wells for the Basin (Modified)



Source: CHG & Wallace Group, 2016 (Modified)

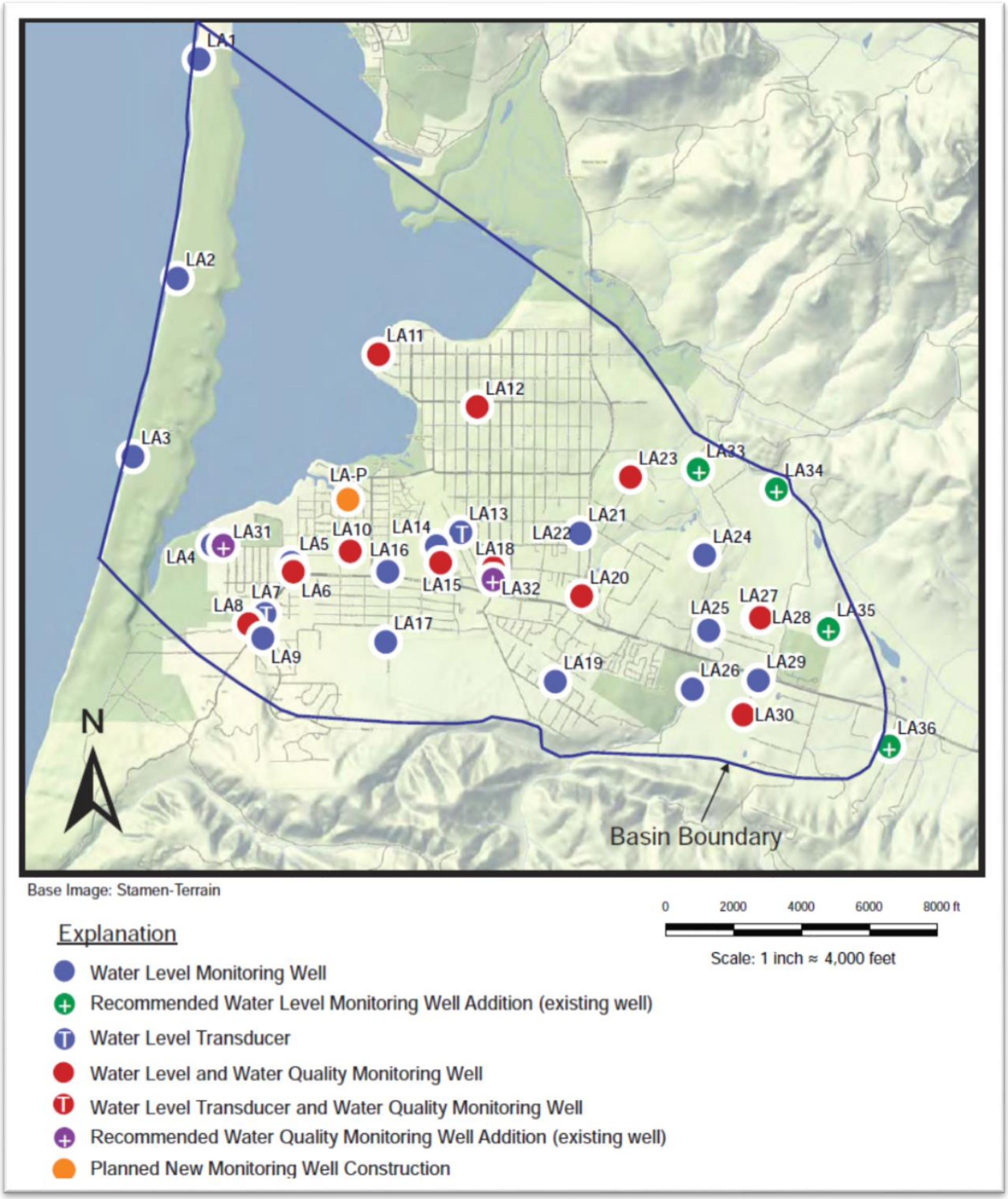
Table 3-13. Upper Aquifer Monitoring Network

Program ID	Well Number	Basin Area	Total Well Depth (ft)	Screened Interval (ft)	Monitoring*
UA1	30S/10E-11A1	Dunes and Bay	160	150-160	L
UA2	30S/10E-14B1	Dunes and Bay	200	190-200	L
UA3	30S/10E-13F1	Western	206	90-195	L, G
UA4	30S/10E-13L1	Western	141	100-141	TL
UA5	30S/11E-7N1	Central	80	56-84	L
UA6	30S/11E-18L8	Western	140	100-140	L
UA7	30S/11E-18L7	Western	220	180-220	L
UA8	30S/11E-18K7	Central	--	--	L
UA9	30S/11E-18K3	Central	232	148-202, 222-232	L, G
UA10	30S/11E-18H1	Central	232	112-125, 145-159, 172-186, 216-231	TL
UA11	Private	Central	--	--	L
UA12	30S/11E-17E9	Central	204	184-194	L
UA13	30S/11E-17E10	Central	220	170-210	L, G
UA14	Private	Central	--	--	L
UA15	Private	Central	--	--	L

* Legend: L = groundwater level; TL = transducer site for groundwater level;
G = groundwater quality: general mineral suite; CEC = constituents of emerging concern

Source: ISJ Group, 2015

Figure 3-18. Groundwater Monitoring Program, Lower Aquifer Wells for the Basin



Source: CHG & Wallace Group, 2016

Table 3-14. Lower Aquifer Monitoring Network					
Program ID	Well Number	Area	Total Well Depth (ft)	Screened Interval (ft)	Monitoring*
LA1	30S/10E-2A1	Dunes and Bay	230	220-230	L
LA2	30S/10E-11A2	Dunes and Bay	244	234-244	L
LA3	30S/10E-14B2	Dunes and Bay	280	270-280	L
LA4	30S/10E-13M1	Western	820	477-537	L, G
LA5	30S/10E-13L7	Western	300	160-300	L
LA6	30S/10E-13L4	Western	675	240-380	L, G
LA7	Private	Western	--	--	TL
LA8	30S/10E-13N	Western	350	260-340	L, G
LA9	30S/10E-24C1	Western	508	250-500	L
LA10	30S/10E-13J4	Western	409	290-406	L, G
LA11	30S/10E-12J1	Central	389	349-389	L, G
LA12	30S/10E-7Q3	Central	270	230-270	L, G
LA13	30S/11E-18F2	Central	625	425-620	TL
LA14	30S/11E-18L6	Western	620	355-375, 430-480, 550-600	L
LA15	30S/11E-18L2	Western	394	340-380	L, G
LA16	Private	Western	--	--	L
LA17	30S/11E-24A2	Western	860	800-860	L
LA18	30S/11E-18K8	Central	650	630-650	L, G
LA19	30S/11E-19H2	Central	740	280-380	L
LA20	30S/11E-17N10	Central	715	225-295, 325-395, 485-695	L, G
LA21	30S/11E-17E7	Central	520	480-490, 500-510	L
LA22	30S/11E-17E8	Central	390	270-280, 370-380	L
LA23	30S/11E-17C1	Central	250	150-250	L, G
LA24	Private	Eastern	--	--	L
LA25	Private	Eastern	--	--	L
LA26	Private	Eastern	--	--	L
LA27	Private	Eastern	--	--	TL
LA28	Private	Eastern	--	--	L, G
LA29	Private	Eastern	--	--	L
LA30	Private	Eastern	--	--	L, G

* Legend: L = groundwater level; TL = transducer site for groundwater level;
G = groundwater quality: general mineral suite; CEC = constituents of emerging concern

Source: ISJ Group, 2015

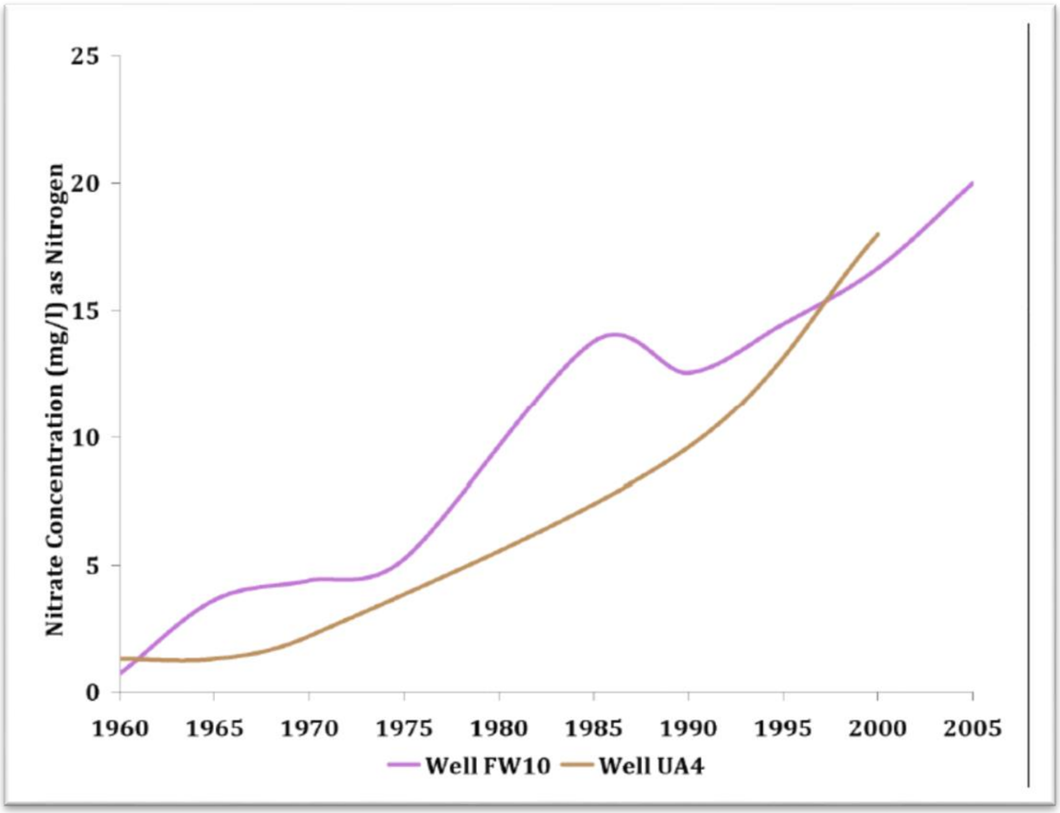
3.7.4 Historical Groundwater Water Quality Trends and Baseline Conditions

In general, to justify averaging TDS, nitrate (as N), and chloride measurement data, time series measurements at a number of locations throughout the Basin were plotted to assess historical trends for these constituents. The estimated continuous spatial and temporal distributions of TDS, nitrate (as N), and chloride (shown in Figures 3-19 to Figure 3-24) represent the constituents baseline conditions in groundwater for the Los Osos SNMP, respectively. The ranges of measured concentrations used to generate these maps and average constituent concentrations for each study area (derived from data shown on the maps) are discussed in the following sections.

3.7.4.1 Nitrates

In the First Water/Upper Aquifer, the level of nitrates in groundwater has increased steadily in past decades from septic system discharged of municipal wastewater (primary source) into the Basin. Historical water quality data from water purveyors' databases in two wells, starting as early as 1960 through 2005, are shown in Figure 3-19. The increase in nitrate levels in the two wells also followed population growth, starting in the 1970s with significant residential development in Los Osos, and continuing since that time as a result of continued nitrate loading. In the late 1980s, the population growth slowed and nitrate concentrations continued rising through the early 2000s in response to the continued nitrate loading from septic systems. First Water well (FW10) is screened at 29 to 43 feet and 54 to 75 feet, which represents First Water (within the first 50 feet of the water table across the Basin) and Zone C of the Upper Aquifer. The Upper Aquifer well (UA4) represents a screen interval between 100 to 141 feet also in Zone C.

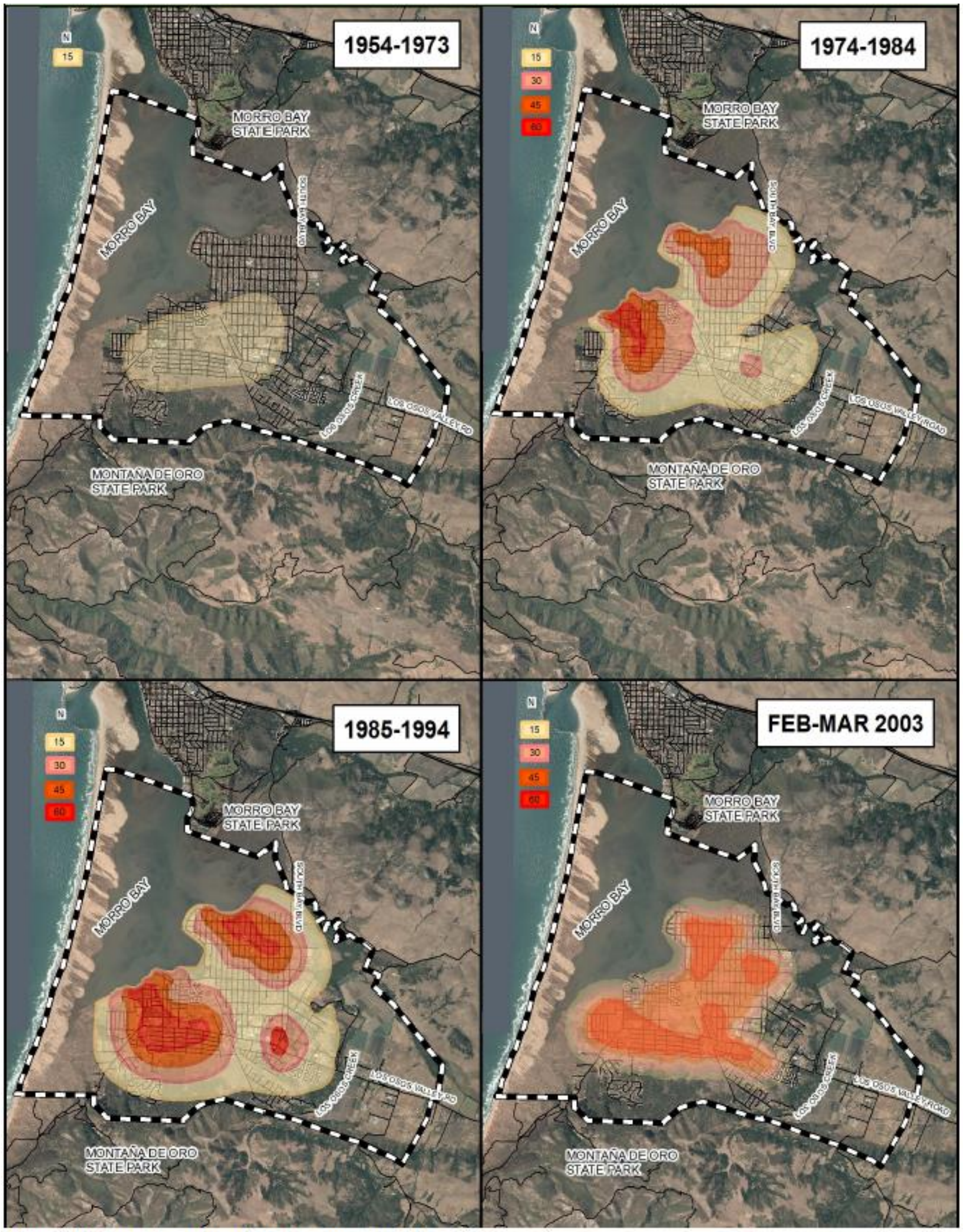
Figure 3-19. Historical Nitrate Levels for First Water/Upper Aquifer Wells (1960-2005)



Abbreviations: milligrams per liter (mg/L)
Source: ISJ Group, 2015

Figure 3-20 shows historical nitrate trend levels increasing in the Upper Aquifer. Nitrate levels have increased in parts of the Basin due to local subsurface conditions, such as Basin geology, hydrogeology, density of septic discharges, and production well locations (ISJ Group, 2015). As shown on Figure 3-20, groundwater samples collected in the Upper Aquifer have nitrate (as N) concentrations above the Title 22 primary drinking water standard recommended MCL for nitrate (as N) of 10 mg/L (Table 3-9), respectfully.

Figure 3-20. Nitrate (as N) Levels in the Upper Aquifer



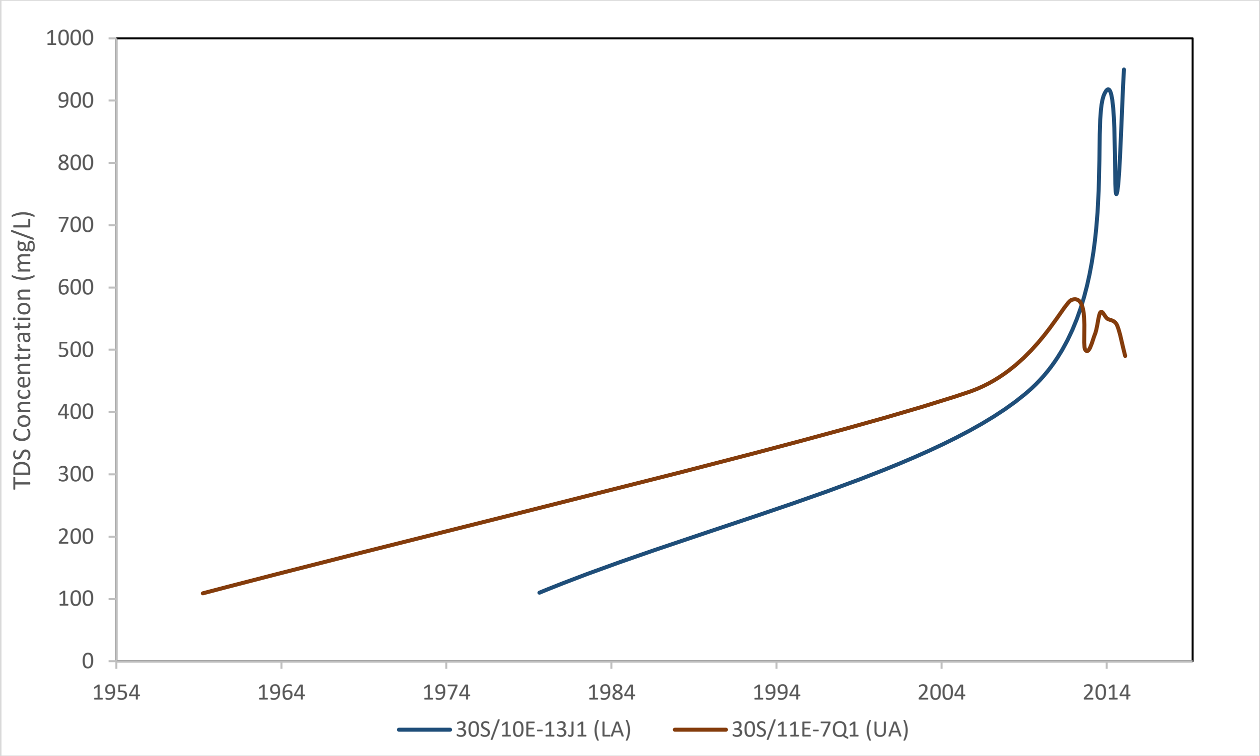
Note: All nitrate concentrations are expressed in mg/L.
Source: ISJ Group, 2015

To address this concern, the LOBP has a Nitrate Metric system with five key wells to monitor First Water in the Upper Aquifer, where nitrate loading to the Basin takes place. This metric system is update annually in the groundwater monitoring report by the Los Osos BMC.

3.7.4.2 Total Dissolved Solids

Total dissolved solids water quality data in most wells were available from the 1950s to early 2000s through 2015. Figure 3-21 shows TDS sampling data from the Lower Aquifer well (13J1) and Upper Aquifer well (7Q1). This data represents historical trends in the Lower Aquifer (red line) and Upper Aquifer (blue line) and shows an increasing TDS concentrations over the last 50 years.

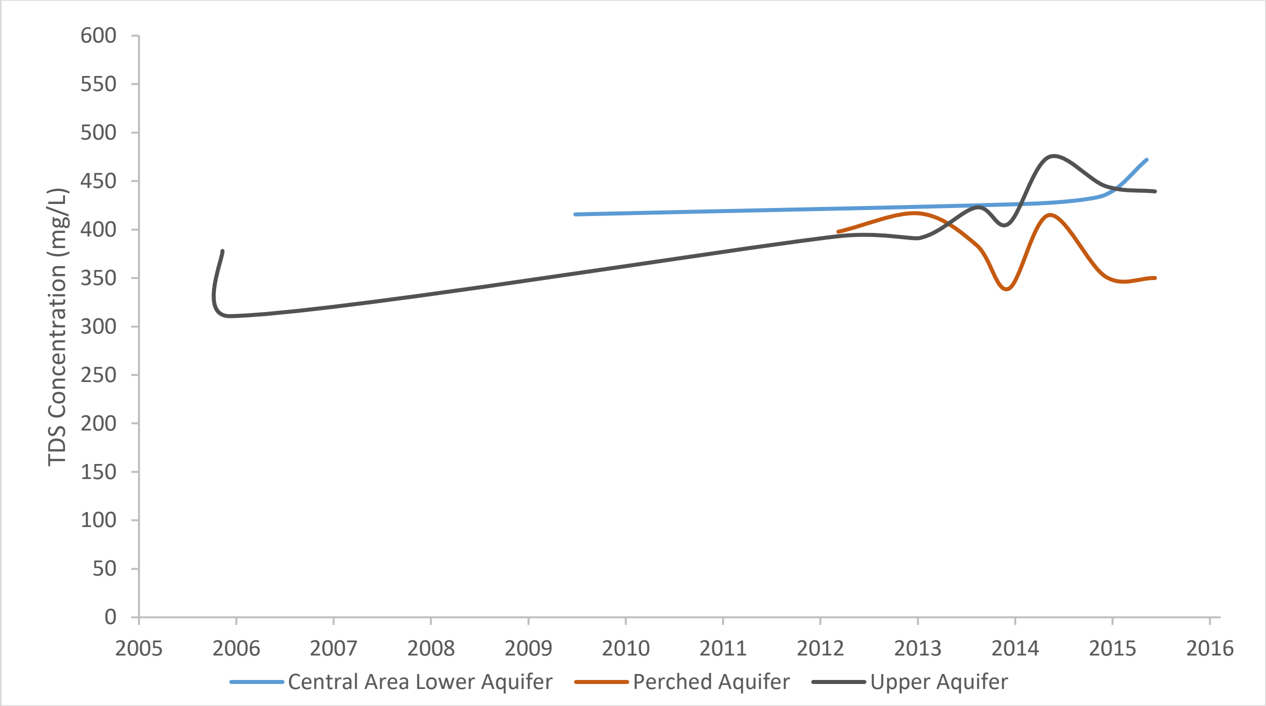
Figure 3-21. Historical TDS Levels for Wells 13J1 & 7Q1 (1959-2015)



Abbreviations: milligrams per liter (mg/L)

Figure 3-22 shows TDS conditions in the Central Area’s Lower Aquifer, Perched Aquifer, and Upper Aquifer that estimated the average TDS concentrations in the Basin. Figure 3-22 shows the approximated trends for each aquifer layer.

Figure 3-22. TDS Levels - Lower (Central Area), Perched, and Upper Aquifer (1959-2015)



Abbreviations: milligrams per liter (mg/L)

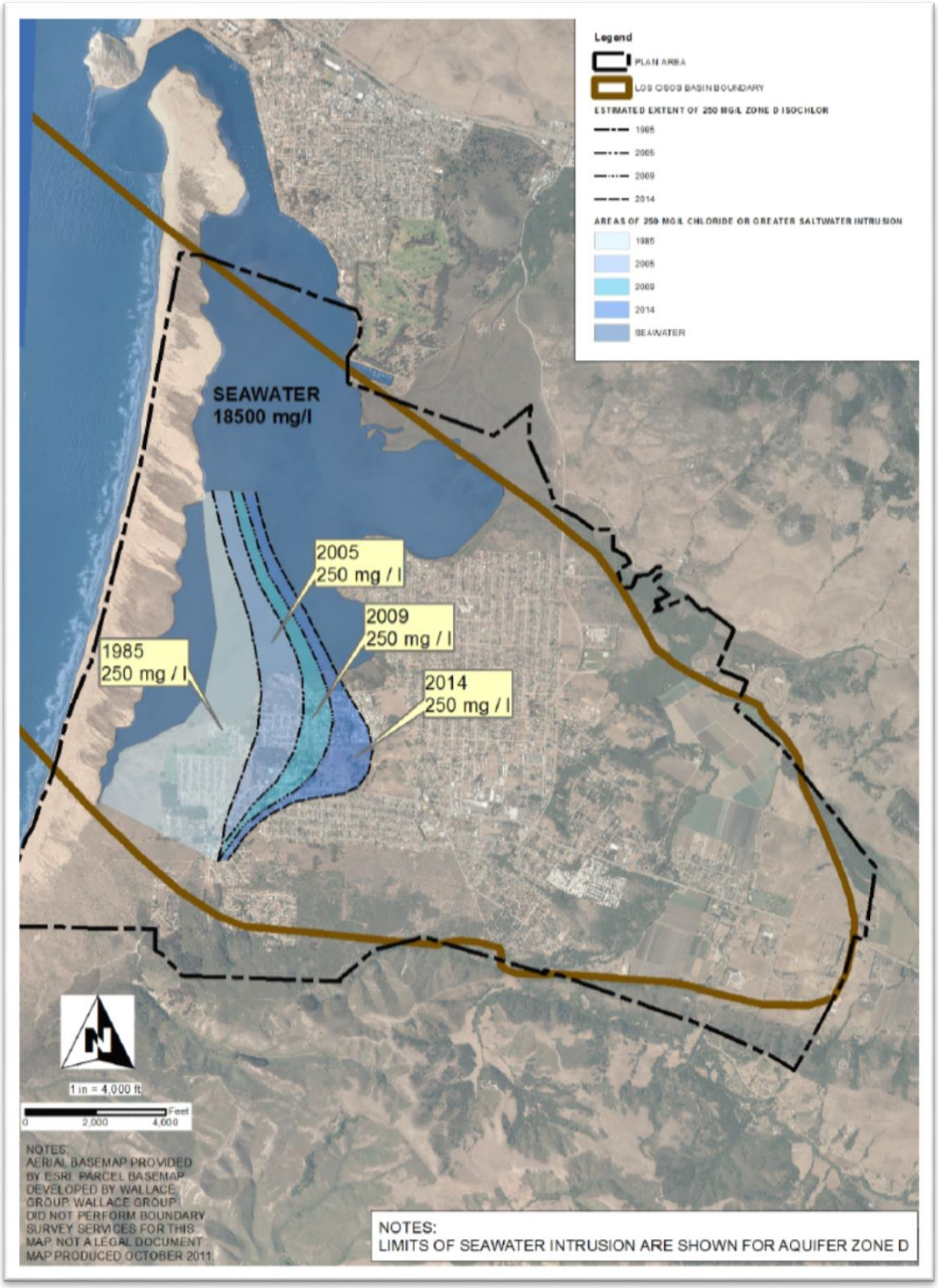
3.7.4.3 Chlorides

In the Lower Aquifer, chlorides have increased over time due to seawater intrusion. Between 1985 and 2005, the average annual rate of intrusion in Lower Aquifer for Zone D was estimated at 60 feet per year for the 250 mg/L isochlor line. Zone E intrusion was estimated at 54 feet per year. Data from a seawater intrusion study performed in 2005 (Cleath & Associates, 2005), showed the rate of intrusion for precursor trends (early-detection at lower chloride concentrations based on ion ratios) at approximately 200 feet per year between GSWC wells Pecho and Rosina, and approximately 600 feet per year between GSWC's Rosina well and LOCSD's Palisades well (ISJ Group, 2015).

Figure 3-23 shows the rates of seawater intrusion are affected primarily by water levels (pressure gradients) and aquifer permeability. The rate of intrusion is typically not uniform over time, but varies seasonally according to pumping cycles, and is accelerated during drought periods. Intrusion may also not be uniform within the aquifer zones, but may follow preferential pathways along discrete sand and gravel layers being tapped by pumping wells. (ISJ Group, 2015)

To address this concern, the LOBP started a Chloride Metric system with key wells to monitor where chloride loading to the Basin takes place. The Chloride Level Metric is based on the weighted average of chloride concentrations in four wells in the Lower Aquifer. The current level of the Chloride Metric is approximately 130 mg/L, and the goal of this LOBP is to lower the metric below 100 mg/L. The monitoring of the four wells used for the metric analysis is discussed in Chapter 8. However, to provide a correlation between seawater intrusion and groundwater interface, historical data is shown in Figure 3-24. Before seawater intrusion became a significant concern, the Water Level Metric was approximately 6.5 feet mean sea level (msl) during the mid-1970s, and after groundwater production in the Basin increased during the 1970s and early 1980s, the Water Level Metric declined by 2012, it was at -1.0 feet msl (ISJ Group, 2015).

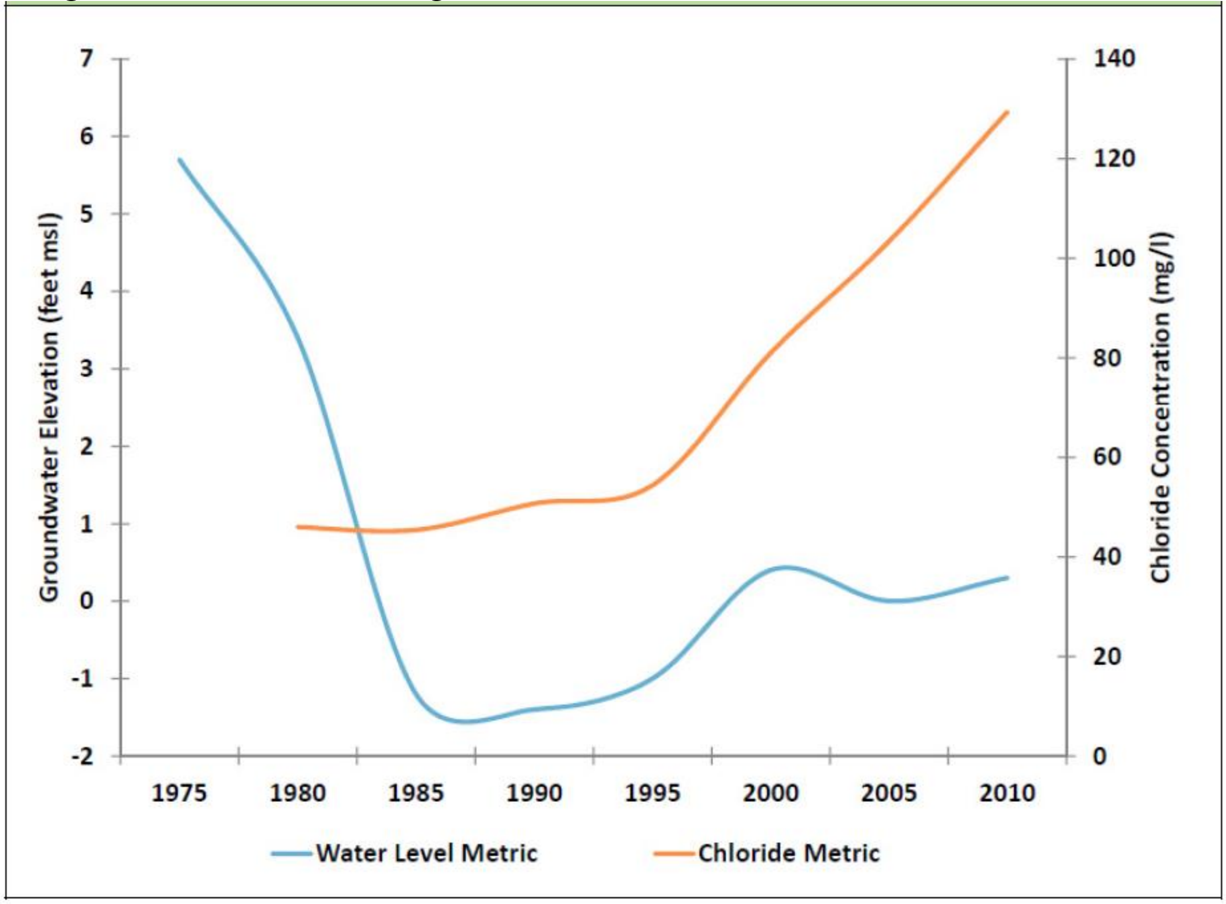
Figure 3 - 23. Historical Progression of Seawater Intrusion in the Lower Aquifer



Abbreviations: milligrams per liter (mg/L)
Source: ISJ Group, 2015

Figure 3-24 shows chloride concentrations of approximately 50 mg/L between 1980 and 1995 (a background value), increasing to 100 mg/L in 2005 and 130 mg/L in 2010 due to seawater intrusion. The figure demonstrates that there was an approximately 15-year lag between when the Water Level Metric fell below approximately 8 feet msl and when the Chloride Metric began to rise above prior historical levels. (ISJ Group, 2015)

Figure 3-24. Historical Tracking of the Water Level and Chloride Metrics from 1975 to 2010



Abbreviations:
milligrams per liter (mg/L)
mean sea level (msl)
Source: ISJ Group, 2015

3.7.5 Historical Surface Water Quality Conditions

Historic water quality date for Los Osos Creek ranges from 1983 to 2014**.** Sampling of the creek is intermittent due to drought conditions with no water flow. Results of sampling events for Los Osos Creek for nitrate as nitrogen (NO_3-N), TDS, and Cl are summarized below. Los Osos Creek average water quality results listed in Table 3-15 are similar to the existing surface water quality values listed for Estero Bay in Table 3-7 in Appendix B-3, Surface Water Quality Objectives for the Central Coast Basin Plan (CCRWQCB, 2016). The Estero Bay planning area includes Santa Rosa, Chorro, San Luis Obispo and Arroyo Grande Creeks.

The average mean value for surface water objectives listed for the Estero Bay planning area include TDS ranging from 500 mg/L to 800 mg/L, chlorides ranging from 50 mg/L to 100 mg/L, and nitrates are not listed (CCRWQCB, 2016).

Table 3-15. Los Osos Creek Water Quality Data

Location	Sample Date	NO3-N	TDS	Cl
		mg/L		
Los Osos Creek upstream	Oct-83	0.79	495	47
	Jan-84	0	418	33
	May-84	0	477	43
	Aug-84	0.29	573	65
	Feb-87	0		48
	Jun-87	0	494	56
	Dec-87	0	519	54
	Dec-88	0	556	53.3
	Mar-89	0	583	57
	Jun-89	0	590	57
	Mar-90	0.79	700	54
	Mar-92	0	538	41
	Jun-92	0	652	55
	Dec-92	0.94	726	72
	Mar-93	0.18	434	51
	Jun-93	0	474	49
	Sep-93	0	646	74
	Dec-93	0.22	658	82
	Mar-94	0	476	46
	Jun-94	0	556	58
	Sep-94	0.76	606	54.8
	Mar-95	0	446	26.7
	Jun-95	0	540	47.6
	Sep-95	0	536	67.3
	Dec-95	0.56	620	74.6
	Mar-96	0	445	30.6
	Jun-96	0	502	48.7
	Sep-96	0.13	622	60
	Mar-97	0.09	397	35
	Jun-97	0.36	552	50.7
	Sep-97	0	680	67.7
	Dec-97	0.74	614	63
	Mar-98	0.25	386	30
	Jun-98	0	430	36
	Sep-98	0	510	50
	Dec-98	0	540	55
	Dec-04	0	540	62
AVERAGE		0.17	543	53

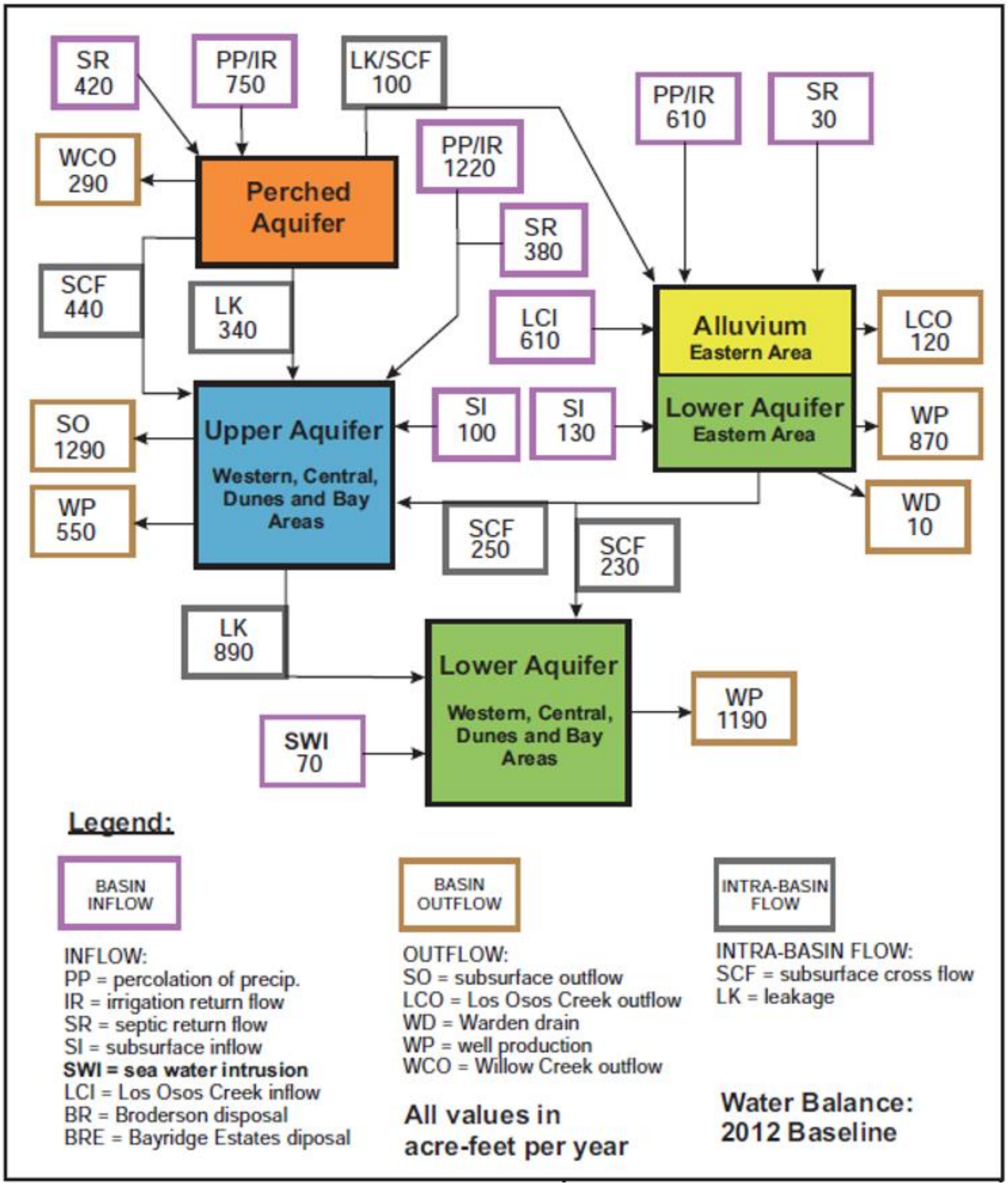
DATA SOURCES: Cleath & Associates (2005)
Baywood Groundwater Study (County, 1998)

3.8 GROUNDWATER BALANCE COMPONENTS AND WATER BUDGET

Average annual water balances for the study area were estimated using results from the Basin groundwater flow model from the 2012 baseline. The water balances for the study areas consist of the major groundwater recharge and discharge processes that occur in the Basin, including seawater intrusion in the Basin, along with high density septic system discharges (CHG, 2012).

Figure 3-25 presents the long-term water balance for the Basin under normal climatic conditions with year 2012 groundwater production distribution. A groundwater basin is a dynamic system with numerous sources of inflow and outflow. The LOBP divides the Basin into four areas (Dunes and Bay, Western, Central, and Eastern) that overlie four aquifers (Perched, Upper, Lower, and Alluvial). The water balance includes Basin boundary flows as well as intra-Basin flows between the Perched Aquifer, Upper Aquifer, Lower Aquifer, and the combined Alluvial and Lower Aquifers in the Eastern Area.

Figure 3-25. Los Osos Water Budget: 2012 Baseline



Source: ISJ Group, 2015

In general, the recharge and discharge components of the water budget can be categorized as either predominantly natural or anthropogenic, as shown in Table 3-16. Historic groundwater studies have identified natural recharge and discharge processes, including Basin subsurface inflows and outflows, percolation of precipitation, streambed seepage creeks, and groundwater discharge to the creeks. Anthropogenic processes include agricultural irrigation return flows, wastewater discharge, and groundwater pumping. The estimated 2012 Baseline hydrologic budget for the Basin is 4,320 AFY (ISJ Group, 2015). Groundwater hydrology is summarized in Table 3-7 (Aquifer Zone Characterization).

Table 3-16. Los Osos Recharge and Discharge Components

Major Groundwater Recharge Components	
Basin subsurface inflows	230 acre-feet (AF)
Percolation of precipitation and irrigation return flows	2,580 AF
Septic return flow	830 AF
Streambed seepage in rivers and creeks	610 AF
Seawater intrusion	70 AF
Major Groundwater Discharge Components	
Basin subsurface outflows	1,290 AF
Groundwater pumping	2,170 AF
Groundwater discharge to creeks	420 AF

Source: ISJ Group, 2015

3.8.1 Groundwater Recharge

Estimated annual groundwater recharge components in aquifers for the Basin are presented in Table 3-16 and described in the following sections.

3.8.1.2 Aquifer Recharge – Perennial Yield

Zone A (Perched Aquifer) and Zone B Recharge

The Perched Aquifer receives recharge from percolation of precipitation and return flows from overlying land uses. The water table contours constructed from available data roughly parallel the ground surface. Groundwater in the Perched Aquifer rises in Willow Creek and emerges as seeps in the Oaks Preserve and along the banks in the lower reach of Los Osos Creek. A groundwater mound between downtown Los Osos and eastern Baywood Park area creates a hydraulic divide between water moving to the east toward Los Osos Creek and water moving to the west toward the Morro Bay Estuary.

Beneath the shallow dune sand deposits are interbedded clay, silt, sand, and gravel layers of the Paso Robles Formation forming the Upper Aquifer comprised of Zones B and C. Water level data indicate the transitional aquifer (Zone B) receives recharge through leakage from Zone A in portions of downtown Los Osos and areas to the east, and represents an intermediate hydraulic zone between the Perched Aquifer (Zone A) and the main water supply aquifer (Zone C).

Zone C (Upper Aquifer Recharge)

Recharge to the Upper Aquifer (Zone C) occurs via the direct recharge sources shown in Figure 3-25, as well as through leakage from Zones A and B. This leakage is evident in both water level and water quality data. Movement of groundwater in Zone C is variable and affected by groundwater production, but generally flows north and west toward the bay. A component of groundwater flows easterly from Baywood toward Los Osos Creek.

Historic groundwater studies have identified that the main water supply in Zone C is recharged primarily by sources that include precipitation, irrigation return flows, septic system percolation, vertical leakage through the confining clay, and subsurface inflow from Zones A and B, the creek valley alluvium, and underlying bedrock. Figure 3-25 shows an approximate total annual recharge to the upper main water supply aquifer is estimated to be on the order of 2,730 acre-feet per year (AFY). Direct percolation of precipitation and irrigation return flows is estimated at approximately 1,220 AFY. Septage return flow is estimated to contribute approximately 380 AFY. Subsurface cross flow from the shallower Zones A and B is approximately 690 AFY.

Zone D and Zone E (Lower Aquifer Recharge)
When groundwater is extracted from the Lower Aquifers, four potential sources of recharge are available for replenishment. These sources are subsurface inflow from underlying bedrock; Los Osos Creek Valley precipitation/irrigation return flow and septic return flow (alluvium eastern area); leakage through the regional aquitard from the Upper Aquifer; and seawater. Recent study has combined the use of water quality characterization, water level information, metered and estimated groundwater production, and Basin geometry and boundary conditions to investigate the sources of Lower Aquifer recharge. These studies have utilized both analytical and numerical methods of analysis. Numerical groundwater models constructed for the groundwater Basin have consistently shown that the main source of recharge to the Lower Aquifer was leakage from the Upper Aquifer through the regional aquitard (Cleath & Associates, 2005).

Figure 3-25 shows recharge to the Lower Aquifers west of Los Osos Creek Valley is estimated to include 890 AFY of Upper Aquifer leakage through the regional aquitard, approximately 230 AFY subsurface inflow from the Creek Valley Alluvial Aquifer to the Lower Aquifer, and 70 AFY of seawater intrusion. Past studies also indicate that recharge from bedrock is negligible.

3.8.2 Groundwater Discharge
Estimated annual groundwater discharge components in the unconfined and confined aquifers for each of the study areas are presented in Table 3-16 and observed in Figure 3-25, respectively, and described in the following sections.

3.8.2.1 Basin Subsurface Outflow
Once percolating water reaches the saturated zones of the Basin, it moves through the water-bearing formations in a variety of pathways. Groundwater flow in the Upper Aquifer moves westerly toward the Pacific Ocean, easterly toward Los Osos Creek, and also downward into the Lower Aquifer. First Water and Upper Aquifer flows may emanate as springs and seeps in sand deposits along the southern margin of Morro Bay, drain into Willow Creek and Los Osos Creek, and discharge where the aquifer subcrops beneath Morro Bay mud flats. Historically, groundwater in the Lower Aquifer also moved generally westward, to where it interfaced with seawater occupying the brackish portion of the aquifer underlying the Pacific Ocean. Following Basin development, groundwater flow in the Lower Aquifer began moving toward production wells and into the pumping depression present in the Central and Western Areas. Overall, estimated annual subsurface outflow from the entire Basin was 1,290 AFY.

3.8.2.2 Groundwater Production
Annual groundwater pumping in the Basin for calendar years 2013 through 2015 is summarized in Table 3-17. In general, the four major sources of groundwater pumping are water purveyors, domestic, community and agricultural. Purveyor production in 2015 has been reduced by 19% compared to 2014 and 31% compared to 2013 (CHG & Wallace Group, 2016).

Table 3-17. Basin Groundwater Production from 2013 to 2015

Year	Purveyors	Domestic	Community	Agriculture	Total
	Acre-Feet				
2013	1,470	200	140	750	2,560
2014	1,240	220	140	800	2,400
2015	1,010	220	140	800	2,170

Note: All figures rounded to the nearest 10 acre-feet

Source: CHG & Wallace Group, 2016

Annual groundwater pumping in the Basin was estimated from purveyor municipal production data (metered readings) for 2014 and 2015, while agricultural, domestic, and community facilities' water production estimates are based on the last reported water use estimates for 2013 from the LOBP with minor adjustments due to changes in land use based on aerial photo review (CHG & Wallace Group, 2016). Specifically, agricultural water use was increased by 50 acre-feet per year from that presented in the LOBP, based on adding 10 acres of peas, 15 acres of truck crops, and 1 acre of pasture east of the Los Osos Creek Valley that were not previously included in the 2013 estimates (CHG & Wallace Group, 2016). Prior estimates for domestic and agricultural water use are detailed in technical memoranda (CHG, 2009a, 2009b).

3.8.2.3 Groundwater Discharge to Creeks

The Basin groundwater system has been identified by previous studies as a source of contribution to surface water features that include springs, streams, lakes, and marshes. Natural groundwater discharges to these features has been observed and are largely unquantified by historical monitoring programs. These features are also believed to be supported by groundwater recharge that is provided from rainfall runoff which is retained onsite and percolated into the groundwater system by recent developments. Table 3-18 list local features for surface water.

Table 3-18. Summary of Local Surface Water Features

Surface Water Feature	Seasonality	Size or Rate of Flow	Source
Los Osos Creek (at Los Osos Road Bridge)	Ephemeral	1,630 - 4,110 AFY	Morro Group, 1990
Willow Creek (Eto Creek)	Ephemeral	438 AFY (Discharge from Perched Aquifer)	Yates & Williams, 2003
Eto Lake	Perennial	NA	NA
Sweet Spring	Perennial	292 AFY	Morro Group, 1990
Sweet Spring Marsh	Ephemeral	NA	Morro Group, 1990
Pecho Road Marsh	Ephemeral	NA	Morro Group, 1990
Third Street Marsh	NA	Approx. 2 - 5 GPM observed	Morro Group, 1990
Baywood Point Spring	NA	Approx. 5 GPM	Morro Group, 1990
Baywood Marsh	NA	NA	Morro Group, 1990
Los Osos Creek Estuary	NA	Several small outflow channels at approx. 0.5 GPM	Morro Group, 1990

NA – Not Applicable
GPM – Gallons per minute
AFY – Acre-feet per year
Source: Michael Brandman Associates, 2008

Stream flow on Los Osos Creek at Los Osos Valley Road has been monitored by the County since 1976. The records from this gauge are considered reasonably representative of inflow from the creek into Morro Bay, approximately 1.5 miles downstream. Previous environmental studies documented observations of declining creek flows within various reaches of Los Osos Creek during the spring of 1985 and occasional observations in 1986 (TMG & TES, 1990). These observations indicated that the creek alluvium continued to drain downstream of the gauging station and resulted in minor surface flows into the estuary for approximately four to six weeks following cessation of flow in the creek at the monitoring location.

Groundwater discharge to the major creek in the Basin, Los Osos Creek, was simulated by the Basin model. Overall, estimated annual groundwater discharge to rivers and creeks for the entire Basin was 420 AFY.

3.9 RESTRICTIVE GROUNDWATER STRUCTURES

Geologic features that impede or impact groundwater flow include faults, uplifts, and the regional aquitard. These impedances are summarized below from the *Los Osos Basin Boundary Modification Request* (CHG, 2016).

- Faults/uplifts: The east-west trending Los Osos fault traverses the valley and is exposed along southeastern Los Osos Valley. Uplifts are also observed in the Basin near the Los Osos fault. These faults and uplifts can significantly impede and impact groundwater flow from offsets.

- Regional aquitard: A regional aquitard exists between the Upper and Lower Aquifers. This aquitard retards downward flow migration, resulting in higher nitrate concentrations in the Upper Aquifer, while the Lower Aquifer is impacted by seawater intrusion in the eastern portion of the aquifer.

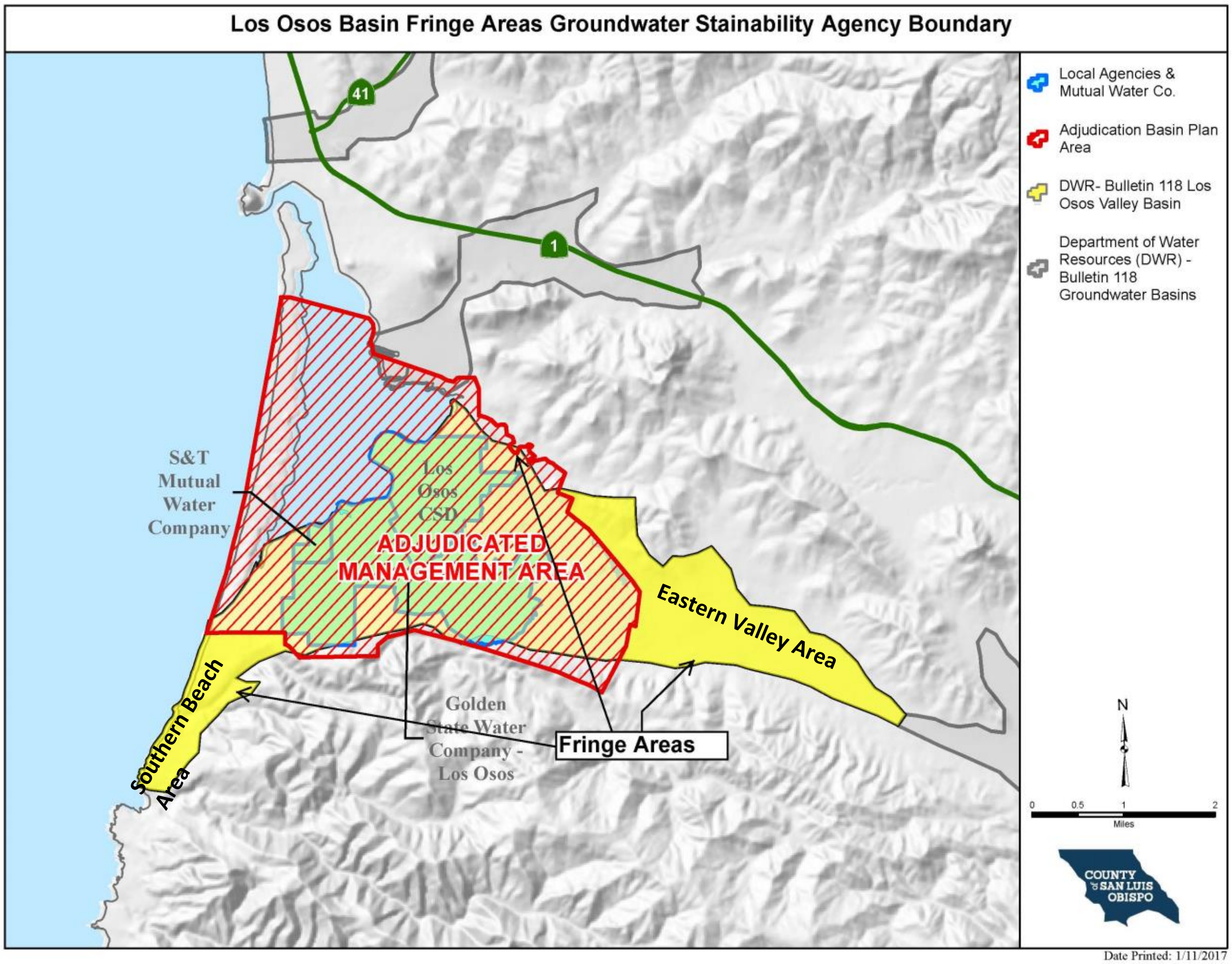
As discussed in Section 3.1, the Basin characterization and groundwater quality for this SNMP is based on the court approved area that is applicable to the LOWRF project area and aligns with the Basin plan area within the Los Osos Valley Groundwater Basin. The study area for the Basin does not include the Eastern Valley Area or the Southern Beach Area (Figure 3-26). These two areas are summarized below from the 2016 Los Osos Basin Boundary Modification Request for reference purposes.

3.9.1 Eastern Los Osos Valley Area - Previous reports and studies on the eastern valley area concluded that this area (non-adjudicated area) has minor groundwater conveyance into the main Basin area (adjudicated area). Reports that have excluded this area from the Basin area are noted below:

> *"In these areas of the (DWR Bulletin 118) groundwater basin, alluvium and Paso Robles Formation are apparently underlain at shallow depth by older rocks that have a limited capacity to store and transmit water. Also, because of the physical relationships between rock units at the easterly and northeasterly limits of the Paso Robles* [Formation] *storage unit, the potential for recharge of the storage unit from areas to the east would appear to be very limited"* - Morro Group (1987)

> *"Little or no groundwater enters the basin from the east end of Los Osos Valley (subbasin 5) for two reasons. First, shallow slopes and thin, clayey soils greatly hinder the horizontal movement of water. Second, the mesa like terrace just inside the east end of the basin probably creates a local groundwater mound, which would tend to prevent inflow from the east."* - U.S. Geological Survey (Yates and Wiese, 1988)

Figure 3-26. Los Osos Groundwater Basin Study Area



"Only in areas less than 4 miles from the coast do water-bearing sediments of significant thickness occur. Farther east, bedrock is overlain by sediments of low permeability, which are less than 30 feet thick. Thus, the groundwater basin begins about 4 miles inland and deepens to the west." - DWR (1989)

From a water supply standpoint, the eastern valley area does not contribute significantly, if any, to groundwater recharge or extraction within the Basin (adjudicated plan area). A basin characterization study will be performed to support a 2018 DWR Basin Boundary Modification Request.

3.9.2 Southern Beach Area - The southern beach area encompasses approximately 1.7 square miles of park land and is not part of the adjudicated Basin area because the primary storage unit (Paso Robles Formation) is interpreted as being absent, unsaturated, or having a restricted hydraulic connection to the Basin. Geologic maps and cross-sections by the Morro Group (1987) and U.S. Geological Survey show bedrock rising to the surface along the southern basin boundary. The main strand of the Los Osos fault zone was mapped as a concealed trace along this general east-west alignment of the Basin area and the southern beach area. (CHG, 2016)

3.10 SUMMARY

This chapter provides a characterization of the Basin for the SNMP. The characterization includes basic descriptions of the Basin setting, land use, climate, geology, hydrology, hydrogeology, and water balance. The three water quality constituents to be addressed in the SNMP for the Basin are TDS, nitrate (as N), and chloride. A major objective of this study was to collect recent and historic measured concentrations of TDS, nitrate (as N), and chloride at different locations in the Basin and use them to establish baseline conditions (i.e., estimated spatial distribution of constituent concentration representative of current conditions) for each of the three constituents. The baseline conditions for the three constituents were derived using water quality data from previous studies and the LOBP. The maps of baseline conditions were used to estimate average constituent concentrations in the Basin. The baseline conditions for TDS, nitrate (as N), and chloride are required for performing the assimilative capacity and antidegradation analyses in the Los Osos SNMP.

Chapter 4 SALT AND NUTRIENT LOADING ANALYSIS

To prepare the assimilative capacity and antidegradation analysis (Chapter 5), a salt and nutrient loading analysis was conducted assuming the current baseline and estimated planned future land uses with associated water use in the Basin area. This section describes the conceptual model and methodology for salt and nutrient transport, identifies the primary constituents of salt and nutrient loading, compiles water quality data, and presents groundwater storage volumes for mass balance calculations.

The County has recently completed construction of the LOWRF, which began receiving and treating wastewater in 2016 from areas with high-density residential parcels within the wastewater service area, overlying the Basin. Recycled water from the treatment facility is being discharged to land at Broderson and Bayridge Estates leach fields, and pending completion of all necessary contractual negotiations recycled water will be available for irrigation reuse at locations across the Basin in 2018. Baseline groundwater data collected for the LOWRF WDR Order No. R3-2011-0001 helped identify salt and nutrient constituents for the water quality objectives (WQOs) from the Central Coast Basin Plan.

Salt and nutrient loading factors identified from previous Basin studies were used in a conceptual model to determine the portion of the applied material (i.e., septic system, animal waste, fertilizer, etc.) that can leach to groundwater. These data are then utilized with groundwater volumetric inflows and outflows in a spreadsheet mixing model to estimate future groundwater quality trends. The groundwater volume in the Basin was determined from previous Basin studies and plans, such as the LOBP. As discussed in Chapter 3, the Basin is comprised of multiple layers (such as the perched, upper, and lower aquifer), and each section will be analyzed for salt and nutrient loading and associated groundwater volume.

Salt and nutrient loading factors from land surface and groundwater sources to the Basin include, predominantly:

- Irrigation water - potable water, groundwater, and future recycled water;
- Residential, commercial, and agricultural inputs - septic systems, soil amendments, and applied water;
- Animal waste - pets and livestock;
- Rainfall infiltration and natural stream losses; and
- Seawater intrusion.

4.1 BASELINE AND FUTURE PLANNING EVALUATION

In accordance with the Recycled Water Policy, Section 9.c.(1), the water quality averaging period to establish the baseline groundwater quality or representative current concentrations of salts and nutrients in groundwater is the most recent 5-year period for which data are available. The data compiled and analyzed for the salt and nutrient loading are from the Los Osos Basin Plan (2015), LOWRF Project Baseline Water Quality Sampling Events (2012 – 2016) per WDR Order, 2015 LOBP Annual Groundwater Monitoring Report (2016), and other previous Basin studies.

This SNMP uses three scenarios to analyze the groundwater water quality for salt and nutrient loading. The 2012 Baseline scenario presents trends in salt and nutrient loading under pre-LOWRF conditions with current land use, and no future development, projects, or programs. The other two scenarios evaluate trends in salt and nutrient loading with the operation of the LOWRF and various programs implemented for the No Further Development and Population Buildout scenarios. Information developed for these analyses includes:

- Water quality for Basin mass balance compartments
- Water quality for Basin inflow sources

- Water quality for raw effluent received by LOWRF
- Recycled water quality
- Groundwater in storage volumes for Basin mass balance compartments
- Current land use and cumulative projects land use
- Salt and nutrient loading factors for land uses
- Basin water balance for Baseline (2012) conditions
- Basin water balance for LOWRF operation with No Further Development and Population Buildout Development (various projects/programs)

The Basin water balance for the Los Osos SNMP is based on the water balance prepared for the LOBP. Current land uses will be used to simulate land use and management practices that may contribute salts and/or nutrients to the groundwater Basin. Plans for future development are currently being updated by the County of San Luis Obispo Planning and Building Department, with the Los Osos Community Plan of the County's General Plan in 2018. The Los Osos Community Plan is the official plan for land use and transportation in Los Osos that will determine how the community grows and develops over the next 20 years.

4.2 IDENTIFICATION OF SALT AND NUTRIENT CONSTITUENTS

The major dissolved ions potentially included in recycled water that reflect its salinity and nutrient content are many and varied, and include sodium, calcium, sulfate, chloride, nitrate, iron, boron and manganese. As discussed in Chapter 3, the County LOWRF collected baseline groundwater samples (semi-annually) and analyzed for TDS, pH, total nitrogen as N (all forms identified), sodium, chloride, sulfate, and boron from 26 groundwater monitoring wells per the LOWRF WDR Order requirements. This data is also shown in the LOBP annual groundwater monitoring report to supplement their groundwater monitoring data.

Simulation of each constituent in the Los Osos SNMP modeling is beyond the scope of this study; therefore, indicators of salt and nutrient loading to the Basin were selected from previously identified constituents of concern for further study, such as chlorides for seawater intrusion and nitrates for high-density residential septic systems. Both sources are designed to be mitigated by the combination of LOWRF operation and cumulative projects under the LOBP. Therefore, chloride and nitrate (as N) are the primarily indicator constituent representing these significant loading sources. Total dissolved solids (TDS) will also be modeled as it is an indicator of total salt loading to the Basin. TDS data are relatively available as compared to other speciated salt concentration data.

Boron will not be modeled in this SNMP. Boron samples were collected and tested from the Basin and LOWRF recycled water. Groundwater results for boron were non-detect or detected at a concentration ranging from approximately 0.1 mg/L to 0.3 mg/L (100 micrograms per liter (µg/L) to 300 µg/L), as shown in Appendix B1 (LOBP 2015 Annual Report) and Appendix B2 (LOWRF Baseline water quality data results (2012 – 2016)). For recycled water, boron samples were collected on March 27, 2017, from the LOWRF ranging from 590 µg/L at the plant influent to 330 µg/L at the recycled water effluent location. Boron is an unregulated chemical without an established MCL. The California State Notification Level (CA-NL) is 1,000 µg/L. The Central Coast Basin Plan establishes guidelines for irrigation, groundwater and surface water as listed in Appendix B3, Table 3-3, 3-7, and Table 3-8 (CCRWQCB, 2016). Based on these guidelines, LOWRF's current recycled water level for boron should not be a concern for recycled water users for irrigation purposes. The boron level in the LOWRF recycled water effluent is slightly higher than the 200 µg/L listed as the median WQO for surface and groundwater samples, but still well below the State's notification level for drinking water systems. Boron levels in the recycled water effluent, once mixed with the groundwater, are anticipated to drop well below the WQO surface and groundwater samples. Groundwater monitoring for boron will continue pursuant the LOWRF WDR Order and notable increase levels of boron in groundwater concentrations will be addressed in the Los Osos SNMP Monitoring Report, as appropriate.

4.2.1 Indicator Parameters of Salts and Nutrients

The primary indicators of mass loading are TDS, chloride, and nitrate as nitrogen (NO_3-N), which are the three constituents used for the assimilative capacity and antidegradation analyses. The SNMPs must consider all salt and nutrient constituents/parameters contained within the Central Coast Basin Plan with prescribed WQOs in the initial assessment (CCRWQCB, 2014), see Tables 3-3, 3-7 and 3-8 from the Central Coast Basin Plan in Appendix B3. The Central Coast Basin Plan provides water quality objectives from data collected from surface and groundwater in the Estero Bay. As mentioned in Chapter 3, Los Osos Basin has no water quality objectives listed in the Central Coast Basin Plan.

To help assess the salt and nutrients constituents and parameters, the following criteria/questions were used to consider or further identify constituents for the basin:

1. Is the constituent subjected to WQO within the Central Coast Basin Plan?
    a. Yes. Constituents subjected to water quality objectives within the Central Coast Basin Plan include TDS, chloride, sulfate, boron, sodium, nitrogen (nitrate and ammonia), bicarbonate, and pH
2. Is the constituent regularly monitored and detected in source water (e.g., discharges or natural recharge)?
    a. Constituents typically monitored in the LOWRF recycled water effluent include total nitrogen as N (all forms identified), pH, TDS, chloride, and sodium. Local water companies are required to routinely monitor drinking water wells for TDS, chloride, sulfate, sodium, pH, and nitrates based on a water quality monitoring scheduled established by the State Water Board – Division of Drinking Water.
3. Is the constituent found in source waters at concentrations above those found in ambient groundwater/surface water from the Estero Bay section in the Central Coast Basin Plan?
    a. Yes. Local water purveyors providing source water to consumers in this Basin can have nitrate levels exceeding the Estero Bay section (ambient groundwater and surface water objectives) in the Central Coast Basin Plan (Tables 3-8 Median Groundwater Objectives listed and chloride levels as listed in Table 3-7 Surface Water Quality Objectives). Local water purveyors are required to meet Title 22 of the California Code of Regulations for drinking water wells.
4. Is the constituent conservative and mobile in the environment?
    a. Yes. TDS, chloride, boron, sulfate, sodium and calcium are conservative and mobile in the environment.
5. Is the constituent a known pollutant in either groundwater or surface water in the study area?
    a. Yes. Chloride, nitrate, and TDS are elevated or have been polluting groundwater and/or surface waters.
6. Is the concentration of the constituent increasing in the Basin area, prior to the construction of the LOWRF?
    a. Yes. Chloride, nitrate, and TDS have been increasing in the Basin area, prior to the construction of the LOWRF.
7. Is the constituent a human health threat, toxic to aquatic life, or does it otherwise threaten beneficial uses?
    a. Yes. Unionized ammonia can be toxic to aquatic life at low levels. Nitrate can be a human health threat at elevated levels. TDS, sodium, and chloride have secondary drinking water contaminant levels or “Consumer Acceptance Level Ranges”. Elevated levels of TDS, sodium, nitrate and chloride could impact the beneficial use of water for irrigation purposes for Table 3-3 from the Central Coast Basin Plan. TDS, sodium, chloride, sulfate and boron could impact

the WQO for groundwater in Table 3-8 from the Estero Bay section in the Central Coast Basin Plan.

8. Is the constituent representative of other salts and nutrients?
    a. Yes. TDS, sodium, chloride, and nitrate are representatives of other salts and nutrients

Each selected indicator constituent of salts and nutrients is not required to meet all the criteria, but as a group, at least one should meet each criterion. Both TDS and chlorides meet all the additional requirements from the questions listed above. TDS, as a compilation of general minerals, provides a good relative indicator of concentrations trends, such as for other salt constituents (sodium, chloride, sulfate, etc.), and chloride is the primary indicator constituent currently used as a measure of salinity intrusion. Nitrate, as a nutrient, meets most of the criteria and has the most water quality data available in the groundwater Basin. The selection of chloride, TDS and nitrate as indicator constituents also correlates well with sampling in the LOBP and the LOWRF WDR Order. Thus, the possible constituents comprising the salt and/or nutrient chemical categories, the ones with water quality objectives per the Central Coast Basin Plan, to be included for discussion in this SNMP are TDS, chloride and nitrate (measured as nitrogen).

4.2.2 Parameters of Salt and Nutrients in the Los Osos Groundwater Basin

Based on the criteria described in Section 4.2.1 and as further explained in this section, TDS, chloride and nitrate are the most appropriate indicators of salts and nutrients in the Basin. Available groundwater quality data from the USGS, DWR, water purveyors, Los Osos BMC, Regional Water Board, County and other Basin studies were used for this effort. Based on these available data and the sub-area specific water quality objectives presented in the Central Coast Basin Plan, indicator constituents were selected and analyzed to develop a single estimate of their concentration in the Basin. Data were also collected for other constituents, where available, including general minerals and hexavalent chromium per the LOBP 2015 Annual Groundwater Monitoring Report, as well as volatile organic compounds and metals per the LOWRF WDR Order (CCR Title 22, Division 4, Chapter 15, Article 5.5, Section 64444 (organic) and Article 4, Section 64431(inorganic)). Guidance on monitoring of constituents of emerging concern (CECs) was developed by a statewide panel of experts (the Blue Ribbon Panel). Per the Panel's findings, no additional monitoring of CECs was recommended based on the types of recycled water to be used in the Basin. However, an effluent sample from the LOWRF will be collected annually and analyzed for CECs per the LOWRF WDR Order, further discussion is in Chapter 8.

4.2.3 Salt and Nutrient Loading Constituents in the Los Osos Groundwater Basin

Based on the criteria described in Sections 4.2.1 and 4.2.2, the appropriate primary indicators of mass loading are TDS, chloride, and nitrate as nitrogen. These constituents are used for the assimilative capacity and antidegradation analyses in Chapter 5.

The Los Osos Groundwater Basin is in the Estero Bay planning area, as mentioned in Section 4.2.1. The Regional Water Board, 2016 Central Coast Basin Plan lists median groundwater objectives for the following sub-basin/sub-areas of the Estero Bay planning area: Santa Rosa, Chorro, San Luis Obispo, and Arroyo Grande. The existing groundwater objectives for TDS ranges from 700 mg/L for Santa Rosa to 1,000 mg/L for Chorro. Groundwater objectives for chloride range from 100 mg/L in Santa Rosa and Arroyo Grande to 250 mg/L in Chorro. Groundwater objectives for nitrate as nitrogen range from 5 mg/L for Santa Rosa, San Luis Obispo, and Chorro to 10 mg/L for Arroyo Grande.

There are no published median groundwater objectives for Los Osos. As a Basin with documented nitrate and seawater intrusion problems, the median groundwater objectives used for the assimilative capacity analysis are based on the highest existing median objectives for the Estero Bay Area: 1,000 mg/L for TDS, 250 mg/L for chloride, and 10 mg/L for nitrate as nitrogen (NO_3-N).

4.2.3.1 Total Dissolved Solids

TDS is a common measure of groundwater salinity, and represents the overall mineral content of water. All forms of salt and nutrient loading contribute to TDS mass accumulation. TDS is defined as the total amount of mobile charged ions, including minerals, salts or metals, and dissolved in a given volume of water. Total salinity is commonly expressed in terms of TDS.

The State of California has established a secondary standard MCL for TDS. Secondary standards are based on customer acceptance levels (e.g.., color, odor and taste) and are not associated with public health concerns. The recommended secondary MCL for TDS is 500 mg/L. There is also an upper MCL for TDS of 1,000 mg/L, and a short-term maximum MCL of 1,500 mg/L. A numerical water quality objective for TDS was not specified for the Los Osos Groundwater Basin in the Central Coast Basin Plan, as discussed in Section 4.2.3. For this report, the upper secondary MCL limit of 1,000 mg/L was utilized for the antidegradation analysis, which is the same number based on the highest existing groundwater median objectives for the Estero Bay Area for TDS of 1,000 mg/L from the Central Coast Basin Plan.

4.2.3.2 Chloride

Chloride is typically associated with salt compounds formed with sodium, potassium, or calcium. Chloride is also one of the general mineral ions found in groundwater. Once dissolved, it is a conservative species that does not interact significantly with the aquifer matrix or form ionic complexes with other solutes. Chloride is the primary indicator of seawater intrusion. In general, a reduction in salinity will result in the increase lifespan of plumbing systems and appliances, resulting in decreases in industrial costs for water treatment and improvements in recycled water quality and beneficial use. The State of California has established secondary standards for chloride. The recommended secondary MCL for chloride is 250 mg/L. There is also an upper MCL for chloride of 500 mg/L, and a short-term maximum MCL of 600 mg/L. A numerical water quality objective for Chloride was not specified for the Los Osos Groundwater Basin in the Central Coast Basin Plan, as discussed in Section 4.2.3. For this report, the recommended secondary MCL for chloride is 250 mg/L was utilized for the antidegradation analysis, which is the same number based on the highest existing groundwater median objectives for the Estero Bay Area for chloride of 250 mg/L from the Central Coast Basin Plan.

Chloride is also essential to plant life, but sufficient in extremely low concentrations. This element is almost never deficient in the environment.

4.2.3.3 Nitrate

Nitrate (NO_3) is an oxidized form of nitrogen, which is one of the primary nutrients used by plants. Nitrogen cycles between the atmosphere, soils, and groundwater through alterations in its chemical state. In groundwater, nitrogen compounds are typically oxidized to nitrate. Nutrient loads may be in other forms, and are often compounds based on ammonia (NH_3). For consistency with reporting requirements for public drinking water systems, nitrate values will be expressed as nitrate as nitrogen (NO_3-N).

The State of California has established a primary standard MCL for nitrate as nitrogen. Primary standards are based on protecting public health. Ingestion of water containing elevated nitrate concentrations can interfere with oxygen transport by red blood cells. The recommended primary MCL for nitrate as nitrogen is 10 mg/L.

Nitrate is a widespread contaminant in California groundwater. High levels of nitrate in groundwater are associated with agricultural activities, septic systems, confined animal facilities, landscape fertilizers and wastewater treatment facilities. Nitrate can persist in groundwater for decades and accumulate to high levels as more nitrogen is applied to the land surface each year. Natural nitrate levels in groundwater are generally very low (typically less than 10 mg/L as NO_3) and well below the primary drinking water standard (Primary

MCL) of 45 mg/L for nitrate as NO_3 (or 10 mg/L for NO_3 as N). A numerical water quality objective for nitrate as nitrogen was not specified for the Los Osos Groundwater Basin in the Central Coast Basin Plan, as discussed in Section 4.2.3. For this report, nitrate will meet the permit requirements for the LOWRF WDR Order and primary MCL of 10 mg/L, which is the same number based on the highest existing groundwater median objectives for the Estero Bay Area for nitrates as nitrogen of 10 mg/L from the Central Coast Basin Plan.

4.3 LOADING ANALYSIS TOOLS

The methodology used to simulate salt and nutrient loading involves a mass balance spreadsheet model, which converts salt and nutrient loads to inflow concentrations, distributes flows according to the groundwater balance and provides for repeated cycles of loading. The conceptual model also allows salt and nutrient load calibration using Basin water quality data. The calibration process provides a rigorous approach to mass balance by evaluating the Basin-specific salt and nutrient loads for key sources, including natural sources and the evaporative enrichment of salts beneath agricultural fields.

4.3.1 Conceptual Model

Salt and nutrient loading takes place at variable rates across the Basin. Every year, salts and nutrients leach into the groundwater system from various sources, including natural, agricultural, residential, and animal sources. Loading factors can be expressed as the amount of salt or nutrient added to the groundwater system over time, per source unit. The mass associated with each loading factor is dissolved and transported into the groundwater system by recharge or return flows. Primary inputs to the model are land use, irrigation water source, recycled water use locations, septic system areas, and surface geology characteristics. These datasets are described in the following sections.

Surface and subsurface inflows to the groundwater Basin also contribute to salt and nutrient loading. These sources have received mass loading from areas outside the basin and transport salts and nutrients into the Basin as recharge. Salt and nutrient mass is also removed every year through surface and subsurface outflow. Removal of mass from the Basin is variable in location and changes over time.

Figure 4-1 presents the various components of salt and nutrient loading and removal from a conceptual mixing cell (aquifer) within the groundwater Basin. Figure 4-2 depicts the areal extent of the mass balance mixing cells used for this study. Figure 4-3 presents a cross-section that, when compared with Figure 5-2 in Chapter 5, shows the relationship between the Basin aquifers and the Basin areas used as mixing cells for mass balance calculations. There are four mixing cells delineated by the conceptual model: the Perched Aquifer, the Upper Aquifer; the Western and Central Area Lower Aquifer; and the Eastern Area Alluvial Aquifer and Lower Aquifer (Figure 4-2).

As shown on Figures 4-2 and 4-3, the Dunes and Bay Area and portions of the Lower Aquifer impacted by seawater intrusion have been removed from the assimilative capacity and antidegradation analysis. The concentration of TDS in Lower Aquifer groundwater in the Western Area has been measured as high as 35,000 milligrams per liter (mg/L), with 17,000 mg/L chloride, which is effectively seawater (Cleath & Associates, 2005). Incorporating the salt mass from these areas into the assimilative capacity and antidegradation calculations would interfere with evaluating the impacts on water quality from other sources of salt loading. Water quality results, if this salt mass section of the Basin was added, would not reflect the true groundwater chemistry of the Basin.

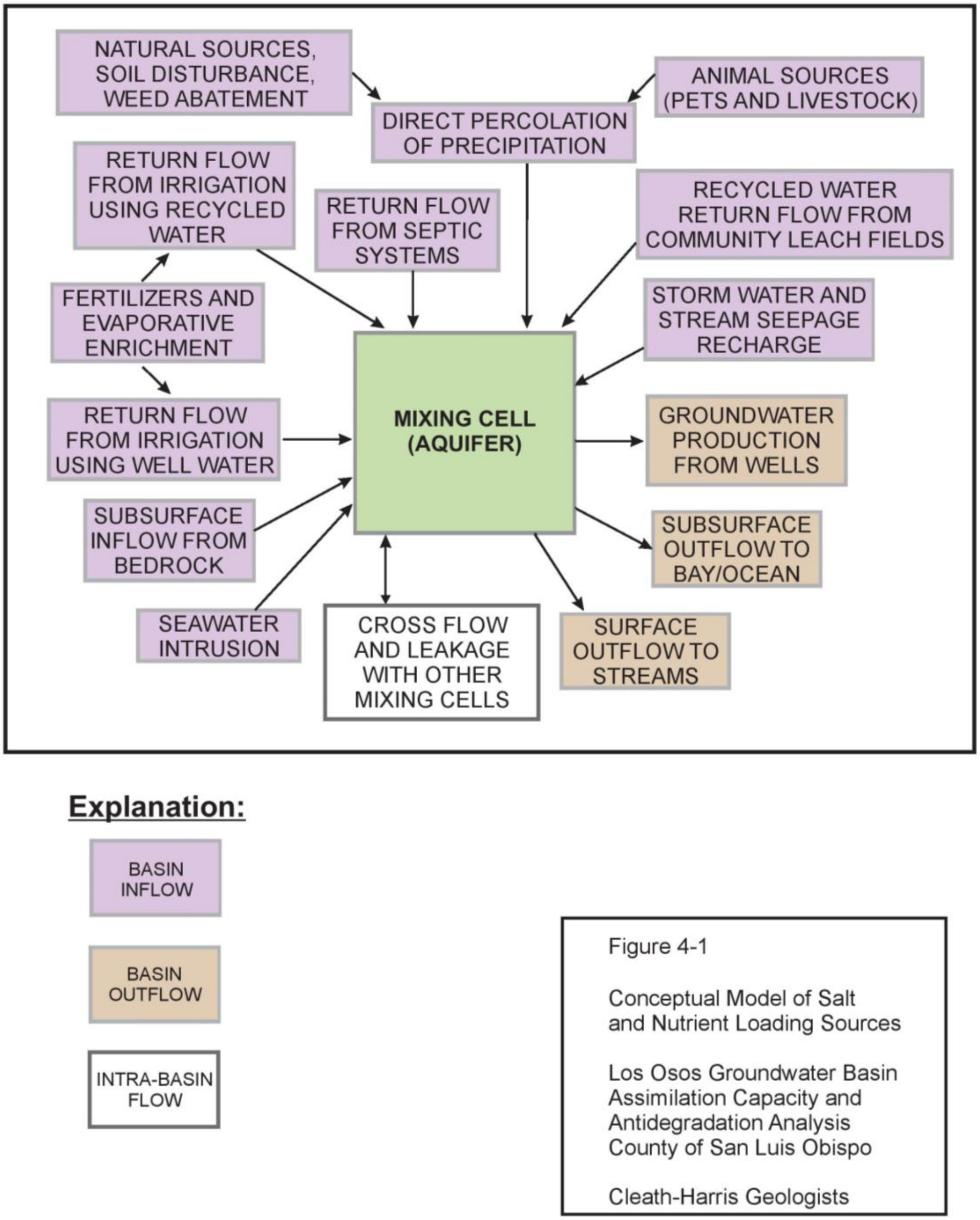


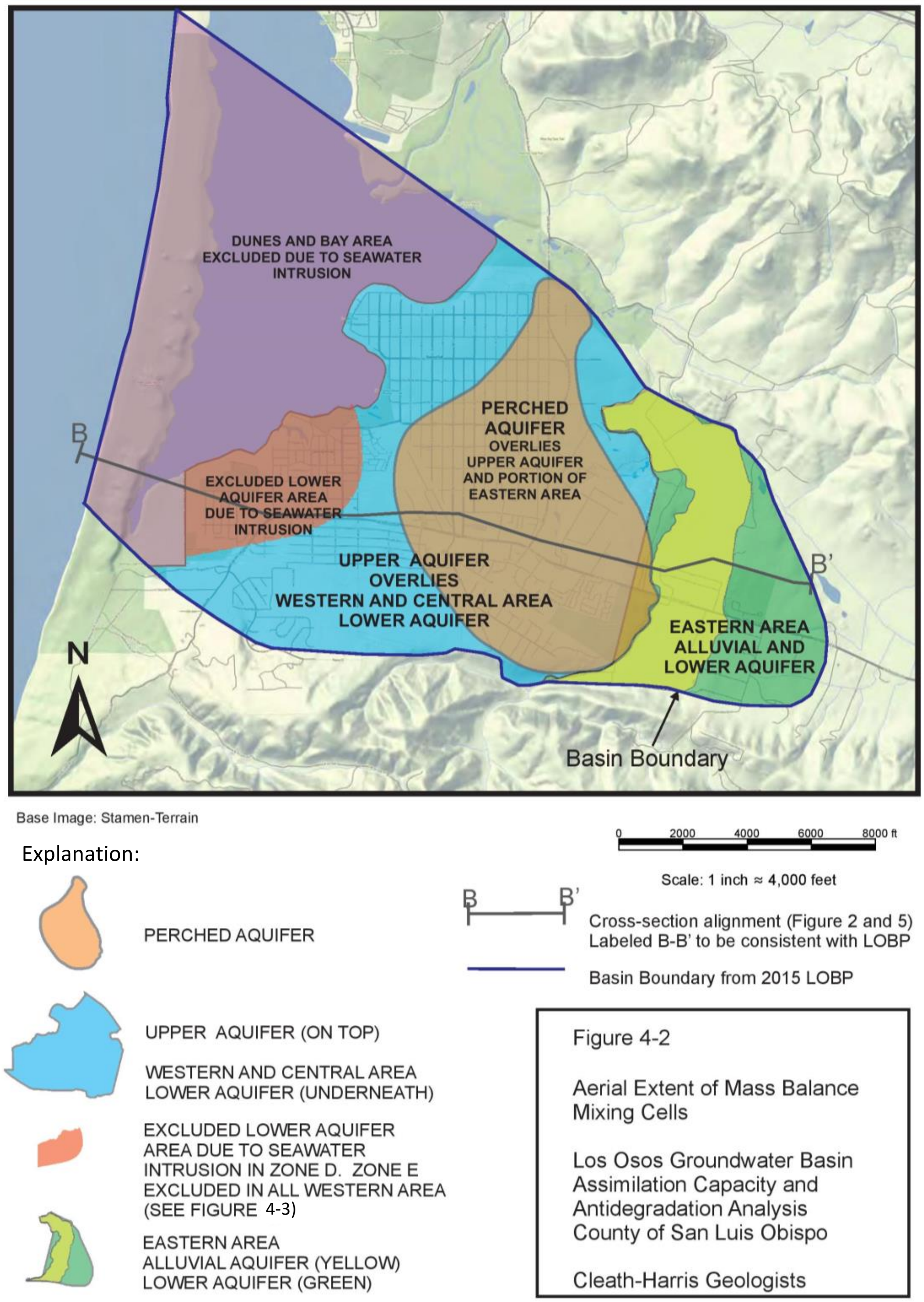
Figure 4-1

Conceptual Model of Salt and Nutrient Loading Sources

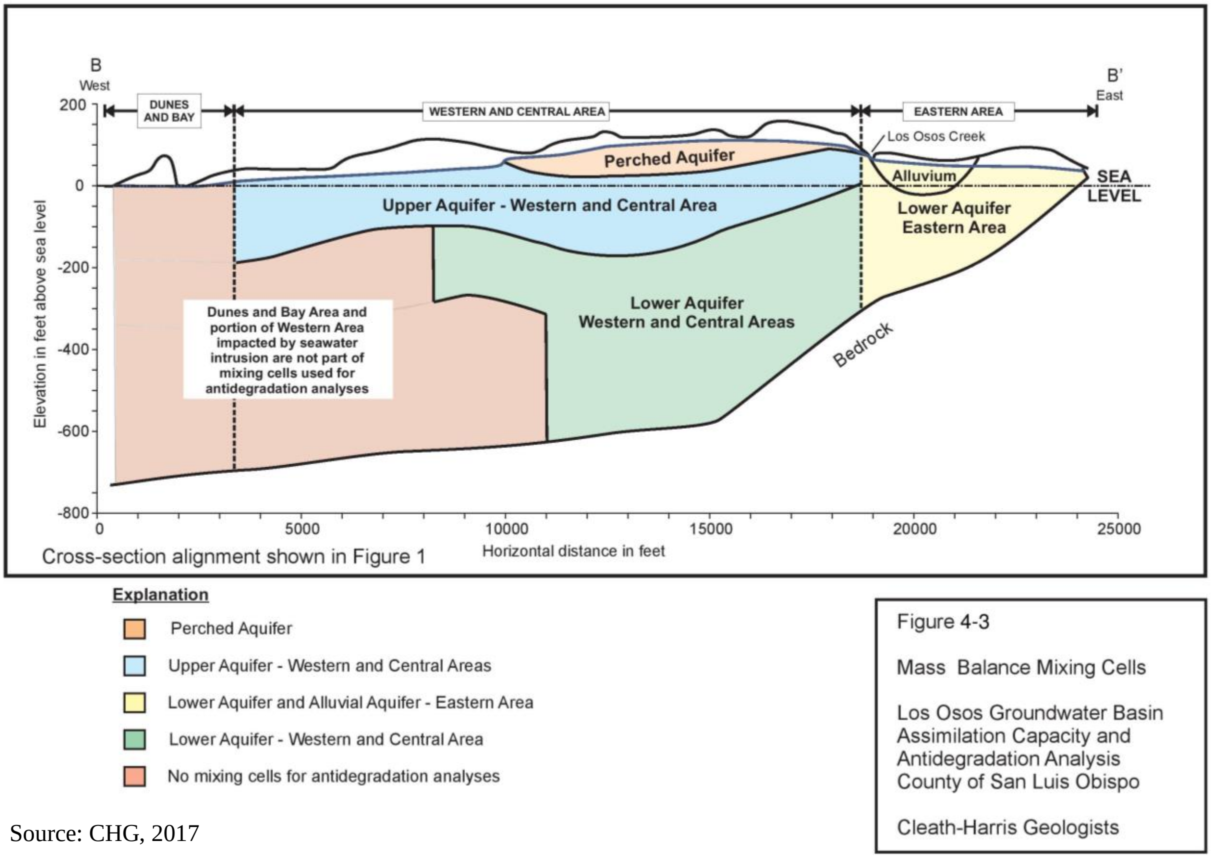
Los Osos Groundwater Basin Assimilation Capacity and Antidegradation Analysis County of San Luis Obispo

Cleath-Harris Geologists

Source: CHG, 2017



Source: CHG, 2017



Source: CHG, 2017

Figures 4-5, 4-6, and 4-7 show the components of inflow and outflow from each of the Basin compartments for the three scenarios analyzed: the 2012 Baseline scenario (pre-LOWRF), the LOBP No Further Development scenario with associated management programs (E+U+AC), and the LOBP Population Buildout scenario with additional management programs (E+UG+ABC), respectively. These scenarios are briefly described below and can be found in detail in the LOBP and the 2015 Annual Groundwater Monitoring Report.

4.3.1.1 2012 Baseline Scenario

The baseline scenario is equivalent to LOBP Program N (no management programs and no treatment facility constructed), and assumes a continuation of the land use and water balance present in 2012. As shown in Figure 4-5, seawater intrusion is occurring in the Basin, along with high density septic system discharges.

4.3.1.2 LOBP No Further Development (E+U+AC)

As shown in Figure 4-6, the No Further Development scenario with associated management programs (E+U+AC) incorporates the Urban Water Use Efficiency Program (E), Urban Water Reinvestment Program (U), and Basin Infrastructure Programs A and C (AC), but with no further development in terms of the population served by community purveyors. Seawater intrusion is mitigated, and high-density septic systems in the wastewater service areas are replaced by wastewater collection and treatment at the LOWRF, followed by recycled water reuse and land disposal. This scenario is compared to the 2012 Baseline scenario for evaluating the effectiveness of the LOWRF for salt and nutrient management in Chapter 5.

Urban Water Use Efficiency Program E refers to water conservation measures with respect to indoor residential and commercial water use, indoor and outdoor water use surveys, public outreach and education, and water use metering.

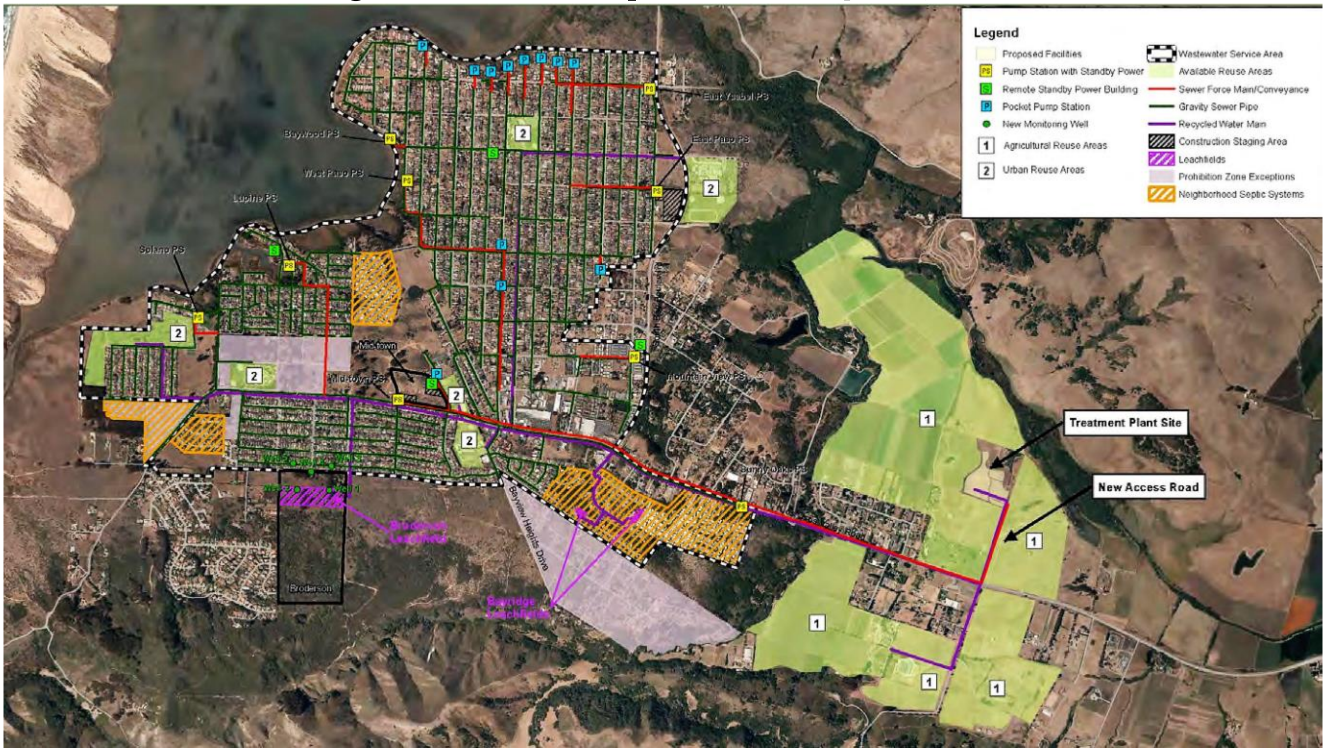
Urban Water Reinvestment Program U refers to recycled water irrigation and disposal sites in the urban area. Table 4-1 summarizes the potential recycled water areas and maximum permitted distribution allocation in the Basin. The urban area options include landscaping and playing fields at school sites, the community park, and Sea Pines golf course, as shown in Figure 4-4.

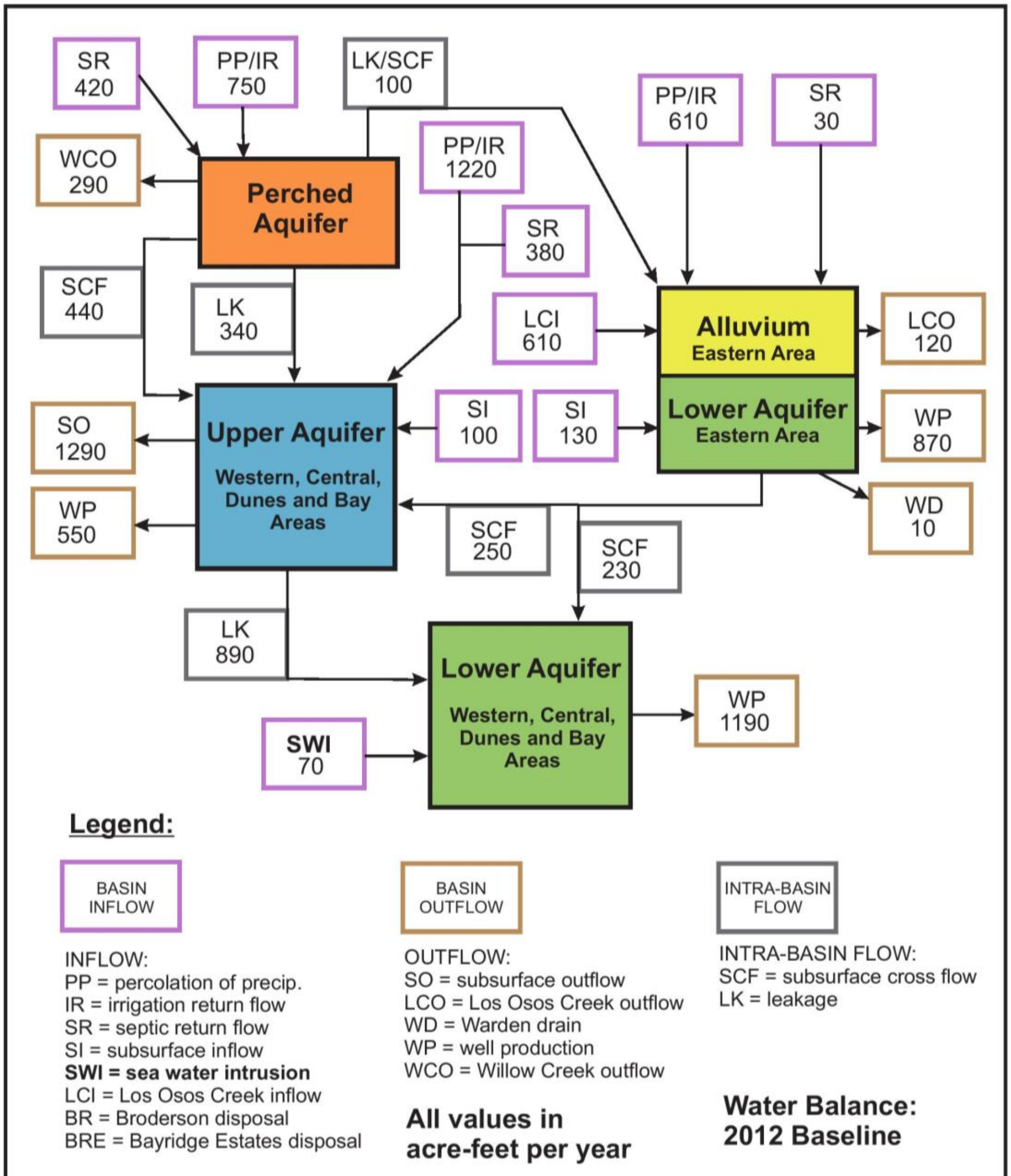
Table 4-1. Urban Water Reinvestment Program Recycled Water Uses

Potential Use	Quantity (AFY)	Percent of Total
Broderson Leach Fields (disposal site)	448	40
Bayridge Estate Leach Fields (disposal site)	33	2.9
Urban Reuse (irrigation)	63	5.6
Sea Pines Golf Course (irrigation)	40	3.6
Los Osos Valley Memorial Park (irrigation)	50	4.5
Agricultural Reuse (irrigation) [1]	486	43.4
Total	1,120	100

Source: ISJ Group, 2015
Abbreviations: acre-feet per year
Notes: [1] The No Further Development scenario distribution allocation for agricultural reuse is up to 146 AFY and the Population Buildout scenario distribution allocation for agricultural reuse is up to 486 AFY.

Figure 4-4. LOWRF Map (Source: ISJ Group, 2015)





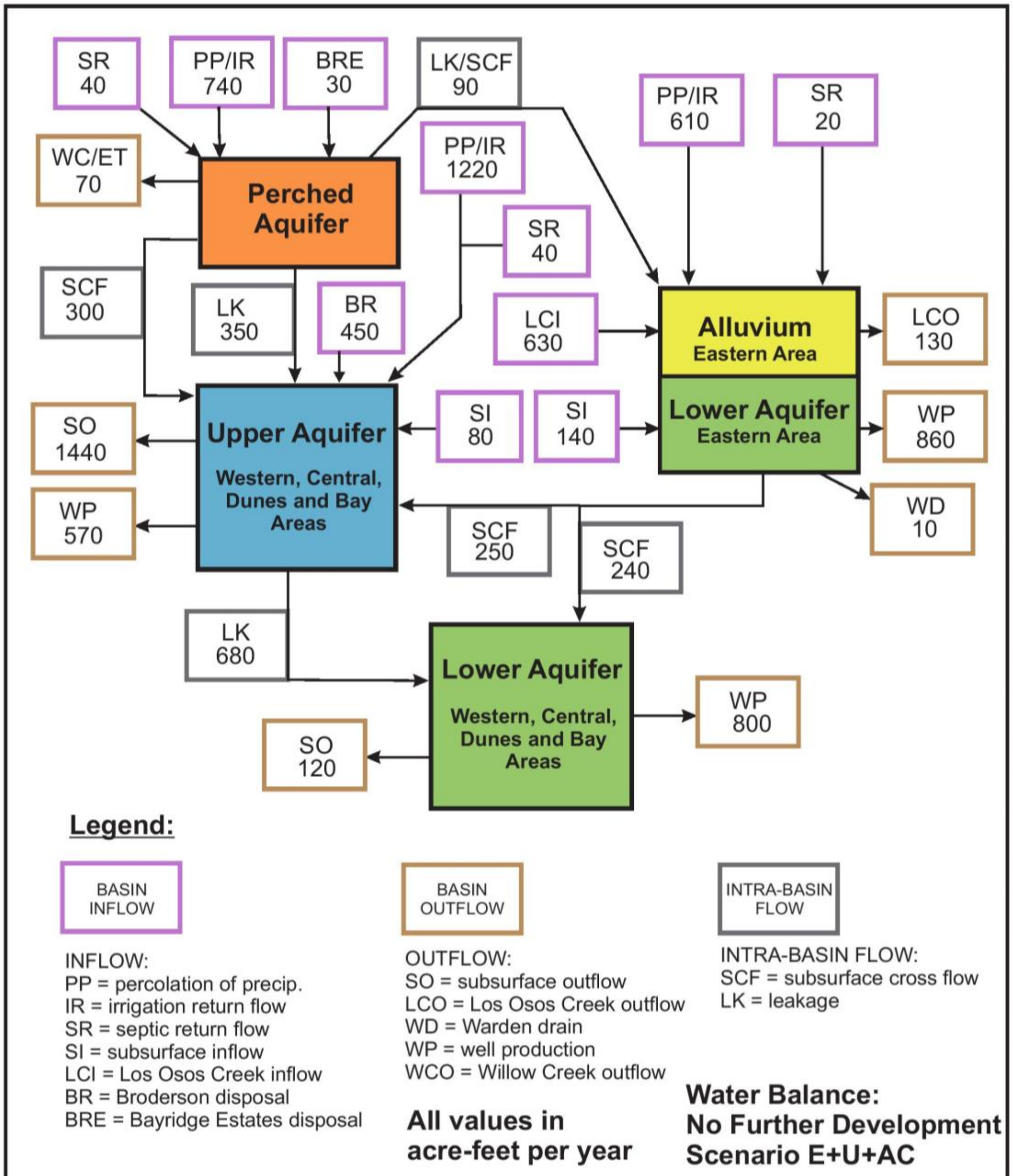
Source: ISJ Group, 2015

Figure 4-5

Water Balance: 2012 Baseline

Los Osos Groundwater Basin
Assimilation Capacity and
Antidegradation Analysis
County of San Luis Obispo

Cleath-Harris Geologists



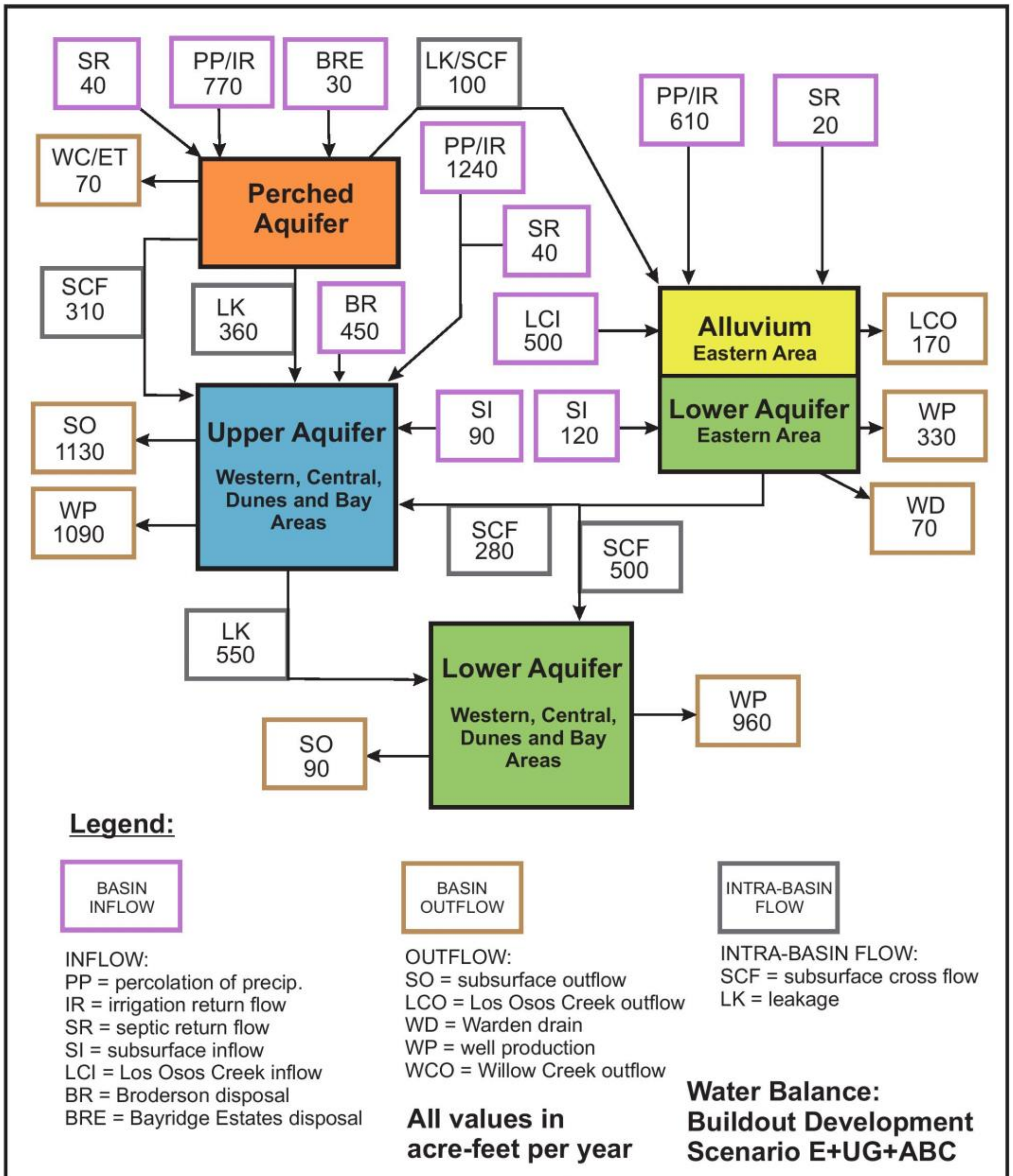
Source: ISJ Group, 2015

Figure 4-6

Water Balance:
LOBP No Further Development

Los Osos Groundwater Basin
Assimilation Capacity and
Antidegradation Analysis
County of San Luis Obispo

Cleath-Harris Geologists



Source: ISJ Group, 2015

Figure 4-7

Water Balance:
LOBP Population Buildout

Los Osos Groundwater Basin
Assimilation Capacity and
Antidegradation Analysis
County of San Luis Obispo

Cleath-Harris Geologists

Basin Infrastructure Program A is designed to increase groundwater production from the Upper Aquifer by purveyors to the greatest extent practicable without construction of large-scale nitrate removal facilities.

Basin Infrastructure Program C is designed to shift some lower aquifer production from the Western Area of the Basin to the Central Area, which is one of the strategies to mitigate seawater intrusion.

4.3.1.3 Population Buildout Scenario (E+UG+ABC)

Figure 4-7 presents the water balance for the Population Buildout scenario, for which the population size increases by 36 percent from 14,600 to 19,850[1]. Agricultural Water Reinvestment Program G and Basin Infrastructure Program B have also been added, as follows.

Agricultural Water Reinvestment Program G prioritizes agricultural reuse deliveries that create overall benefits to the Basin and help mitigate seawater intrusion. The program includes added wastewater treatment capacity and storage, along with outreach to the agricultural community.

Basin Infrastructure Program B is designed to maximize groundwater production from the Upper Aquifer, and includes new wells and a community-scale nitrate removal facility.

The amount of agricultural reuse in the Program G component of Scenario E+UG+ABC is 486 AFY (Table 4-1). The total potential recycled water use at population buildout is 1,120 AFY (1.0 million gallons per day).

Water quality trends from the 2012 Baseline scenario may be compared to corresponding trends from the LOBP No Further Development scenario and Population Buildout scenario. Demonstrating antidegradation under LOWRF project conditions involves the comparison of LOBP project scenarios with the current Basin assimilative capacity. The 2012 Baseline scenario is included for perspective on the importance of salt and nutrient management. These scenarios are compared in Chapter 5.

4.4 SOURCE ANALYSIS

The principal sources of salt and nutrient loading in the Basin under 2012 Baseline (pre-LOWRF) conditions includes natural, agricultural, residential, and animal waste sources. With the operation of the LOWRF, recycled water reuse and disposal becomes another principal source of salt and nutrient loading for the No Further Development and Population Buildout scenarios.

For mass balance calculations and the antidegradation analysis, all salt and nutrient loads need to be converted into inflow concentrations. For example, the loads for agricultural fertilizer applications are represented as concentrations in irrigation return flows, and loads for natural sources and animal waste are represented as concentrations in percolation of precipitation. Some of the estimates for salt and nutrient loading, such as agricultural fertilizer applications, originate as a mass load per source unit per year. Other estimates, such as septic tank discharges or recycled water applications, originate as a concentration per source unit volume per year. A summary of nitrate as nitrogen loading factors along with salt and nutrient loading factors for inflow water quality are presented below.

4.4.1 Salt and Nutrient Loading Factors

Loading factors refer to the amount of salt or nutrient added to the groundwater system over time, per source unit. Loading factors for various sources are presented in Tables 4-2 and 4-3. While TDS and chloride are

[1] The Population Buildout is referenced from the 2015 LOBP. The County of San Luis Obispo is re-evaluating the buildout potential within the Urban Reserve line in the Draft Los Osos Community Plan. The current Population Buildout number of 19,950 is anticipated to decrease under a lower projected density and revised dwelling unit count, resulting in a lower projected community water demand and decreased waste stream to the LOWRF.

relatively conservative in the vadose zone and groundwater, nitrates from residential fertilizer use, animal waste, and septic systems undergo varying degrees of attenuation through volatilization, plant uptake, and denitrification. Table 4-2 includes the per unit nitrogen loads, along with the attenuation factor used in the model analysis.

Table 4-2. NO_3-N Loading Factors

Source	Total Units (Baseline)	NO_3-N (lb/year)		
		Per unit (lb/year)	Attenuation (loss)	Total (lb/year)
Natural (Basin wide)[1]	4,000 acres	3.1	(incorporated)	12,400
Septic Tank Discharge[2]	830 acre-feet	152	41%	74,500
Agriculture/Turf Fertilizer[3]	400 acres	150	68%	19,200
Residential Landscape/Turf Fertilizer[3]	370 acres	45	80%	3,300
Animal Waste[4]	200 Horses	110	79%	4,600
	4,400 Dogs	2.9	92%	1,000
	6,600 Cats	1.4	92%	700

Source: CHG, 2017
NOTES:
[1] calibrated to pre-development conditions.
[2] influent quality to LOWRF, calibrated to baseline conditions.
[3] Viers et al. (2012); Metcalf & Eddy (1995)
[4] Metcalf & Eddy (1995)

Table 4-3. Inflow Source Water Quality

Source	TDS (mg/L)	Chloride (mg/L)	NO_3-N (mg/L)
Septic / LOWRF Influent (initial)[1]	790	200	56[2]
Septic / LOWRF Influent (transient)[1]	WS+352	WS+115	56[2]
Recycled Water (initial)[3]	713	200	6.6
Recycled Water (transient)[3]	IW-77	IW	6.6
Landscape Irrigation Return Flow[4]	WS*3.4+N load	WS*3.4	WS+N load
Agricultural Irrigation Return Flow[4]	WS*3.4+N load	WS*3.4	WS+N load
Perc. of Precip. with natural/animal[5]	146	36	3
Subsurface Bedrock Inflow[6]	493	50	0.2
Los Osos Creek Inflow[6]	540	53	0.2

Source: CHG, 2017
Abbreviations:
WS = domestic/irrigation water quality
IW = influent wastewater quality (same as septic discharge)
NOTES:
[1] based on initial water supply quality and LOWRF raw influent data (Appendix C, Table C14)

[2] mostly as ammonia-nitrogen (Appendix C, Table C14)
[3] based on LOWRF treated effluent data (Appendix C, Table C15)
[4] 3.4 evaporative enrichment factor calibrated to baseline conditions (Section 4.4.3 in Appendix D)
[5] natural loading calibrated to pre-development conditions (Section 4.4.2 and Appendix D)
[6] based on water quality data (Appendix C, Table C10)

As previously mentioned, salt and nutrient loading factors may also be described as concentrations for inflow source quality, as presented in Table 4-3. For example, the nitrate as nitrogen load for septic tank discharge is presented in both Table 4-2 and Table 4-3. For 830 AFY of septic tank discharge to leach fields (from Table 4-2), and assuming a concentration of 56 mg/L nitrate as N (from Table 4-3), the resulting load is 152 pounds of nitrogen per acre-foot, which after 41% attenuation due to denitrification, would add a total of 74,500 pounds of nitrogen per year (lb/yr) to the groundwater Basin[2].

Initial water quality for septic discharges and LOWRF influent are based on current water quality analyses (Appendix C, Table C14). The transient (time-dependent) water quality for septic discharges and LOWRF influent are expressed as a salt pick-up concentration added to the water supply quality. The water supply source is groundwater and quality will vary over time in accordance with the mixing equations. The salt pick-up, however, is from residential indoor activities and is relatively constant over time.

As shown in Table 4-3, there is also a salt loss component in transient recycled water for TDS. Wastewater treatment at the LOWRF results in a reduction of influent water alkalinity during nitrification of ammonia (LOWRF influent and effluent data in Appendix C, Tables C14 and C15). The LOWRF water quality data in Appendix C also show a slight decrease in chloride concentrations between the influent and effluent waste streams. The conservative assumption for salt and nutrient loading, however, is that no chloride is removed by the LOWRF.

4.4.2 Natural Sources

Natural sources of salt and nutrient loading include contributions from soils and rock, native vegetation and wildlife, and sea spray. An evaluation of natural nutrient loads was performed by determining the loads required to create historical water quality, as represented by available water quality results for TDS, chloride, and nitrate have data from the 1950s for the Upper Aquifer and from the 1970s and 1980s for the Lower Aquifer (pre-development water quality in Appendix C, Tables C11-C13). This pre-development hydrologic budget assumes that salt and nutrient loading from septic, fertilizer, domestic animals, and other anthropogenic sources are negligible. Percolation of precipitation is used by the mass balance spreadsheet model for transporting natural salt and nutrient loads to groundwater.

The historical background nitrate as nitrogen concentration ranged from 0.4 mg/L in the Lower Aquifer to 1.9 mg/L in the Perched and Upper Aquifer (Appendix C, Table C11 and C12). A nitrogen load of 12,500 pounds per year was necessary to produce similar background concentration in the mixing cells. Spread over approximately 4,000 acres of Basin inland of the bay, the natural nutrient load is estimated at 3.1 pounds nitrogen per acre per year (Table 4-2). Using percolation of precipitation as the natural load transport mechanism resulted in an average nitrate as nitrogen concentration of 2 mg/L for recharge (Appendix D, Table D2).

[2] Sample calculations: 56 mg/L NO_3-N * 1.23E6 L/AF * 2.20E-6 lb/mg = 152 lb/AF NO_3-N
830 AF/yr *152 lb/AF NO_3-N * (1-0.41) = 7.45E4 lb/yr NO_3-N

Natural background (pre-development) TDS and chloride concentrations for the Perched and Upper Aquifer averaged 165 mg/L for TDS and 37 mg/L for chloride (Appendix C, Table C11). Lower Aquifer background quality averaged 356 mg/L for TDS and 48 mg/L for chloride (Appendix C, Table C12). Eastern Area alluvial and Lower Aquifer background quality averaged 397 mg/L for TDS and 49 mg/L for chloride (Appendix C, Table C13).

Using percolation of precipitation as the natural transport mechanism, an average TDS concentration of 141 mg/L and an average chloride of concentration of 35 mg/L was required to produce similar background concentrations in the mixing cells. Natural sources calibration results are presented in Appendix D, Table D1 and D2.

Although significant land use changes have occurred during development that would replace some of the natural load, the pre-development natural loading was added to all scenarios as a conservative measure to address uncertainty and account for minor loads associated with soil disturbance and weed abatement.

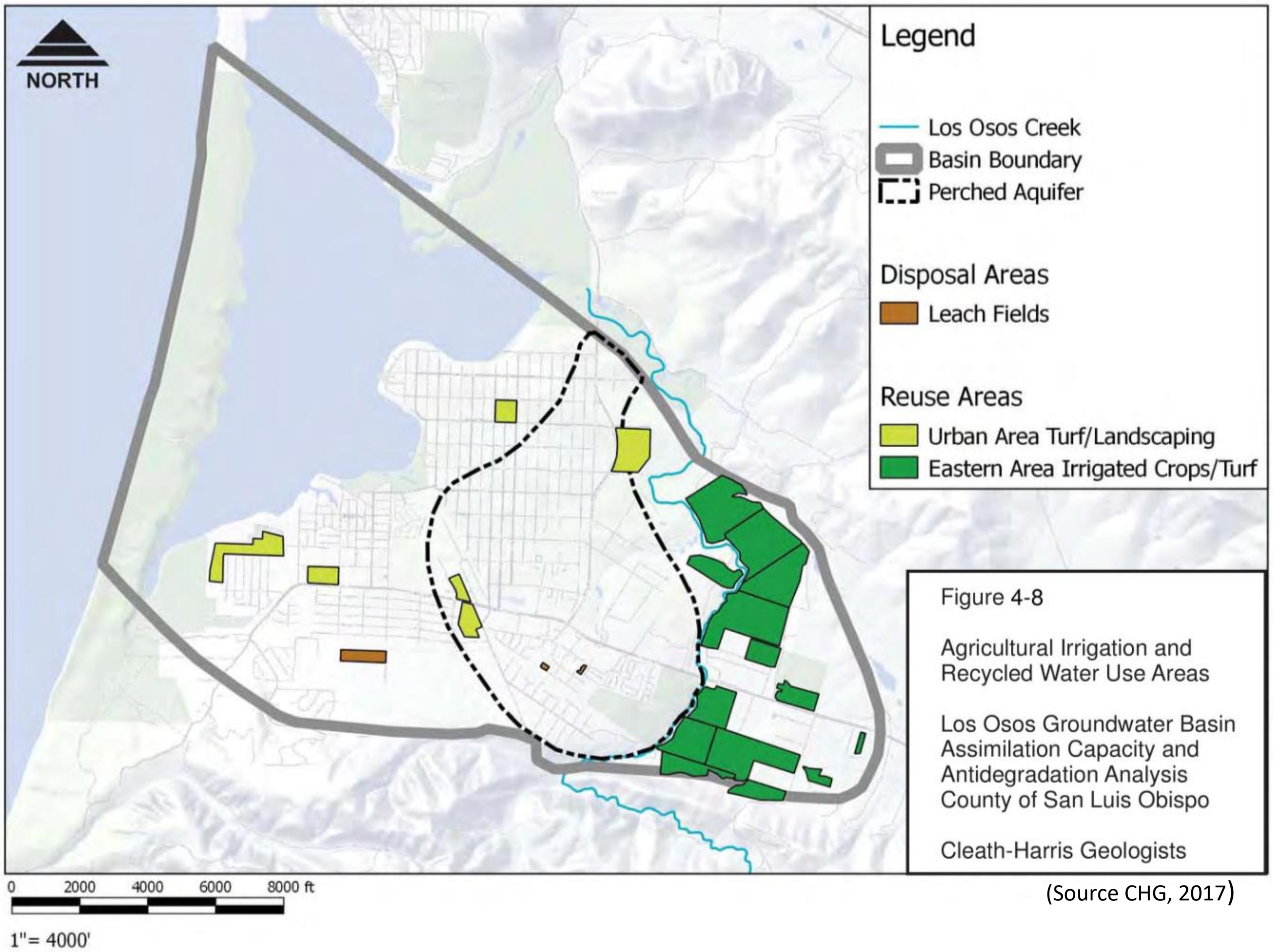
4.4.3 Agricultural Sources

Fertilizer is the main source of nitrogen loading from agricultural operations. Values of nitrogen loading for agricultural fertilizer in Los Osos was estimated by Metcalf & Eddy (1995) at approximately 150 pounds nitrogen per acre (lbs N/acre) per year, with an attenuation factor of 80 percent, mostly due to volatilization and plant uptake. A review of more recent literature confirms an average typical application rate for crops of 150 lbs N/acre with an average nitrogen removal during harvest of 90 lbs N/acre (Viers et al., 2012). The remaining 60 lbs N/acre left in the field is assumed to undergo an additional 20 percent loss from denitrification prior to loading groundwater (Metcalf & Eddy, 1995), for a net 68 percent total attenuation of applied nitrogen (48 lbs N/acre net loading).

Agricultural fertilizers do not represent a significant source of either dissolved solids or chlorides. However, irrigation water drawn from Basin aquifers contains a salt load. The bulk of irrigation water applied on fields is consumed via evapotranspiration, which results in increased concentration of salts in the soil. Over time, the salts left over from evaporation and crop evapotranspiration leach to groundwater will add to the salinity of existing water quality.

With each cycle of irrigation return flow, a significant portion of the salts are left behind in the fields through the evaporative enrichment process. A mass loading factor (multiplier) of 3.4 was derived by calibrating the salt and nutrient spreadsheet model to best match the baseline TDS, chloride, and nitrate as nitrogen concentrations in the Eastern Area, where agricultural return flows occur. This multiplication factor is applied to irrigation return flow concentrations and is used for evaporative enrichment of both agricultural and residential irrigation water (Table 4-3). Evaporative enrichment calibration results are presented in Appendix D, Table D3 and Figures D4, D5, and D6.

Figure 4-8 presents the Basin areas with agricultural irrigation and LOWRF project recycled water use. Cross-referencing Figure 4-8 with Figure 4-2 shows that salt and nutrient loading sources associated with agriculture overlying the Eastern Area alluvial aquifer and Lower Aquifer.



(Source CHG, 2017)

4.4.4 Residential Sources

Residential sources include salt and nutrients associated with human waste, water softeners, residential fertilizer, household products, and domestic pets waste. The bulk of these salt and nutrients have historically entered the groundwater Basin via septic return flows[3]. Residential fertilizer can leach to groundwater with irrigation return flow, and domestic pet waste and livestock loads are incorporated into the percolation of precipitation.

Attenuation of loads for septic system discharges can vary significantly due to site conditions. The resulting attenuation factor was a 41 percent net removal of the nitrogen load due to subsurface denitrification processes (Table 4-2). The attenuation of loads is discussed in Chapter 5.

The major residential contribution to salt loading occurs during domestic indoor water use. Water is delivered by purveyors to customers, who introduce salts through softeners, detergents, household products, or waste. In order to isolate the residential salt loading component for the Basin, the TDS and chloride concentrations of the community water supply was subtracted from the corresponding concentrations of

[3] Over 95% of the septic system have been removed in the wastewater service area in the Basin.

influent raw wastewater to the LOWRF. The resulting average salt pickup for the domestic indoor use cycle is estimated at 352 mg/L TDS and 115 mg/L chloride (Table 4-3).

Figure 4-9 depicts the residential salt and nutrient loading areas. Under 2012 Baseline conditions, all residential areas were on septic systems, except for one housing tract that treats wastewater for use at Sea Pines golf course. The distribution of urban residential areas over the mixing cells (labeled Urban Perched, Urban Eastern, and Urban Upper) are shown, along with the LOWRF collection area (labeled Prohibition

Zone). Recycled water beneficial use areas for residential and urban sources are shown in Figure 4-8 and Figure 4-4 LOWRF Map.

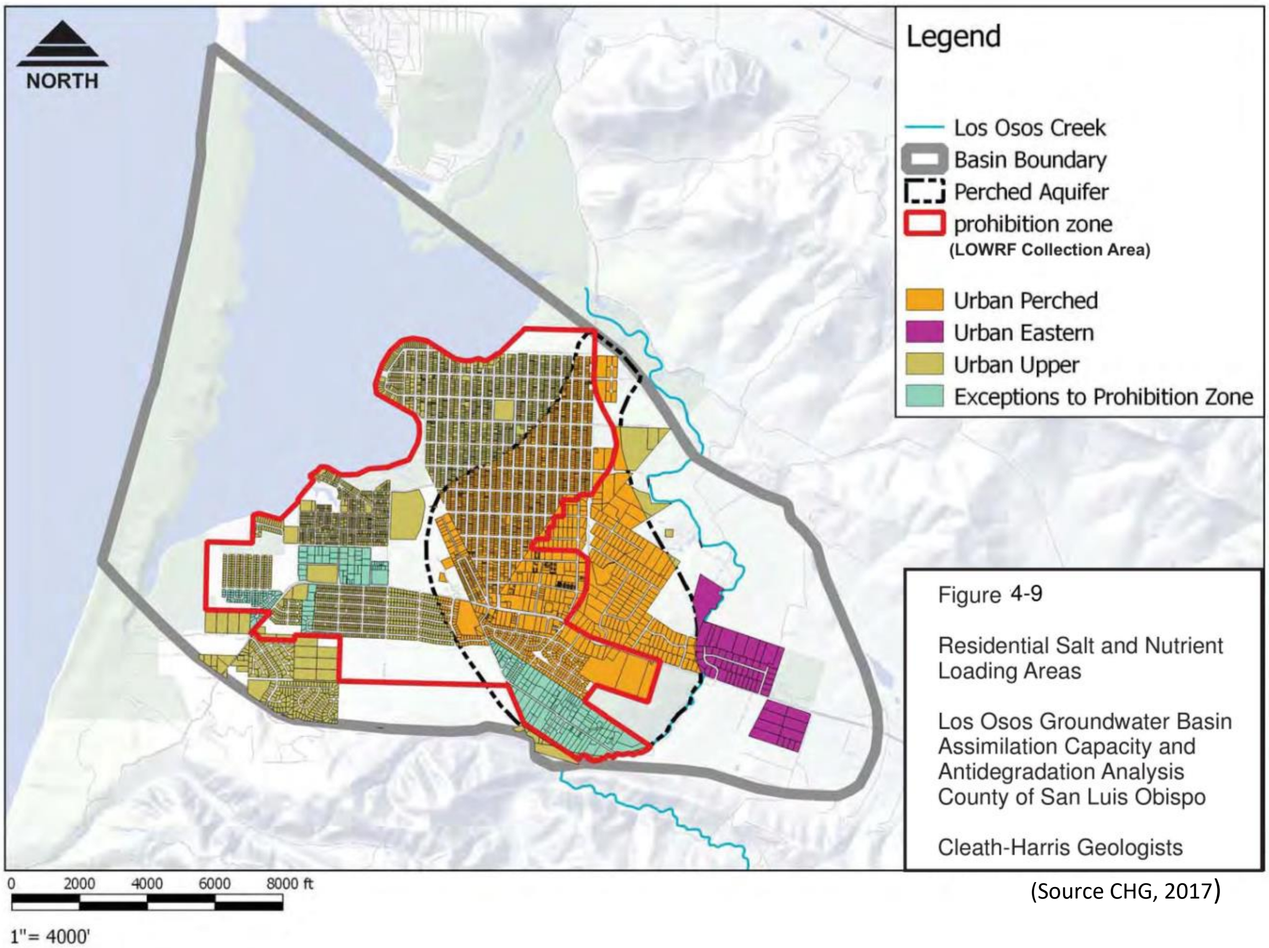


Figure 4-9

Residential Salt and Nutrient Loading Areas

Los Osos Groundwater Basin Assimilation Capacity and Antidegradation Analysis County of San Luis Obispo

Cleath-Harris Geologists

(Source CHG, 2017)

4.4.5 Animal Waste

Animal waste is a diffuse nitrogen source, associated with both urine (primarily) and uncollected feces. Within the mass balance spreadsheet model, salt and nutrient loading from animal waste is added as a constituent of percolation of precipitation, which is the most likely mechanism to transport nutrients associated with animal waste to groundwater. As the residential population has not changed significantly over the last 20 years due to the building moratorium, Metcalf and Eddy's 1995 estimate of 200 horses, 4,400 dogs, and 6,600 cats in the Basin is considered to be representative of the baseline domestic animal population (Table 4-2). These pet population estimates were based on San Luis Obispo County Health Department records for communal stables and dog registration, with adjustments for unregistered pets based on recommendations from the American Humane Society (Metcalf & Eddy, 1995). After attenuation, the animal waste would create a mass load of 6,400 pounds of nitrate as nitrogen for the Basin, a conservative estimate (if the waste is not cleaned-up). Using percolation of precipitation for carrying the mass flux into the groundwater Basin yields a concentration of 1 mg/L NO_3-N[4]. The volume of percolation of precipitation used is 2,330 AFY (equivalent to 2.87E9 liters per year), which is derived from the Basin water balance (Figure 4-5).

The National Academy of Sciences (NAS) lists a recommended daily intake of chloride at 300 mg per day per dog, 60 mg per day per cat and 15,000 mg per day for each horse (NRC, 2006a, 2006b, 2007). If the totality of this daily load is conserved in the Basin, then pets and livestock add approximately 1,720 kilograms per year (kg/year) chloride, or a concentration of 0.6 mg/L chloride to the percolation of precipitation flux load[5]. To calculate total dissolved solid load, daily dietary requirements for adult dogs, cats and horses were examined (NRC, 2006a, 2006b, 2007). It is assumed that in an adult animal, mass is conserved so daily intake is equal to daily output over time. Thus, TDS is approximately equal to the sum of dietary major ions and cations for an average adult animal. Based on NAS dietary recommendations for soluble minerals, daily TDS contribution is estimated at 2,785 mg/dog, 765 mg/cat, and 99,000 mg/horse. This would add 4.7 mg/L of TDS to the percolation of precipitation flux load.

There is no change to salt and nutrient loading from animal sources under the No Further Development scenario (E+AC+U). For the Buildout Population scenario (E+ABC+UG), a conservative 36 percent increase in salt and nutrient loads from animal waste is projected, which is proportional to the population increase at buildout. As previously mentioned, the Buildout Population is being re-evaluated by the County and is anticipated to decrease from the estimate presented in the LOBP.

4.4.6 Seawater Intrusion

Seawater is a virtually unlimited, but highly undesirable, source of recharge to the groundwater Basin. Both Upper and Lower Aquifers in the Basin extends offshore and are hydraulically connected to the Pacific Ocean. Seawater intrusion into the freshwater portion of the Lower Aquifer has been occurring for decades in the Western Area of the Basin (CHG, 2016).

As shown in Figure 4-5, under the steady-state 2012 Baseline scenario conditions, approximately 70 acre-feet of seawater intrusion is estimated to occur annually (ISJ Group, 2015). This leads to elevated levels of both TDS and chloride in the Western Area Lower Aquifer. The salt and nutrient spreadsheet model calculates the purveyors water supply quality based on the source aquifer quality and pumping distribution. The No Further Development and Population Buildout scenarios (Figures 4-6 and 4-7) model calculations include water quality (over a 25 year period) of each mixing cell changing for every year of the projection, along with the raw groundwater supply from each cell volume.

The Lower Aquifer is a major source of community water supply. Under the 2012 Baseline scenario with seawater intrusion occurring, TDS and chloride concentrations rise significantly in the water supply over time. The salt and nutrient loads of the domestic use cycle are added to the water supply, which then serves customers throughout the urban area, including those overlying the Perched Aquifer (Figure 4-2). Since a

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[4] Calculations: 200 horses * 110 lb/yr NO3-N * (1-0.79) = 4,620 lb/yr
4,400 dogs * 2.9 lb/yr NO3-N * (1-0.92) = 1,020 lb/yr
6,600 cats * 1.4 lb/yr NON3-N * (1-0.92) = 740 lb/yr
Perc. of Precip loading: 6,380 lb/yr NO_3-N * 453593 mg/lb ÷ 2.87E9 L/yr = 1 mg/L NO_3-N

[5] Calculations: 200 horses * 15,000 mg/d Cl * 365 d/yr ÷ 1E6 mg/kg = 1,095 kg/yr
4,400 dogs * 300 mg/d Cl * 365 d/yr ÷ 1E6 mg/kg = 482 kg/yr
6,600 cats * 60 mg/d Cl * 365 d/yr ÷ 1E6 mg/kg = 145 kg/yr
Perc. of Precip loading: 1,722 kg/yr Cl * 1E6 mg/kg ÷ 2.87E9 L/yr = 0.6 mg/L Cl

portion of this aquifer spills into the creek valley Alluvial Aquifer (Figure 4-5), salt loading from seawater intrusion can affect the water quality in the Eastern Area of the Basin.

Both the LOBP No Further Development and Population Buildout scenarios are designed to be sustainable, and eliminate the estimated 70 acre-feet of seawater intrusion under Baseline conditions. The LOWRF is an integral component of achieving sustainability, through the use of recycled water to reduce pumping, that will reduce the salt load to the Basin by mitigating seawater intrusion.

4.5 SUMMARY

Seawater intrusion and the community's use of septic systems was at least partially responsible for the nitrate contamination in the Basin have been the largest sources of salt and nutrient loading to the Basin. As such, the most appropriate primary indicators of mass loading from these sources are TDS, chloride, and nitrate as nitrogen, which are the three constituents used for the assimilative capacity and antidegradation analyses in Chapter 5.

Chapter 5 ASSIMILATIVE CAPACITY AND ANTIDEGRADATION ANALYSES

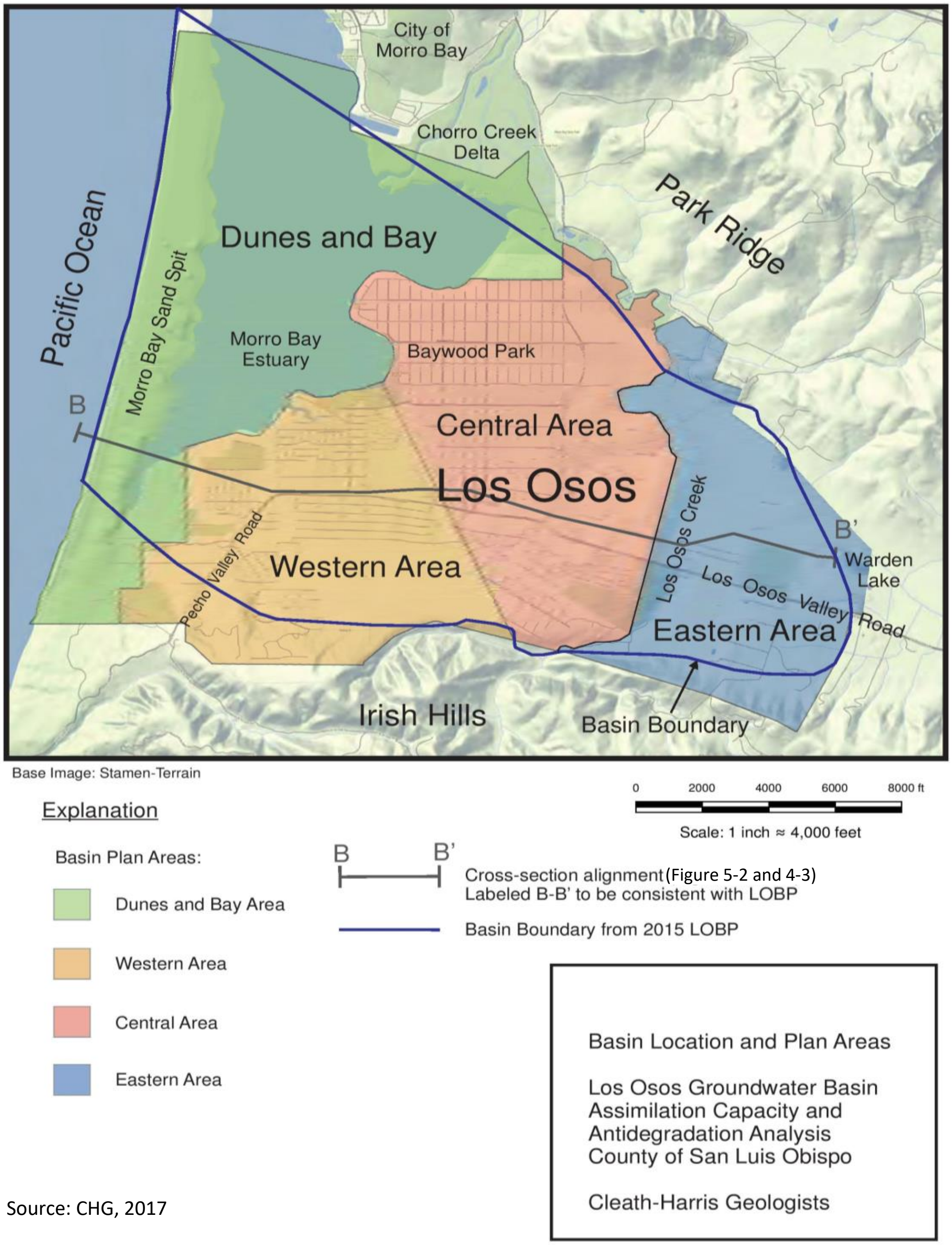
This assimilative capacity and antidegradation analysis are required elements in the Los Osos SNMP in accordance with the Recycled Water Policy and the LOWRF WDR Order. The assimilative capacity and antidegradation analyses will evaluate the impacts of salt and nutrient loadings on a groundwater basin to facilitate management of salts, nutrients, and other significant chemical compounds on a watershed- or basin/subbasin-wide basis. Recycled water reuse is an integral part of water resource management, and the Recycled Water Policy establishes a mandate to encourage and increase the use of recycled water in California.

As part of the policy, State Water Board Resolution No. 68-16 is the State of California's antidegradation policy which, in summary, establishes the requirement that discharges to waters of the State be regulated to achieve the "highest water quality constituent to the maximum benefit to the people of the State". This resolution essentially establishes a two-step process for compliance. First, if a discharge will degrade high quality water, the discharge may be allowed if any change in water quality (1) will be consistent with the maximum benefit to the people of the State, (2) will not unreasonably affect present and anticipated beneficial uses of such water (as defined in the Central Coast Basin Plan), and (3) will not result in water quality less than that prescribed in State policies. This point is demonstrated in an antidegradation analysis. The second step requires the use of best practicable treatment or control of the discharge necessary to avoid a pollution or nuisance and to maintain the highest water quality consistent with the maximum benefit to the people of the State. Resolution No. 68-16 was incorporated into the State Water Board's Recycled Water Policy in Section 9, Antidegradation, which sets forth the parameters under which recycled water may be used. Specifically, the Recycled Water Policy states that in cases where more than 10% of a basin's assimilative capacity will be used by a project (or more than 20% of a basin's assimilative capacity will be used by multiple projects), an antidegradation analysis consistent with Resolution No. 68-16 must be performed to provide sufficient information to the Regional Water Board to make a determination that the proposed projects will provide the maximum benefit to the people of the State.

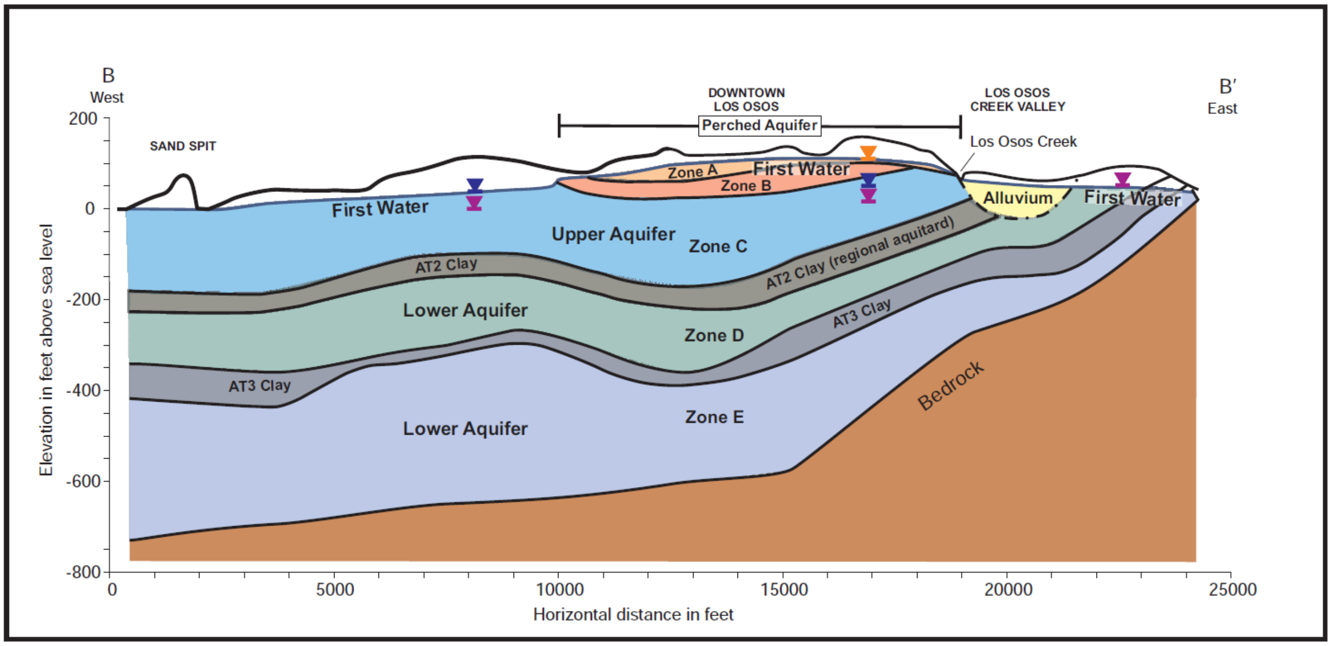
The groundwater quality trend analysis presented herein uses data collected and analyzed as part of this project to address the requirements of the Recycled Water Policy and Resolution No. 68-16. These data were used in a mass balance model to perform the groundwater quality trend analysis.

For the assimilative capacity and antidegradation analysis, the Basin has been divided into mass balance compartments, or mixing cells, that correspond to the aquifers and plan areas used for water balance in the Basin. Figure 5-1 shows the location of the Basin and plan areas. Figure 5-2 shows the hydrogeologic cross-section of the Basin aquifers. In the assimilative capacity analysis, the average groundwater quality in the Basin plan area is compared with the LOWRF WDR Order for the California Code of Regulations (CCR) for Title 22 and the Central Coast Basin Plan median groundwater objectives. The difference between the Basin groundwater quality (as represented by concentrations of indicator compounds) and the respective water quality objectives contained in LOWRF WDR Order for CCR Title 22 and the Central Coast Basin Plan, represents the assimilative capacity of the groundwater Basin, or the additional 'load' which the groundwater Basin can accept without exceeding the water quality objectives. This analysis is then repeated using projected future conditions with No Further Buildout and Population Buildout scenarios, as discussed in Section 4.3, to see if the groundwater quality will remain below the water quality objectives contained in the LOWRF WDR Order and Central Coast Basin Plan median groundwater objectives.

As described in Chapter 3, the basin characterization and groundwater quality for this SNMP is based on the adjudicated Basin area within the Los Osos Valley Groundwater Basin. The Basin conceptual model is discussed in Chapter 4, as well as salt and nutrient source analysis and loading for the assimilative capacity and antidegradation analyses.



Source: CHG, 2017



Cross-section alignment shown in Figure 5-1.

Explanation

- Perched Aquifer Water level
- Upper Aquifer Water level
- Lower Aquifer Water level

Source: CHG & Wallace Group, 2016

Figure 5-2
Basin Aquifers
Los Osos Groundwater Basin
2015 Annual Report

5.1 FATE AND TRANSPORT

Fate and transport in groundwater describes the way salts and nutrients move through the soil and water. Water has the ability to naturally dissolve salts and nutrients in the hydrologic cycle. Transport of salt and nutrient loads through the vadose zone between surface sources and the water table can involve a complex series of chemical and soil processes which affect both the load concentration and transit time. Nitrogen loads, in particular, generally attenuate before reaching groundwater through processes of nitrification and denitrification, assimilation, fixation, transformation, uptake and leaching occurring in various environments. In groundwater, both nitrate and chloride anions are relatively conservative, and do not interact significantly with the aquifer matrix. Nitrate is the primary form of nitrogen detected in groundwater. It is soluble in water and can easily pass through soil to the groundwater table. Nitrate can persist in groundwater for decades and accumulate to high levels as more nitrogen is applied to the land surface every year. TDS, which is primarily composed of general mineral cations and anions, is also relatively conservative. Ion exchange processes, however, can alter the character of the water as it moves through Basin sediments, particularly in response to seawater intrusion. Salt and nutrients within the Basin that are not removed, recycled, or immobilized would discharge into Morro Bay, the Pacific Ocean, or Los Osos Creek.

5.2 VADOSE ZONE TRANSIT TIME

Accumulation of salt and nutrients can occur within the vadose zone, and accounts for variable transit times for applied salt and nutrient loads to reach groundwater. Salts, particularly within agricultural areas, are concentrated in soils by evapotranspiration processes (evaporative enrichment). Based on the relative difference between applied and deep percolating water, salts in applied irrigation water will concentrate due to a lack of significant consumptive uptake by plants. A portion of this concentrated salt is returned with the irrigation water that normally percolates to the aquifer, but a portion is stored in the soil until sufficient rainfall infiltration, or the addition of a leaching fraction to irrigation[1] flushes it into the aquifer. Transit time is a function of soil type and chemistry, vadose zone thickness, irrigation methods, and rainfall quantity and distribution. For purposes of mass balance in this study, vadose zone transit time is assumed to be zero and the concentrated salt load is returned with irrigation infiltration.

5.3 METHODOLOGY

The methodology used to simulate salt and nutrient loading involves a mass balance spreadsheet model, which converts salt and nutrient loads to inflow concentrations, distributes flows according to the water balance, and provides for repeated cycles of loading. The spreadsheet model also allows salt and nutrient load calibration using Basin water quality data. The calibration process provides a rigorous approach to mass balance by evaluating the Basin-specific salt and nutrient loads for key sources, such as natural sources and the evaporative enrichment of salts beneath agricultural fields.

Water quality trends from the 2012 Baseline scenario (pre-LOWRF construction/no management programs) may be compared to corresponding trends from the No Further Development scenario (LOWRF is operational/management programs) and Population Buildout scenario (LOWRF is operational/ additional management programs/projects). Demonstrating the antidegradation analyses under the LOWRF conditions involves the comparison of scenarios with the assimilative capacity. The 2012 Baseline scenario is included in the comparison for perspective on the importance of salt and nutrient management and the operation of the LOWRF.

Mixing Equations

For each Basin compartment, herein referred to as mixing cells for mass balance purposes, two equations were used to determine the mass balance at equilibrium and at a specified interval of years (Larry Walker Associates et al., 2015).

Equation 1:

$$C_{t=\infty} = \left(\frac{\sum_{i=1}^{n} C_i * Q_i}{\sum_{i=1}^{n} Q_i}\right)$$

Where:

C = concentration [mg/L],
Q = volume [L],
t = time in years,
i = an inflowing constituent
n = total number of inflowing constituents

[1] Leaching fraction is the amount of water needed to flush excess salts from the root zone that would otherwise impact crop production.

Equation 2:

$$C_t = C_{t=\infty} + (C_o - C_{t=\infty}) * e^{\frac{-\sum_t^n Q_t * t}{V}}$$

Where:

C = concentration [mg/L],
Q = inflow volume [L],
t = time in years,
V = mixing cell volume [L]
n = total number of inflowing constituents
o = mixing cell starting concentration
e = Euler's number (constant)

For each mixing cell, the fully mixed equilibrium concentration ($t = \infty$) was calculated for the salt and nutrient loads of each scenario. This equilibrium concentration was used in conjunction with Equation 2 to calculate loading for a period of 25 annual salt and nutrient loading cycles, which exceeds the minimum ten-year time frame required for impacts analyses under the state Recycled Water Policy. The annual cycles of loading are referred to as years, but due to local variations in groundwater mixing, mass loading, and migration of salts through the vadose zone, there can be a significant lag time between the annual loads and the projected trends in water quality. Equation 2 accounts for the residence time for a solute mass in the mixing cell. Mixing in the cells is not "instantaneous" per the transient loading analysis in Equation 2, but takes place incrementally over annual cycles. Furthermore, the concentration of outflow is equal to the concentration of the mixing cell at the beginning of each loading cycle, which also means that mixing is not instantaneous within each loading cycle, but takes place after the outflow.

The mass balance equations only require inflow volumes and concentrations to project water quality trends. The assumption is that the mixing cell is a fixed volume, therefore outflow is always equal to inflow. This is also true for the Basin water balance at steady-state (equilibrium). The concentration of outflow is equal to the concentration of the mixing cell at the beginning of a loading cycle.

<u>Scenario Operations</u>

Salt and nutrient loads were combined with the scenario water balances and mass balance equations to calculate concentration trends. The loading concentrations, evaporative enrichment, and attenuation factors used for selected constituents were based on literature review (see Chapter 5 references), LOWRF influent and effluent data, and calibration process to the Basin’s groundwater quality data. Concentration trends from the mass balance spreadsheet model were compared to assimilative capacity estimates for each mixing cell (separately) and average Basin assimilative capacity (Basin as a whole).

State Recycled Water Policy requires assimilative capacity and antidegradation analysis impacts to be evaluated for basins and subbasins wide. The compartments used herein for mixing cells are not subbasins. Use of assimilative capacity and associated antidegradation analysis thresholds has been evaluated using groundwater Basin average concentrations. Concentration trends for individual mixing cells may be useful in adaptive management when considering implementation measures for mitigating salt and nutrient loading impacts.

5.4 MIXING CELL WATER QUALITY

Representative water quality for each Basin compartment (mixing cell) of the conceptual model is needed for evaluating assimilative capacity and establishing the initial conditions for mass balance calculations. Data from groundwater monitoring programs in the Basin, along with water quality studies, were used for assigning water quality. Water quality estimates are shown in Table 5-1. Data used for developing the estimates is included in Appendix C.

Table 5-1. Current Water Quality

Mixing Cell	TDS (mg/L)	Chloride (mg/L)	NO_3-N (mg/L)
Perched Aquifer[1]	380	93	15
Upper Aquifer[1]	380	88	15
Lower Aquifer - Western and Central Areas[2]	440	79	2
Lower Aquifer and Alluvial Aquifer - Eastern Area[3]	530	75	6
Basin Average (weighted)[4]	440	81	6

Source: CHG, 2017
[1]Appendix C, Tables C1-C4
[2]Appendix C, Tables C5-C7
[3]Appendix C, Table C8
[4]by volume - sample calculation below

The Basin average (weighted) concentrations in Table 5-1 and in subsequent tables is weighted by volume in accordance with *Equation 1* and the mixing cell storage volumes in Table 5-2. For example, the Basin average TDS in Table 5-1 is calculated as follows:

$$\frac{(380\ mg/L*5.19E9\ L) + (380\ mg/L*3.33E10\ L) + (440\ mg/L*8.68E10\ L) + (530\ mg/L*2.21E10\ L}{(5.19E9\ L + 3.33E10\ L + 8.68E10\ L + 2.21E10\ L)} = 440\ mg/L$$

5.5 MIXING CELL STORAGE VOLUMES

Mixing cell groundwater storage volumes are used in the mass balance equations. Groundwater in storage for Basin areas and aquifers was estimated through a systematic approach of water level contouring, boundary definition, volume calculations, and aquifer property estimation (CHG & Wallace Group, 2016). Table 5-2 summarizes the Spring 2015 groundwater storage volumes for the mass balance mixing cells.

Table 5-2. Groundwater in Storage[1]		
Mixing Cell	**Groundwater in Storage (Spring 2015)**	
	Acre-Feet	Liters[3]
Perched Aquifer	4,200	5.18E9
Upper Aquifer	27,000	3.33E10
Lower Aquifer - Western and Central Areas[2]	70,400	8.68E10
Lower Aquifer and Alluvial Aquifer - Eastern Area	17,900	2.21E10
Total	119,500	1.47E11

Source: CHG, 2017
NOTES:
[1]LOBP Groundwater Monitoring Program 2015 Annual Report (CHG & Wallace Group, 2016).
[2]excludes seawater intruded area
[3]Liters are used for weighted average calculations (e.g. Table 5-1)

5.6. BASIN ASSIMILATIVE CAPACITY

The Regional Water Board website defines assimilative capacity as:
(http://www.waterboards.ca.gov/centralcoast/publications_forms/publications/basin_plan/bp_glossary.shtml)

> *The capacity of a natural body of water to receive (a) wastewaters, without deleterious effects, (b) toxic materials, without damage to aquatic life or humans who consume the water, (c) Biochemical Oxygen Demand, within prescribed dissolved oxygen limits.*

Based on the above definition, the assimilative capacity of a groundwater basin to receive recycled water and return flows from irrigation would be the difference between ambient concentrations of selected water quality constituents in groundwater and the maximum concentration (or water quality objective, if specified) of the constituent that would preclude deleterious effects. Assimilative capacity for salt loading has been evaluated using TDS and chloride concentrations, and nutrient loading has been evaluated using nitrate as nitrogen (NO_3-N) concentrations.

As discussed in Section 4.2.3, the Los Osos Groundwater Basin is in the Estero Bay planning area. The Central Coast Basin Plan lists median groundwater objectives for the following sub-basin/sub-areas of the Estero Bay planning area: Santa Rosa, Chorro, San Luis Obispo, and Arroyo Grande Creeks. Existing water quality objectives are shown in Table 5-3.

Table 5-3. Existing Median Groundwater Objectives			
Area	**TDS**	**Chloride**	**NO_3-N**
	mg/L		
Santa Rosa	700	100	5
Chorro	1,000	250	5
San Luis Obispo	900	200	5
Arroyo Grande	800	100	10

Source: CCRWQCB, 2016

There are no published median groundwater objectives for Los Osos in the state Central Coast Basin Plan. As a Basin with documented nitrate and seawater intrusion problems, the median groundwater objectives used for the assimilative capacity analysis are based on the highest existing median objectives for the Estero Bay Area: 1,000 mg/L TDS, 250 mg/L chloride, and 10 mg/L NO_3-N. In comparison, a TDS concentration of 1,000 mg/L is the Upper Limit of the Secondary MCL for drinking water in California. A chloride concentration of 250 mg/L is the Recommended Limit of the Secondary MCL for drinking water in California. A nitrate as nitrogen concentration of 10 mg/L is the Primary MCL for drinking water in the CCR for Title 22.

From the water quality data in Table 5-1, the assimilative capacity of each mixing cell has been calculated, along with a weighted Basin average. Results of the assimilative capacity calculations are presented in Tables 5-4, 5-5, and 5-6.

Table 5-4. TDS Assimilative Capacity - Los Osos Groundwater Basin

Mass Mixing Cell	Allowable TDS[1] [mg/L]	Current TDS[2] [mg/L]	Assimilative Capacity[3] [mg/L]	10% Assimilative Capacity Use [mg/L]	20% Assimilative Capacity Use [mg/L]
Perched Aquifer	1,000	380	620	62	124
Upper Aquifer	1,000	380	620	62	124
Lower Aquifer-Western and Central Area	1,000	440	560	56	112
Lower Aquifer and Alluvial Aquifer - Eastern	1,000	530	470	47	94
BASIN AVERAGE (weighted)[4]	**1,000**	**440**	**560**	**56**	**112**

Source: CHG, 2017
[1]Allowable TDS from maximum existing median objective for Estero Bay planning area.
[2]TDS data from Appendix D
[3]Allowable TDS - Current TDS = Assimilative Capacity; 1000 mg/L - 380 mg/L = 620 mg/L for Perched Aquifer.
[4]Basin averages weighted by volume (sample calculation in Section 5.4).

Table 5-5. Chloride Assimilative Capacity - Los Osos Groundwater Basin

Mass Mixing Cell	Allowable Chloride[1] [mg/L]	Current Chloride[2] [mg/L]	Assimilative Capacity[3] [mg/L]	10% Assimilative Capacity Use [mg/L]	20% Assimilative Capacity Use [mg/L]
Perched Aquifer	250	93	157	16	31
Upper Aquifer	250	88	162	16	32
Lower Aquifer-Western and Central Area	250	79	171	17	34
Lower Aquifer and Alluvial Aquifer - Eastern Area	250	75	175	18	35
BASIN AVERAGE (weighted)[4]	**250**	**81**	**169**	**17**	**34**

Source: CHG, 2017

[1] Allowable chloride from maximum existing median objective for Estero Bay planning area.
[2] Chloride data from Appendix D
[3]Allowable chloride - Current chloride = Assimilative Capacity; 250 mg/L - 93 mg/L = 157 mg/L for Perched Aquifer.
[4] Basin averages weighted by volume (sample calculation in Section 5.4).

Table 5-6. NO_3-N Assimilative Capacity - Los Osos Groundwater Basin

Mass Mixing Cell	Allowable NO_3-N[1] [mg/L]	Current NO_3-N[2] [mg/L]	Assimilative Capacity[3] [mg/L]	10% Assimilative Capacity Use [mg/L]	20% Assimilative Capacity Use [mg/L]
Perched Aquifer	10	15	-5 (none)	0 (none)	0 (none)
Upper Aquifer	10	15	-5 (none)	0 (none)	0 (none)
Lower Aquifer- Western and Central Area	10	2	8	0.8	1.6
Lower Aquifer and Alluvial Aquifer - Eastern Area	10	6	4	0.6	1.2
BASIN AVERAGE (weighted)[4]	**10**	**6**	**4**	**0.4**	**0.8**

Source: CHG, 2017
[1] Allowable NO_3-N from maximum existing median objective for Estero Bay planning area.
[2] NO_3-N data from Appendix D
[3]Allowable NO_3-N - Current NO_3-N = Assimilative Capacity; 10 mg/L - 15 mg/L = -5 mg/L for Perched Aquifer. A negative assimilative capacity is equivalent to no capacity.
[4] Basin averages weighted by volume (sample calculation in Section 5.4).

The 10 percent and 20 percent assimilative capacity values are thresholds established by the State Water Board with respect to demonstrating compliance with State Water Board Resolution No. 68-10 (Statement of Policy with Respect to Maintaining High Quality of Waters in California) for recycled water projects:

> *"A project that utilizes less than 10 percent of the available assimilative capacity in a basin/sub-basin (or multiple projects utilizing less than 20 percent of the available assimilative capacity in a basin/sub-basin) need only conduct an antidegradation analysis verifying the use of the assimilative capacity."* (SWRCB, 2009)

5.7 ANTIDEGRADATION ANALYSIS

The antidegradation analysis evaluates potential impacts to water quality from to three scenarios (i.e., 2012 Baseline, No Further Development and Population Buildout scenarios, see Section 4.3.1 for scenario details) and compares those impacts to the assimilative capacity of the groundwater Basin. The analysis is required under State Recycled Water Policy for operating the LOWRF, which mandates compliance with State Water Board Resolution 68-16 (*Statement of Policy with Respect to Maintaining High Quality of Waters in California*). This antidegradation analysis has been prepared to satisfy both the Los Osos SNMP requirements and operating permit requirements of the LOWRF WDR Order. Results from the mass balance spreadsheet model are in Appendix E: Tables E1 – E5. Graphs of water quality trends for individual mixing cells, and for the Baseline scenario, are included in Appendix F.

5.7.1 Total Dissolved Solids Trends

Table 5-7 presents the assimilative capacity of TDS used by the No Further Development and the Population Buildout scenarios in the antidegradation analysis. Positive values of assimilative capacity use (in red) indicate a reduction in Basin assimilative capacity, while negative values of use (in blue and bold) indicate a gain, or improvement, in capacity.

Table 5-7. TDS Antidegradation Analysis - Los Osos Groundwater Basin[1]

Mass Mixing Cell	Assimilative Capacity [mg/L]	Assimilative Capacity Used (+lost -gained)							
		No Further Development[2]				Population Buildout[3]			
		10 Years		25 Years		10 Years		25 Years	
		mg/L	%	mg/L	%	mg/L	%	mg/L	%
Perched Aquifer	620	-65.7	**-10.6**	-80.4	**-13.0**	-33.6	**-5.4**	-35.2	**-5.7**
Upper Aquifer	620	-18.5	**-3.0**	-34.2	**-5.5**	-10.2	**-1.7**	-15.8	**-2.5**
Lower Aquifer- Western and Central Area	560	11.7	2.1	26.2	4.7	13.5	2.4	33.2	5.9
Lower Aquifer and Alluvial Aquifer - Eastern Area	470	8.8	1.9	14.2	3.0	22.2	4.7	39.0	8.3
BASIN TOTAL	**560**	1.7	0.3	7.0	1.3	7.8	1.4	20.7	3.7

Source: CHG, 2017
Notes:
[1] Data tables with sample calculations in Appendix E, Tables E3 and E5.
[2] No Further Development scenario - includes the operation of the LOWRF and implementation of projects/programs by various entities.
[3] Population Buildout scenario - population size increases to buildout, the operation of the LOWRF project, and the implementation of project/programs from the No Further Development scenario and additional projects/programs by various entities.

Gains of up to 13 percent assimilative capacity are achieved for TDS in the Perched and Upper Aquifer, due primarily to the collection, treatment and redistribution of septic discharges within the prohibition zone for No Further Development scenario at 25 years. Conversely, use of up to 8.3 percent of the assimilative capacity for TDS, corresponding to 39 mg/L, is projected in the Eastern Area for the Population Buildout scenario after 25 years. The Eastern Area would receive a net increase in salt loading under Population Buildout scenario due to recycled water use in lieu of groundwater pumping (the TDS of recycled water is greater than current Eastern Area water quality). The weighted average use of TDS assimilative capacity in the Basin is 1.3 percent for the No Further Development scenario and 3.7 percent for the Population Buildout scenario after 25 years.

Figure 5-3 shows the Basin average trends in TDS concentrations under the No Further Development and Population Buildout scenarios. Trends in TDS for individual mixing cells are included in Appendix F. The Baseline scenario water quality trend is also included in Appendix F for TDS trends comparison

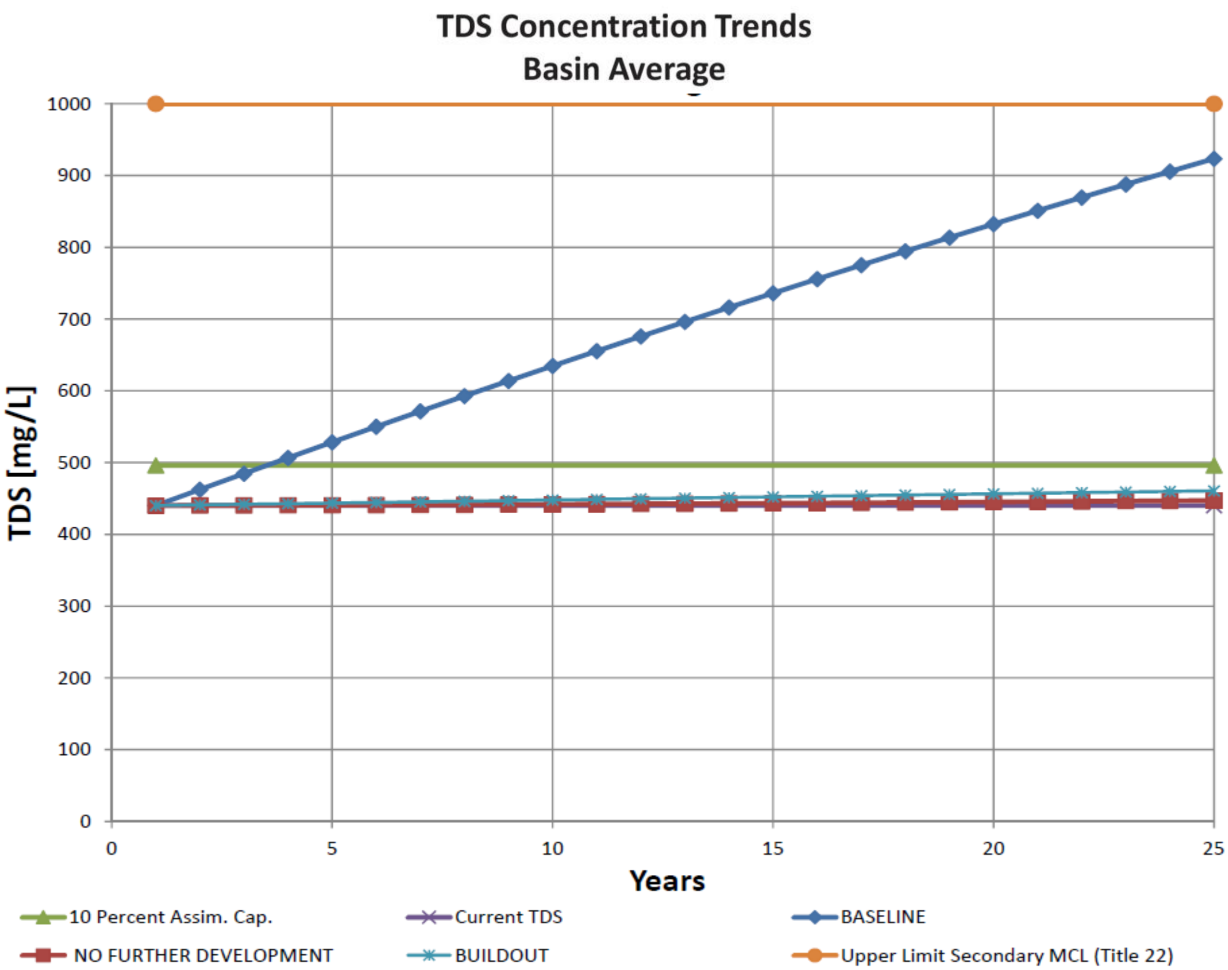


Figure 5-3

Basin Average TDS Concentration Trends

Los Osos Groundwater Basin
Assimilation Capacity and Antidegradation Analysis
County of San Luis Obispo

Cleath-Harris Geologists

Source: CHG, 2017

(Figures F1 through F5). Seawater intrusion, along with continued septic tank discharges, results in a much greater level of water quality degradation under the 2012 Baseline (pre-LOWRF) conditions than under the sustainable scenarios for No Further Development and Population Buildout.

5.7.2 Chloride Trends

Table 5-8 presents the assimilative capacity of chloride used by the No Further Development and the Population Buildout scenarios in the antidegradation analysis. Positive values of assimilative capacity use (in red) indicate a reduction in Basin assimilative capacity, while negative values of use (in blue and bold) indicate a gain, or improvement, in capacity.

Table 5-8. Chloride Antidegradation Analysis - Los Osos Groundwater Basin[1]

Mass Mixing Cell	Assimilative Capacity [mg/L]	Assimilative Capacity Used (+lost -gained)							
		No Further Development[2]				Population Buildout[3]			
		10 Years		25 Years		10 Years		25 Years	
		mg/L	%	mg/L	%	mg/L	%	mg/L	%
Perched Aquifer	157	-19.5	**-12.4**	-23.6	**-15.0**	-12.8	-8.1	**-14.9**	**-9.5**
Upper Aquifer	162	-1.4	**-0.8**	-3.8	**-2.4**	0.4	0.3	0.6	0.4
Lower Aquifer-Western and Central Area	171	1.4	0.8	3.2	1.9	1.4	0.8	4.3	2.5
Lower Aquifer and Alluvial Aquifer - Eastern Area	175	1.7	1.0	2.8	1.6	10.8	6.2	20.4	11.6
BASIN TOTAL	**169**	0.1	0.1	0.6	0.4	2.1	1.2	5.2	3.1

Source: CHG, 2017
Notes:
[1] Data tables with sample calculations in Appendix E, Tables E3 and E5.
[2] No Further Development scenario - includes the operation of the LOWRF and implementation of projects/programs by various entities.
[3] Population Buildout scenario - population size increases to buildout, the operation of the LOWRF project, and the implementation of project/programs from the No Further Development scenario and additional projects/programs by various entities.

Gains of up to 15 percent assimilative capacity are achieved for chloride in the Perched and Upper Aquifer for No Further Development scenario at 25 years, due primarily to the collection, treatment and redistribution of septic discharges within the prohibition zone. Use of up to 11.6 percent of the assimilative capacity for chloride, corresponding to 20.4 mg/L, is projected in the Eastern Area for the Population Buildout scenario after 25 years. As with the TDS increase in the Eastern Area, a net increase in chloride is projected due to the use of recycled water in place of groundwater for irrigation. The weighted average use of assimilative capacity of chloride in the Basin is 0.4 percent for the No Further Development and 3.1 percent for the Population Buildout scenarios at 25 years.

Figure 5-4 shows the Basin average trends in chloride concentrations under the No Further Development and Population Buildout scenarios. Trends in chloride for individual mixing cells are included in

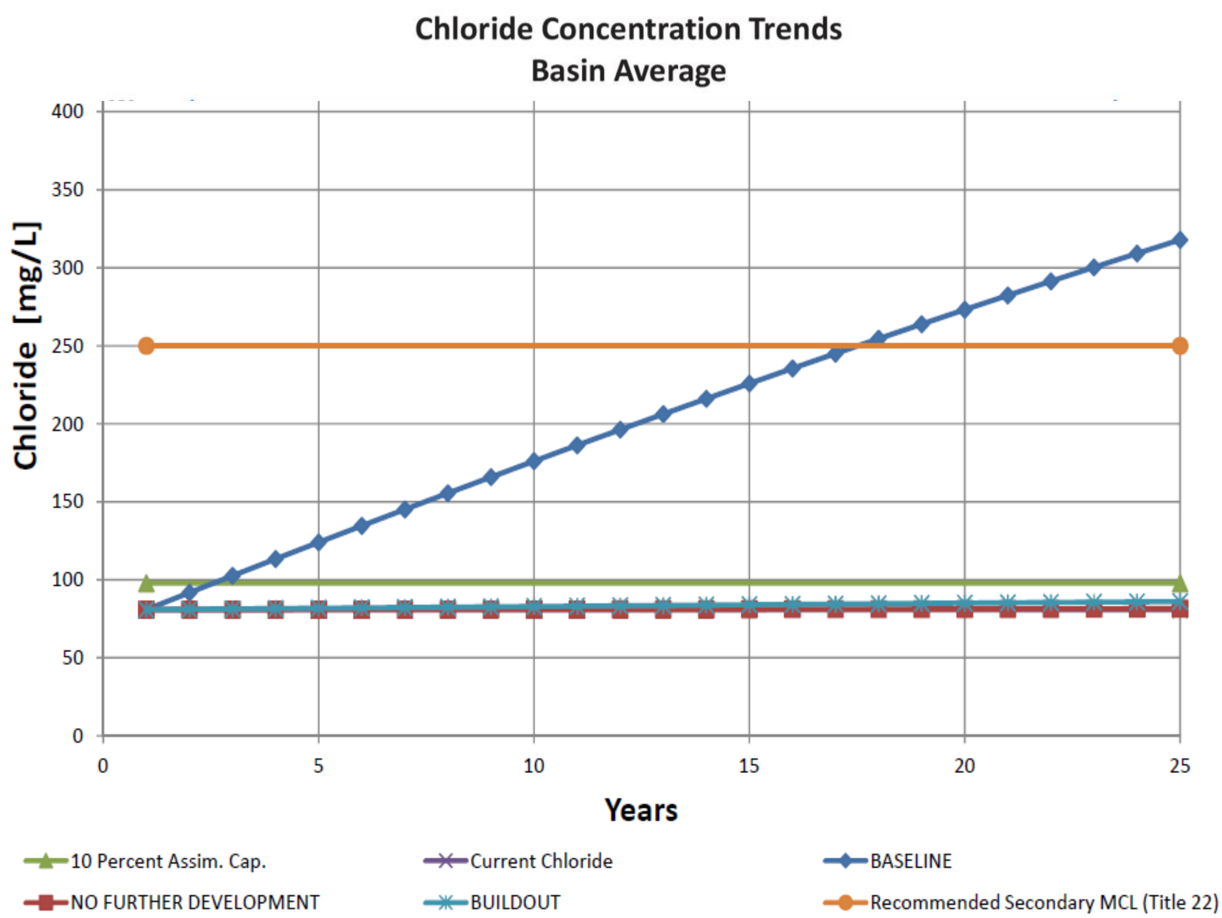


Figure 5-4

Basin Average Chloride ConcentrationTrends

Los Osos Groundwater Basin Assimilation Capacity and Antidegradation Analysis
County of San Luis Obispo

Cleath-Harris Geologists

Source: CHG, 2017

Appendix F (Figures F6 through F10). The Baseline scenario water quality trend is also included in Appendix F for chloride trends comparison. As with the TDS Baseline trend, seawater intrusion, along with continued septic tank discharges, results in a much greater level of water quality degradation under the 2012 Baseline (pre-LOWRF) conditions than under the sustainable No Further Development and Population Buildout scenarios.

5.7.3 NO_3-N Trends

Table 5-9 presents the assimilative capacity of nitrate as nitrogen used by the No Further Development and the Population Buildout scenarios in the antidegradation analysis. Positive values of assimilative capacity use (in red) indicate a reduction in Basin assimilative capacity, while negative values of use (in blue and bold) indicate a gain, or improvement, in capacity.

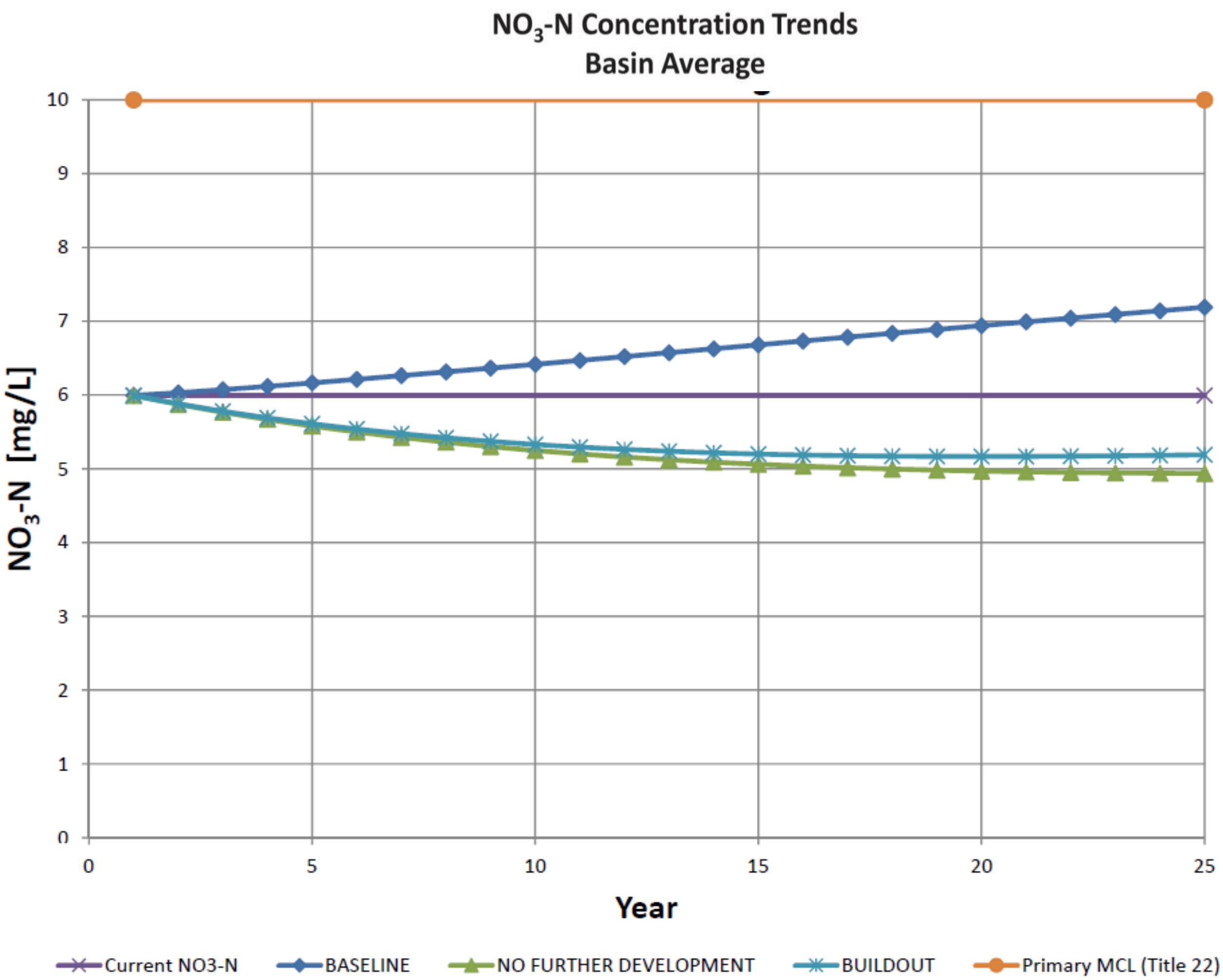
Table 5-9. NO_3-N Antidegradation Analysis - Los Osos Groundwater Basin[1]

Mass Mixing Cell	Assimilative Capacity [mg/L]	Assimilative Capacity Used (+lost -gained)							
		No Further Development[2]				Population Buildout[3]			
		10 Years		25 Years		10 Years		25 Years	
		mg/L	%	mg/L	%	mg/L	%	mg/L	%
Perched Aquifer	-5	-7.9	**-159**	-9.6	**-192**	-7.5	**-151**	-9.1	**-182**
Upper Aquifer	-5	-5.1	**-101**	-8.5	**-170**	-5.0	**-99.5**	-8.2	**-165**
Lower Aquifer-Western and Central Area	8	1.0	12.3	1.8	22.6	1.0	12.0	1.9	24.0
Lower Aquifer and Alluvial Aquifer - Eastern Area	4	0.7	16.3	0.9	23.1	1.1	26.3	1.6	40.5
BASIN TOTAL	**4**	-0.7	**-18.7**	-1.1	**-26.5**	-0.6	**-15.4**	-0.8	**-20.5**

Source: CHG, 2017
Notes:
[1] Data tables with sample calculations in Appendix E, Tables E3 and E5.
[2] No Further Development scenario - includes the operation of the LOWRF and implementation of projects/programs by various entities.
[3] Population Buildout scenario - population size increases to buildout, the operation of the LOWRF project, and the implementation of project/programs from the No Further Development scenario and additional projects/programs by various entities.

Gains of up to 192 percent assimilative capacity (from negative effective capacity to positive capacity) are achieved for nitrate as nitrogen in the Perched and Upper Aquifer at 25 years of the No Further Development scenario, due primarily to the collection, treatment and redistribution of septic discharges within the prohibition zone. Use of up to 41 percent of the assimilative capacity for nitrate as nitrogen, corresponding to 1.6 mg/L, is projected in the Eastern Area for the Population Buildout scenario at 25 years. Unlike TDS and chloride increases in the Eastern Area, the net increase in nitrate as nitrogen is not due to the use of recycled water in place of groundwater for irrigation (both have similar nitrate as nitrogen concentrations), but from on-going nitrogen loading, primarily from fertilizer applications. The nitrate as nitrogen concentrations in the Western and Central Area Lower Aquifer also increase under the 2012 Baseline, the No Further Development, and the Population Buildout scenarios, primarily due to the low initial concentration in the lower aquifer, which, over time, moves closer toward the average Basin nitrate as nitrogen concentration. The weighted average use of assimilative capacity of nitrate as nitrogen in the Basin is a 26.5 percent gain in assimilative capacity.

Figure 5-5 shows the Basin average trends in nitrate as nitrogen concentrations for the for No Further



Source: CHG, 2017

Figure 5-5

Basin Average NO_3-N Concentration Trends

Los Osos Groundwater Basin Assimilation Capacity and Antidegradation Analysis
County of San Luis Obispo

Cleath-Harris Geologists

Development and Population Buildout. Trends in nitrate as nitrogen for individual mixing cells are included in Appendix F (Figures F11 through F15). The Baseline water quality trend is also included in Appendix F for nitrate as nitrogen trend comparison. Continued septic tank discharges would result in a much greater level of water quality degradation with respect to nitrate as nitrogen under the 2012 Baseline (pre-LOWRF) conditions than under the sustainable No Further Development and Population Buildout scenarios.

5.8 SUMMARY

The Recycled Water Policy requires assimilative capacity and antidegradation to be evaluated for basins and subbasins where recycled water is to be used. The compartments used herein for mixing cells are not subbasins, therefore, use of assimilative capacity and associated antidegradation thresholds has been evaluated using groundwater Basin average concentrations.

As stated by the Regional Water Board in the LOWRF WDR Order No. R3-2011-001: "*the discharge of recycled water will not cause further degradation of the groundwater as the upper groundwater aquifer is already polluted due to the continued us of onsite wastewater systems. The effluent limitations of the permits are more stringent than the applicable water quality objectives from the Central Coast Basin Plan and will eventually result in improving the quality of the groundwater.*" Results of the antidegradation analysis indicates LOWRF operation over a 25-year period with No Further Development scenario uses less than 2 percent of the assimilative capacity of the Basin for TDS and chloride, while providing a net gain in Basin assimilative capacity for nitrate as nitrogen. LOWRF operation over a 25-year period with Population Buildout scenario uses less than 4 percent of the assimilative capacity of the Basin for TDS and chloride, while providing a net gain in Basin assimilative capacity for nitrate as nitrogen. These results show compliance with antidegradation criteria for recycled water projects established by the State Water Board (SWRCB, 2009). Table 5-10 summarizes the antidegradation analysis from Tables 5-7, 5-8, and 5-9.

Table 5-10. Basin Antidegradation Analysis - Los Osos Valley Groundwater Basin

Constituent	Assimilative Capacity [mg/L]	Assimilative Capacity Used (+lost -gained)							
		No Further Development[1]				Population Buildout[2]			
		10 Years		25 Years		10 Years		25 Years	
		mg/L	%	mg/L	%	mg/L	%	mg/L	%
TDS	560	1.7	0.3	7.0	1.3	7.8	1.4	20.7	3.7
Chloride	169	0.1	0.1	0.6	0.4	2.1	1.2	5.2	3.1
NO_3-N	4	-0.7	**-18.7**	-1.1	**-26.5**	-0.6	**-15.4**	-0.8	**-20.1**

Source: CHG, 2017
Notes:
[1] No Further Development scenario - includes the operation of the LOWRF and implementation of projects/programs by various entities.
[2] Population Buildout scenario - population size increases to buildout, the operation of the LOWRF project, and the implementation of project/programs from the No Further Development scenario and additional projects/programs by various entities.

Results for assimilative capacity use within mixing cells vary and can exceed 20 percent for nitrate as nitrogen in the Eastern Area and Lower Aquifer (Table 5-9). As previously mentioned, continued septic tank discharges would result in a much greater level of water quality degradation with respect to nitrate as nitrogen under the 2012 Baseline (pre-LOWRF) conditions than under the sustainable No Further Development and Population Buildout scenarios.

The antidegradation analysis for TDS, chloride, and nitrates demonstrated that the LOWRF Project satisfied the policy requirements for the State Water Board's Resolution No. 68-16. Results show that the operations of the LOWRF, removal of septic systems in the wastewater service area, and programs implemented (e.g., water conservation) from the LOBP will improve groundwater quality over time with respect to nitrates. Also, with the operation of the LOWRF, pumping is reduced in the Basin due to the in lieu use of recycled water used for irrigation. Reduced pumping could infer a greater groundwater pressure head with the potential to reduce seawater intrusion in the Basin.

The completion of the assimilative capacity and antidegradation analyses is a critical step toward meeting the requirements of the Recycled Water Policy. Results from these analyses indicate that the overall groundwater quality baseline would have continued to degrade (over the 25 year planning horizon) without the construction and operation of the LOWRF and removal of septic systems within the wastewater service area.

Chapter 6 SNMP GOALS AND OBJECTIVES

This chapter documents the identified groundwater Basin management goals and objectives that will aid in managing salt and nutrient loading to groundwater. The Los Osos SNMP technical analyses indicate that the overall groundwater quality baseline will continue to degrade (over the 25 years planning horizon) without the operation of the LOWRF and removal of septic systems within the wastewater service area. Basin management practices and recycled water reuse with the associated recycled water regulatory requirements (such as the LOWRF WDR Order and California Coastal Commission Recycled Water Management Plan) will support in maintaining sustainable groundwater quality for the Basin. No new implementation measures or best management practices (BMPs) are therefore recommended as part of this SNMP process, except for the Quality Assurance Project Plan (QAPP) in Appendix G. The QAPP is intended to establish best management practices related to quality assurance and quality control for collecting and analyzing groundwater samples.

When plans or BMPs are developed in the future they will be incorporated into the Los Osos SNMP as part of the adaptive management strategies, as discussed in Chapter 7. One future anticipated document being prepared pursuant the LOWRF WDR Order is the countywide Onsite Wastewater Treatment Systems (OWTS) Local Agency Management Program (LAMP), which will outline the management of the septic systems outside the wastewater service area in the Basin (CCRWQCB, 2011a). The LAMP goals and objectives will be incorporated into the Los Osos SNMP Monitoring Program, as appropriate, once it is approved by the Regional Water Board.

Mission Statement

The following governing mission statement for the Los Osos Wastewater Project was developed to guide the overall County effort:

> *To evaluate and develop a wastewater treatment system for Los Osos, in cooperation with the community water purveyors, to solve the Level III water resource shortage and groundwater pollution, in an environmentally sustainable and cost effective manner, while respecting community preferences and promoting participatory government, and addressing individual affordability challenges to the greatest extent possible.*

6.1 BASIN MANAGEMENT GOALS AND OBJECTIVES

Basin management goals and objectives were identified, developed and vetted during the development of the Los Osos Basin Plan (LOBP) and updated in the LOBP Annual Groundwater Monitoring Reports. The primary Basin goals are to halt seawater intrusion into the Basin and to provide sustainable water supplies for existing and future residential, commercial, institutional, recreational and agricultural development within Los Osos. Immediate Basin goals are designed to balance supplies and demands in the Basin by focusing on maintaining and improving groundwater levels and groundwater quality. On-going Basin goals to help achieve sustainable water include:

- Water conservation goals and mandatory standards and policies that promote water use efficiency.
- Updating the hydrologic assessment of the Basin, its water resources and sustainable yield.
- Water resource accounting which can meet the information needs for planning, monitoring, environmental management, utility operations, land development and agricultural operations.
- Establish a strategy for maximizing the reasonable and beneficial reuse of Basin water resources.
- Sustainable water supplies for future development within Los Osos, consistent with local land use planning policies.
- Water conservation goals and strategies to promote water use efficiency and innovation for agricultural water users, including use of recycled water.
- Clarifying the risk arising from future changes in the availability of groundwater for extraction.

- Allocating costs equitably among all who benefit from the Basin's water resources.
- Protecting water quality in the Basin.
- Protecting environmentally sensitive areas within the Basin or influenced by Basin hydrology.
- Developing strategies to maximize grant and other funding and financing opportunities for ongoing Basin Plan implementation.

These Basin management goals and objectives will be further developed and revised in the future as groundwater management efforts are completed by the Los Osos BMC. The County will update and reference the Los Osos BMC goals and objectives in their SNMP Monitoring Report, to be discussed in Chapter 8.

6.1.1 Groundwater Management Metrics Goals

The LOBP established metric goals to measure nitrate impacts to the Upper Aquifer, seawater intrusion into the Lower Aquifer, and the effect of management efforts to the BMC. These metrics allow the BMC, regulatory agencies and the public to evaluate the status of nitrate levels, seawater intrusion, and the impact of implementation of the LOBP programs in the Basin through objective, numerical criteria that can be tracked overtime. The implementation of the metrics is discussed in Chapter 7. The constituents evaluated by the LOBP metrics are similar to the indicator constituents used in this SNMP[1].

6.1.2 Water Management Principles - *General Principles*

Basin groundwater management involves balancing sets of economic, environmental and social interests. The LOBP states that sustainable use of the Basin means:

- Groundwater will be available to meet all reasonable, beneficial water demands within the Basin Plan Area;
- Groundwater elevations will remain sufficiently high to prevent seawater intrusion, land subsidence or other negative impacts of falling groundwater levels;
- Groundwater quality will be protected for use as a source of drinking water with reasonable treatment;
- Groundwater levels and quality will support or enhance groundwater dependent ecosystems in the Basin based on existing conditions as of adoption of the LOBP;
- Groundwater resources are managed for the long term, considering climatic and hydrologic variability and potential change as well as limits to human understanding of the Basin; and
- Water supplies and demands of the Basin will be managed to avoid the need for imported water supplies in the Plan Area, to the extent possible.

6.2 RECYCLED WATER AND STORMWATER GOALS

Collectively, the existing programs discussed in the LOBP are designed to achieve or support the goals discussed below.

6.2.1 Recycled Water Goals

Recycled water goals were developed through the Water Reinvestment Program in the LOBP. These goals were coordinated with the County's development of the LOWRF project. Wastewater will be collected and treated by the LOWRF for irrigation reuse. Actions to be taken under current conditions are known as the Urban Water Reinvestment Program (described below), while additional water may be delivered to agricultural users in the future under the Agricultural Water Reinvestment Program.

The County is delivering recycled water directly to the Broderson and Bayridge Estates leach fields (disposal sites) and will deliver recycled water to irrigation areas in 2018. Terms and conditions regarding

[1] TDS is not evaluated as a metric in the LOBP.

the irrigation with recycled water will be negotiated between the County and each user. Purveyors will deliver recycled water to users within their respective service areas based on permit and code requirements, pursuant to an agreement between the County and each Purveyor.

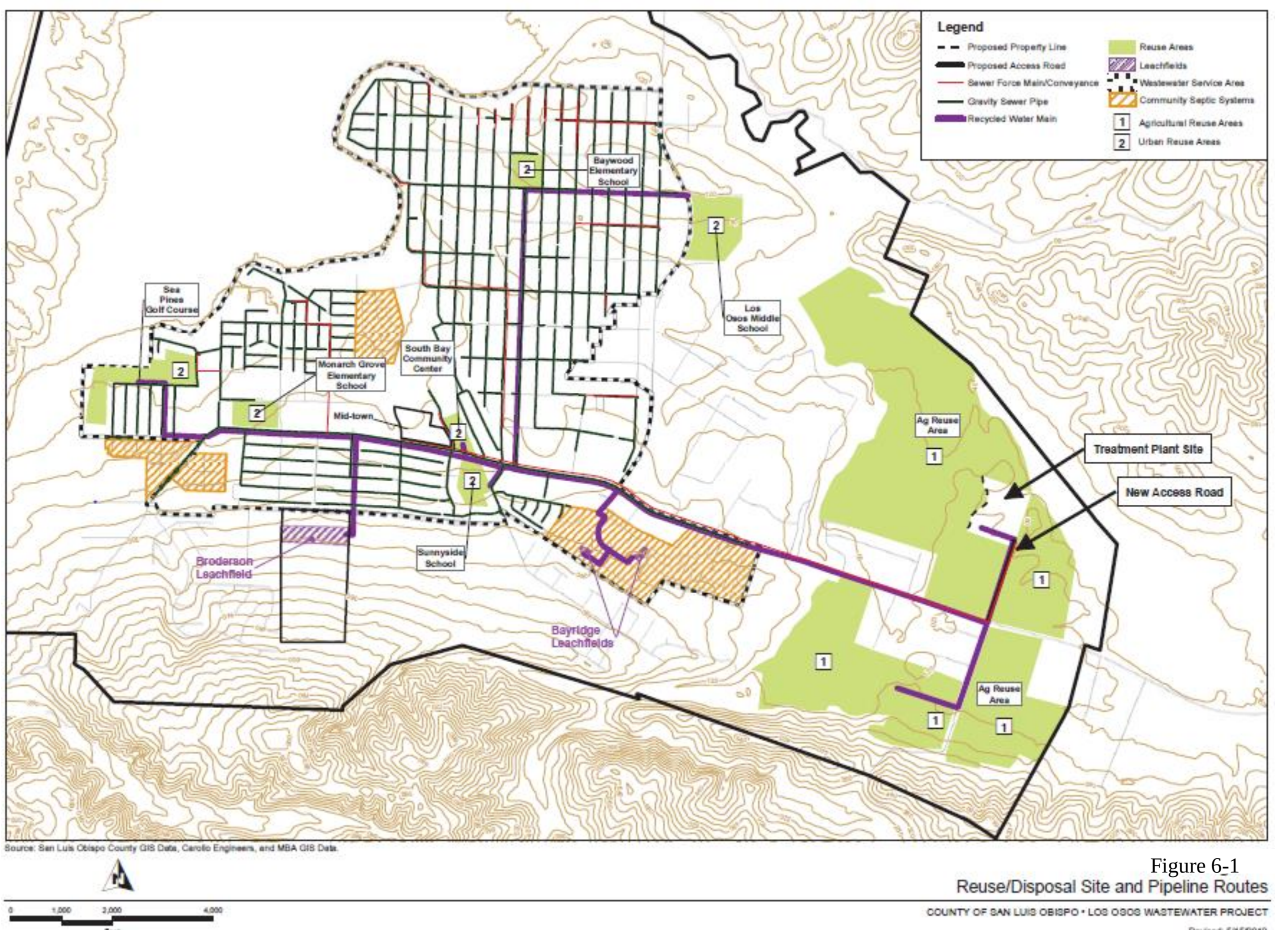
6.2.1.1 Urban Water Reinvestment Program

The Urban Water Reinvestment Program will accomplish the LOBP's goal of reinvesting all water collected and treated by the LOWRF in the Basin through reuse. Water treated by the LOWRF will be of a sufficient quality (tertiary treated) for beneficial reuse at permitted locations for landscape or agricultural irrigation purposes. Urban reuses will include park and school irrigation, along with other approve public landscape irrigation, see Figure 6-1.

6.2.1.2 Agricultural Water Reinvestment Program

The Agricultural Water Reinvestment Program will prioritize agricultural reuse deliveries that create overall benefits to the Basin and mitigate seawater intrusion by reducing groundwater pumping from the Basin. Potential agricultural reuse sites are shown in Figure 6-1, labeled as "1," together with urban reuse site, labeled as "2." Recycled water use could replace or reduce groundwater use on existing farms to irrigate crops that are historically grown in the area.

Figure 6-1. Potential Urban and Agricultural Reuse Sites for Los Osos Basin



6.2.2 Stormwater Recharge Goals

Stormwater recharge goals for the Basin were developed using knowledge of the Basin's hydrogeologic characteristics and current stormwater management strategies. In 1997, the County of San Luis Obispo prepared a Preliminary Engineering Evaluation, Los Osos/Baywood Park Community Drainage Project Report. This preliminary engineering report identified, evaluated and recommended solutions, and ranked drainage problem areas within the community. The report included identification of BMPs and low impact development (LID) projects that could help manage stormwater runoff. Other potential projects include bioretention swales, infiltrators, and underground perforated pipes to aid with stormwater runoff and puddling. Stormwater management goals include maximizing the onsite runoff and infiltration through LID techniques and implementation of the Regional Water Board Post-Construction Runoff Control Requirements. Additional stormwater goals and BMPs are anticipated to be developed in the future once the Stormwater Resource Plan is completed in 2018.

Implementing Stormwater BMPs is an essential component in reducing stormwater pollutants in receiving waters to the maximum extent practicable (MEP). The Wasteload Allocation Attainment Plan (WAAP) was revised in 2012 to identify additional BMPs and address Total Maximum Daily Loads (TMDLs) in the Morro Bay Watershed and unincorporated County areas. The plan was developed to comply with the National Pollutant Discharge Elimination System (NPDES) Phase II for Small Municipal Separate Storm Sewer Systems (MS4) General Permit for watersheds (SWRCB, 2013). The WAAP addresses discharges from County MS4 Permit areas, which are typically urban developed land uses. Agriculture, grazing, and open space land uses are not within the County's jurisdictional control with respect to TMDL wasteload allocation attainment (Geosyntec Consultants, 2016). The County anticipates developing and implementing Minimum Control Measures, such as the following identified in the WAAP:

- Public Education and Outreach
- Public Participation and Involvement
- Illicit Discharge Detection and Elimination
- Construction Site Runoff Control
- Post-Construction Stormwater Management
- Pollution Prevention/Good Housekeeping for Municipal Operations (Geosyntec Consultants, 2016)

Although specific stormwater capture and reuse goals have not been developed for large-scale projects, post-construction runoff control requirements provide guidelines for BMPs. Various LID and stormwater BMPs are currently applied in the Basin but not included in this SNMP groundwater quality analyses due to uncertainties in projected quantity and stormwater recharge volumes. By not including these non-quantified stormwater volumes, a conservative estimate of groundwater quality is provided, as stormwater supplemented to the Basin would likely decrease concentrations of TDS, chloride, and nitrate.

6.3 OTHER BASIN GOALS

Other Basin goals include the Urban Water Use Efficiency Program and Wellhead Protection Program, both of which are described below.

6.3.1 Urban Water Use Efficiency Program Goal

The goal of the Urban Water Use Efficiency Program in the LOBP is to limit urban water use in Los Osos to 1,450 AFY for the current population and 2,100 AFY at buildout. Achieving that goal should make Los Osos one of the most water-efficient communities in California, exceeding the standards of the California Urban Water Conservation Council, the State's *20 x 2020 Water Conservation Plan*, and the California Green Building Standards Code.

6.3.2 Wellhead Protection Program Goal

The goal of the Wellhead Protection Program in the LOBP is to protect water quality in the Basin by managing activities within a delineated source area or protection zone around drinking water wells.

6.4 FUTURE BASIN GOALS

Future goals will be incorporated into the Los Osos SNMP Monitoring Program as part of the adaptive management program, discussed in Chapter 7. One future anticipated document being prepared by the County Planning Department is the countywide OWTS LAMP, which incorporates management of the septic systems outside the wastewater service area in the Basin (CCRWQCB, 2011a).

Chapter 7 IMPLEMENTATION MEASURES

Implementation measures associated with the goals and objectives in Chapter 6 will aid in managing salt and nutrient loading to groundwater. Existing groundwater quality best management practices (BMPs) or measures already in place will continue. Measures for the LOWRF permit are being implemented to allow for beneficial reuse of recycled water. New implementation measures or BMPs developed in the future will be incorporated into the Los Osos SNMP, as appropriate, as part of the adaptive management strategies in this Chapter. One future anticipated document being prepared pursuant the LOWRF WDR Order is the Onsite Wastewater Treatment Systems (OWTS) Local Agency Management Program (LAMP) for management of the septic systems outside the wastewater service area in the Basin (CCRWQB, 2011a). The OWTS LAMP will be incorporated into the Los Osos SNMP Monitoring Program once it is approved by the Regional Water Board.

7.1 MANAGEMENT STRATEGIES

The Los Osos SNMP technical analyses indicated that the overall groundwater quality baseline will continue to degrade (over the 25 years planning horizon) without the construction and operation of the LOWRF. The operation of the LOWRF is the critical first-step towards long-term sustainable integrated water management benefits. The implementation measures and management strategies for this SNMP, as described below, include adaptive Basin management. Adaptive management strategies will allow flexibility to respond to changing conditions in the Basin. Those strategies selected for implementation in the groundwater Basin are described below.

Management strategies are based on three Basin scenarios (over the 25 years planning horizon) discussed below and in Chapter 5.

- 2012 Baseline scenario (pre-construction LOWRF) - Groundwater quality will continue to degrade with the increase concentration of nitrates from the continued use of septic systems and no recycled water treatment facility constructed. Nitrates concentrations and seawater intrusion would increase in the Basin. As discussed in Chapter 1, the 1988 discharge moratorium by the State Water Board was established for a portion of the Los Osos community area known as the “Prohibition Zone” would remain. The moratorium prohibited discharge from additional individual and community sewage disposal systems, the moratorium effectively halted new construction or major expansions of existing development until the water pollution problem was dealt with. However, in 2016 the LOWRF was constructed and Basin management programs are in place by the Los Osos BMC to support sustainable water and help resolve Basin water issues.
- No Further Development scenario– The septic systems in the “Prohibition Zone” are removed and recycled water treatment facility is built. Nitrates concentrations and seawater intrusion will decrease over time, but the “Prohibition Zone” remains (over the 25 years planning horizon) until the Coastal Commission and the County Environmental Coordinator are satisfied with Basin conditions and removes the restriction.
- Population Buildout scenario – The Population Buildout results are similar to the No Further Development results, except the restrictions on new development are removed by the Coastal Commission and the County Environmental Coordinator.

7.1.1 LOWRF - Implementation and Management Strategies

Adaptive management strategies will be implemented for the LOWRF to prevent degradation in groundwater quality in the Basin with recycled water beneficial reuse. The operation of the LOWRF will provide significant benefits to the Basin through the irrigation with recycled water, reduced groundwater pumping, and the removal of septic systems and associated salt and nutrient loadings to the Upper Aquifer system. Recycled water quality for irrigation and land disposal will meet the LOWRF WDR Order requirements for Title 22 standards for disinfected tertiary-treated effluent.

From the technical analyses discussed in Chapter 5, the No Further Development and Population Buildout scenarios shows that the Basin water quality averages for nitrate, chloride, and TDS concentrations are below the 10 percent assimilated capacity analysis meet the antidegradation analysis requirements. Both sustainable scenarios show that the operation of the LOWRF with recycled water reuse is beneficial to the Basin. The antidegradation analyses indicates that the operation of the LOWRF will improve groundwater quality over time. A monitoring program from the LOWRF permit will ensure that potential future use and Basin groundwater quality are protected. This monitoring program, in parallel with that of the LOBP, will protect the Basin by tracking groundwater elevation and water quality changes.

The Los Osos SNMP technical analyses for all three scenarios (2012 Baseline, No Further Development, and Population Buildout conditions) shows a slight increase in nitrate as nitrogen concentration over the 25 years planning horizon in the Lower Aquifer in the Eastern Area (from 6 mg/L to 7.8 mg/L) and Western Area (from 2 mg/L to 5 mg/L), as shown in Appendix F Figures F14 and F15. Nitrate results are below the LOBP Nitrate Metric of 10 mg/L and the Title 22 LOWRF permit requirements of 10 mg/L for daily maximum. There is a slight increase in the nitrate trend lines in the Eastern Area due to on-going nitrogen loading, primarily from fertilizer applications. The Western Area shows a slight nitrate increase primarily due to the low initial concentration in the Lower Aquifer (2 mg/L), which, over time, moves closer toward the average Basin nitrate as nitrogen concentration. Although there is a small increase in nitrates in the Western and Eastern Area with the operation of the LOWRF, the 2012 Baseline results (the continuation of septic tank discharges and no construction of the water recycling facility) shows nitrate concentrations continuing to increase and degrade water quality, as shown in Appendix F Figures.

Los Osos SNMP - Adaptive Management

The Los Osos SNMP will use the LOBP approach for adaptive management (discussed in Section 7.1.2.1), while utilizing their LOBP annual report data and the LOWRF monitoring data to develop the best available implementation measures, if necessary. The adaptive management approach will allow for modifications of this SNMP over time in response to project monitoring to protect groundwater resources. For example, if the observed nitrate levels in groundwater are trending higher than expected in the Western or Eastern Area of the Lower Aquifer, a nitrate adaptive management strategy could include alternating recycled water reuse and disposal between irrigation and leach fields areas in the Basin. Other implemented or potential implementation measures are summarized in Tables 7-1 through 7-3. Table 7-1 includes measures associated with the community water supply. Table 7-2 includes measures associated with Basin recharge. Table 7-3 includes measures associated with wastewater and reclaimed water quality.

Table 7-1. Implementation Measures - Water Supply

Status	Specific Measure	Description	Effect
In Progress[1]	Improve Community Water Use Efficiency	Continued measures to improve community water efficiency as technology and money are available	Reduces pumping induced seawater intrusion
Potential future measure	Softening of Groundwater Supplies	Advanced treatment to soften community water supplies	Reduces need for self-regenerating water softeners. Fewer self-regenerating water softeners will reduce the salt load in residential wastewater stream

Source: CHG, 2017
Note 1: LOBP Urban Water Use Efficiency Program

Table 7-2. Implementation Measures - Recharge/Return Flow

Status	Specific Measure	Description	Effect
Potential future measure	Expand LOWRF Collection Area	Expand LOWRF connections to septic systems within Basin but outside current collection area	Reduces nitrate loading from septic discharges
In Progress[1]	Evaluate/Adopt Recharge Projects using Recycled Water	Evaluate/optimize discharge to improve efficiency at reducing/reversing seawater intrusion	Increases freshwater head to limit seawater intrusion by reducing pumping in the Lower Aquifer
In Progress[2]	Improve Stormwater Capture	Identify and consider new projects for additional capture/infiltration of stormwater	Increases recharge of low salt/nutrient concentration water
In Progress[3]	Agricultural Grower Education and Outreach	Optimize fertilization/irrigation techniques to minimize nitrate loading and improve irrigation efficiency	Reduce fertilizer use (nitrate loading), reduce water use and associated concentration of salts in soil
In Progress[4]	Improve Domestic Irrigation Efficiency	Outreach/incentives to use native plants and/or xeroscapes in landscaping	Reduces salt and nutrient loading and salt concentration in domestic irrigation return

Source: CHG, 2017
Notes:
[1] Broderson disposal site completed, discharge to Los Osos Creek being evaluated
[2] Septic tank repurposing program in progress
[3] Regional Board Irrigated Lands Regulatory Program
[4] LOBP Urban Water Use Efficiency Program

Table 7-3. Implementation Measures - Wastewater

Status	Specific Measure	Description	Effect
Potential future measure	Source Control-Chloride	Education/outreach/regulation to reduce the number of self-regenerating water softeners	Fewer self-regenerating water softeners will reduce the salt load in residential wastewater
Potential future measure	Regulatory	Ordinance regulating or banning discharge of saltwater or brine from commercial or industrial activities	Reduces salt loading in wastewater stream
Potential future measure	Regulatory	Ordinance limiting or banning self-regenerating water softeners from discharging to the sanitary sewer	Reduces salt loading in wastewater stream

Source: CHG, 2017

7.1.1.1 SNMP Performance Measures and Evaluation

Performance measures were developed to evaluate the effectiveness of the proposed implementation measures to manage salt and/or nutrient loading to the groundwater Basin. These performance measures include the Los Osos SNMP Monitoring Program (Chapter 8); specifically, the collection, analysis, and reporting of SNMP-related data in groundwater throughout the Basin. To further assess indicator constituents in groundwater, the BMC's annual monitoring report will provide metric figures depicting chloride and nitrate concentrations and a TDS figure will be developed by the County. The Los Osos SNMP will have a discussion of salt and nutrient concentrations/trends in groundwater with respect to water quality objectives established in the LOBP and LOWRF WDR Order. The water quality objectives were developed to assess overall groundwater quality in the Basin. Thus, both the County's LOWRF permit requires a monitoring and reporting program and the Los Osos BMC annual report will provide the means for assessing and reporting on salt and nutrient concentrations in groundwater and an ongoing evaluation of the effectiveness of the existing and potential measures specified in the Los Osos SNMP.

7.1.2 BMC Groundwater Basin Management Implementation and Management Strategies

The Los Osos BMC set forth goals and objectives for Basin management, identified a governmental structure and process for stakeholder involvement, outlined a groundwater monitoring and data collection program, and presented recommendations for ensuring groundwater sustainability. It is anticipated that the BMC will continue to update the objectives and implementation status in their annual groundwater monitoring report, which will be reflected in the Los Osos SNMP Monitoring Report.

The Los Osos BMC has several implementation/management strategies described in detail in the LOBP and updated in their 2015 Annual Groundwater Monitoring Report. Each of these reports focuses on a different aspect of Basin management. The following summarizes several LOBP management strategies, including:

- Adaptive Management Program;
- Basin Metrics Implementation;
- Groundwater Monitoring Program;
- Urban Water Use Efficiency Program;
- Urban and Agricultural Water Reinvestment Program; and
- Wellhead Protection Program.

Other implementation/management strategies are discussed in the LOBP. Implementation of the LOBP Programs is expected to result in sustainable use of the Basin.

7.1.2.1 Adaptive Management Program

The Adaptive Management Program will provide a status update on the implementation of the LOBP Programs, assess the overall effectiveness of the LOBP, and offer a tool for modifying the LOBP programs to better meet overall LOBP objectives.

The Adaptive Management Program for the BMC includes:

- Evaluate the key metric trends of the groundwater Basin,
- Identify additional data needs,
- Report the data analysis to the various interested parties,
- Modify the LOBP programs and schedule, if necessary, in response to current conditions and observed trends in the groundwater Basin,
- Modify procedures to utilize current best management practices, and
- Modify pumping, treatment and/or reuse procedures if groundwater Basin trends are showing signs of degradation of water quality, including increased levels of contamination and/or increased levels of seawater intrusion.

Adaptive management is used to provide guidance on the overall effectiveness of the LOBP and supply a tool by which the programs can be modified to better meet the overall Basin objectives. Each program of the LOBP will contain an adaptive management analysis, including:

- Evaluation of recent changes made in prior years,
- Summary of recommendations and projected benefits,
- Project cost impact of program changes,
- Anticipated implementation schedule, and
- Documentation and public information.

Identified problem areas will be addressed through the adaptive management analysis to identify suitable actions. If water quality issues are observed in areas of the Basin, adaptive management strategies will be applied.

7.1.2.2 Basin Performance Measures and Evaluation

The LOBP established metrics to measure nitrate impacts in the Upper Aquifer, seawater intrusion into the Lower Aquifer, and the effect of management efforts. These metrics allow the Los Osos BMC, regulatory agencies, and the public to evaluate the status of nitrate levels and seawater intrusion, and the impacts of implementation of the LOBP programs in the Basin through objective, numerical criteria that can be tracked over time.

The 2015 groundwater monitoring results and quantification of the groundwater metric goals are summarized below and discussed in detail in the LOBP. The metric values evaluate the implementation of the LOBP programs.

Basin metrics set forth in the LOBP for implementation and 2015 results are as follows:

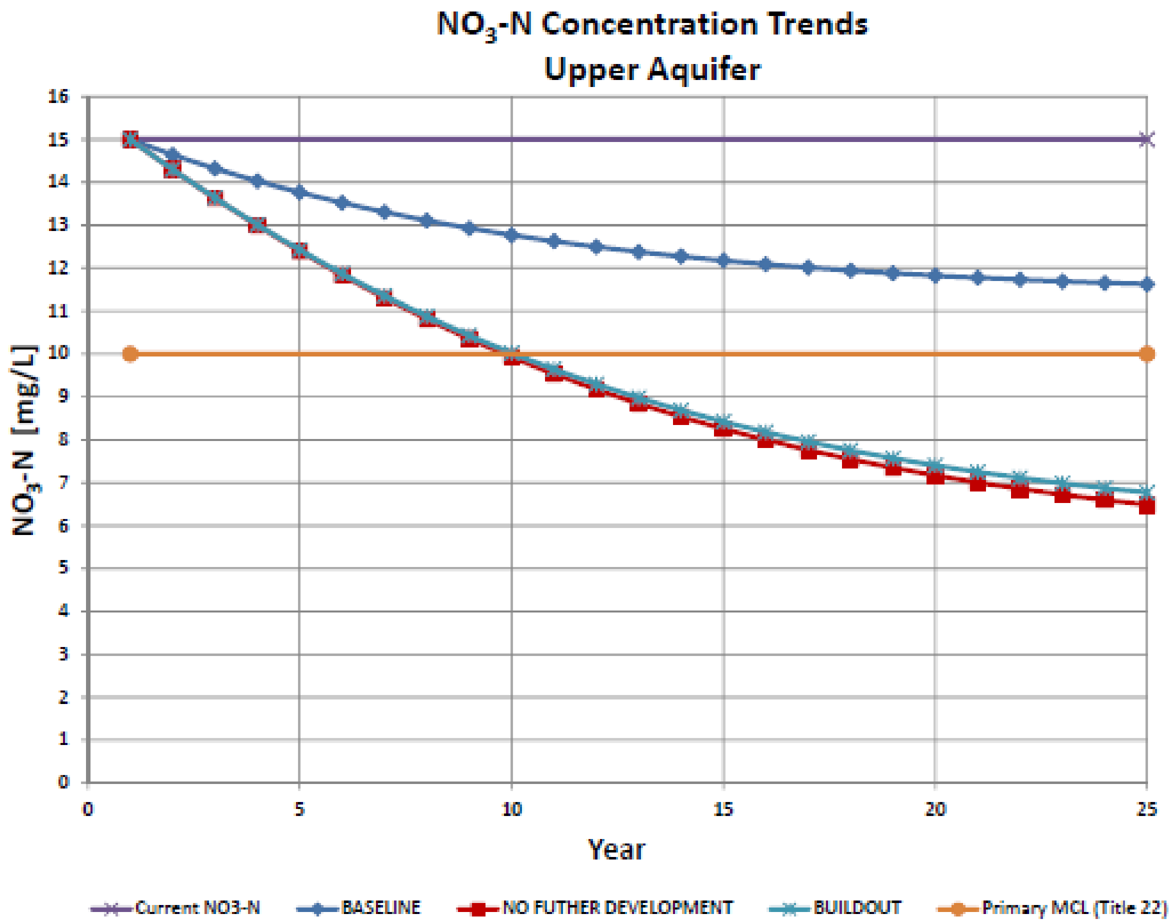
- **Nitrate Level Metric** - to reduce nitrates to below 10 mg/L. From the 2015 Annual Groundwater Monitoring Report, recommendations for improving the quality and availability of data include the following potential action, the addition of up to 12 existing wells to the Monitoring Program, the construction of two new monitoring wells, the development of a private well outreach program, and the performance of a sensitivity and error analysis for groundwater storage calculations. The results in the 2015 nitrate metric shows an increase of 8 mg/L from 2014 to 2015, indicating a lack of improvement. However, the Los Osos SNMP antidegradation analyses in the Upper Aquifer show nitrate levels below 10 mg/L at approximately 10 years based on the cessation of septic tank discharges with the operation of the LOWRF, see Figure 7-1 (CHG, 2017).

- **Water Level Metric** – to raise the groundwater elevation by 8 feet mean sea level (msl) in order to provide sufficient freshwater head to keep seawater out of the Western and Central Areas of the Basin. This water level metric was unchanged between Spring 2014 and Spring 2015, but current water elevations in these areas remain several feet below the target value, indicating a lack of improvement in 2015.

- **Chloride Level Metric** – to reduce the chloride concentration to 100 mg/L or below. Average groundwater chloride measurements in the 2015 Annual Groundwater Monitoring Report was 190 mg/L (spring) and 188 mg/L (fall). These 2015 data indicate a lack of improvement from the 2014 data.

The operation of the LOWRF and Basin management programs should improve the Basin water quality conditions over time.

Figure 7-1



Source: CHG, 2017

7.1.2.3 LOBP Groundwater Monitoring Program

The purpose of the LOBP Groundwater Monitoring Program is to collect and organize groundwater data on a regular basis for use in management of the Basin. Design of the LOBP Groundwater Monitoring Program is detailed in Chapter 7 of the LOBP. In order to allow evaluation of data for comparison with the above metrics with a higher degree of accuracy, the LOBP Groundwater Monitoring Program was implemented in 2014 and used previous Basin studies to support the metric calculations. The Groundwater Monitoring Program is designed to collect, organize, and report data regarding the health of the Basin from a current network of 73 wells. Twelve additional existing wells are recommended for the monitoring program.

In addition to facilitating the calculation of metrics, this data provides information needed to manage the Basin for long-term sustainability. The LOBP 2015 Annual Report represents the first monitoring event under the Groundwater Monitoring Program. The LOBP annual report will be utilized in the Los Osos SNMP Monitoring Report.

7.1.2.4 Urban Water Use Efficiency Program

In order to reduce annual groundwater production from the Basin, the LOBP recommends implementation of the Urban Water Use Efficiency Program. In October 2012, the San Luis Obispo County Board of Supervisors adopted a Water Conservation Implementation Plan (County Water Conservation Plan), the details of which are described in the LOBP. The County Water Conservation Plan limits indoor water use to no more than 50 gallons per person per day on average within the Basin. The water conservation program is designed to help Basin residents reduce their potable water use as much as possible through measures including, but not limited, to retrofit and installation of low water use fixtures and grey water systems.

The County Water Conservation Plan was implemented through the LOWRF beginning in October 2012. Under this program, all properties connecting to the sewer project (LOWRF) are required to be retrofitted to low water use fixtures, prior to lateral connections to the wastewater collection system. In 2018, it is anticipated that almost all properties within the wastewater service area will be connected to the sewer and all indoor water fixtures subject to the County Water Conservation Plan will be upgraded (retrofitted). In addition, Table 7-4 shows the total fixtures retrofitted and the total rebates provided as of May 2016.

Table 7-4. Summary of Conservation Rebates Provided through May 2016

Fixture	Total
Toilets	3,246
Showerheads	2,362
Faucet aerators	3,211
Clothes washers	101
Total Value of Provided Rebates	$907,270

Source: ISJ Group, 2015

7.1.2.5 Urban and Agricultural Water Reinvestment Program

The Water Reinvestment Program set forth in this chapter is divided into two parts. The first part, known as the Urban Water Reinvestment Program, is intended for beneficially reuse of all recycled water produced by the LOWRF under the No Further Development scenario. The second part, known as the Agricultural Water Reinvestment Program, is intended to use all marginal recycled water produced under the Buildout Population scenario. The urban reinvestment program for irrigation is anticipated to be in full operation in 2018.

The implementation of the Urban Water Reinvestment Program was recommended in the LOBP to increase the sustainable yield of the Basin (and thus reduce the Basin Yield Metric). The Water Reinvestment Program will accomplish the LOBP's goal of reinvesting all wastewater collected and treated by the LOWRF as beneficial reuse. Water treated by the LOWRF will be tertiary treated and meet Title 22 permit requirements for landscape or agricultural irrigation purposes at permitted locations, see Table 7-5. The LOWRF is expected to produce up to approximately 780 AFY under current conditions.

Table 7-5. Recycled Water Use in the Water Reinvestment Program (Source: ISJ Group, 2015)

Potential Use	Current Conditions (AFY)	Buildout (AFY)
Broderson Leach Fields Disposal	448	448
Bayridge Estates Leach Fields Disposal	33	33
Urban Reuse - Irrigation	63	63
Sea Pines Golf Course - Irrigation	40	40
Los Osos Valley Memorial Park - Irrigation	50	50
Agricultural Reuse - Irrigation	146	486
Total	**780**	**1,120**

For the Agricultural Water Reinvestment Program, the County will deliver recycled water on a strict priority basis to: (1) properties within the Basin that will offset existing pumping of the Basin by using recycled water; and (2) properties within the Basin that will use recycled water in addition to existing pumping of the Basin (ISJ Group, 2015). The County will not deliver recycled water to any properties located outside the Basin. Currently, up to four agricultural owners/growers have signed program participation agreements that were approved by the County Board of Supervisors in previous meetings. These properties provide an estimated 80 acres of agricultural land that will be potentially irrigated. No recycled water has been delivered to agricultural users to date. However, deliveries are anticipated to begin in summer 2018, pending issuance of the Recycled Water Permit by the Regional Water Board.

7.1.2.6 Basin Infrastructure Programs A and C

Implementation of the Basin Infrastructure Program is designed to reduce purveyor groundwater production from the Lower Aquifer in the Western Area and replace it with additional pumping from the Upper Aquifer and Central and Eastern Areas. This shift will also increase the Basin's sustainable yield, which in turn will help to drive down the Basin Yield Metric. The Basin Infrastructure Program A and C of the LOBP were recommended for immediate implementation.

- Program A consists of actions that have already been taken by the Basin purveyors or for which the purveyors have funding. Those actions are designed to allow the purveyors to increase groundwater production from the Upper Aquifer to the greatest extent practicable.
- Program C includes a set of infrastructure improvements that would allow the purveyors to shift some groundwater production within the Lower Aquifer from the Western Area to the Central Area of the Basin.

7.1.2.7 Wellhead Protection Program

The Wellhead Protection Program is designed to protect water quality in the Basin by managing activities within a delineated source area or protection zone around drinking water wells. This program consists primarily of the purveyors conducting Drinking Water Source Assessment and Protection surveys for each of their wells, as well as construction and operation of the LOWRF. The LOWRF will provide wellhead protection by removing septic-related nitrogen and microbiological mass loading from the Basin.

The BMC will identify specific actions to protect water quality in the Basin as deemed appropriate in the future, though no specific actions are recommended at this time.

7.1.3 Stormwater/Runoff Management

Multiple low impact development (LID) and stormwater BMPs were implemented in Los Osos for the LOWRF project. These practices approach stormwater management to improve pavement road conditions and drainage enhancements. Drainage projects included bioretention swales, infiltrators, and/or drainage medians implemented over fifteen different drainage sites. These stormwater and/or runoff management measures help manage flooding. Other measures and BMPs include septic tank repurposing for stormwater collection and implementing the Regional Water Board's Post-Construction Runoff Control Requirements, such as minimizing the compaction of highly permeable soils and limiting clearing and grading of native vegetation.

This chapter endorses these measures and encourages their continued implementation to promote stormwater infiltration into the groundwater Basin. Additional LID techniques may be implemented in the Basin on a site-specific basis.

Another plan is the Total Maximum Daily Load (TMDL) Wasteload Allocation Attainment Plan (WAAP) for Morro Bay, San Luis Obispo Creek, and Nipomo Watersheds includes additional BMPs to supplement current practices and reduce nutrient and bacteria loading in receiving waters. Implementation of fertilizer management will address nitrogen, phosphorous, and other pollutants associated with abundant use of fertilizers, as irrigation water and stormwater can transport these pollutants to downstream receiving waters. The WAAP recommends education and outreach to homeowners and landscape contractors to practice source reduction by minimizing the use of fertilizers, pesticides, and herbicides. Education and outreach efforts should also encourage conservative irrigation watering to prevent transport of pollutants to storm drains. Additionally, the WAAP suggests outreach efforts aimed toward golf course management to ensure water quality management plan compliance. The County's jurisdiction in the Morro Bay watershed includes Dairy Creek Golf Course and Sea Pines Golf Resort. Outreach efforts may focus on conserving water to the maximum extent practical (MEP) and the application of fertilizer, such as when rain is not immediately forecasted.

7.1.4 Best Management Practices

Water management BMPs include practices to conserve water, minimize waste, and protect groundwater quality. Urban BMPs include water conservation programs, water budgeting, potential ordinances and landscape irrigation BMPs.

7.1.5 Wastewater Salinity/Nutrient Source Control

Management of salts and nutrients in wastewater would aid in the protection of groundwater quality. Industrial wastewater source controls could include regulation of industrial and commercial discharges, source control program permits, inspection and monitoring of discharges, development of source control and pollution prevention requirements.

7.1.6 Source Water Salinity Control

Source water salinity control is a potential key for managing the concentrations of salts in the Basin. Managing salt loading to the Basin from urban areas could be obtained through the use of potential ordinances and/or education outreach. Potential programs could include regulating the use of self-regenerating water softeners and/or discharges of wastes with high salt concentrations, and through education programs to discourage the use of water softeners utilizing salts.

7.1.6.1 Water Softeners

Water with high concentrations of calcium and magnesium is referred to as 'hard water.' Hard water, which can clog pipes and reduce the lathering action of soaps, may be treated using a water softener that exchanges magnesium and calcium ions for sodium or potassium ions. In order for the water softener to function properly, the exchange resin must be periodically recharged using highly saline brine. The brine used in the regeneration process is discharged to municipal sewage systems or a septic leach field. Wide-spread use of water softeners has been known to significantly increase salinity levels in wastewater sent to water treatment facilities and in the subsequently produced recycled water. As of August 2014, more than 25 communities in the state have banned or greatly restricted the use of salt-based water softeners, and more are mulling the ban.

7.1.7 Public Education

Public education about groundwater issues is strong in the Los Osos community. San Luis Obispo County and the purveyors maintain websites and provide outreach to the public, such as meeting announcements, meeting material, and groundwater monitoring reports. The County's website provides access to published groundwater-related data, documents, and regular updates on groundwater management activities in the Basin.

7.1.8 Institutional

As previously discussed, the BMC and County have established a governance structure to develop solutions for the groundwater Basin and promote sustainable groundwater management. Furthermore, San Luis Obispo County Flood Control and Water Conservation District (District) currently acts as the designated monitoring entity for California Statewide Groundwater Elevation Monitoring (CASGEM)-required monitoring, and regulations are currently utilized to both promote onsite stormwater recharge for groundwater augmentation and to minimize the potential loading of salts and pollutants to the groundwater Basin. These measures, and other similar institutional controls, will continue to be used by governmental agencies to protect and sustain groundwater resources.

7.1.9 Recycled Water

The Los Osos SNMP is accomplished in a manner designed to maximize the Basin's long-term ground and surface water health and sustainability, including the offset of seawater intrusion as much as possible. The implementation of recycled water is regulated by the Title 22 of the California Code of Regulations. Numerous BMPs and operating procedures must be followed when using recycled water for irrigation to ensure safety. Several notable BMPs mentioned below will be implemented in recycled water operations:

- Water quality monitoring – Water quality is monitored at the treatment plant to ensure regulatory compliance with Title 22, and to demonstrate meeting of monitoring requirements for indicator emerging contaminants as part of the LOWRF WDR Order.
- Irrigation at agronomic rates at urban landscape areas– Irrigation is applied at a rate that does not exceed the demand of the plants and does not exceed the field capacity of the soil.
    - The maximum irrigation agronomic rates of nutrient loading for total nitrogen loading is 54.3 lbs/acre/year and the total TDS loading is 4,806 lbs/acre/year. The Title 22 engineer report (2013) estimated the amount of total irrigation for urban irrigation to be 30 in/year as opposed to the 34 in/year as the maximum total irrigation at an agronomic rate. Since some areas like the golf course and park may blend the recycled water with their onsite irrigation wells, this further supports that the amount of nutrient loading calculated would be below the maximum limit. The 2014 analysis did not include agriculture irrigation. (County of San Luis Obispo, 2014)
- Site Supervisor – A site supervisor who is responsible for the recycled water system and for providing surveillance at all times will be present to ensure compliance with regulations and permit requirements. The Site Supervisor is trained to understand recycled water and required supervision duties. In addition to monitoring the recycled water system, the Site Supervisor must also conduct an annual self-inspection of the system.
- Minimize runoff of recycled water from irrigation – Irrigation is not allowed to occur at any time when uncontrolled runoff may occur, such as during times of rainfall or very low evapotranspiration; any overspray must also be controlled.

7.1.9.1 Recycled Water - Coastal Commission Permit Conditions

The California Coastal Commission Permit Conditions (as described under the Coastal Development Permit [CDP]) for the LOWRF contains a number of conditions related to water resource management in the Basin, including reinvestment of recycled water. The CDP required the preparation of the Recycled Water Management Plan with four programs: Recycled Water Reuse Program, Water Conservation Program (discussed in Section 7.1.2.4), Monitoring Program for groundwater monitoring program and environmental monitoring program (discussed in Chapter 8), and Reporting and Adaptive Management Program. The groundwater monitoring program is necessary to determine compliance with the waste discharge requirements and ensure protection of the beneficial reuse of waters of the state and public health. This groundwater monitoring program for the CDP is the same report for the LOWRF WDR Order.

A few noted measures for the groundwater monitoring program are the effluent flows to each reuse/disposal component of the LOWRF will not be constant throughout the year. Recycled water demands from urban and agricultural reuse sites will be maximized during the irrigation season with peak reuse flows in the late summer. Agricultural reuse will only occur during the growing season, with peak flows in July. There will be little or no reuse between December and February. During this period, it is likely that most of the winter flows will be delivered to the leach field disposal sites at Broderson or Bayridge Estates or stored in ponds at the LOWRF, which can hold up to 50 AF of recycled water.

The Recycled Water Reuse Program shall ensure that all tertiary treated recycled water is disposed of in locations within the Basin that will maximize its ability to meet LOBP objectives. The highest priority for reuse shall be replacing existing potable water use with recycled water use where feasible and permitted, including both urban and agricultural reuse. Recycled water beneficial reuse is achieved through (a) developing and installing recycled water connections and entering into delivery/use agreements with urban and agricultural property owners as much as possible and permitted, and (b) developing and installing other recycled water delivery systems. Recycled water reuse will meet LOWRF permit conditions.

7.1.10 Stormwater Strategies

Flood control and storm water management within the Study Area is overseen by the District and the Department of Public Works. Over fifteen LID drainage sites (infiltrators) were implemented by the County associated with the LOWRF Project. These drainage sites were constructed to mitigate flooding and ponding from storm events. Additionally, a BMP for septic tank repurposing was implemented by residents in the Los Osos Community. These efforts will capture stormwater runoff which could be used to augment residential irrigation. With proper design, stormwater recharge can provide a high-quality inflow to the groundwater system that can help lower concentrations of nutrients and salts. The TMDL WAAP recommends additional fertilizer management aimed at homeowners, landscape contractors, and golf course managers to supplement current practices and reduce nutrient and bacteria loading in receiving waters (Geosyntec Consultants, 2016).

Stormwater goals and implementation measures to help augment Basin recharge were not developed as part of this SNMP effort. Stormwater projects in Los Osos could be advanced through the development of the Integrated Regional Water Management Plan (IRWMP) and the Stormwater Resource Plan which will be an attachment to the IRWMP. The County will also implement the Stormwater Management Program (SWMP) as required by the U.S. Environmental Protection Agency NPDES Phase II Final Rules in order to protect water quality in the Basin. These and related efforts are expected to result in additional development of stormwater capture projects. Future updates to stormwater project efforts will be discussed in Los Osos BMC meetings and updated in their annual groundwater monitoring report.

7.1.11 Salinity Management Strategies

Specific to salinity management, Los Osos BMC and LOWRF will continue to monitor salinity concentrations through analysis of groundwater samples. The monitoring results will be analyzed by looking for changes in regional trends. Should those trends begin to turn upward (demonstrating increasing concentrations), additional management strategies will be considered. Historic groundwater quality data from the past 50 years indicate that gradual increases in groundwater chlorides and TDS concentrations have both occurred within the Basin. The groundwater quality trend analyses presented in Chapter 5, projected that these gradual increases may continue under both existing and projected load conditions. Precipitation and recharge represents the only significant mechanism for removing salt from the Basin.

Additional monitoring, referenced in Chapter 8, in conjunction with ongoing stormwater compliance efforts will allow for better understanding of groundwater quality trends. Stormwater recharge, in particular, may beneficially influence groundwater quality, as stormwater recharge can provide a high-quality inflow to the groundwater system that can help lower concentrations of salts.

7.1.12 Nutrient Management Strategies

Specific to nutrient management, the BMC and LOWRF will continue to monitor nitrate concentrations through analysis of groundwater samples. The monitoring results will be analyzed by looking for changes in regional trends. If the nitrate concentration shows an upward trend (indicating increasing concentrations in groundwater), additional management strategies will be considered for recycled water. However, the removal of nutrients when applied as irrigation is not necessarily subject to the same accumulation over time due to nitrate uptake by plants.

The Baseline groundwater quality trend analysis in Chapter 5 shows an increase in nitrates in groundwater over time for the Upper Aquifer, if the removal of septic systems and operation of the LOWRF are not implemented. Septic systems are a significant source of nitrates to the groundwater system. The removal of the septic systems helps protect water quality at local supply wells. It is recognized that a centralized wastewater collection and treatment system provides the best method and flexibility to manage nitrate as nitrogen from wastewater.

To address the LOWRF WDR Order and Section VIII.D.3.g of the Central Coast Basin Plan, the County is preparing the Local Agency Management Programs (LAMP) for the Onsite Wastewater Treatment Systems (OWTS). In accordance with the LOWRF WDR Order and Central Coast Basin Plan, residences located outside of the wastewater service area will not be connected to the LOWRF and a wastewater management plan must be developed for this area. This will help support the water quality efforts for the Basin. The OWTS LAMP is a countywide document that will be reviewed and vetted to North and South County stakeholders, then submitted to the Regional Water Board for approval. Appropriate data from the countywide OWTS LAMP will be incorporated into the Los Osos SNMP Monitoring Report following the Regional Water Board's approval.

7.1.13 Need for Additional Implementation Measures

The County will continue to coordinate with the Los Osos BMC for the preparation of their Annual Groundwater Monitoring Program and the Los Osos SNMP Monitoring Program data. The Los Osos SNMP Monitoring Report shall be submitted to the Regional Water Board at least every three years for the Basin in accordance to the Recycled Water Policy. Salt and nutrient management strategies and options will be updated in this report in accordance with actions that have been taken (or in response to potential expanded salinity or nutrient problems due to any action not taken) since the previous review. Additionally, based on results from the Los Osos SNMP Monitoring Program, interim updates to the SNMP may be conducted when deemed necessary.

As demonstrated above, a significant number of implementation measures are currently practiced or are planned for future implementation in the Basin that will help mitigate and manage salt and nutrient loading. Based on this analysis, no additional implementation measures beyond what has been implemented and planned for the Los Osos SNMP planning period are being implemented, except for the addition of the LAMP for the OWTS. Further measures may be warranted in the future. It is important to recognize that the salt and nutrient concentrations in groundwater will be monitored and reported to the Regional Water Board every three years to determine if water quality improvement objectives are met in the future and/or the need for additional implementation measures in the future. For example, the Los Osos Basin Management Committee may develop and pursue additional measures related to the Groundwater Monitoring and Urban Water Use Efficiency programs, such as:

- **Consider Developing Additional Water Quality Metrics.** Consider developing additional metrics and/or numerical goals to the water quality, if necessary.

- **Development of Contingency Plan.** Develop a contingency plan and related actions in the event Basin Metric trends fail to demonstrate progress toward LOBP goals, including defined schedules and milestones.

- **Potential Adaptation of Water Conservation Measures.** Evaluate the Urban Water Use Efficiency Program to determine which conservation measures are the most efficient and effective to meet the LOBP's goals. This analysis may result in adaptation of some of the conservation measures set forth in the LOBP.

- **Discussion and Recommendation of Criteria for Future Growth.** Provide input into the Los Osos Community Plan (LOCP), including consideration of Basin Metrics and defined goals as they relate to the timing of future growth within the Basin.

7.2 SUMMARY

Implementation actions for salt and nutrient management in the Los Osos Basin includes monitoring and evaluation, prevention, and planning activities to continue active management of the Basin for the long-term beneficial reuse. These activities have been developed to continue providing the data needed to base decisions on sound, scientific data and to provide short-term and long-term prevention and planning activities appropriate for the current and anticipated future salt and nutrient conditions in the Basin. The Los Osos SNMP will incorporate additional implementations for the OWTS LAMP in the future, following approval by the Regional Water Board.

Chapter 8 GROUNDWATER QUALITY MONITORING

This section describes the Los Osos SNMP Groundwater Quality Monitoring Program (SNMP Monitoring Program), and includes descriptions of the groundwater sampling locations, sampling frequency, constituents monitored, sampling protocols and associated quality assurance and quality control (QA/QC) procedures, data analysis, evaluation criteria, and reporting procedures. The SNMP Monitoring Program will submit a Los Osos SNMP Monitoring Report to the Regional Water Board every three years. The entities responsible for monitoring and reporting are also described.

The SNMP Monitoring Program is required for the LOWRF WDR Order as part of the Recycled Water Policy. The County is anticipating that the Regional Water Board to review and approve the Los Osos SNMP prepared for the Los Osos Basin and tier the SNMP Monitoring Program from the LOWRF WDR Order. The Regional Water Board has discretion to adopt the Los Osos SNMP as an amendment to the Central Coast Basin Plan, provided that it is approved by the State Water Board and other regulatory agencies.

8.1 BACKGROUND AND MONITORING PROGRAM GOALS

With respect to groundwater monitoring, the Recycled Water Policy states that the SNMP should include a monitoring program that consists of a network of monitoring locations *"... adequate to provide a reasonable, cost-effective means of determining whether the concentrations of salts, nutrients, and other constituents of concern as identified in the salt and nutrient plans are consistent with applicable water quality objectives."* Additionally, the SNMP *"... must focus on basin water quality near water supply wells and areas proximate to large water recycling projects, particularly groundwater recharge projects. Also, monitoring locations shall, where appropriate, target groundwater and surface waters where groundwater has connectivity with the adjacent surface waters."* The preferred approach is to *"... collect samples from existing wells if feasible as long as the existing wells are located appropriately to determine water quality throughout the most critical areas of the basin. The monitoring plan shall identify those stakeholders responsible for conducting, sampling, and reporting the monitoring data. The data shall be reported to the RWQCBs at least every three years."*

The County and stakeholders will satisfy the monitoring requirements set forth for the Los Osos SNMP in the Recycled Water Policy through the existing groundwater quality monitoring programs implemented across the Basin area. The data for the SNMP Monitoring Program will be coordinated with key Basin monitoring programs, including the Monitoring and Reporting Program (MRP) and the Local Agency Management Programs (LAMP) for the Onsite Wastewater Treatment Systems (OWTS) (future countywide plan) for the LOWRF WDR Orders, Monitoring Program in the Recycled Water Management Plan (RWMP) for the California Coastal Commission (CCC) Coastal Development Permit (CDP), the LOBP Annual Groundwater Monitoring Report for the Los Osos BMC, California Statewide Groundwater Elevation Monitoring (CASGEM), and other monitoring programs, as appropriate. It is anticipated that the majority of data needs of the SNMP Monitoring Program will be met by the existing Los Osos BMC Groundwater Monitoring Program in the LOBP and the County LOWRF Monitoring and Reporting Program. Data overlaps between existing monitoring plans will be resolved in future groundwater monitoring efforts for the annual reports from the Los Osos BMC and County LOWRF.

8.1.1 Background and Monitoring for Constituents of Emerging Concern (CECs)

With regard to constituents of emerging concern (CECs), for basins with recycled water reuse projects, the Recycled Water Policy requires that the SNMP include "….a provision for annual monitoring of Constituents of Emerging Concern consistent with recommendations by California Department of Public Health (CDPH) and consistent with any actions by the State Water Board…." CECs generally have no established water quality standards. These chemicals may be present in waters at very low concentrations and are now detectable as the result of more sensitive analytical methods. Information regarding their health significance is evolving with the development of acceptable daily intake levels and drinking water equivalent levels; however, information is lacking on the full spectrum of potential CECs and their health significance in mixtures. CECs include several types of chemicals such as pesticides, pharmaceuticals and ingredients in personal care products, veterinary medicines, and endocrine disruptors. The State Water Board's Recycled Water Policy states, "Each salt and nutrient management plan shall include . . . [a] provision for annual monitoring of Emerging Constituents/Constituents of Emerging Concern consistent with recommendations by CDPH and consistent with any actions by the State Water Board taken pursuant to paragraph 10(b) of this Policy."

To address concerns of the CECs, a Science Advisory Panel was formed to identify a list of CECs for monitoring recycled water used for groundwater recharge and landscape irrigation. The Panel completed its report (Panel Report) on CECs in June 2010 and recommended monitoring of selected health-based and treatment performance indicator CECs and surrogates for groundwater recharge projects. No CEC monitoring was recommended for landscape irrigation due to low risk for ingestion of the water. The groundwater recharge monitoring recommendations were directed at surface spreading using tertiary recycled water (recycled water and groundwater monitoring) and injection projects using reverse osmosis and advanced oxidation (recycled water monitoring).

Since 1976, the State Water Board's Division of Drinking Water (formerly CDPH) has issued numerous draft versions of Groundwater Replenishment Reuse Regulations that served as guidance for requirements applied to permitted groundwater replenishment projects. Final regulations for groundwater replenishment using recycled water (Groundwater Replenishment Reuse Regulations or 2014 GWR Regulations) became effective on June 18, 2014. The 2014 *General Waste Discharge Requirements for Recycled Water Use* (Order WQ 2014-0090-DWQ) includes Recycled Water Policy requirements that the SNMP include *"...*monitoring requirements for Constituents of Emerging Concern (CECs) for the use of recycled water for groundwater recharge by surface and subsurface application methods. The monitoring requirements and criteria for evaluating monitoring results in the Recycled Water Policy are based on recommendations from a Science Advisory Panel. Because this General Order is limited to non-potable uses and does not authorize groundwater replenishment activities, monitoring for CECs is not required." Because the LOWRF recycled water for irrigation and land disposal are non-potable uses and recycled water is not injected into the Basin for recharge, monitoring for CECs in groundwater in the Los Osos Basin is not required under the General Waste Discharge Requirements for Recycled Water Use (2014-0090-DWQ). However, the LOWRF Project will test for CECs annually with an annual grab sample from the effluent of the treatment facility under the current Monitoring and Reporting Program *Order R3-2011-0001* (WDR Order*)* for the Los Osos Basin. This Order No. R3-2011-0001 was adopted by the Regional Water Board in May 2011 for this Basin (CCRWQCB, 2011a).

8.2 MONITORED PARAMETERS

As discussed in Chapter 4, chloride, TDS, and nitrate are the indicators of salts and nutrients identified and selected for use in the Los Osos SNMP. Total salinity is commonly expressed in terms of chlorides and TDS. TDS can be an indicator of anthropogenic impacts such as infiltration of runoff, soil leaching, and land use; there is also a natural background TDS concentration in groundwater.

Nitrate is a widespread contaminant in California groundwater. High levels of nitrate in groundwater are associated with agricultural activities, septic systems, confined animal facilities, landscape fertilization, and wastewater treatment facility discharges. Natural nitrate levels in groundwater are generally very low (typically less than 10 mg/L for nitrate as nitrate (nitrate-NO_3)). Nitrate is commonly reported as either nitrate-NO_3 or nitrate as nitrogen (nitrate-N) and one measurement type can be converted to the other; however, use of a consistent reporting form for nitrate is necessary to ensure the appropriate comparisons are being made between measured data points and Basin water quality objectives. Nitrate as nitrogen (NO_3-N) is the form of nitrate selected for assessment for this SNMP.

Chloride is the primary indicator of seawater intrusion. Chloride is typically associated with salt compounds formed with sodium, potassium, or calcium. Chloride is also one of the general mineral ions found in groundwater. Once dissolved, it is a conservative species that does not interact significantly with the aquifer matrix or form ionic complexes with other solutes.

8.3 STUDY AREA

As discussed in Chapter 3, the Basin area for the Los Osos SNMP is based on the court approved adjudicated Basin area from the October 15, 2015 Stipulated Judgment. The LOWRF and recycled water beneficial use areas are located within the Basin. This Basin area is part of the Los Osos Valley Groundwater Basin, the DWR Bulletin 118, Basin No. 3-8. The County, along with local water purveyors and Basin stakeholders, has been actively managing local water resources in the Basin through practices such as developing and implementing local monitoring programs, investigating local hydrogeology, determining the Basin's water balance, and planning cooperatively with outreach.

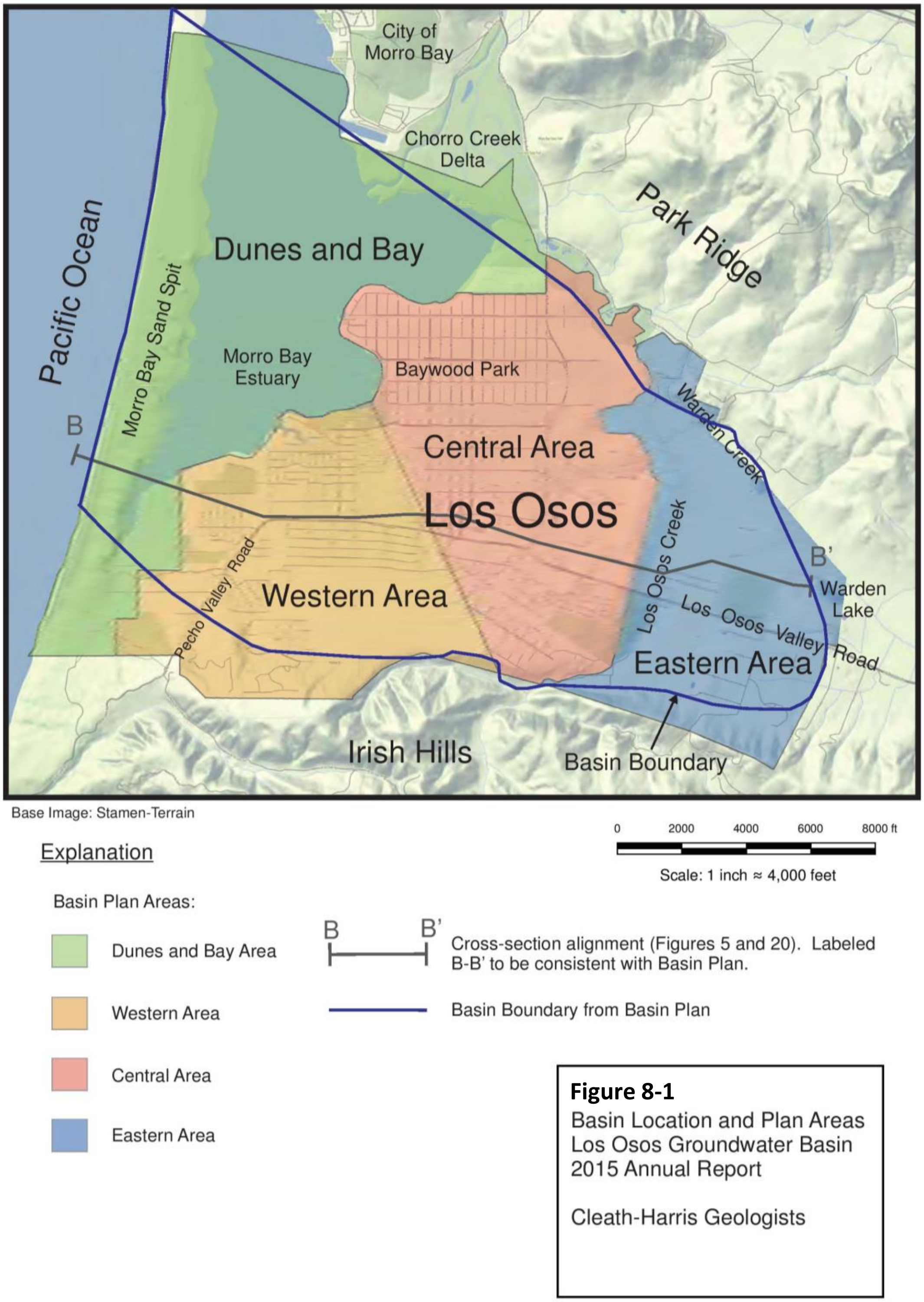
The Basin is situated in the Los Osos Valley, west of San Luis Obispo County (Figure 8-1). The adjudicated Basin plan area is approximately 7,530 acres, of which 80 percent (5,985 acres) are on land and the remaining 20 percent are underwater beneath Morro Bay. There are approximately 240 water supply wells in the Basin, and at least another 30 monitoring wells, respectively. Basin groundwater resources are extracted by water purveyors (52%), private domestic wells (22%), community facilities (2%), and agriculture (24%). (ISJ Group, 2015)

The LOWRF is owned and operated by the County of San Luis Obispo and located on a parcel of approximately 25 acres, as shown on Figure 8-2. The LOWRF produces tertiary treated recycled water for reuse at permitted locations including leach fields disposal sites, urban landscape irrigation (e.g., Los Osos Middle School, Baywood Elementary School, Sunnyside Elementary School, Monarch Grove Elementary School, South Bay Community Center, and Sea Pines Golf Course) and agricultural irrigation; refer to Figure 8-2 for locations. The recycled water reuse and disposal sites will meet the existing LOWRF WDR Order for Title 22 for the Recycled Water Policy (CCRWQCB, 2011a).

The vicinity of the Broderson leach field is characterized by sandy soils overlying an Upper Aquifer (Old Dune Sand deposits) and a Lower Aquifer (Paso Robles formation). This area is located in sandy soils on moderately sloping terrain, overlying 150 feet separation to groundwater in the Basin. Other disposal and reuse areas are located on level to gently sloping terrain with depth to groundwater varying from 30 to 150 feet. The direction of groundwater flow is predominantly northwest toward Morro Bay.

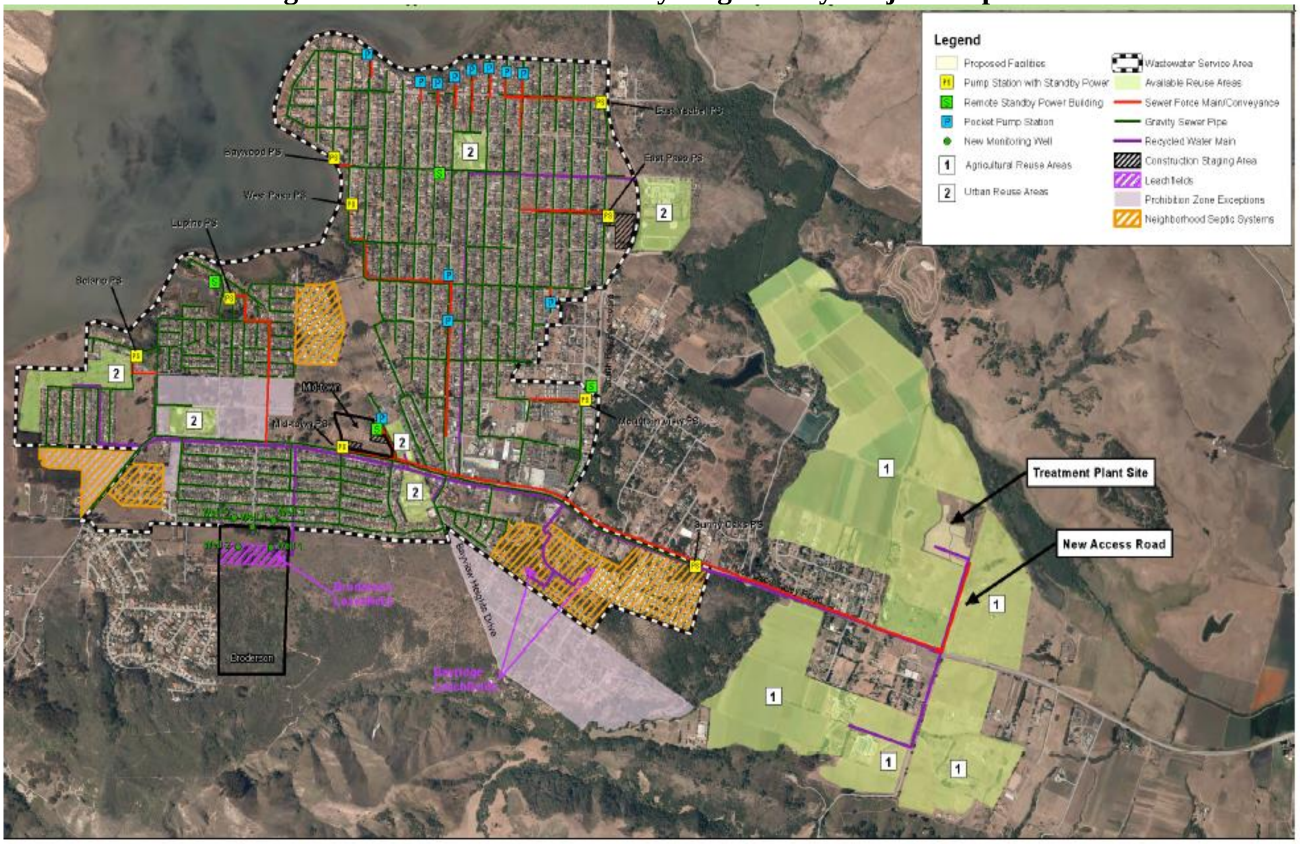
The County is anticipating future wastewater service connections for the LOWRF with the Monarch Grove Development and Bayview Heights and Martin Tracts. The Monarch Grove Development is a development of approximately 83 residences, which discharges approximately 200,000 gallons of domestic wastewater to a wastewater treatment plant located in the Sea Pines Golf Course. The Monarch Grove Development is located within the service area, but is not currently proposed to be served by the LOWRF. The Bayview Heights and Martin Tracts areas were exempted from the prohibition zone in March 2000. These areas will not be connected to the LOWRF. However, individual residential dwellings may connect to the LOWRF in the future. (CCRWQCB, 2011)

Figure 8-1. Los Osos Basin Location and Plan Areas



Source: ISJ Group, 2015

Figure 8-2. Los Osos Water Recycling Facility Project Map



Source: ISJ Group, 2015

8.4 EXISTING GROUNDWATER MONITORING PROGRAMS

As mentioned in Section 8.1, it is anticipated that the majority of data needs of the SNMP Monitoring Program will be met by the existing LOBP Annual Groundwater Monitoring Program for the Los Osos BMC and the LOWRF Monitoring and Reporting Program for the County. Recent and historical water quality measurements were collected from the above and previous studies to generate baseline conditions for TDS, nitrate, and chloride for the Los Osos SNMP. Basin monitoring was extensively characterized in the LOBP and the baseline groundwater monitoring for the LOWRF WDR Order. These data sets were used in the SNMP antidegradation analysis in Chapter 5, and these two monitoring programs will continue to collect data for use in the SNMP Monitoring Reports.

The Los Osos BMC has a total of 73 wells, including 35 monitoring wells, 15 municipal wells (active and inactive) and 23 private wells (pending well owner participation) (CHG, 2016). The County LOWRF baseline sampling program includes 26 monitoring wells, including 20 Los Osos Community Services District wells and 6 private wells. The Los Osos BMC and County LOWRF monitoring programs have overlapping monitoring and data analysis in a few wells. The monitoring collection efforts for these wells will be coordinated in the future for cost efficiency and to reduce duplicative requirements. The County baseline water quality requirements per the LOWRF WDR Order (collected from 2012 to 2016) are noted below, as well as the Los Osos BMC constituents listed in their 2015 Annual Groundwater Monitoring Report:

- Carbonate Alkalinity (BMC)
- Bicarbonate Alkalinity (BMC)
- Boron (BMC, LOWRF)
- Calcium (BMC)

- Total Alkalinity (as $CaCO_3$) (BMC)
- Total dissolved solids (BMC, LOWRF)
- Ammonia as Nitrogen (LOWRF)
- Total Kjeldahl Nitrogen (LOWRF)
- Nitrite as Nitrogen (LOWRF)
- Nitrate as Nitrogen (LOWRF)
- Organic Nitrogen (BMC, LOWRF)
- Total Nitrogen (LOWRF)
- Potassium (BMC)
- Sodium (BMC, LOWRF)
- Magnesium (BMC)
- Sulfate (BMC, LOWRF)
- Chloride (BMC, LOWRF)
- Electrical conductance (BMC, LOWRF)
- Temperature (BMC, LOWRF)
- pH (BMC, LOWRF)

Electrical conductance, temperature, and pH are also recorded on the groundwater monitoring field logs during sampling of each well. Other constituents are monitored by the Los Osos BMC as part of their general minerals laboratory analysis. The LOWRF will have additional constituents collected for their permit, as discussed in Section 8.5.

8.5 SNMP MONITORING NETWORK AND REPORTING

The Los Osos groundwater monitoring programs for the SNMP include groundwater data collected by the Los Osos BMC for the LOBP, CASGEM, and baseline groundwater monitoring and MRP per the LOWRF WDR Order. The LOBP is intended to be the primary groundwater monitoring program for the Basin, adopted pursuant to the court-approved adjudicated Basin in 2015 and the LOWRF data will be collected in accordance with the LOWRF WDR Order (CCRWQCB, 2011a). Groundwater monitoring and networks will be coordinated between the Los Osos BMC and County. The use of the existing monitoring network locations will provide a reasonable, cost-effective means of determining whether the concentrations of salt, nutrients and other constituents of concern as identified in the Los Osos SNMP are consistent with applicable water quality objectives of the Central Coast Basin Plan.

Monitoring reports are prepared annually by the Los Osos BMC for the LOBP and by the County for the LOWRF MRP permit requirements. The County will utilize appropriate data from both reports to prepare the SNMP Monitoring Report for the Regional Water Board. Future and other monitoring plans will be incorporated into the SNMP, as necessary.

A future management program will be prepared by the County Planning Department for 2018. This is a countywide Local Agency Management Program (LAMP) for the Onsite Wastewater Treatment Systems (OWTS), in accordance with the LOWRF WDR Order. Appropriate data from the countywide OWTS LAMP will be incorporated into the SNMP, once approved by the Regional Water Board’s approval.

Groundwater monitoring and reporting is essential for addressing many issues related to groundwater resources in the Basin, including determination of the groundwater level, water quality, sustainable yield, seawater intrusion, nitrate contamination, and future dynamic changes to the Basin. The SNMP will also examine Basin water quality near water supply wells and areas proximate to large water recycling projects. The data and parameters currently collected and analyzed under existing monitoring programs for use in the SNMP Monitoring Program are described below.

8.5.1 Los Osos BMC – Annual Groundwater Monitoring Report

The Annual Groundwater Monitoring Program for the Los Osos BMC will provide an updated hydrologic assessment of the Basin with water balance and sustainable yield. Groundwater levels are collected in the spring and fall of each year, when water levels are typically at their highest and lowest. Groundwater quality sample will be coordinated with the County. Monitoring frequency for water quality sampling and analyses for the annual report will generally be collected in the fall for the First Water and Upper Aquifer.

This is when groundwater levels are seasonally low and many water quality constituents have historically been at a higher concentration than their corresponding spring measurement. The Lower Aquifer groundwater monitoring will also be performed in the fall and spring as a means of tracking seawater intrusion in greater detail. Groundwater monitoring for the first annual report started in 2014, and in 2017, monitoring should include recycled water reuse.

8.5.1.1 Los Osos BMC - Groundwater Level Monitoring

The Los Osos BMC groundwater level monitoring is performed at 73 Groundwater Monitoring Program locations. Table 8-1 summarizes the location area and number of wells for groundwater level measurements. Groundwater monitoring wells were chosen for their specific characteristics and to achieve areal and vertical (with depth) distribution across the Basin. Of the 73 wells currently in the groundwater monitoring network, 28 wells are representative of First Water, 15 wells are representative of the Upper Aquifer, and 30 wells are representative of the Lower Aquifer. Laterally, 31 water level monitoring wells are in the Western Area, 30 wells are in the Central Area, and 12 wells are in the Eastern Area.

Table 8-1. Distribution of Monitoring Wells

	Western Area	**Central Area**	**Eastern Area**
First Water	11	12	5
Upper Aquifer	6	9	*0
Lower Aquifer	14	9	7

* There are no monitoring wells in the Upper Aquifer in the Eastern Area because that area is defined as First Water east of Los Osos Creek.
Source: ISJ Group, 2015

The monitoring network will help determine changes to groundwater in storage within an aquifer by estimating changes in the hydraulic head in the Basin. If the monitoring network does not fully achieve the goals of the LOBP Groundwater Monitoring Program, then additional wells may be added in the future by the Los Osos BMC.

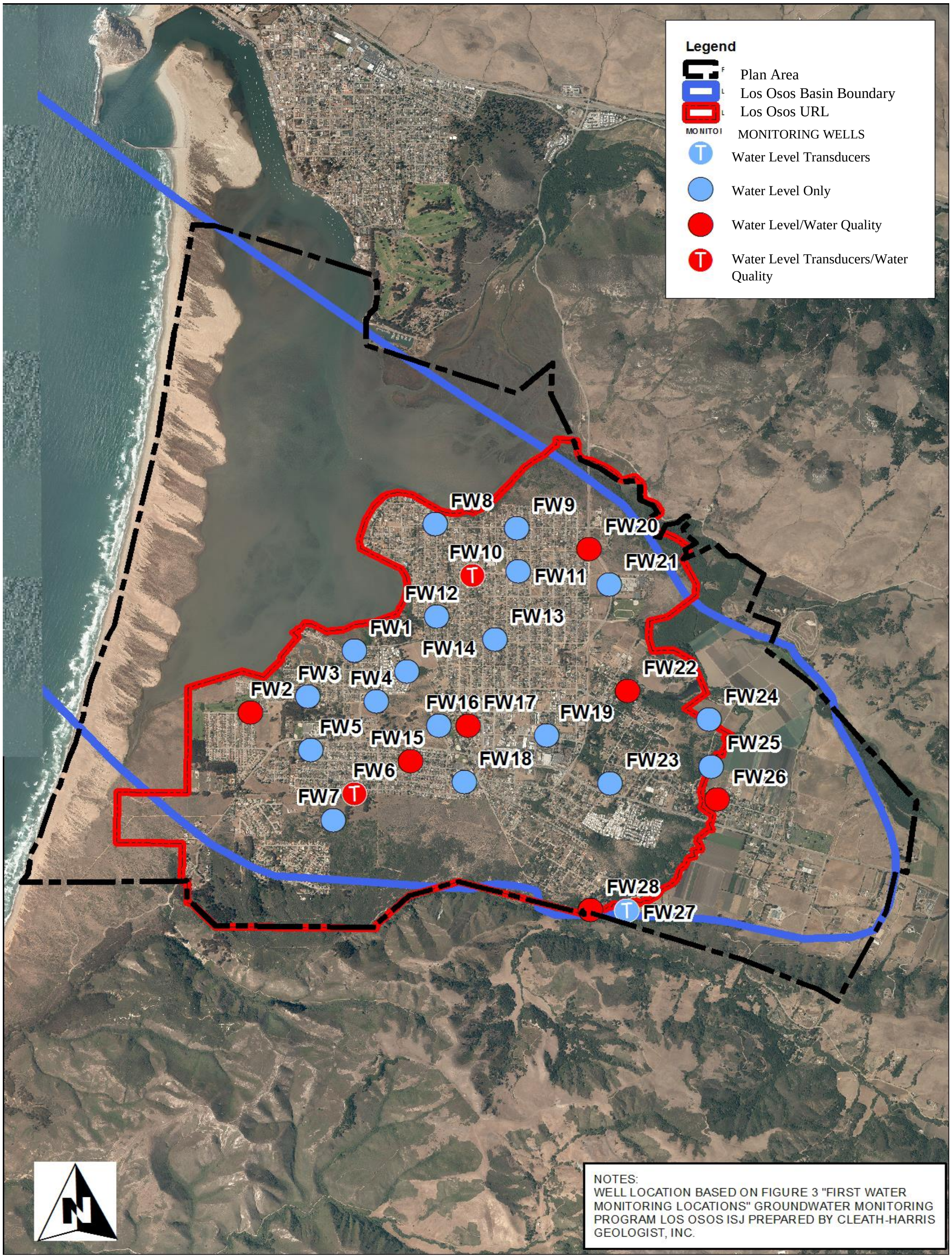
The monitoring locations and monitoring activities are compiled in Tables 8-2, 8-3, and 8-4, and shown in Figures 8-3, 8-4, and 8-5. The tables and figures are organized according to aquifer group, i.e., First Water, Upper Aquifer and Lower Aquifer. Some of the wells identified for potential inclusion in the monitoring network are privately owned. It is expected that employees or contractors of the Los Osos BMC would perform monitoring activities for those wells, with each respective owner's permission. If access to a specific well cannot be gained, it may be removed from the LOBP Groundwater Monitoring Plan or replaced with another well, as appropriate.

The 2017 LOBP monitoring of the existing wells include the following:

Table 8-2. First Water Monitoring Network				
Program ID	**Well Number**	**Area**	**Well Type**	**Monitoring***
FW1	Private	Western	Private	L
FW2	30S/10E-13L8	Western	Monitoring	L, G
FW3	30S/10E-13G	Western	Monitoring	L
FW4	30S/10E-13H	Western	Monitoring	L
FW5	30S/10E-13Q2	Western	Monitoring	L
FW6	30S/10E-24A	Western	Monitoring	TL, G, CEC
FW7	30S/10E-24Ab	Western	Monitoring	L
FW8	30S/11E-7L4	Central	Monitoring	L
FW9	30S/11E-7K3	Central	Monitoring	L
FW10	30S/11E-7Q1	Central	Monitoring	TL, G
FW11	30S/11E-7R2	Central	Monitoring	L
FW12	30S/11E-18C2	Central	Monitoring	L
FW13	30S/11E-18B2	Central	Monitoring	L
FW14	Private	Western	Private	L
FW15	30S/11E-18N2	Western	Monitoring	L, G
FW16	30S/11E-18L11	Western	Monitoring	L
FW17	30S/11E-18L12	Central	Monitoring	L, G
FW18	30S/11E-18P	Western	Monitoring	L
FW19	30S/11E-18J7	Central	Monitoring	L
FW20	30S/11E-8M	Central	Monitoring	L, G
FW21	30S/11E-8N4	Central	Monitoring	L
FW22	Private	Central	Private	L, G
FW23	Private	Central	Private	L
FW24	Private	Eastern	Private	L
FW25	Private	Eastern	Private	L
FW26	Private	Eastern	Private	L, G, CEC
FW27	Private	Eastern	Private	TL
FW28	Private	Eastern	Private	L, G

* Legend: L = groundwater level; TL = transducer site for groundwater level; G = groundwater quality: general mineral suite; CEC = constituents of emerging concern
Source: ISJ Group, 2015

Figure 8-3. First Water Monitoring Network



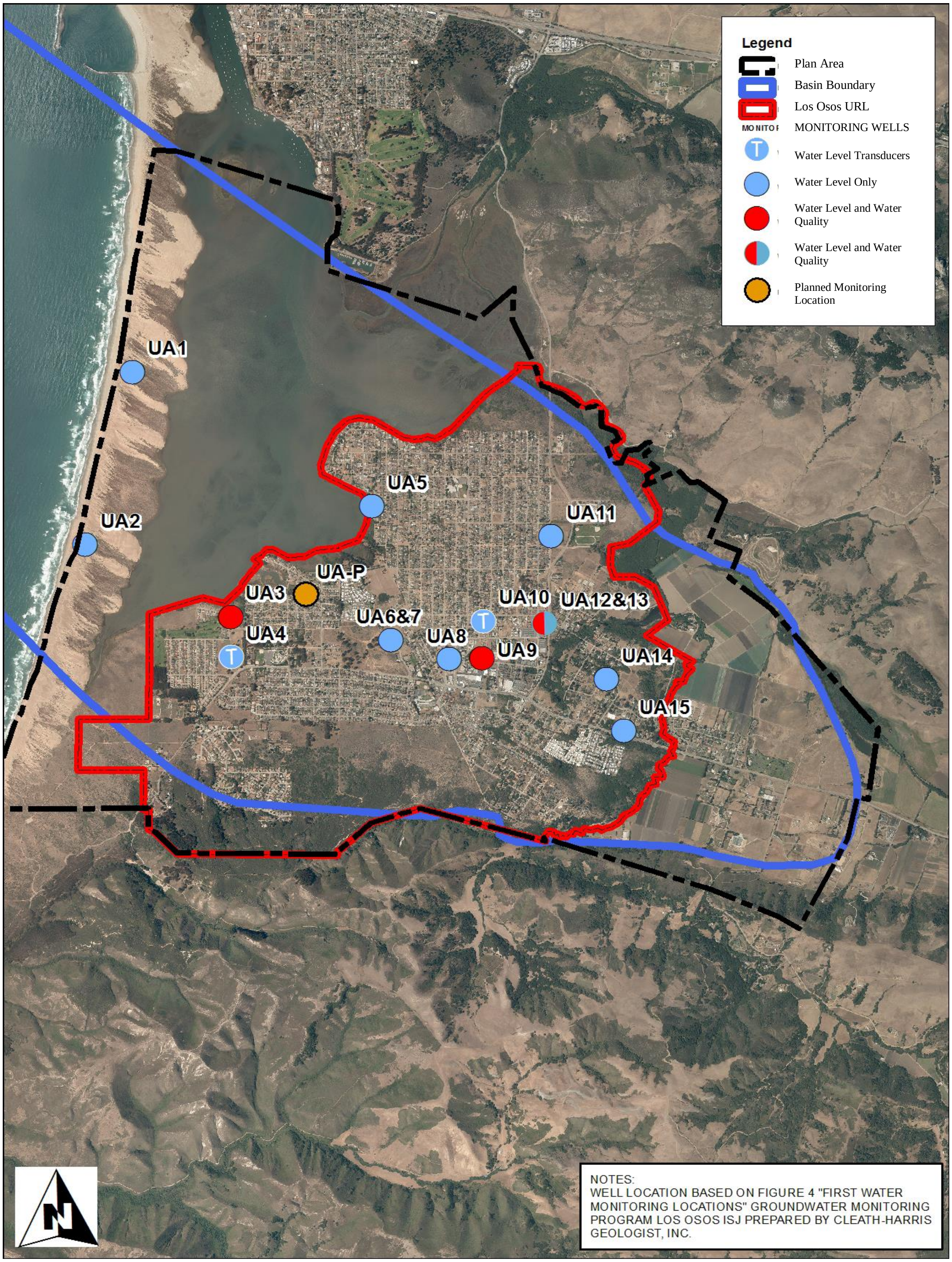
Source: ISJ Group, 2015

Table 8-3. Upper Aquifer Monitoring Network				
Program ID	**Well Number**	**Area**	**Well Type**	**Monitoring***
UA1	30S/10E-11A1	Dunes and Bay	Monitoring	L
UA2	30S/10E-14B1	Dunes and Bay	Monitoring	L
UA3	30S/10E-13F1	Western	Municipal	L, G
UA4	30S/10E-13L1	Western	Municipal	TL
UA5	30S/11E-7N1	Central	Municipal	L
UA6	30S/11E-18L8	Western	Monitoring	L
UA7	30S/11E-18L7	Western	Monitoring	L
UA8	30S/11E-18K7	Central	Monitoring	L
UA9	30S/11E-18K3	Central	Municipal	L, G
UA10	30S/11E-18H1	Central	Municipal	TL
UA11	Private	Central	Private	L
UA12	30S/11E-17E9	Central	Monitoring	L
UA13	30S/11E-17E10	Central	Municipal	L, G
UA14	Private	Central	Private	L
UA15	Private	Central	Private	L

* Legend: L = groundwater level; TL = transducer site for groundwater level; G = groundwater quality: general mineral suite; CEC = constituents of emerging concern

Source: ISJ Group, 2015

Figure 8-4. Upper Aquifer Monitoring Network



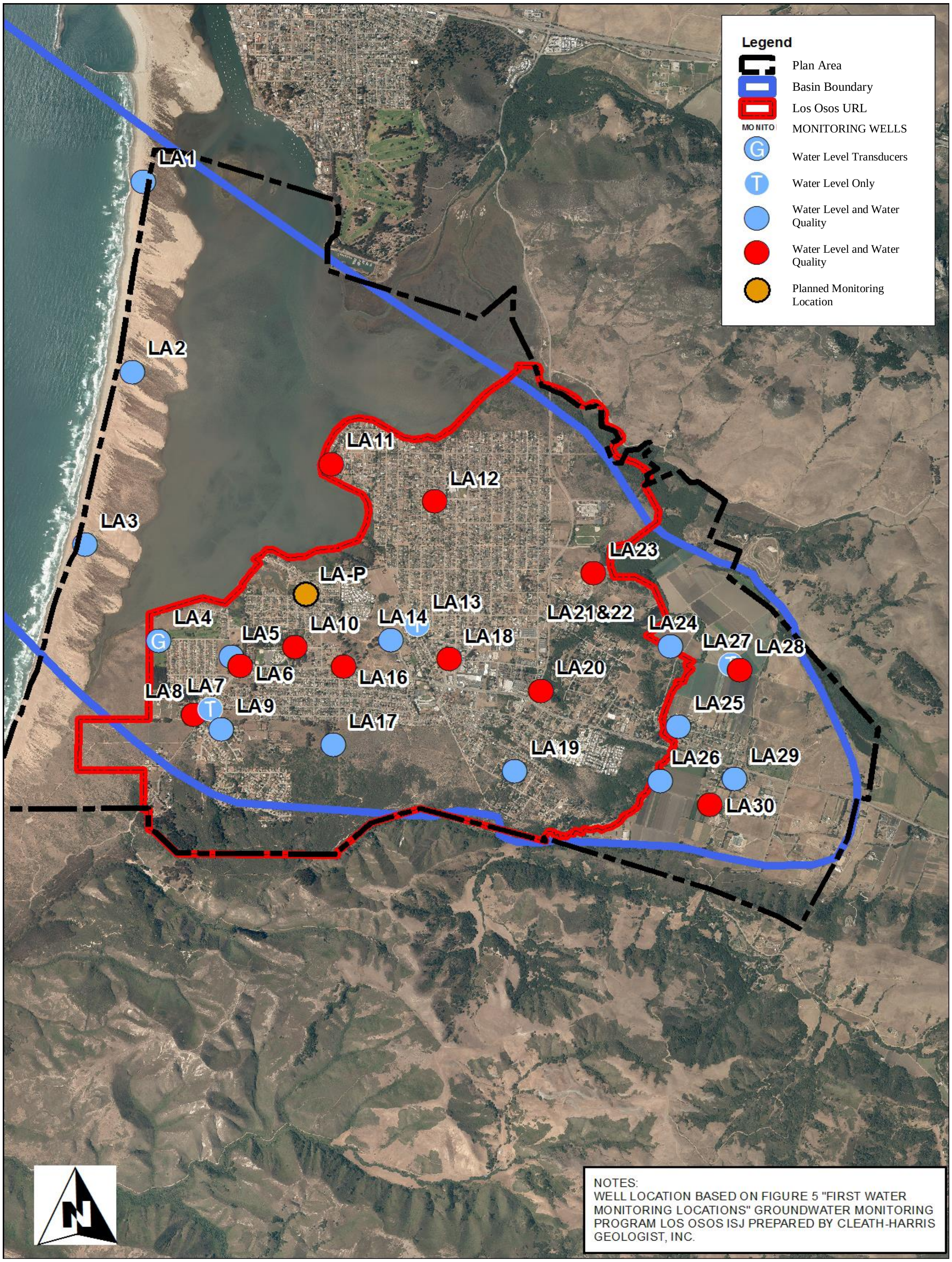
Source: ISJ Group, 2015

Table 8-4. Lower Aquifer Monitoring Network				
Program ID	**Well Number**	**Area**	**Well Type**	**Monitoring***
LA1	30S/10E-2A1	Dunes and Bay	Monitoring	L
LA2	30S/10E-11A2	Dunes and Bay	Monitoring	L
LA3	30S/10E-14B2	Dunes and Bay	Monitoring	L
LA4	30S/10E-13M1	Western	Monitoring	L, G
LA5	30S/10E-13L7	Western	Municipal	L
LA6	30S/10E-13L4	Western	Municipal	L, G
LA7	Private	Western	Private	TL
LA8	30S/10E-13N	Western	Municipal	L, G
LA9	30S/10E-24C1	Western	Municipal	L
LA10	30S/10E-13J4	Western	Municipal	L, G
LA11	30S/10E-12J1	Central	Monitoring	L, G
LA12	30S/10E-7Q3	Central	Municipal	L, G
LA13	30S/11E-18F2	Central	Municipal	TL
LA14	30S/11E-18L6	Western	Monitoring	L
LA15	30S/11E-18L2	Western	Municipal	L, G
LA16	Private	Western	Private	L
LA17	30S/11E-24A2	Western	Monitoring	L
LA18	30S/11E-18K8	Central	Monitoring	L, G
LA19	30S/11E-19H2	Central	Monitoring	L
LA20	30S/11E-17N10	Central	Municipal	L, G
LA21	30S/11E-17E7	Central	Monitoring	L
LA22	30S/11E-17E8	Central	Monitoring	L
LA23	30S/11E-17C1	Central	Monitoring	L, G
LA24	Private	Eastern	Private	L
LA25	Private	Eastern	Private	L
LA26	Private	Eastern	Private	L
LA27	Private	Eastern	Private	TL
LA28	Private	Eastern	Private	L, G
LA29	Private	Eastern	Private	L
LA30	Private	Eastern	Private	L, G

* Legend: L = groundwater level; TL = transducer site for groundwater level; G = groundwater quality: general mineral suite; CEC = constituents of emerging concern

Source: ISJ Group, 2015

Figure 8-5. Lower Aquifer Monitoring Network



Source: ISJ Group, 2015

8.5.1.2 Los Osos BMC - Water Quality Monitoring

The Los Osos BMC collects groundwater samples from 23 designated wells for water quality, which are distributed laterally and vertically across the Basin (Tables 8-2, 8-3, and 8-4). Table 8-5 lists the current constituents monitored as part of the Los Osos BMC monitoring program. These constituents were selected to analyze for salt loading, nitrate impacts, and seawater intrusion. Results from the 2015 Annual Groundwater Monitoring Report are included in Appendix B – 1. Long term trend analysis of Chlorides Level Metric and Nitrate Metric are also performed by the Los Osos BMC.

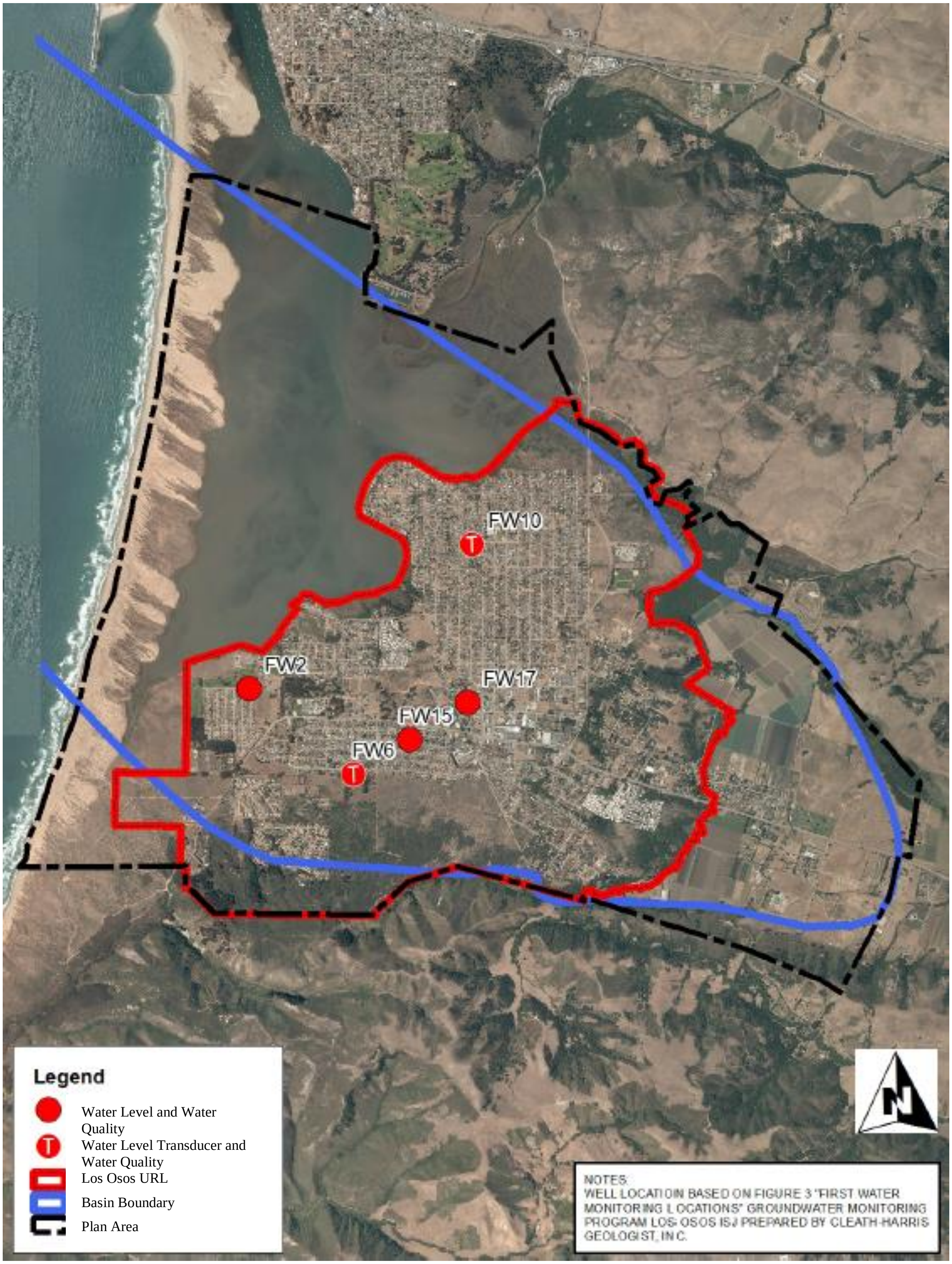
Table 8-5. LOBP Water Quality Monitoring Constituents

Constituent	Reporting Limit	Units
Specific Conductance	1	µs/cm
pH (field)	0.01	pH units
TDS	1	mg/L
Carbonate Alkalinity	1	mg/L
Bicarbonate Alkalinity	1	mg/L
Total Alkalinity	1	mg/L
Chloride	1	mg/L
Nitrate as Nitrogen (NO_3-N)	0.1	mg/L
Sulfate	0.5	mg/L
Boron	0.05	mg/L
Calcium	0.03	mg/L
Magnesium	0.03	mg/L
Potassium	0.1	mg/L
Sodium	0.05	mg/L
Temperature	N/A	°F

Source: ISJ Group, 2015

The LOBP annual report includes Chloride (100 mg/L) Level Metric and Nitrate (10 mg/L) Metric systems. The Nitrate Metric (NO_3-N) is measured with five key wells to monitor First Water (perched and upper aquifer water) where nitrate loading to the Basin takes place (see Figure 8-6). The Chloride Level Metric is based on the weighted average of chloride concentrations in four wells in the Lower Aquifer for seawater intrusion. Both metrics system will be update annually in the groundwater monitoring report by the Los Osos BMC.

Figure 8-6. Key Wells for the Nitrate Metric



Source: ISJ Group, 2015

8.5.1.3 Los Osos BMC – Annual Groundwater Monitoring Program Cost
Costs associated with the Los Osos Groundwater Monitoring Program are expected to be approximately $25,000 per year (ISJ Group, 2015). These costs include water level recording and sampling at private domestic and dedicated monitoring wells, water quality laboratory testing, data collection and analysis and reporting, but do not include groundwater level recording or water quality sampling at community supply wells, which will be performed by the purveyors and their staff (ISJ Group, 2015).

8.5.1.4 Los Osos BMC - Annual Report
The Los Osos SNMP Monitoring Report will utilize the data from the annual LOBP Groundwater Monitoring Report. The report will be completed by the Los Osos BMC with a reporting period from January 1 through December 31 of the preceding year. The following outline provides an example of the report content:

- Introduction and Background;
- Conduct of work: services performed, methods, equipment;
- Monitoring results: monitoring results, well location maps, data maps, data tables;
- Data interpretation: calculation of Basin metrics and trends, water level contour maps, hydrographs, chemographs, ion ratio graphs, change in storage calculations;
- Basin status: seawater intrusion, drought, supply issues, changes from prior year's report; and
- Groundwater monitoring program recommendations

The annual LOBP Groundwater Monitoring Report will be made available to the public, presented at the Los Osos BMC meetings, and posted in electronic form on a website maintained by the County of San Luis Obispo on behalf of the Los Osos BMC.

8.5.2 LOWRF – Groundwater Monitoring and Reporting Program
The purpose of the groundwater monitoring program for the LOWRF is to collect and analyze groundwater and LOWRF effluent data in accordance with the Monitoring and Reporting Program (MRP) for the County LOWRF WDR Order. The LOWRF MRP is necessary to determine compliance with the waste discharge requirements and ensure protection of the beneficial uses of waters of the state and public health (CCRWQCB, 2011b).

8.5.2.1 LOWRF Groundwater Baseline Monitoring
The WDR Order for the LOWRF issued by the Regional Water Board requires the County to collect baseline groundwater samples (Water Code Section 13267, CCRWQCB, 2011a). The County analyzed samples for total dissolved solids, pH, total nitrogen as N (all forms identified), sodium, chloride, sulfate, and boron from approximately 25 groundwater monitoring wells. Groundwater quality samples and groundwater level measurements were collected semi-annually (spring and fall) for the baseline monitoring from July 2012 to July 2016. The baseline data will initiate long-term monitoring in the Los Osos Basin and evaluate long-term efficiency of the wastewater treatment facility.

The County is required to submit monitoring reports by February 1, 2013, and every six months thereafter to the Regional Water Board. The reports contain the results of all samples collected, a potentiometric surface map derived from the depth to water measurements, a map showing nitrate isopleths, and a discussion of results. The LOWRF baseline water quality results are included in Appendix B – 2. The full requirements of the MRP takes effect in the six-month period prior to startup of the community wastewater system (CCRWQCB, 2011b). The LOWRF monitoring well network is summarized in Table 8-6.

Table 8-6. Baseline Monitoring Well Network and Construction

Groundwater Monitoring Well Construction Details
Los Osos Water Recycling Facility

Well ID	Well Ownership	Total Well Depth (ft bgs)	Well Screen Interval (ft bgs)	Well Diameter (in)	TOC Elevation (ft amsl)
13G	CSD	52	47-52	2	50.95
13H	CSD	34	29-34	2	49.33
13L5r	CSD	37	26-36	2	32.63
13Q1r	CSD	105	95-105	2	101.27
17D	Private	120	NA	10	NA
17E9	CSD	204	184-194	2	105.85
17F4	Private	72	48-72	8	78.57
17N4	Private	60	40-60	6	162.61
18B1r	CSD	35	25-35	2	79.89
18Clr	CSD	35	25-35	2	34.55
18E1	Private	100	40-60	6	39.61
18J6r	CSD	35	25-35	2	125.74
18L3r	CSD	55	43-53	2	88.02
18L4r	CSD	35	25-35	2	103.85
18N1r	CSD	95	85-95	2	125.53
18R1	Private	50	40-50	8	170.96
24A	CSD	164	154-164	2	193.04
7K3r	CSD	70	55-65	2	90.71
7L3r	CSD	50	40-50	2	45.76
7N1	CSD	83	61-71, 73-83	8	11
7Q1	CSD	75	29-43, 54-75	8	25.29
7R1r	CSD	35	25-35	2	61.93
8Ma	CSD	45	35-45	2	91
8Mb	CSD	47	37-47	2	95
8N2r	CSD	50	40-50	2	95.99

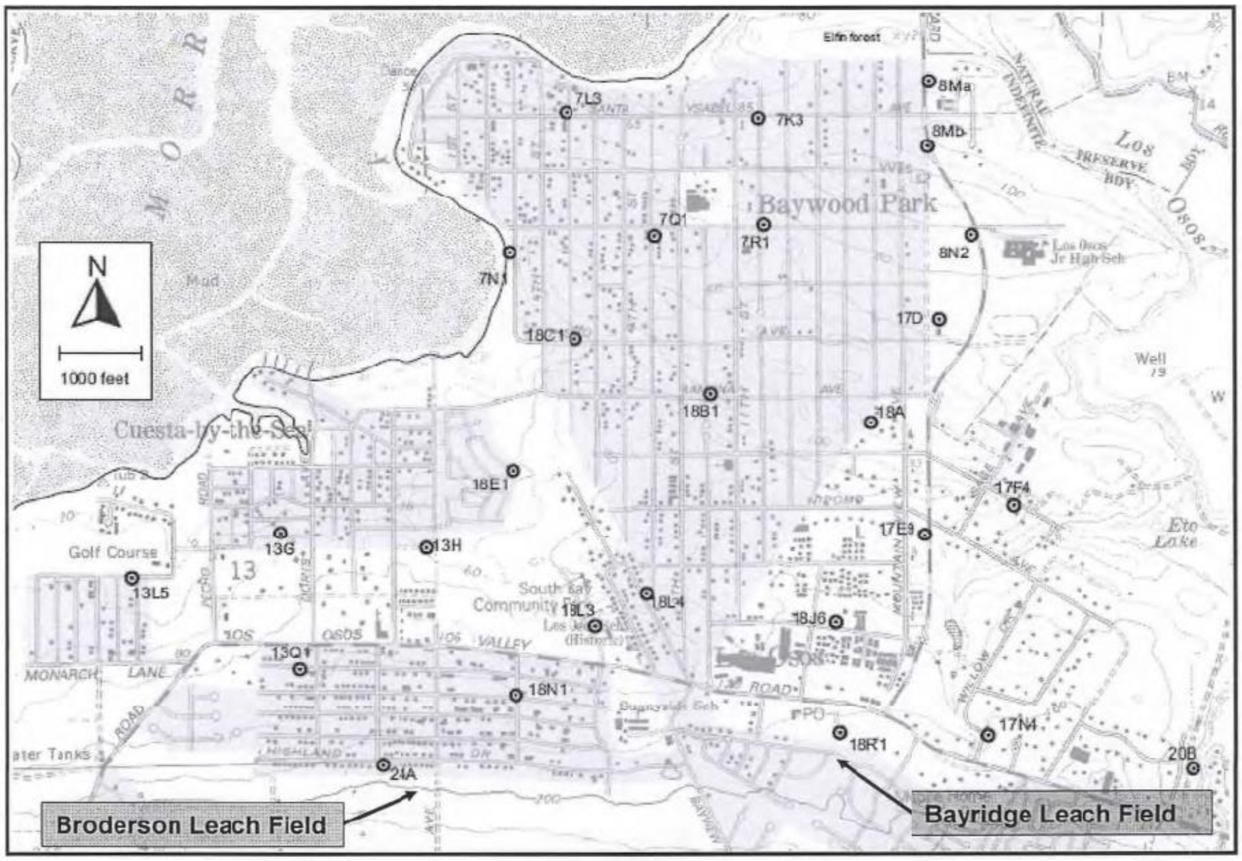
Notes: Well ID's ending with "r" are reconstructed wells
bgs - below ground surface
amsl - above mean sea level
TOC - top of casing
CSD - Los Osos Community Service District Monitoring Well
Private - Owned by a private party
NA - not available

Source: Rincon, 2014

8.5.2.2 LOWRF Monitoring Well Selection

Wells selected for the LOWRF are chosen from a network of "key wells" and carefully screened by County technical staff to optimize groundwater quality characterization across the service area while concentrating monitoring efforts in areas of active groundwater use and management to address impacts from potentially contaminating land use activities. The list of wells is reviewed and updated in consideration of current water development and management activities, screened depths, site/well ownership, and access. The number of dedicated monitoring wells sampled for groundwater quality under the LOWRF Monitoring Plan is 25 wells as shown in Figure 8-7.

Figure 8-7. Monitoring and Reporting Program Wells



Source: CCRWQCB, 2011a

8.5.2.2.1 LOWRF Groundwater Monitoring – Discharge of Recycled Water to Leach Fields

The County discharges recycled water to land at the Broderson and Bayridge Estates Leach Fields. The leach fields location are shown on Figure 8-7 and discussed in detail below.

Broderson Leach Field: The Broderson site has eighty-acres of property, currently in open space. The LOWRF leach field at Broderson underlies approximately eight-acres of the property with an anticipated recycled water disposal volume of 448 acre-feet per year (AFY). The site is underlain by dune sands and unconsolidated sands (including silty and clayey sand lenses) of the Paso Robles Formation that extend to depths of 200-240 feet below ground surface. Beneath the sands is a relatively impermeable clay layer approximately 70 feet thick that separates the Upper Aquifer from the Lower Aquifer, discharge from the disposal site may mound on the clay layer.

In preparation for groundwater monitoring, the County installed five vadose zone monitoring locations down-slope of the Broderson leach field disposal site, as shown on Figure 8-8. These wells were installed to monitor groundwater conditions at the site. Each monitoring location includes a nested set of three piezometers at approximately 14 feet, 27 feet, and 40 feet depth, as shown on Table 8-7. The monitoring network for LOWRF MRP is 30 groundwater monitoring wells with the addition of these 5 monitoring well.

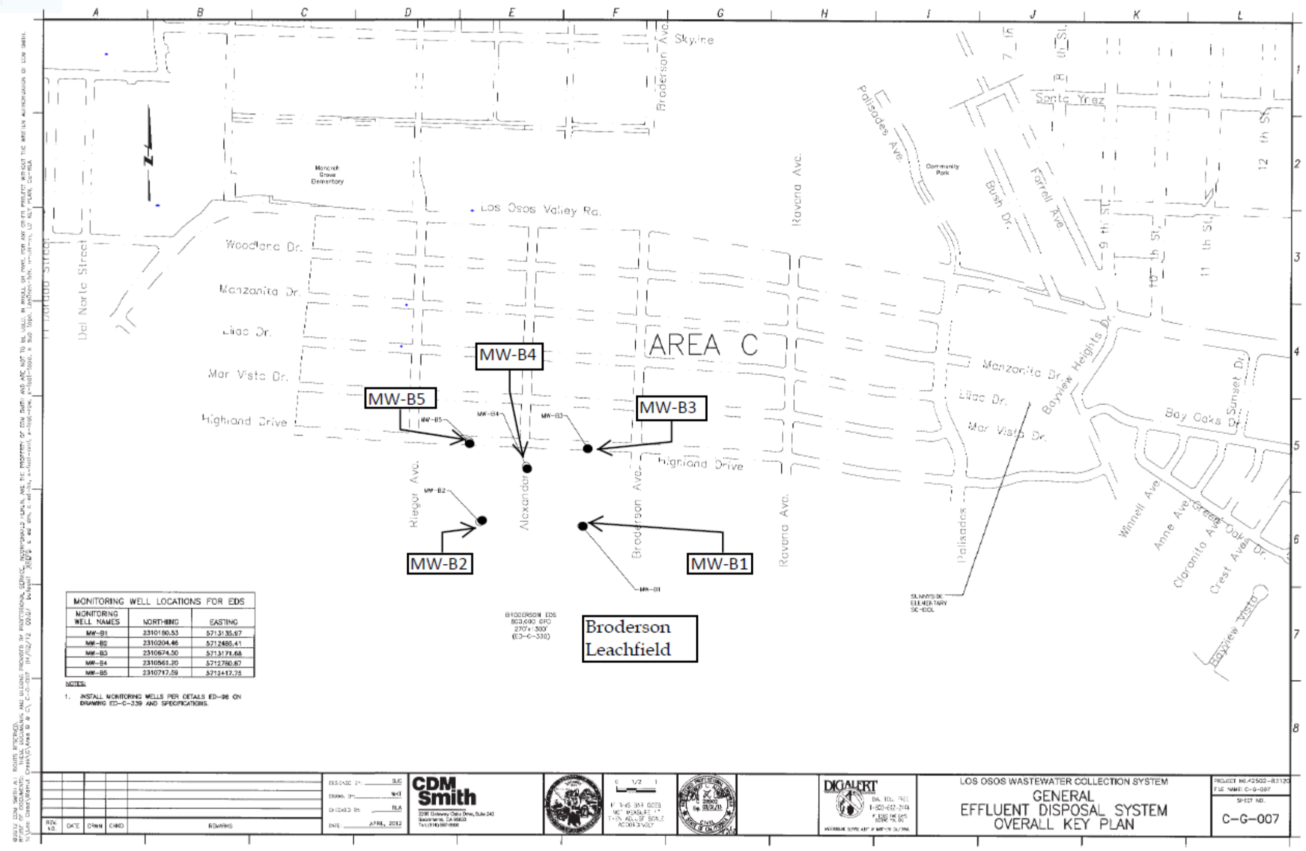
Table 8-7. Broderson Vadose Zone Monitoring Wells
Inspected May 4, 2016

Well Name	Piezometer depth in feet	Water Level
MW-B1	14	Dry
	27	Dry
	40	Dry
MW-B2	14	Dry
	27	Dry
	40	Dry
MW-B3	14	Dry
	27	Dry
	40	Dry
MW-B4	14	Dry
	27	Dry
	40	Dry
MW-B5	14	Dry
	27	Dry
	40	Dry

Source: CHG, 2016a

The Broderson site was selected based on a 2008 Hopkins Groundwater Consultants study that summarized current hydrological conditions of the Los Osos Basin as well as potential impacts of the Los Osos wastewater treatment plant discharge. This study concluded that disposal at the Broderson site would result in less than significant impacts to adjacent groundwater (adjacent groundwater includes impacts to the upper and lower aquifer). More specifically, the recycled water disposal would result in lower nitrogen loading than septic systems discharges and would also allow for improved planning strategies to reduce seawater intrusion rates. (CCRWQCB, 2011)

Figure 8-8. Broderson Vadose Zone Monitoring Wells Locations



Source: CHG, 2016a

Bayridge Estates Leach Field: The Bayridge Estates subdivision was developed in the late 1970's with two existing leach fields that serve the subdivision's engineered septic system. The LOWRF will use these existing leach fields for recycled water disposal after decommissioning the septic system and connecting to the community sewer system. The anticipated recycled water disposal volume of 33 acre-feet per year is permitted from the LOWRF WDR Order at Bayridge Estates. The site is underlain by permeable dune sands that are approximately 60-100 feet thick. Beneath the dune sands is a relatively impermeable clay horizon within the Paso Robles Formation, estimated to be approximately 20 feet thick, that acts as a perching layer. The return flow from the leach fields is estimated to travel into the perched layer of the Basin.

8.5.2.4 LOWRF Groundwater and Effluent Limitations for Recycled Water Discharge

The MRP requires routine wastewater effluent and receiving water (groundwater) sampling and analysis to verify compliance with the LOWRF WDR Order for discharge (CCRWQCB, 2011b). Other notable requirements in the LOWRF permit for receiving water limitations include the following:

- The discharge shall not cause groundwater to contain taste- or odor-producing substances in concentrations that adversely affect beneficial uses.
- The discharge shall not cause radionuclides to be present in concentrations that are deleterious to human, plant, animal, or aquatic life or result in the accumulation of radionuclides in the food web to an extent which presents a hazard to human, plant, animal, or aquatic life.
- The discharge shall not cause groundwater to contain concentrations of organic or inorganic chemicals in excess of the limiting concentrations set forth in California Code of Regulations, Title

22, Division 4, Chapter 15, Article 5.5, Section 64444 (organic) and Article 4, Section 64431 (inorganic).

- The discharge shall not cause a significant increase in mineral constituent concentrations in the underlying groundwater, as determined by comparison of samples collected from wells located upgradient and down gradient of the disposal area (CCRWQCB, 2011a).

Tables 8-8 shows secondary effluent limitation for infiltration limits to leach fields disposal sites and Table 8-9 shows recycled water limitations for irrigation reuse areas. Subsequently, since all recycled water is discharged through a single pipeline from the LOWRF, the limitations shown in Tables 8-8 and Table 8-9 applies to all recycled water effluent (infiltration to leach fields disposal site and irrigation reuse areas). The tables are only separated for consistency with the LOWRF WDR Order.

Table 8-8. Effluent Limitations

Constituent	Units	Monthly Average (30 day)	Daily Maximum
Settleable Solids	mL/L	0.1	0.5
Suspended Solids	mg/L	60	100
Biochemical Oxygen Demand, 5 day	mg/L	60	100
Total Nitrogen (as N) (all forms identified)	mg/L	7	10

mL/L -milliliters per liter
mg/L - milligrams per liter
Source: CCRWQCB, 2011a

The County will collect and analyze representative samples of water provided for reuse in accordance with the standards and specifications set forth in the LOWRF WDR Order (CCRWQCB, 2011a). Monitoring activities will be consistent with the Engineering Report (2013) on the Production, Distribution and Use of Recycled Water that the County adopts pursuant to the LOWRF WDR Order (Carollo, 2013; CCRWQCB, 2011a).

Table 8-9. Recycled Water Limitations

Constituent	Units	Monthly mean	Maximum
Biochemical Oxygen Demand, 5 day	mg/L	30	90
Suspended Solids	mg/L	30	90
pH (1)	Standard unit	6.5 – 8.4	

mg/L - milligrams per liter
Notes: (1) The pH limitation is set per the Central Coast Basin Plan.
Source: CCRWQCB, 2011

8.5.2.5 LOWRF Groundwater Monitoring for Operations

On a semi-annual, annual, and biennial basis, the County will perform groundwater level measurements and collect/analyze representative samples of groundwater as discussed below.

Semi-annual Groundwater Monitoring: Representative samples of groundwater shall be collected and analyzed semi-annually from the following 14 monitoring wells: Well ID Nos. 13G, 13H, 13L5, 13Ql, 17E9, 17F4, 17N4, 18E1, 18J6, 18L3, 18L4, 18Nl, 18Rl, and 24A (CCRWQCB, 2011a), as well as from the 5 monitoring locations with nested wells at the Broderson leachfield disposal site (MW-B1 through MW-5). Furthermore, Well No. 18R1 shall be sampled for Total Coliform (MPN/100 mL) on a semi-annual basis. The semi-annual samples are to be analyzed in accordance with the following table and reported in the MRP annual report (CCRWQCB, 2011b).

Table 8-10. Semi-annual Groundwater Monitoring

Constituent	Units	Type of Sample
Depth to groundwater	Feet	measure
Total Dissolved Solids	mg/L	grab
pH	Standard unit	grab
Total Nitrogen (as N) (all forms identified) (1)	mg/L	grab
Sodium	mg/L	grab
Chloride	mg/L	grab
Sulfate	mg/L	grab
Boron	mg/L	grab

Notes: (1) All forms identified - including nitrate as nitrogen, nitrite as nitrogen, organic nitrogen, ammonia as nitrogen, Total Kjeldahl Nitrogen, and total nitrogen.

Source: CCRWQCB, 2011b

Annual Groundwater Monitoring: Annual groundwater samples shall be collected from Well Nos. 24A and 18R1 and analyzed for priority pollutants (as per California Code of Regulations, Title 22, Division 4, Chapter 15, Article 5.5, Section 64444 (organic) and Article 4, Section 64431 (inorganic), and total organic carbon on an annual basis) (CCRWQCB, 2011b). These results shall be reported in the LORWF MRP annual report.

Biennial Groundwater Monitoring: Representative samples of groundwater shall be collected and analyzed every two years from the following 12 monitoring wells: Well ID Nos. 7K3, 7l3, 7N1, 7Q1, 7R1, 8N2, 8Ma, 8Mb, 17D 18A 18B1, and 18C1 (CCRWQCB, 2011b). Additional wells may be added to the groundwater monitoring program as deemed appropriate. The biennial samples are to be analyzed in accordance with the following table and results will be reported in the LOWRF MRP annual report.

Table 8-11. Biennial Groundwater Monitoring

Constituent	Units	Type of Sample
Death to groundwater	Feet	measure
Total Dissolved Solids	mg/L	grab
pH	Standard unit	grab
Total Nitrogen (as N) (all forms identified)	mg/L	grab
Sodium	mg/L	grab
Chloride	mg/L	grab
Sulfate	mg/L	grab
Boron	mg/L	grab

mg/L - milligrams per liter
Notes: (1) All forms identified - including nitrate as nitrogen, nitrite as nitrogen, organic nitrogen, ammonia as nitrogen, Total Kjeldahl Nitrogen, and total nitrogen.
Source: CCRWQCB, 2011b

8.5.2.6 LOWRF Effluent Sampling

The County will collect representative samples of the effluent from the LOWRF and analyze the samples in accordance with the standards and specifications set forth in Table 8-12 and Table 8-13. The MRP requires routine wastewater effluent and receiving water (groundwater) sampling and analysis to verify compliance with the LOWRF WDR Order (CCRWQCB, 2011b). Results will be summarized in the LOWRF MRP annual report and SNMP Monitoring Report, as appropriate. Table 8-12 and 8-13 are collected from the same effluent pipe from the recycled water facility. Both tables are shown separate for consistency with the LOWRF WDR Order. Table 8-12 shows secondary effluent monitoring for infiltrations to the leach fields disposal sites, while Table 8-13 shows recycled water monitoring for irrigation reuse areas and the collection of the annual CEC sample.

Table 8-12. Effluent Monitoring

Constituent	Units	Type of Sample	Minimum Sampling and Analyzing Frequency
Flow Volume	mgd	metered	Daily
Total Dissolved Solids	mg/L	grab	Semi-annually
Biochemical Oxygen Demand, 5 day	mg/L	24-hr. Composite	Weekly
Total Nitrogen (as N) (all forms identified)	mg/L	grab	Monthly
Suspended Solids	mg/L	24-hr. Composite	Weekly
Settleable Solids	mL/L	grab	Daily
Chloride	mg/L	grab	Semi-annually
Sodium	mg/L	grab	Semi-annually

mgd - million gallons per day
mL/L -milliliters per liter
mg/L - milligrams per liter
Source: CCRWQCB, 2011b

Table 8-13. Recycled Water Monitoring

Constituent	Units	Type of Sample	Minimum Sampling and Analyzing Frequency
Flow Volume	mgd	metered	Daily
Biochemical Oxygen Demand, 5 day	mg/L	24-hr. Composite	Weekly
pH	Standard unit	grab	Weekly
Suspended Solids	mg/L	24-hr. Composite	Weekly
Total Coliform Or Cianisms	MPN/l00mL	grab	Daily
Turbidity (1)	NTU	metered	Continuous
Total Chlorine Residual (2)	mg/L	metered	Continuous
Ultraviolet Disinfection System (3)	-	metered	Continuous
CECs (4)	ng/L	grab	annually

MPN/100mL - Most Probable Number per 100 milliliters
mg/L - milligrams per liter
ng/L- nanograms per liter
NTU - Nephelometric Turbidity Units
CEC - Chemicals of Emerging Concern
Notes:

(1) Recycled water shall be sampled for turbidity using a continuous meter and recorder following filtration. Compliance with the 2 NTU daily average limitation shall be determined by averaging the recorded turbidity levels at a minimum of four-hour intervals over a 24·hour period. Compliance with the 5 NTU limitation shall be determined using the recorded turbidity levels taken at intervals of no more than 1.2 hours over a 24-hour period, Should the continuous turbidity meter and recorder fail, grab sampling at a minimum frequency of 1.2 hours may be substituted for a period of up to 24 hours.

(2) Continuous chlorine residual monitoring may be performed using alternative methods until such time as methods of analysis for continuous chlorine residual monitoring are approved by U.S. EPA under 40 CFR 136. Chlorine monitoring is not required if chlorine is not needed for disinfection.

(3) Routine UV disinfection system monitoring based on continuous on-line measurement shall be performed as follows:
   a. Wastewater - flow rate, fluid transmittance (after filtration and prior to UV disinfection), and turbidity (after filtration and prior to UV disinfection); and
   b. UV Disinfection System - UV intensity and lamp age in hours.

(4) According to the *June* 25*, 2010 Final Report: Monitoring Strategies for Chemicals of Concern* (CECs) *In Recycled Water*, Health based and performance-based indicator CECs and performance surrogates 17B-estradiol, triclosan, caffeine, NDMA, gemfibrozll, DEET, lopromide, and sucralose.

Source: CCRWQCB, 2011b

8.5.2.7 LOWRF Monitoring Report

For the Los Osos SNMP, the County will utilize the LOWRF MRP annual report, which is required by January 30th of each year (CCRWQCB, 2011b). This annual report should include tabulated monitoring results and a narrative description of sampling procedures and analytical results (general mineral constituents, including all forms of nitrogen, depth to groundwater, and groundwater flow direction) and water quality trends (changes in water quality and impacts from sea water intrusion).

8.6 GROUNDWATER MONITORING PROGRAMS SUPPLEMENTAL DATA

The SNMP Monitoring Program will include supplemental data from various ongoing programs in the Basin. The data collected from other special/technical studies conducted in the Basin for groundwater quality and/or water level monitoring includes data from local water purveyors, CASGEM, Morro Bay National Estuary Program, LOWRF Recycled Water Management Plan (RWMP) for the California Coastal Commission, GAMA Geotracker, and Irrigated Lands Regulatory Program Sites. The SNMP Monitoring Program for this Basin will incorporate data collected by these other monitoring programs to the extent the data are useful and reasonable.

8.6.1 Recycled Water Management Plan

The California Coastal Commission requires, in their Coastal Development Permit A-3-SLO-09-055/069, the preparation of a Basin RWMP. The RWMP Monitoring Program will likely rely heavily on the LOBP as a source of data for annual reports, as well as for the required baseline assessment, establishing success criteria, and ensuring its objectives are achieved. As the owner and operating entity for the LOWRF, the RWMP will be prepared by the County for submission to the Coastal Commission Executive Director, in cooperation with the water purveyors. The report states that the Annual Report will be prepared for each calendar year, January 1 through December 31, for each year that the LOWRF operates. The elements required in the RWMP include the following:

- **Recycled Water Reuse Program -** identify the quantity of recycled water available at start-up and at build-out. Also, outline the intended uses that will provide the groundwater Basin with the highest level of benefit and the various regulations pertaining to proper treatment and reuse of recycled water.
- **Water Conservation Program -** urban water use efficiency with water conservation measures.
- **Monitoring Programs –** Two programs are included in the monitoring program.
    - A. **Groundwater Monitoring Program** - The groundwater monitoring program for the LOWRF is to collect and organize groundwater data on a regular basis for use in management of the Basin in accordance with MRP for the LOWRF WDR Order.
    - B. **Environmental Monitoring Program** (EMP)- The goal of the EMP is to identify any changes in wetland and riparian habitat areas and habitat values potentially related to decommissioning of the septic systems throughout the community of Los Osos, and to provide remedial actions as necessary to address any such changes. This goal will be accomplished through regular monitoring, data analysis, and adaptive management for the life of the project. Specifically, the EMP is to quantitatively and qualitatively identify changes in wetland, stream, creek, riparian, and marsh habitats.
- **Reporting and Adaptive Management Program -** is to provide the final "check and balance" for the Recycled Water Management Program to ensure that the overall objectives of the groundwater Basin are being met.

Details and requirements for each program listed above are discussed in the RWMP.

8.6.2 County Semi-Annual Water Level Monitoring Program

San Luis Obispo County Flood Control and Water Conservation District (District) has been monitoring groundwater levels countywide on a semi-annual basis (spring and fall) for more than 50 years to support general planning and for engineering purposes. The monitoring takes place from a voluntary network of production wells. The voluntary monitoring network has changed over time as access to wells has been lost or new wells have been added to the network.

Los Osos Basin currently has approximately 49 wells in the District's Groundwater Level Monitoring Program. This information is used in the groundwater monitoring and reporting program for the Basin. Wells are measured by the District and other participating agencies. The District coordinates with local, state, and federal agencies to develop better information on groundwater level monitoring and comply with current monitoring and report requirements, such as California Statewide Groundwater Elevation Monitoring (CASGEM) Program.

8.6.3 CASGEM - Senate Bill X7-6

CASGEM is another groundwater basin management measure that is currently being implemented in the Basin by the District. In 2009, the California Legislature amended the California Water Code (§10920 et seq.) with *Senate Bill X7-6 (*SBx7-6), which mandates a statewide groundwater elevation monitoring program to track seasonal and long-term trends in groundwater elevations in California's groundwater basins. In accordance with this amendment to the Water Code, DWR developed the CASGEM program with the intent to establish a permanent, locally-managed program of regular and systematic monitoring in all of California's alluvial groundwater basins. For the first time in California, collaboration is occurring between local monitoring parties and DWR to collect groundwater elevations statewide and to make this information available to the public.

For the Los Osos Basin, not all of the wells in the LOBP Groundwater Monitoring Program would be eligible for use in the CASGEM. Currently, municipal supply wells are excluded from CASGEM due to infrastructure security concerns from CDPH. The LOBP Groundwater Monitoring Program in the Basin includes municipal supply wells because of their location in key areas of the Basin and the ability to maintain consistent monitoring through the water purveyors (ISJ Group, 2015).

The County currently has nine CASGEM wells in the program for Los Osos Basin. Groundwater levels are collected semi-annually (Water Code section 10932) by the District and entered into the DWR CASGEM website.

8.6.4 Title 22 Drinking Water Program

The Los Osos water purveyors monitor many constituents in groundwater on a schedule determined by the State Water Board's Division of Drinking Water (formerly CDPH), and relevant data from those monitoring efforts will be incorporated into the LOBP annual report, as appropriate. The State Water Board's Division of Drinking Water regulates California's public drinking water systems to ensure the delivery of safe drinking water to the public. The State Water Board defines the public drinking water system in Section 116275 of the California Safe Drinking Water Act, which is contained in Part 12, Chapter 4 of the California Health and Safety Code as a system "…for the provision of water for human consumption through pipes or other constructed conveyances that has 15 or more service connections or regularly serves at least 25 individuals daily at least 60 days out of the year". Private domestic wells, wells associated with drinking water systems with less than 15 residential service connections, and irrigation wells are not regulated by the State Water Board's Division of Drinking Water (RMC, 2015). County-level public health and well permitting agencies regulate individual domestic wells, local small water system wells (2 to 4 residential service connections), and State small water system wells (5 to 14 residential service connections) to varying degrees (RMC, 2015).

As shown in Table 8-14, the State Water Board's Division of Drinking Water enforces the monitoring and data requirements established in Title 22 of the California Code of Regulations for drinking water wells. As discussed in Chapter 3, Title 22 sets the regulatory limits, known as MCLs, which is the legal threshold limit on the amount of a constituent that is allowed in public water systems under the Safe Drinking Water Act. Monitoring data collected by water purveyors are collected and managed in accordance with the California Code of Regulations (CCRs), Title 22 Drinking Water Program for the ongoing regular monitoring of shallow and deeper production zones.

Table 8-14. California Code of Regulations, Title 22 Drinking Water Well Monitoring Program

Program Origin	Title 22 of the California Code of Regulations: http://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/Lawbook.shtml
Responsible Agency	Public water system well owners meeting the regulation connection definitions.
Well Permits	Active drinking water wells are permitted by the State Water Board's Division of Drinking Water.
Constituents and Frequency	Public water system wells are sampled for many parameters, including coliform bacteria/ e-coli, volatile organic compounds, non-volatile synthetic organic compounds, inorganic chemicals (such as hexavalent chromium), radionuclides, disinfection byproducts, and other general physical constituents. The constituents monitored and the frequency of monitoring varies based on the well location, size of the water system, and history of water quality results. Drinking water wells must be sampled in accordance with monitoring schedules (http://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/Monitoring.shtml) enforced by the State Water Board's Division of Drinking Water.
Other Media Monitored and Monitoring Locations	Water samples are collected at various locations throughout the distribution system, such as: • Raw water at the well, • Service connections to other systems or imported water service connections, • Designated sampling points along the distribution piping, • Effluent of water storage tanks and blending tanks, and • Effluent of treatment plants.
Reporting and Databases	• Analytical results are submitted directly to the State Water Board's Division of Drinking Water database as Electronic Database Files: http://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/EDT.shtml • Annual Consumer Confidence Reports issued by the water system to their drinking water customers • Title 22 monitoring data can be downloaded from the State Water Board's Division of Drinking Water website: http://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/EDTlibrary.shtml • Title 22 monitoring data as well as other water quality data are available at the Groundwater Ambient Monitoring and Assessment (GAMA) Program website: http://geotracker.waterboards.ca.gov/gama/
QA/QC Program	• Provided by certified laboratories and their established quality assurance and quality control (QA/QC) programs • Laboratories utilize U.S Environmental Protection Agency (EPA) method acceptance criteria and laboratory internal controls for QC parameters, such as preparation blanks, surrogates, spikes, duplicates and laboratory control samples

Source: Modified from RMC, 2015

8.7 SURFACE WATERS MONITORING

As discussed in Chapter 3, the Morro Bay Estuary abuts the community of Los Osos along its northern and western perimeters. Los Osos Creek meanders east of the community and discharges to Morro Bay at the northeastern tip of Los Osos. Morro Bay is listed as an impaired waterbody in the Clean Water Act 2006 303(d) list.

8.7.1 LOWRF Environmental Monitoring Program Monitoring

As stated in the LOWRF WDR Order (2011), "*A DNA study, completed on March 29, 2002, identified humans as the primary source of coliform bacteria in freshwater seeps from shallow groundwater along the estuarine edge of Los Osos. On December 13, 2002, the Central Coast Water Board adopted a pathogen Total Maximum Daily Load (TMDL) for Morro Bay, including an associated implementation plan to achieve TMDL goals. Completion of the community wastewater system in Los Osos is a vital component of the Pathogen TMDL Implementation Plan. Los Osos Creek is impaired by nutrients and priority organic pollutants. However, based on local topography and direction of groundwater flow, such impacts are likely the result of surface runoff to Los Osos Creek rather than seepage of groundwater. On December 3, 2004, the Central Coast Water Board adopted a nutrient TMDL for Los Osos Creek, Warden Creek, and Warden Lake Wetland. The TMDL became effective on March 1, 2005*" (CCRWQCB, 2011a). The TMDL for the Warden Creek branch of Los Osos Creek is set at a maximum concentration for nitrate of 10 mg/L-N in receiving water to protect the municipal beneficial use (RWQCB, 2004).

Although the LOWRF does not include discharges to surface waters, protection of these beneficial uses is important. Surface water quality monitoring will be a part of the annual Environmental Monitoring Program (EMP) included in the RWMP Monitoring Program for the LOWRF per the California Coastal Commission CDP (A-3-SLO-09-055/069) requirements, as mentioned in Section 8.6.1. The goal of the EMP is to identify any changes in wetland and riparian habitat areas and habitat values potentially related to decommissioning of the septic systems throughout the community of Los Osos, and to provide remedial actions as necessary to address any such changes. This goal will be accomplished through monitoring, data analysis, and adaptive management. The EMP will identify changes in wetland, stream, creek, riparian, and marsh plant and animal abundance.

EMP monitoring locations (primary and secondary) consist of surface water features were identified by the 2009 LOWWP Environmental Impact Report hydrologic analysis. The primary surface waters to be monitored in the Basin are Los Osos Creek, Willow Creek, and bay-front wetlands. The primary sites will provide monitoring information on western Basin bay front wetlands and on eastern Basin Willow Creek wetland and riparian areas. The secondary sites will provide additional qualitative information and photo reference data for use in assessing overall habitat conditions and trend analysis. All monitoring sites are in the vicinity of existing groundwater monitoring well locations, and data and trends documented during annual monitoring efforts can be correlated with available monitoring well information.

The LOWRF waste discharge requirements will result in improved water quality in the Basin, since the advanced tertiary treatment will remove nitrates, among other constituents, to concentrations below applicable water quality objectives, and because discharges from individual onsite systems that have polluted groundwater and contaminated surface water will cease upon completion and operation of the LOWRF (CCRWQCB, 2011a).

8.7.2 Morro Bay National Estuary Program

The Morro Bay National Estuary Program (MBNEP) is another monitoring program for surface waters and the Morro Bay estuary. The MBNEP works to protect important natural areas within and around the estuary and, when needed, restore areas that have been degraded. Healthy habitats provide homes to many plants and animals, protect water quality in the estuary, and preserve the scenic beauty and recreational opportunities in the bay.

MBNEP staff and volunteers monitor the bay, tracking long-term trends to determine the effectiveness of specific conservation projects and collecting data to prioritize future projects, evaluating the effectiveness of existing projects, and assessing long-term changes in health. The MBNEP prepares an annual stormwater and annual sediment monitoring report with data collected at sites throughout the bay and at the creek mouths. MBNEP collects the following samples:

- *E. coli* (creeks and bay)
- Enterococcus (bay)
- Turbidity (creeks)
- Dissolved oxygen (bay and creeks)
- Specific conductance (creeks)
- Salinity (bay)
- pH (creeks)
- Temperature (bay and creeks)
- Nitrates (creeks)
- Orthophosphates (creeks)
- Macroinvertebrates (creeks)
- Suspended sediment concentration (creeks)
- Discharge (creeks)
- Continuous water depth measurements (creeks)

Protocols describing sample collection, analysis and interpretation are contained in the program's Quality Assurance Project Plan (QAPP). This plan follows the 24-section Surface Water Ambient Monitoring Program (SWAMP) format for QAPPs. It is updated on an annual basis and reviewed by the EPA's Office of Quality Assurance, as well as the QA Officer for the Regional Water Board. (MBNEP, 2015a)

The Morro Bay Water Science Lab (MBWSL) conducts ongoing accuracy checks of equipment and procedures throughout the year. Balances are routinely checked with calibration weights and re-calibrated annually by a certified technician. The MBWSL operating procedures, protocols, and quality assurance measures are documented in detail as part of the Estuary Program's QAPP which is updated annually and undergoes review by the EPA and State Water Board. (MBNEP, 2015b)

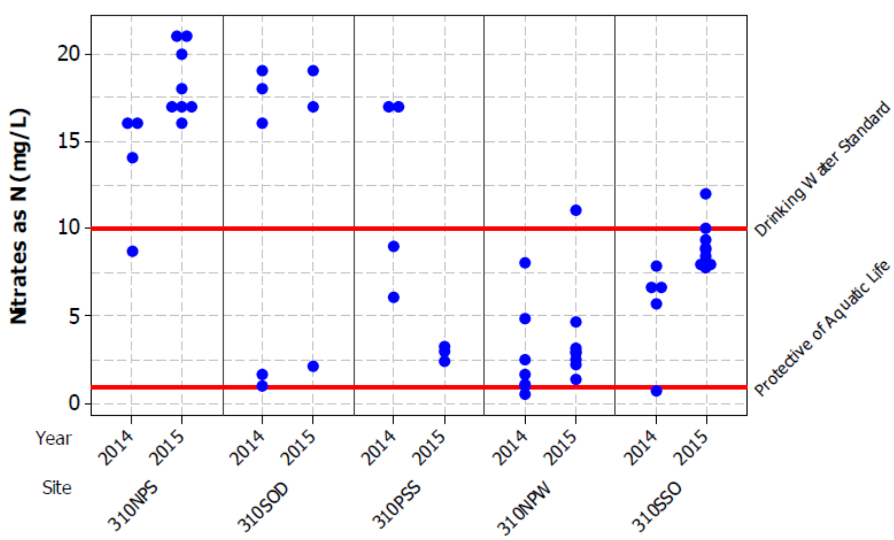
8.7.2.1 MBNEP - Nitrate Monitoring

Morro Bay, a small estuary of 2,300 acres, is fed by Chorro and Los Osos Creeks. The Estuary Program has been collecting monthly samples for analysis of nitrate as nitrogen since April 2014 (pre-operations of the LOWRF). The samples are analyzed by a state-certified lab and the results included in the MBNEP annual report. The following map shows the locations of the bay shoreline monitoring sites (Figure 8-9).

Figure 8-9. Shoreline Monitoring Locations for Morro Bay (Source: MBNEP, 2015)

Monthly monitoring data from April 2014 through September 2015 are summarized in the following graph (Figure 8-10). The results are compared to the drinking water standard of 10 mg/L nitrate as N and the level protective of aquatic life, 1 mg/L (MBNEP, 2015). The scatter plot data for the same sites show the variability in the data.

Figure 8-10. Morro Bay Shoreline Freshwater Seeps (MBNEP, 2015)



When the LOWRF is operational, the expected impacted to the estuary is a reduction in nutrient and bacteria inputs from the freshwater seeps that border the Los Osos shoreline (MBNEP, 2015). The Estuary Program will continue monitoring for at least a year after the LOWRF is operational to determine if the nitrate concentrations in bay shoreline sites have reduced.

8.8 STORMWATER MONITORING

Stormwater management at the LOWRF is graded to collect and direct stormwater into catch basins followed by a retention basin. All of the stormwater that is captured in the recycled water facility is pumped to the headworks for treatment.

8.8.1 Stormwater Management Program (SWMP)

In 2003, the EPA Phase II regulations for Municipal Separate Stormwater Systems (MS4) communities went into effect which included the community of Los Osos. The County and Los Osos Community Services District (LOCSD), is classified as a non-traditional MS4, prepared and submitted plans the State Water Board in accordance with the regulations. The goal of the stormwater program are to:

- Reduce the discharge of pollutants to the "maximum extent practicable" (MEP)[1]
- Protect water quality; and
- Satisfy the appropriate water quality requirements of the Clean Water Act.

The County's stormwater program encompasses all of Los Osos except for a few facilities maintained by the LOCSD. The County remains the overall governing authority for planning, land use, grading, building permits, and roads with regard to storm water runoff management.

In 2015, the California Stormwater Quality Association (CASQA) developed *A Strategic Approach to Planning for and Assessing the Effectiveness of Stormwater Programs* (guidance documents), which established six outcome levels for effective municipal stormwater programs. The BMPs implemented by the County are primarily aimed at methods for source control and have little performance monitoring data, making it difficult to produce quantifiable estimates of expected performance (e.g., load reductions resulting from source control implementation) (Geosyntec Consultants, 2016). Therefore, the BMPs focus on the first 3 outcome levels of the Guidance Document: (1) Stormwater Program Activities; (2) Barriers & Bridges to Action; and (3) Target Audience Actions (CASQA, 2015). These outcome levels are also less quantifiable than the other outcome levels in the Guidance Document and are instead directed at the desired results of effective stormwater program implementation such as activity documentation, increased awareness, and behavioral changes regarding source control of pollution. To assess the effectiveness of BMPs, specific assessment methods could be implemented, such as:

- Confirmation of BMP implementation/completion;
- Tabulation of actions, participants, or items associated with each BMP;
- Representative surveys of a population used to understand the attitudes, beliefs, or knowledge of that group;
- Inspections/Direct Observations, particularly for construction sites, industrial facilities, etc.; and
- Monitoring of water quality (Geosyntec Consultants, 2016).

Additionally, the WAAP includes a sediment monitoring program in the Morro Bay watershed, which identifies 10 sites to monitor for TMDL target compliance. The Regional Water Board and MBNEP Volunteer Program will perform monitoring activities, including 10 year rolling averages of residual pool volume, median diameter, percent of fine fines, percent of coarse fines, and tidal prism volume.

[1] MEP is the performance standard specified in Section 402(p) of the Clean Water Act

The NPDES Phase II Small MS4 General Permit requires that the County submit annual reports to the Regional Water Board by October 15th of each year. This annual report may include:

- The status of compliance with the Phase II Permit conditions;
- An assessment of the appropriateness and effectiveness of the identified BMPs, including new BMPs identified in the WAAP;
- The status of all identified measurable goals;
- The results of information collected and analyzed, including monitoring data, if any, during the reporting period (currently July 1 – June 30);
- A summary of the stormwater activities planned during the next reporting cycle; and
- A summary of any meetings or other correspondence that the County has had with the Regional Water Board staff and other stakeholders regarding progress of the TMDLs (Geosyntec Consultants, 2016).

8.9 OTHER MONITORING PROGRAMS

There are many other historical, existing or proposed environmental monitoring programs within the Morro Bay watershed and Basin region. These programs are summarized below for reference.

8.9.1 Irrigated Lands Regulatory Program

The Irrigated Lands Regulatory Program (ILRP) was initiated in 2003 to prevent agricultural runoff from impairing surface waters, and in 2012, groundwater regulations were added to the program. The Regional Water Board adopted Agricultural Order No. R3-2012-001 (2012), a *Conditional Waiver of Waste Discharge Requirements for Discharges from Irrigated Lands* (Agricultural Order). The goal of the ILRP is to protect surface water and groundwater quality and to reduce impacts of irrigated agricultural discharges to waters of the State. This includes preserving both the human right to safe, clean, affordable, and accessible water, and a healthy and sustainable irrigated agriculture.

The permit requires that growers need to implement practices to reduce nitrate pollution into groundwater and improve surface receiving water quality. Studies indicate that fertilizer from irrigated agriculture is a source of nitrate pollution in drinking water wells and that significant loading of nitrate can occur as a result of agricultural fertilizer (Carle, Esser, and Moran, 2006). A range of pollutants can generally be found in runoff from irrigated lands, such as pesticides, fertilizers, salts, pathogens, and sediment. Requirements for individual growers are structured into three tiers (Tier 1, 2, and 3) based on the relative risk their operations pose to water quality. Growers enroll and pay fees, as well as meeting monitoring and reporting requirements according to their tier level.

Growers are required to implement groundwater monitoring, either individually or as part of a cooperative regional monitoring program. Growers electing to implement individual monitoring (i.e., not participating in the regional monitoring program) are required to test all on-farm domestic wells and the primary irrigation supply well for nitrate or nitrate plus nitrite, and general minerals (such as TDS, sodium, chloride and sulfate).

Data from the Agricultural Order is available to the public in GeoTracker GAMA with well locations obfuscated to within a one-half mile radius of their actual location. GAMA GeoTracker data is not included in this SNMP given that the Agriculture Order was emerging with sampling updates at the time the SNMP was being developed. Also, the monitoring/reporting data varies from what tier level was assigned to the irrigated lands. Only, a few data samples have been collected in Los Osos under the Agriculture Order. Consequently, any subsequent analyses should include these data to more accurately reflect existing groundwater quality conditions in the agricultural area of the Basin.

8.9.2 GAMA/Geotracker Groundwater Monitoring

The Groundwater Ambient Monitoring and Assessment (GAMA) Program is California's comprehensive groundwater quality monitoring program that was created by the State Water Board and expanded by the Groundwater Quality Monitoring Act of 2001, (http://www.swrcb.ca.gov/water_issues/programs/gama/). The main goals of GAMA Geotracker is to improve statewide groundwater monitoring, increase the availability of groundwater quality information to the public, and better understand and identify risks to groundwater resources.

GeoTracker GAMA is a publicly-accessible, on-line groundwater information system that integrates and displays water quality data on an interactive, searchable map (http://geotracker.waterboards.ca.gov/gama/). Its analytical tools and reporting features help users assess groundwater quality and identify potential groundwater issues. GeoTracker GAMA contains over 125 million data records from different sources such as cleanup sites, well logs, State Water Board's Division of Drinking Water quality data from public water system wells (discussed in the previous section), water levels from the DWR, California Department of Pesticide Regulation, GAMA Priority Basin Project, GAMA Domestic Well Project, GAMA Special Studies Project, and the Irrigated Lands Regulatory Program. GeoTracker GAMA also includes water quality compliance monitoring data for on-farm domestic wells and irrigation supply wells associated with the ILRP.

8.9.3 Los Osos Nitrate Monitoring Program

The Los Osos Nitrate Monitoring Program operated from 1982 through 1998 under County staff, was reorganized in 2002, and was operated from 2002 through 2006 by LOCSD (ISJ Group, 2015). The program consisted of quarterly water level and water quality monitoring at 25 shallow groundwater wells across the Basin. Water quality parameters included all forms of nitrogen, along with minerals.

8.9.4 Septic System Decommissioning Planning and Reuse Plan

Since 2016, septic systems are being decommissioned in the wastewater service area of Los Osos, which are source of pollution in the groundwater. Property owners have options for decommission their septic systems by either abandoning the septic system in place or repurposing it for a number of sustainable uses which benefit water resources, such as capturing rain water run-off and returning it to the groundwater supply. The County Septic System Decommissioning and Reuse Plan provides guidance for property owners in planning for a range of septic system repurposing solutions. Rain water capture and infiltration to groundwater will be a comparable cost to abandoning in-place, while sustainably benefiting local water resources. Reusing septic tanks to increase water supply for irrigation or toilet flushing are also discussed in the plan. Septic tanks could provide about 1,000 gallons of storage for stormwater reuse, if repurposed, such as a rain water capture basin for roof runoff or for recycled water storage

Annual water savings for this program are estimated to be 4,500 gallons per year per unit, depending on the number of participants and irrigation events. The cost of this measure is estimated to be approximately $1,800/ac-ft for a Basin savings of approximately 100 to 140 ac-ft/year if widely implemented. (Wallace Group, 2016)

8.10 OTHER PROGRAMS

Other existing or planned monitoring programs include the following:

- USEPA National Monitoring Program
- Regional Water Board - Ambient Monitoring
- Regional Water Board - Storm Water Runoff Monitoring
- Regional Water Board - Total Maximum Daily Load Monitoring (Future)
- Los Osos Habitat Conservation Plan Monitoring (Future)

- 2014-2015 Lower Aquifer Monitoring Program. Water levels measured semi-annually; program ended in 2015.

The SNMP Monitoring Program will incorporate data collected from these other monitoring programs to the extent useful and reasonable. These other monitoring programs will provide additional context to the SNMP; however, implementation of the SNMP and associated monitoring requirements may be met without relying on these other programs.

8.11 SNMP GROUNDWATER QUALITY MONITORING PROGRAM

As previously noted throughout this chapter, the SNMP Monitoring Program is built from these existing groundwater monitoring programs. The County will coordinate the data collection and prepare the SNMP report for the Regional Water Board every three years. Accordingly, the proposed SNMP Monitoring Program is required by the LOWRF WDR Order per the Recycled Water Policy (CCRWQCB, 2011a).

8.11.1 SNMP Groundwater Monitoring

Groundwater monitoring locations for the Los Osos SNMP will be the same as those used in exiting monitoring programs; specifically, the LOBP annual groundwater monitoring report for the Los Osos BMC and the LOWRF MRP annual report for the LOWRF WDR.

8.11.1.1 Groundwater Level Monitoring Locations

Groundwater monitoring locations are measured semi-annually or annually for the LOBP annual groundwater monitoring report and the LOWRF MRP annual report (CCRWQCB, 2011b).

- **Los Osos BMC -** Figure 8-4 through Figure 8-6 shows the groundwater level monitoring performed at 73 wells. Table 8-1 summarizes the location area and number of wells for groundwater level measurement, including 28 First Water wells, 15 Upper Water wells, and 30 Lower Aquifer wells. In addition, 12 existing wells were added to the LOBP network to help improve the quality and consistency of basin water level contours, which are used for groundwater storage calculations (CHG, 2016; CHG, 2017).

- **LOWRF MRP** – Figure 8-7 through Figure 8-8 shows the groundwater level monitoring performed at approximately 30 wells for the LOWRF MRP. These wells are located in the First Water or Upper Aquifer, and the majority of these wells are already sampled in the LOBP Annual Groundwater Monitoring Report by the Los Osos BMC. For cost efficiency, the overlapping monitoring locations will be reviewed by the County and Los Osos BMC.

8.11.1.2 Groundwater Quality Sampling

- **Los Osos BMC** – Table 8-5 shows the constitutes analyzed in the 2015 annual report from 30 designated wells which are distributed laterally and vertically across the Basin. The monitoring frequency for water quality sampling and analyses performed under the LOBP Groundwater Monitoring Program will generally be once per year in October (Fall), when groundwater levels are seasonally low and many water quality constituents have historically been at higher concentrations than their corresponding Spring measurement. Lower Aquifer groundwater monitoring will also be performed in April (Spring) as a means of tracking seawater intrusion in greater detail.

- **LOWRF MRP -** ***Groundwater Monitoring for Operations*****.** On a semi-annual, annual, and biennial basis, the County will collect and analyze representative samples of groundwater as discussed is Section 8.5.2.5, Table 8-10 through Table 8-13. Monitoring wells may be added to the groundwater monitoring program as deemed appropriate by the Regional Water Board Executive Officer (CCRWQCB, 2011b).

Semi-annual Groundwater Monitoring: Representative samples of groundwater shall be collected and analyzed semi-annually from the following 14 monitoring wells: Well ID Nos. 13G, 13H, 13L5, 13Ql, 17E9, 17F4, 17N4, 18E1, 18J6, 18L3, 18L4, 18Nl 18Rl , 24A, and the 5 monitoring locations with nested wells by Broderson (MW-B1 through MW-5). The samples are analyzed for pH, nitrate as nitrogen, nitrite as nitrogen, organic nitrogen, ammonia, Total Kjeldahl Nitrogen, total nitrogen, total dissolved solids (TDS), sodium, chloride, sulfate, and boron.

Annual Groundwater Monitoring: In addition, representative groundwater samples shall be collected from Well Nos. 24A and 18R1 and analyzed for priority pollutants (such as California Code of Regulations, Title 22, Division 4, Chapter 15, Article 5.5, Section 64444 (organic) and Article 4, Section 64431 (inorganic), and total organic carbon on an annual basis).

Biennial Groundwater Monitoring: Representative samples of groundwater shall be collected and analyzed every two years from the following 12 monitoring wells: Well ID Nos. 7K3, 7l3, 7N1, 7Q1, 7R1, 8N2, 8Ma, 8Mb, 17D 18A 18B1, and 18C1. The biennial samples are to be analyzed for pH, nitrate as nitrogen, nitrite as nitrogen, organic nitrogen, ammonia as nitrogen, Total Kjeldahl Nitrogen, and total nitrogen, total dissolved solids (TDS), sodium, chloride, sulfate, and boron.

- **LOWRF Effluent Sampling -** The County will collect representative samples of the effluent downstream of any return flows and analyze the sample(s) in accordance with the standards and specifications set forth in the WDR Order. CECs will be sampled annually from the effluent of the treatment facility.

Some of the constituents of analysis that are part of the LOBP Groundwater Monitoring Program are not included in the LOWRF Baseline Groundwater Monitoring Program. The missing constituents include specific conductance, alkalinity (bicarbonate, carbonate, and total), calcium, magnesium, and potassium. For efficiency, a recommendation in the Los Osos BMC 2015 Annual Report was made to add LOBP Groundwater Monitoring Program constituents to the Fall LOWRF Groundwater Monitoring Program monitoring event for wells that are part of both programs. (CHG, 2016)

8.11.2 SNMP Surface Water Monitoring

Surface water monitoring will be performed in accordance with the California Coastal Commission CDP annual report. The RWMP includes a report from the Environmental Monitoring Program (EMP), performed by County Staff. Surface water monitoring may use supplemental data from the MBNEP. Although the LOWRF permit does not include discharges to surface waters, protection of these beneficial uses is important as the discharges may have direct and indirect impacts to surface waters.

The environmental monitoring will include appropriate monitoring targets for groundwater and surface waters connectivity with adjacent surface waters. The surface waters to be monitored in the Basin are Los Osos Creek, Willow Creek, and bay-front wetlands. The County will collect representative samples in order to ensure compliance with effluent limitations and water quality objectives of the receiving water. The primary sites will provide monitoring information on western Basin bay front wetlands and on eastern Basin Willow Creek wetland and riparian areas. The secondary sites will provide additional information and photo reference data for use in assessing overall habitat conditions and trend analysis over the life of the project. All monitoring sites are in the vicinity of existing groundwater monitoring well locations, and data and trends documented during annual monitoring efforts can be correlated with available monitoring well information.

EMP implementation will establish baseline conditions for wetland and riparian resources; ensure annual monitoring and trend analysis of wetland and riparian habitat areas; provide adaptive management measures for remedial action; and maintain the current function and values of wetland and riparian habitats.

8.11.3 SNMP Monitoring - Sampling Procedures, Analysis, and Quality Assurance

Analysis and reporting of groundwater quality data should be evaluated on a regular basis for trends and exceedances of water quality objectives.

Quality Assurance/Quality Control (QA/QC)

A Quality Assurance Project Plan (QAPP) was prepared and describes the County's groundwater sampling activities in the Los Osos Basin. This QAPP is intended to establish best management practices related to quality assurance and quality control for collecting and analyzing groundwater samples. This includes sampling BMPs that is conducted in accordance with industry accepted standard protocols and analyses that are conducted by California-certified laboratories (see Appendix G).

8.12 SUMMARY AND RECOMMENDATIONS

The SNMP Groundwater Quality Monitoring Program includes descriptions of the groundwater sampling locations, sampling frequency, constituents monitored, sampling protocols and associated quality assurance and quality control (QA/QC) procedures, data analysis, evaluation criteria, and reporting procedures. The Los Osos SNMP may tier off from LOWRF WDR Order, once approved by the Regional Water Board. The SNMP will combine information with the appropriate data from the LOBP annual groundwater monitoring report and other monitoring programs, if necessary.

All publicly available groundwater quality data collected through approximately 2016 were compiled to assess Basin water quality for the SNMP. Existing groundwater quality data were found to be adequate to support the antidegradation analysis for the SNMP. Data from the LOWRF MRP annual report and the Los Osos BMC annual groundwater monitoring report constitutes the proposed SNMP Groundwater Quality Monitoring Program.

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9.6 Chapter 7 – Implementation Measures

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9.9 Appendix B – Water Quality Data

Appendix B1

Cleath-Harris Geologists (CHG), & Wallace Group. (2016*). Los Osos Basin Plan Groundwater Monitoring Program - 2015 Annual Monitoring Report*. San Luis Obispo, CA.

Appendix B2

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Appendix B3

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9.10 Appendix C – Antidegradation Analysis

Cleath-Harris Geologists (CHG). (2017). Los Osos Groundwater Basin Assimilation Capacity and Antidegradation Analysis. San Luis Obispo, CA.

9.11 Appendix D – Natural Loading and Evaporative Enrichment Calibration

Cleath-Harris Geologists (CHG). (2017). Los Osos Groundwater Basin Assimilation Capacity and Antidegradation Analysis. San Luis Obispo, CA.

9.12 Appendix E – Mass Loading Spreadsheet Model Results – Tables with Sample Calculations

Cleath-Harris Geologists (CHG). (2017). Los Osos Groundwater Basin Assimilation Capacity and Antidegradation Analysis. San Luis Obispo, CA.

9.13 Appendix F – Mass Loading Spreadsheet Model Results – Graphs

Cleath-Harris Geologists (CHG). (2017). Los Osos Groundwater Basin Assimilation Capacity and Antidegradation Analysis. San Luis Obispo, CA.

9.14 Appendix H – Field Methods

Cleath-Harris Geologists (CHG), & Wallace Group. (2016). *Los Osos Basin Plan Groundwater Monitoring Program - 2015 Annual Monitoring Report*. San Luis Obispo, CA.

APPENDIX A

SNMP Outreach Material

TO: **Los Osos Basin Management Committee**

FROM: **Cathy Martin, SLO County Public Works Water Resources Engineer**

DATE: **September 14, 2016**

SUBJECT: ITEM 7b –PRESENTATION OVERVIEWING THE SALT AND NUTRIENT MANAGEMENT PLAN ELEMENTS

Recommendations

Receive a brief presentation summarizing elements required in a Salt and Nutrient Management Plan (SNMP) related to the Los Osos Wastewater Project and Recycled Water Permit.

Discussion

In February 2009, the State Water Resources Control Board (SWRCB) adopted Resolution No. 2009-011, which established a statewide Recycled Water Policy (Policy). The Policy requires the development of a SNMP for the Los Osos Groundwater Basin, as it relates to the Los Osos Wastewater Project Recycled Water Permit. In response, San Luis Obispo County is preparing the SNMP with assistance from Cleath and Harris Geologist (Consultants).

The objective of the SNMP is to manage salts/nutrients in a manner that ensures attainment of water quality objectives and protection of beneficial uses. It will describe the established framework under which salt and nutrient issues can be managed. The SNMP will also streamline the permitting process of new recycled water projects, once approved by the Central Coast Regional Water Quality Control Board (RWQCB).

County Staff will present an overview of the elements required in an SNMP. The SNMP is being prepared in accordance the RWQCB discussions and the State's Recycled Water Policy, and will use numerous reference reports, including the *Los Osos Groundwater Management Plan* and *Los Osos Groundwater Monitoring Program - 2015 Annual Report*. Once a draft SNMP is available, County Staff will present an overview to the BMC and to the community, as outlined below.

Tentative Schedule	Key Milestones & Public Meetings
Mid- November 2016	Publish Draft SNMP followed by a 21 calendar day public comment period
November 16, 2016	BMC Meeting – Present Summary of Draft SNMP
Late November 2016	Host Community Meeting – Present Draft SNMP
December 12, 2016	Request letters of support from BMC and water purveyors
January 2016	Present to the County Board of Supervisors/RWQCB

1

Recycled Water Policy

Salt and Nutrient Management Plan Elements

September 21, 2016

2

Background Overview

- In February 2009, the State Water Resources Control Board (SWRCB) adopted Resolution No. 2009-011, which established a statewide Recycled Water Policy (Policy).
  - The Policy requires the development of a Salt and Nutrient Management Plan (SNMP) for the Los Osos Water Recycling Facility.
- The SNMP will allow the facility to enroll in the Statewide 2014 General Waste Discharge Requirements for Recycled Water and will streamline the permit process. This permit will also allow the start of supplying recycled water for agriculture irrigation.

Element Categories

3

Groundwater Basin Description/Environmental Setting

4

- Geology
- Hydrogeology/hydrology
- Existing/background groundwater and quantity conditions
- Beneficial uses

Source Analysis

5

- Conceptual model
- Water balance
- Salt and nutrient balance
  - source identification/
  - loading/concentration analysis
- Antidegradation Analysis

Monitoring Plan

6

- Water quality/Salt and nutrient monitoring
- Water balance monitoring
- Trend analyses
- Data management and reporting

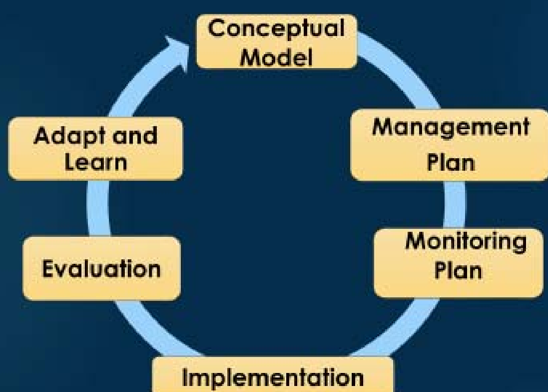
Goals

Quantitative

- Sustainable salt/water balance plan(s)
- Load reduction
- Water conservation
- Water recycling
- Beneficial use

Implementation

- Performance measures
- Adaptive Management Plan



Next Steps

9

Tentative Schedule - Key Milestones / Public Meetings

Mid Nov.	Publish Draft SNMP followed by a 21 calendar day public comment period
Nov. 16th	BMC Meeting Present Summary of Draft SNMP
Late Nov.	Host Community Meeting Present Draft SNMP
Dec. 12th	Obtain Letters of Support from the BMC and water purveyors

Questions?

10

Optimization of Beneficial Recycled Water

Protection of Water Resources

To: Los Osos Basin Management Committee

From: Catherine Martin, SLO County Public Works Water Resources Engineer

DATE: May 17, 2017

SUBJECT: Item #: PRESENTATION ON THE LOS OSOS BASIN SALT AND NUTRIENT MANAGEMENT PLAN

Recommendations
Staff recommends that the Committee receives a presentation from County Public Works Staff on the Los Osos Basin Salt and Nutrient Management Plan (SNMP).

Discussion
In February 2009, the State Water Resources Control Board (SWRCB) adopted Resolution No. 2009-011, which established a statewide Recycled Water Policy (Policy). The Policy requires the development of a Salt and Nutrient Management Plan (SNMP) for the Los Osos Groundwater Basin, as it relates to the Los Osos Wastewater Project's Recycled Water Permit. The objective of the SNMP is to manage salts/nutrients in a manner that ensures attainment of water quality objectives and protection of beneficial uses.

County Staff's presentation will summarize the SNMP for the Committee and public, and overview the process and timing for stakeholders to provide input. Comments should be submitted via email to Catherine Martin at cmmartin@co.slo.ca.us (*to assist staff, please use Subject: "SNMP Comment"*).

The draft SNMP was prepared pursuant to the State's Recycled Water Policy and subsequent discussions with the Central Coast Regional Water Quality Control Board (CCRWQCB) staff. After the SNMP is finalized, it will go through necessary processes for submittal to the CCRWQCB.

Los Osos Salt/Nutrient Management Plan

May 17, 2017

Presented by

Catherine Martin, Water Resource Engineer

Topics

- Recycled Water Policy
- SNMP Sources
- Recycle Water Use
- Goals and Implementations
- Conceptual Model
- Antidegradation Analysis
- SNMP Monitoring Network / Report
- Next Steps

Recycled Water Policy

- Encourages and provides guidance for use of recycled water
- Requires an SNMP for the basin

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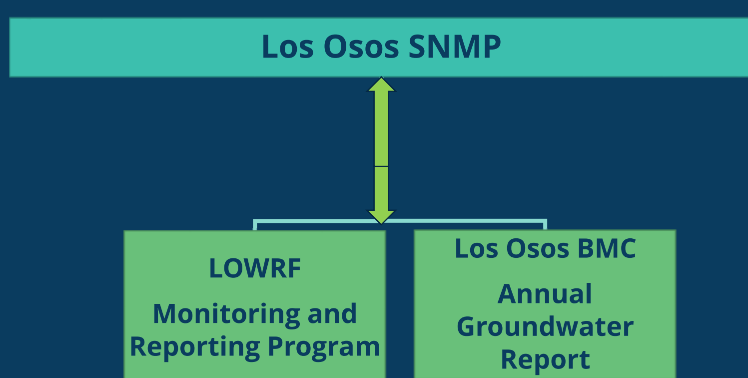
SNMP Sources



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SNMP Goals

- Halt or to the extent possible, reverse seawater intrusion in the Basin
- Provide sustainable water supplies and water quality
- Promote water conservation

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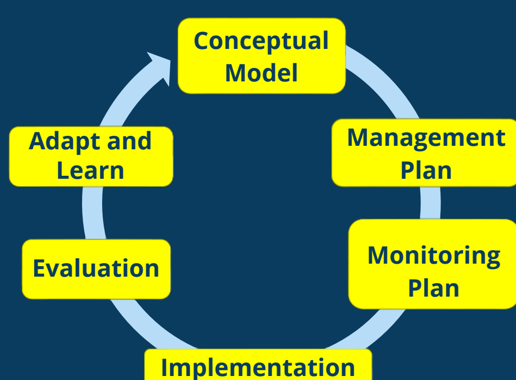
SNMP Implementation

- Performance measures to manage salt and nutrient loading
- Adaptive Management Plan



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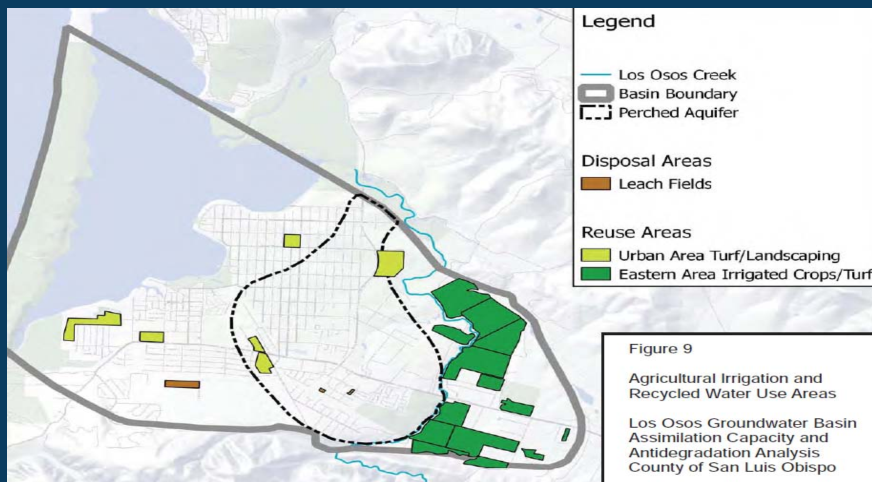
Recycle Water Use in Los Osos Basin



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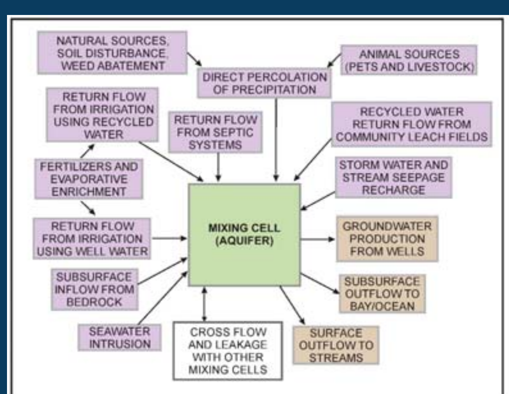
SNMP – Conceptual Model



Salt and Nutrient Loading:
- **Chloride, Nitrate, and TDS**

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Conceptual Model

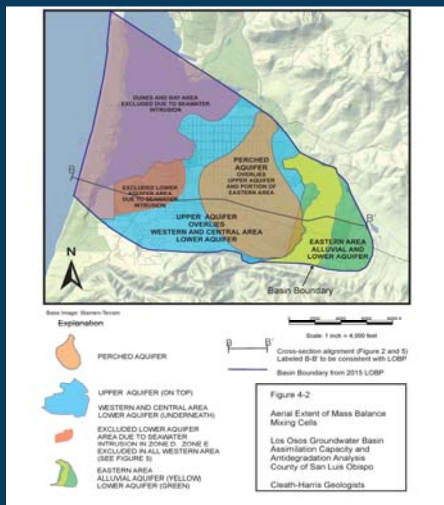

Table 5-6. NO_3-N Assimilative Capacity - Los Osos Groundwater Basin

Mass Mixing Cell	Allowable NO_3-N[1] [mg/L]	Current NO_3-N[2] [mg/L]	Assimilative Capacity[3] [mg/L]	10% Assimilative Capacity Use [mg/L]
Perched Aquifer	10	15	-5 (none)	0 (none)
Upper Aquifer	10	15	-5 (none)	0 (none)
Lower Aquifer-Western and Central Area	10	2	8	0.8
Lower Aquifer and Alluvial Aquifer - Eastern Area	10	6	4	0.6
BASIN AVERAGE (weighted)[4]	**10**	**6**	**4**	**0.4**

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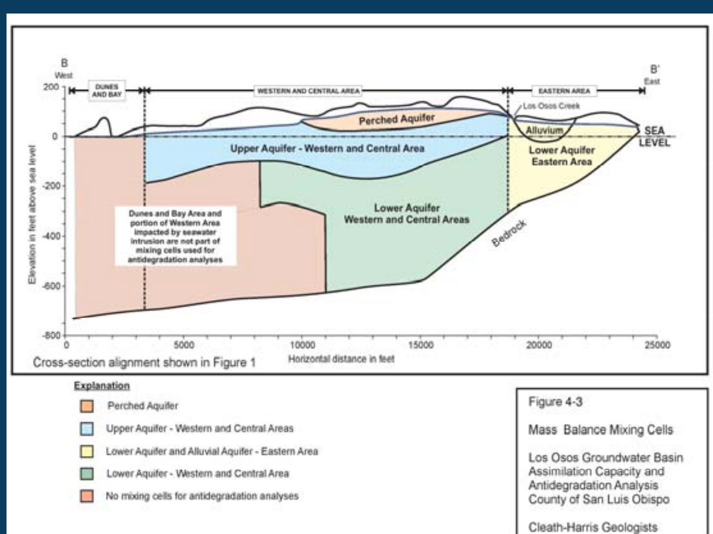
Conceptual Model



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SNMP – 3 Scenarios / Conceptual Model

2012 Baseline Conditions
- Pre-LOWRF construction
- No management plans implemented

No Further Development
- BMC – management plans (E+U+AC)
- Construction of LOWRF
- Prohibition Zone Enforced

Buildout Development
- BMC – management plans (E+UG+ABC)
- Construction of LOWRF
- Prohibition Zone Removed

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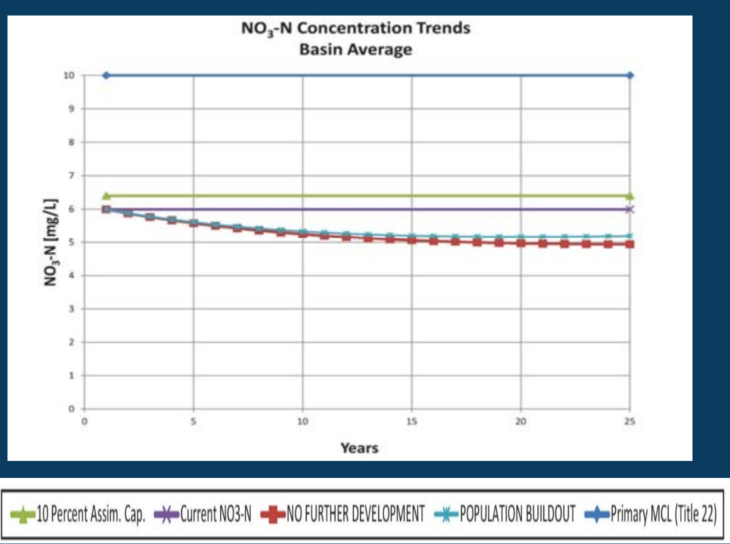
Antidegradation Analysis



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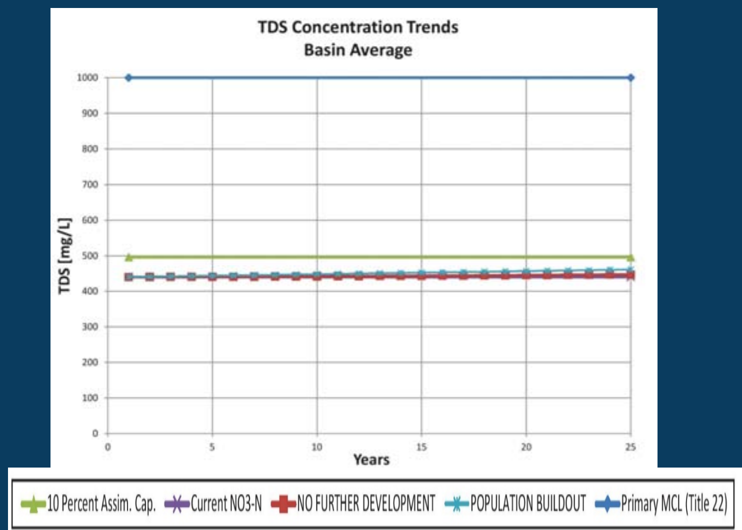
Antidegradation Analysis



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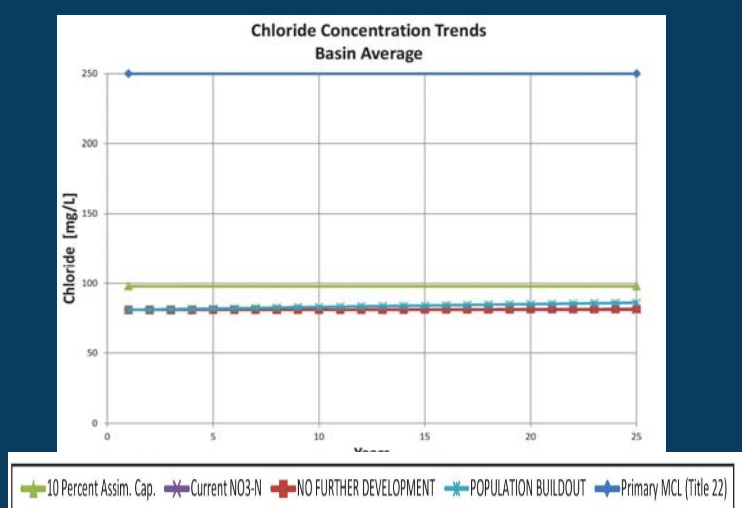
Antidegradation Analysis



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SNMP Monitoring Report

Los Osos SNMP Monitoring Report:

- Introduction and Background
- Collect and compile appropriate data from existing programs / reports
  - Monitoring results: maps/ figures/ tables
  - Data interpretation: calculation of Basin metrics and trends, water level contour maps, hydrographs, change in storage calculations;
  - Basin status: seawater intrusion, drought, supply issues; and
- SNMP monitoring program recommendations

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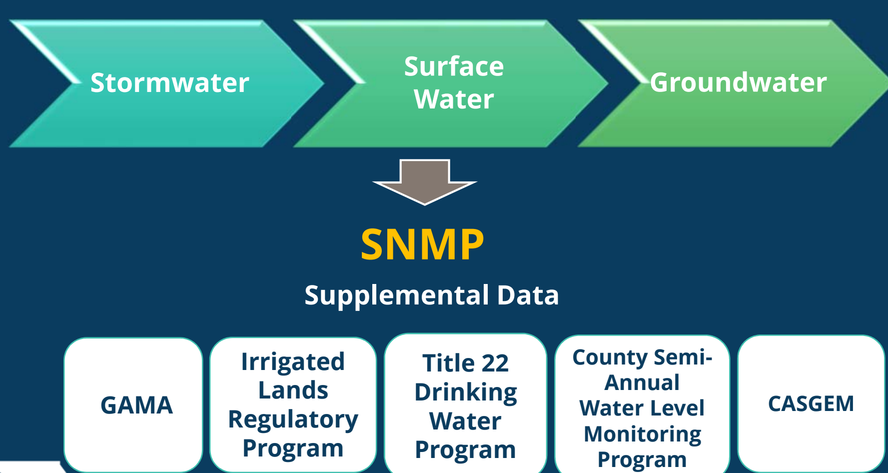
SNMP Monitoring Report



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SNMP Monitoring Report

Los Osos BMC: Annual Groundwater Monitoring Report

LOWRF: Monitoring and Reporting Program

Coastal Development Permit:

Recycled Water Management Plan

Onsite Wastewater Treatment Systems

(**future countywide program)**

SNMP Monitoring Report

(submitted at least every 3 years)

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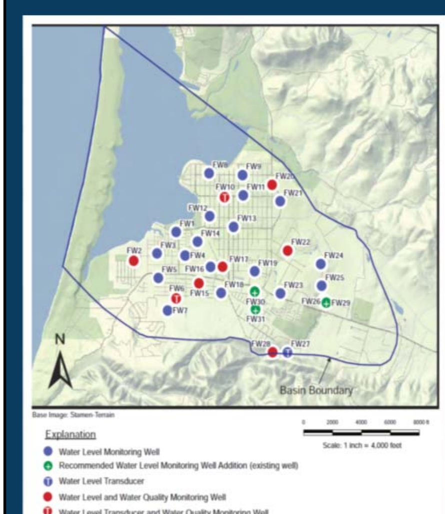
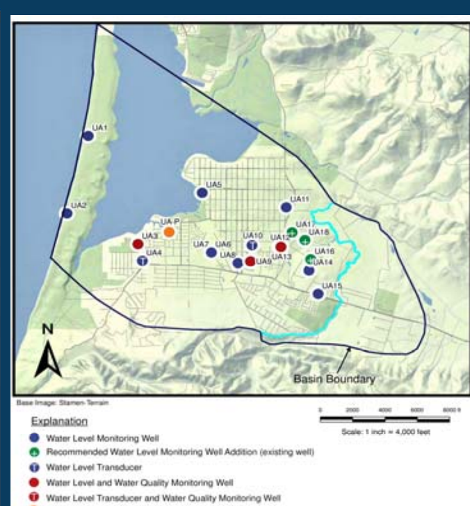
SNMP Monitoring Network / Report





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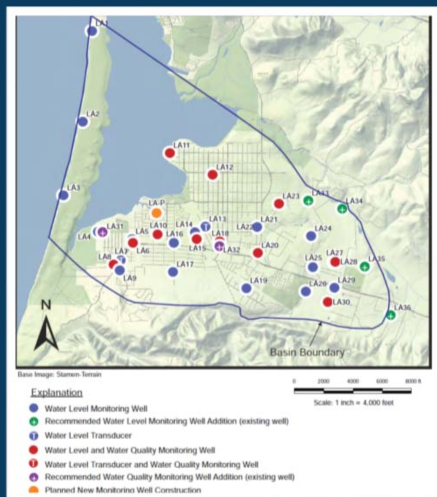
SNMP Monitoring Network / Report



Los Osos Basin Plan

- Lower Aquifer = approx. 30 wells Water quality monitoring – spring / fall sampling (track seawater intrusion)
- Groundwater level monitoring performed at approx. 73 wells
- Fresh Water & Upper Aquifer Wells Water Quality Monitoring - 23 wells are sampled in the fall

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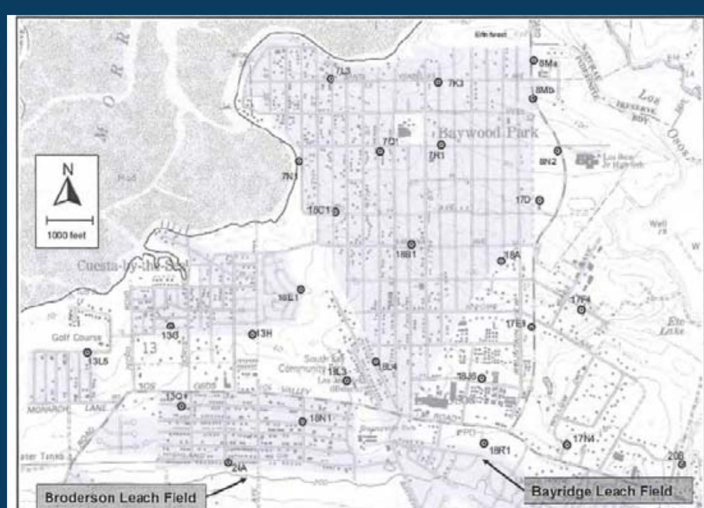
SNMP Monitoring Network / Report



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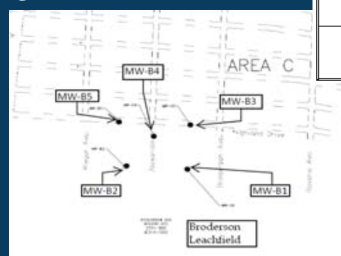
SNMP Monitoring Network/Reporting

LOWRF Monitoring Plan

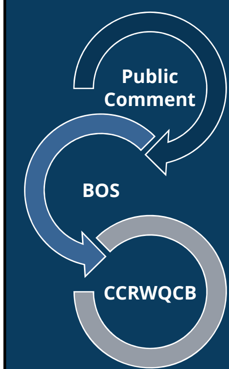
- 25 wells in 2012 through 2016 for baseline monitoring
- Semi-annual and annual sampling
- Annual CEC sampling from the LOWRF effluent
- **Broderson Leachfield** -
  5 additional monitoring wells installed

Well Name	Piezometer depth in feet
MW-B1	14
	27
	40
MW-B2	14
	27
	40
MW-B3	14
	27
	40
MW-B4	14
	27
	40
MW-B5	14
	27
	40



Next Steps

Next Steps



- June 6th – Last day for public comments
- July 11th - County Board of Supervisors
- July 18th - Submit to the CCRWQCB

Stay informed: www.slocountywater.org

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Questions

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Thank you

Los Osos Wastewater Project Mission Statement:
To evaluate and develop a wastewater treatment system for Los Osos, in cooperation with the community water purveyors, to solve the Level III water resource shortage and groundwater pollution, in an environmentally sustainable and cost effective manner, while respecting community preferences and promoting participatory government, and addressing individual affordability challenges to the greatest extent possible.

Please submit written comment to:
Cathy Martin
cmmartin@co.slo.ca.us
(805) 781-5275

COUNTY OF SAN LUIS OBISPO

www.slocounty.ca.gov

TO: Board of Supervisors

FROM: Cathy Martin, Water Resources Engineer
Carolyn K. Berg, Senior Water Resources Engineer

VIA: Courtney Howard, Water Resources Division Manager

DATE: January 23, 2018

SUBJECT: Submittal of a resolution approving the Salt and Nutrient Management Plan for the Los Osos Groundwater Basin; authorizing the Director of Public Works or his/her designee to submit the plan to the Regional Water Quality Control Board and to take actions necessary to implement the plan related to monitoring and reporting; and finding that the project is exempt from Section 21000 et seq. of the California Public Resources Code (CEQA). District 2.

RECOMMENDATION

It is recommended that the Board adopt the attached Resolution approving the Salt and Nutrient Management Plan (SNMP) for the Los Osos Groundwater Basin; authorizing the Director of Public Works or his/her designee to submit the plan to the Regional Water Quality Control Board and to take actions necessary to implement the plan related to monitoring and reporting; and finding that the project is exempt from Section 21000 et seq. of the California Public Resources Code (CEQA).

DISCUSSION

The State Water Resources Control Board (State Water Board) adopted a Recycled Water Policy (Policy) on February 3, 2009. The purpose of this Policy is to increase the use of recycled water from municipal wastewater sources that meet the definition of “recycled water” set forth in Water Code Section 13050(n). The Policy recognizes the potential for recycled water use to result in increased salt and nutrient loading to groundwater basins. Therefore, the Policy requires the development of a SNMP in all basins using recycled water, in order to identify and manage salts, nutrients, and other significant chemical compounds, to ensure the attainment of water quality objectives, increase beneficial use of recycled water, and provide protection of groundwater resources.

Los Osos Water Recycling Facility (LOWRF)

The LOWRF produces disinfected, tertiary-treated recycled water for beneficial uses in irrigation and land disposal. As of August 2016, recycled water is being disposed of on community leachfields, and in early 2018, recycled water will be available at permitted urban and agriculture irrigation locations, pending completion of all necessary contractual negotiations. It is recommended that the Board adopt the attached Resolution to approve and submit the SNMP developed for the Los Osos Groundwater Basin pursuant to the Policy and the LOWRF Regional Water Board Waste Discharge/Recycled Water Requirement Order R3-2011-0001 (WDR Order). This SNMP will also support compliance with Special Condition 5 of the coastal development permit (CDP) A-3-SL0-09-055/069 for the LOWRF related to the Recycled Water Management Plan.[1]

Los Osos Basin SNMP

County Public Works staff, with assistance from Cleath-Harris Geologists (Consultant), prepared the SNMP. County staff coordinated with the Regional Water Board and the Los Osos Basin Management Committee (BMC)[2] on required data for the plan and outreach processes during SNMP development. County staff provided presentations and updates, and sought stakeholder comments via public BMC meetings on September 21, 2016, March 15, 2017, and May 17, 2017. Stakeholders included local water agencies, agriculture and environmental interests, residents, and other interested parties.

The SNMP discusses a framework under which salt and nutrient issues can be managed, while protecting beneficial uses. The SNMP summarizes a technical analysis of known salt and nutrient issues (i.e. total dissolved solids (TDS), chlorides, and nitrates). This includes “assimilative capacity” and “antidegradation” analyses to evaluate the impacts of loading of these three listed constituents over the basin plan area (attached as Exhibit A in the Resolution). The assimilative capacity analysis compares the LOWRF’s actual and future estimated groundwater quality data (under Title 22 permit requirements) with the Regional Water Board’s Central Coast Basin Plan water quality objectives. The antidegradation analysis projects each constituent over a future 25-year period under three scenarios of estimated future land uses and associated water use.

The three scenarios considered in the antidegradation analysis include the following:

1. 2012 Baseline scenario (pre-construction of the LOWRF) with no implementation of projects/programs;
2. No Further Development scenario, which includes the operation of the LOWRF and implementation of basin management projects/programs with current population; and
3. Population Buildout scenario, which is the second scenario with a population increase and additional projects/programs.

Notable results of the antidegradation analysis include:

- Basin groundwater quality will improve over time with the operation of the LOWRF and removal of septic systems in the “Prohibition Zone” under both the No Further Development and Population Buildout scenarios.
- Beneficial use of recycled water for irrigation and land disposal will reduce groundwater pumping, potentially increase groundwater storage, and support the potential reduction of the seawater intrusion front in the basin.
- The 2012 Baseline scenario results showed the continued degradation of groundwater quality over time with no projects/programs implemented, such as the removal of septic systems, and seawater intrusion.

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[1] The Recycled Water Management Plan is an annual report required by the Coastal Commission’s CDP that provides documentation of the implementation of the LOWRF project and beneficial recycled water reuse over the basin.

[2] The BMC consists of representatives from the Los Osos Community Services District, Golden State Water Company, S&T Mutual Water Company and the County.

To track progress, the Regional Water Board will require the County to implement an SNMP monitoring program and submit a monitoring report every three years that tracks groundwater quality over time. This monitoring and reporting will include conditions of the groundwater level, water quality, seawater intrusion, nitrate contamination, and future dynamic changes to the basin. The SNMP monitoring program will leverage appropriate data collected by existing groundwater programs including the BMC's Annual Groundwater Monitoring Reports, the LOWRF groundwater data collection program, and other monitoring programs. These monitoring programs will provide the majority of information required by the Regional Water Board. Using the existing groundwater monitoring networks will provide a reasonable, cost-effective means of tracking whether the concentrations of salt, nutrients and other constituents of concern are consistent with applicable water quality objectives set in the Central Coast Basin Plan and LOWRF WDR Order.

Implementation Actions

The County Public Works Director or his/her designee, if authorized, will implement the SNMP by coordinating and reviewing appropriate groundwater data from the existing monitoring programs, such as the LOWRF Monitoring and Reporting Program, Coastal Commission's CDP Recycled Water Management Plan, and BMC Basin Plan; conducting stakeholder outreach when necessary; preparing and submitting the SNMP groundwater monitoring report for the Regional Water Board; and implementing, after the appropriate approval processes and environmental review, adaptive management strategies if needed to address future basin issues.

OTHER AGENCY INVOLVEMENT/IMPACT

The Regional Water Board has responsibility to review and approve the SNMP per the LOWRF WDR Order, and has discretion to adopt the Los Osos Basin SNMP and amend the Central Coast Basin Plan with approval from the State Water Board and other agencies.

The County will continue to coordinate with the Los Osos BMC in order to collect data and conduct outreach as needed for the SNMP.

County Counsel has reviewed the resolution as to legal form and effect.

The Environmental Coordinator has reviewed the project and determined it is exempt from CEQA.

FINANCIAL CONSIDERATIONS

The costs associated with development of the Los Osos Basin SNMP and stakeholder outreach are included in both the County's Public Works LOWRF and Flood Control and Water Conservation District FY 2017-2018 approved budget.

Future implementation of the SNMP, preparation of updates to the SNMP and development of required monitoring reports will be considered as a part of the proposed budget for the LOWRF administration and operation, once the SNMP is approved by the Regional Water Board.

RESULTS

Approval of the recommended action will help to contribute to the County's goal of promoting safe, healthy and livable communities, by meeting the County's requirements under the State's Recycled Water Policy and LOWRF WDR Order, and thereby helping to protect the Los Osos Groundwater Basin.

ATTACHMENTS

1. Vicinity Map
2. Notice of Exemption
3. Resolution approving the Salt and Nutrient Management Plan for the Los Osos Groundwater Basin; authorizing the Director of Public Works or his/her designee to submit the plan to the Regional Water Quality Control Board and to take actions necessary to implement the plan related to monitoring and reporting; and finding that the project is exempt from Section 21000 et seq. of the California Public Resources Code (CEQA)
4. Salt and Nutrient Management Plan for the Los Osos Groundwater Basin (Clerk's File)

File: CF 310.84.01

Reference: 18 JAN23-C-2

L:\Water Resources\2018\January\BOS\Salt and Nutrient Management Plan\SNMP brd ltr.docxCM:sm

BEFORE THE BOARD OF SUPERVISORS

of the

COUNTY OF SAN LUIS OBISPO

Tuesday, January 23, 2018

PRESENT: Supervisors Bruce S. Gibson, Adam Hill, Lynn Compton, Debbie Arnold and Chairperson John Peschong

ABSENT: None

RESOLUTION NO. 2018-20

RESOLUTION APPROVING THE SALT AND NUTRIENT MANAGEMENT PLAN FOR THE LOS OSOS GROUNDWATER BASIN; AUTHORIZING THE DIRECTOR OF PUBLIC WORKS OR HIS/HER DESIGNEE TO SUBMIT THE PLAN TO THE REGIONAL WATER QUALITY CONTROL BOARD AND TO TAKE ACTIONS NECESSARY TO IMPLEMENT THE PLAN RELATED TO MONITORING AND REPORTING; AND FINDING THAT THE PROJECT IS EXEMPT FROM SECTION 21000 ET SEQ. OF THE CALIFORNIA PUBLIC RESOURCES CODE (CEQA)

The following Resolution is hereby offered and read:

WHEREAS, the California State Water Resources Control Board adopted the Recycled Water Policy ("Policy") in 2009 to provide guidance related to the use of recycled water; and

WHEREAS, the Policy requires entities, such as the County of San Luis Obispo ("County") as the owner and operator of the Los Osos Water Recycling Facility ("LOWRF"), that produce tertiary-treated recycled water to prepare a salt and nutrient management plan ("SNMP") to ensure protection of groundwater quality and beneficial uses, as well as attainment of water quality objectives established by the Central Coast Regional Water Quality Control Board ("Regional Water Board") in the 2016 Water Quality Control Plan for the Central Coast Basin ("Central Coast Basin Plan"); and

WHEREAS, the Policy requires the Regional Water Board to review and approve the SNMP prepared for the Los Osos Groundwater Basin ("Los Osos SNMP"), and under its discretion, to adopt the Los Osos SNMP as an amendment to the Central Coast Basin Plan provided that it is approved by the State Water Resources Control Board and other regulatory agencies; and

WHEREAS, the Los Osos SNMP will be implemented within the area subject to the Stipulated Judgment and the Updated Basin Plan for the Los Osos Groundwater Basin incorporated therein, as more specifically defined in the order signed by the San Luis Obispo Superior Court on October 14, 2015 in *Los Osos Community Services District v. Golden State Water Company, et al.* (CV 040126) ("Basin Plan Area"), and in coordination with the Los Osos Basin Management Committee created by the Stipulated Judgment and composed of representatives from the Los Osos Community Services District, Golden State Water Company, S&T Mutual Water Company, and the County; and

WHEREAS, the County retained the services of Cleath-Harris Geologists, Inc. to develop a technical memorandum that analyzes constituents known to be an issue within the Basin Plan Area (i.e. chlorides, total dissolved solids, and nitrates) in order to comply with Policy requirements related to salt and nutrient loading within said area; and

WHEREAS, development of the Los Osos SNMP included a stakeholder participation process to allow for input on the data, approach, and results of the Los Osos SNMP, during which County staff provided presentations, updates, and sought comments via meetings of the Los Osos Basin Management Committee on September 21, 2016, March 15, 2017, and May 17, 2017; and

WHEREAS, the County is committed to compliant operation of the LOWRF within the Basin Plan Area, including implementation of the Los Osos SNMP, and its required monitoring and reporting to the Regional Water Board every three years.

NOW, THEREFORE, BE IT RESOLVED AND ORDERED by the Board of Supervisors of the County of San Luis Obispo, State of California, that:

Section 1: The foregoing recitals are true and correct and are incorporated herein by reference.

Section 2: The County hereby approves the Los Osos SNMP. A complete copy of the Los Osos SNMP is on file and available for review in the Water Resources Division of the County Department of Public Works. In addition, the Executive Summary to the Los Osos SNMP is attached hereto as Exhibit A.

Section 3: The Director of Public Works of the County of San Luis Obispo or his/her designee is hereby authorized and directed to submit the Los Osos SNMP to the Regional Water Board and to coordinate with the Regional Water Board as needed throughout the subsequent review and approval process.

Section 4: The Director of Public Works of the County of San Luis Obispo or his/her designee is hereby authorized and directed to take all such actions as may be necessary or appropriate to implement the intent and purposes of the Los Osos SNMP and related monitoring and reporting.

Section 5: The project is exempt from Section 21000 et seq. of the California Public Resources Code (CEQA) because it consists of basic data collection, research, experimental management and resource evaluation activities which do not result in a serious or major disturbance to an environmental resource and there is no reasonable possibility that the project will have a significant effect on the environment due to unusual circumstances (State CEQA Guidelines § 15306).

Upon motion of Supervisor Gibson, seconded by Supervisor Hill, and on the following roll call vote, to wit:

AYES: Supervisors Gibson, Hill, Compton, Arnold and Chairperson Peschong
NOES: None
ABSENT: None
ABSTAINING: None

the foregoing resolution is hereby adopted on the 23rd day of January, 2018.

John Peschong
Chairperson of the Board of Supervisors

ATTEST:

Tommy Gong
Clerk of the Board of Supervisors
By: *Sandy Currens*
Deputy Clerk
[SEAL]

APPROVED AS TO FORM AND LEGAL EFFECT:

RITA L. NEAL
County Counsel

By: */s/Erica Stuckey*
Deputy County Counsel
Dated: December 22, 2017

STATE OF CALIFORNIA, }
County of San Luis Obispo, ss.

I, Tommy Gong, County Clerk and ex-officio Clerk of the Board of Supervisors, in and for the County of San Luis Obispo, State of California, do hereby certify the foregoing to be a full, true and correct copy of an order made by the Board of Supervisors, as the same appears spread upon their minute book.

WITNESS my hand and the seal of said Board of Supervisors, affixed this 29th day of January, 2018.

Tommy Gong
County Clerk and Ex-Officio Clerk of the Board of Supervisors

(SEAL)

By Sandy Currens
Deputy Clerk

EXHIBIT A

Salt and Nutrient Management Plan for Los Osos Groundwater Basin Executive Summary

The State Water Resources Control Board (State Water Board) adopted the Recycled Water Policy (Policy) in 2009 which requires that salt and nutrient management plans be developed to manage salts, nutrients, and other significant chemical compounds on a watershed- or basin/subbasin-wide basis. The plans are intended to help streamline permitting of new recycled water projects while ensuring compliance with water quality objectives and protection of beneficial uses. In accordance with the Policy, the County of San Luis Obispo (County), with technical support from Cleath-Harris Geologists Inc. (Cleath-Harris Geologists or CHG), prepared the Salt and Nutrient Management Plan for the Los Osos Groundwater Basin (Los Osos SNMP). The groundwater basin area for the Los Osos SNMP (Basin) is based on the area subject to the Stipulated Judgment and the Updated Basin Plan for the Los Osos Groundwater Basin incorporated therein (Basin Plan or LOBP) approved by the San Luis Obispo Superior Court on October 14, 2015 (Basin Plan Area).

The Los Osos SNMP presents a baseline picture of groundwater quality and establishes a framework under which salt and nutrient issues can be monitored and managed. The Policy encourages increased use of recycled water and local stormwater capture, reuse, and requires the following elements to be addressed in the Los Osos SNMP:

- A monitoring plan that includes an appropriate network of monitoring locations.
- A provision for monitoring constituents of emerging concern (CECs) consistent with recommendations by California Department of Public Health (now the Division of Drinking Water under the State Water Board).
- Water recycling and stormwater recharge/use goals and objectives.
- Salt and nutrient source identification, assimilative capacity and loading estimates, together with fate and transport of salts and nutrients.
- Implementation measures to manage salt and nutrient loading in the Basin on a sustainable basis.
- An anti-degradation analysis demonstrating that the projects included within the Los Osos SNMP will, collectively, satisfy the requirements of the State Water Board's *Statement of Policy with Respect to Maintaining High Quality of Waters in California* (also referred to as Resolution No. 68-16).

The Los Osos SNMP has been developed in a cooperative and collaborative manner among water purveyors, regulators, and other salt and nutrient stakeholders. The plan will be utilized by the Central Coast Regional Water Quality Control Board (Regional Water Board) and local agencies to aid in the management of Basin groundwater quality.

ES-1 Introduction

The Basin is impacted from excess nitrate concentrations in the upper aquifer and seawater intrusion in the lower Basin (western edge of the aquifer). Groundwater is currently the only water resource for Los Osos Valley. Excessive concentrations of salts and nutrients can damage Basin resources and can have various direct and indirect impacts on the community and surrounding region, such as potentially threatening public health, crop productivity, and access to this valuable resource, and requiring additional treatment of groundwater prior to use.

In 1983, the Regional Water Board determined that the community's use of septic systems was at least partially responsible for the nitrate contamination exceeding the State standards that occurred in the Basin (upper aquifer). Therefore, in January 1988, the State Water Board approved an amendment to the *Water*

Quality Control Plan, Central Coast Basin (Central Coast Basin Plan) that contained a discharge moratorium established by the Regional Water Board for a portion of Los Osos known as the "Prohibition Zone." The moratorium effectively halted new construction or major expansion of existing development until the water pollution is dealt with.

To help remediate the situation of seawater intrusion and excess nitrate concentration, the County has completed construction of the Los Osos Water Recycling Facility (LOWRF). In March 2016, residents located in the Prohibition Zone began to decommission their septic systems and connect to the wastewater service lines. The LOWRF receives and treats wastewater from these areas using a tertiary treatment system. Recycled water from LOWRF meets the Waste Discharge/Recycled Water Requirement Order R3-2011-2001 (WDR Order) prior to being discharged to land at community leach fields. Recycled water reuse will be available for beneficial use at permitted locations in the Basin, expected to start in early 2018. As such, it is anticipated that the County will apply for the Notice of Intent for the General Order WQ 2016-0068-DDW in early 2018.

In mid-2018, the County will likely seek a Basin Boundary Modification Request with the California Department of Water Resources (DWR), which would not modify the main Basin (Basin Plan Area), but only sections (known as "fringe areas") outside of the Basin Plan Area. Recycled water is not permitted for beneficial use in the fringe areas, per the WDR Order. These fringe areas would likely either be removed or recategorized as a subbasin by DWR. Any modified Basin boundaries will be noted in the Los Osos SNMP monitoring report due every three years to the Regional Water Board.

ES-2 Outreach

The Los Osos SNMP was developed in a collaborative setting with input from stakeholders and interested parties. The Los Osos SNMP utilized the existing stakeholder infrastructure set up by the Los Osos Basin Management Committee (BMC) Board of Directors established under the Stipulated Judgment for outreach, public meetings, and to receive input. The primary method for engaging the Los Osos SNMP stakeholders was through the BMC meetings, the County's BMC webpage, and email notifications. The Los Osos SNMP was discussed at three public meetings of the BMC between September 2016 and May 2017, and at the County Board of Supervisors meeting in January 2018.

Participants in the Los Osos SNMP development and/or review process included:

- Water purveyors: Los Osos Community Services District (LOCSD), Golden State Water Company (GSWC), and S&T Mutual Water Company (S&T)
- Environmental resource groups: Morro Bay National Estuary Program (MBNEP)
- Agricultural interests: individual farm owners
- Regulatory/government agencies: County and Regional Water Board
- Others: private well owners

ES-3 Basin Characterization

The objectives of the Basin characterization were to:

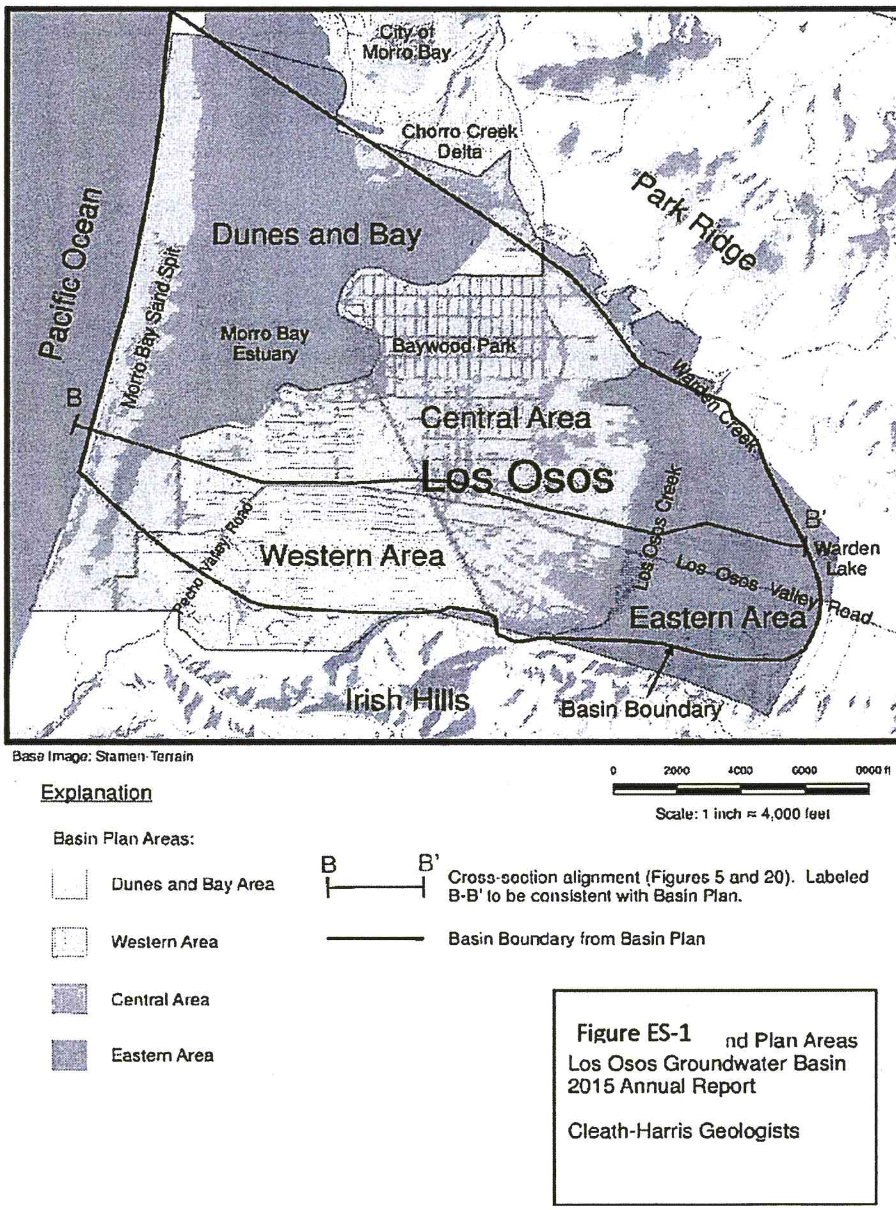
1. Review and collect data necessary to quantify, characterize, and describe the setting, land use, climate, hydrology, geology, and hydrogeology of the Basin.
2. Discuss baseline conditions (i.e., current spatial distributions) for each of the water quality constituents to be discussed in the Los Osos SNMP.
3. Discuss the water balance for the study areas of the Basin.

Groundwater Basin Setting

This Basin is formally recognized by DWR as part of the Basin No. 3-8 in Bulletin 118, *California's Groundwater*. The Basin area for purposes of the Los Osos SNMP is the same as the Basin Plan Area established by the Stipulated Judgment (Exhibit ES-1), and is approximately 7,530 acres, of which 80 percent (5,985 acres) are on land and the remaining 20 percent are underwater beneath Morro Bay (ISJ Group, 2015).

Figure ES-1 depicts the Basin Plan Area separated into individual sections, which are utilized in calculations for a technical analysis, as discussed in sections ES-4 and ES-5 of this Executive Summary.

Figure ES-1. Basin Location and Plan Areas



Source: CHG & Wallace Group, 2016

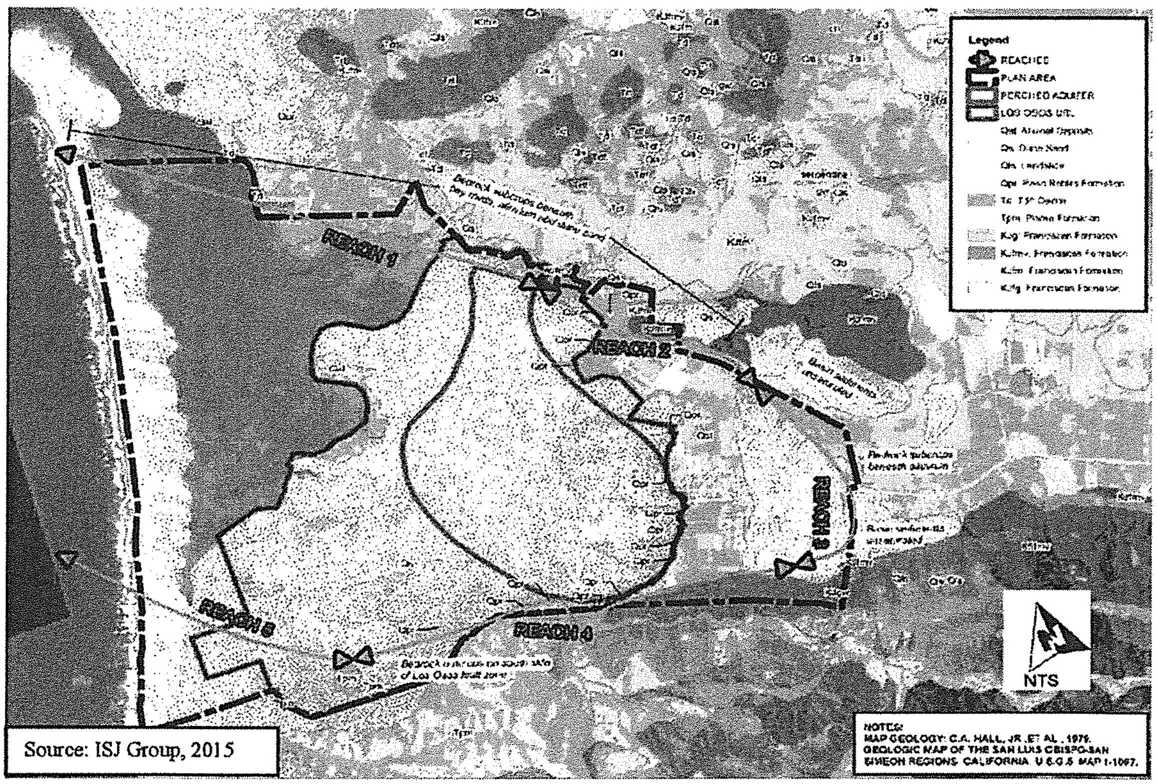
Surface Waters

The main streamflow in the Basin comes from Los Osos Creek and its tributaries. Water use in the creek valley has been estimated at 800 acre-feet per year (AFY) for irrigation and 75 AFY for rural residential use. Recharge to the aquifers underlying the creek valley comes mainly from streamflow seepage, which is estimated at 600 AFY during normal years (CHG, 2009).

Basin Geology

Figure ES-2 shows a map displaying the Basin and surficial geology. The Basin boundaries were originally defined by DWR (1958), and the Basin was refined by Cleath-Harris Geologists using information from well logs, geologic maps and cross-sections, water levels, water quality data, and fault investigations (ISJ Group, 2015; CHG, 2016).

Figure ES-2. Surficial Geology and Boundaries



Source: ISJ Group, 2015

Cleath-Harris Geologists developed six geologic cross-sections to characterize the Basin. The cross-sections include several sub-horizontal aquifer layers, which are discussed in Chapter 3. These cross-sections depict the Paso Robles Formation as the major water bearing unit in the Basin.

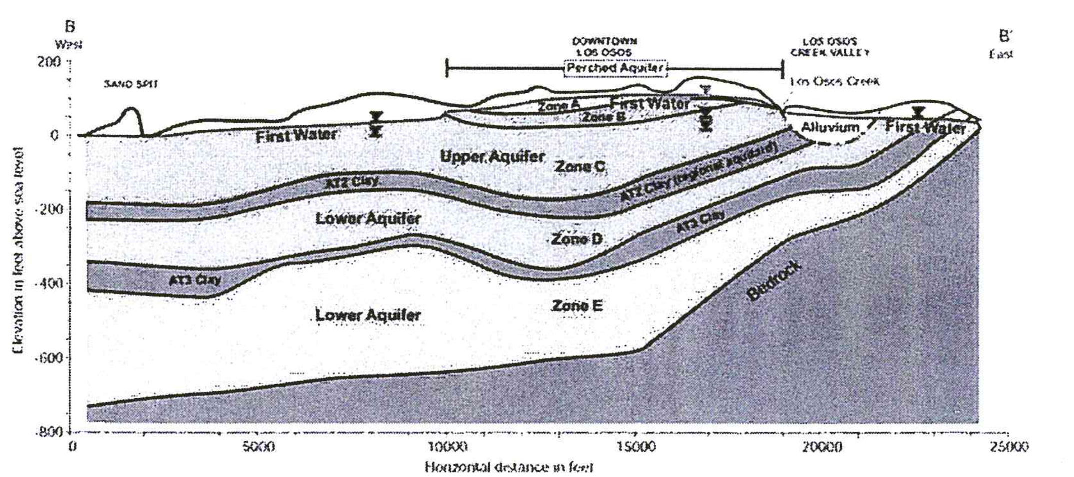
Aquifer Zone Characterization

The Basin is made up of several sub-horizontal stacked aquifer layers, each of which has distinct characteristics. The aquifer layers are designated as Zones A through E, an alluvial aquifer, and a regional aquitard (Figure ES-3):

- Zone A – perched aquifer;
- Zone B – perched aquifer (transitional upper aquifer);
- Zone C – Upper Aquifer;
- Regional aquitard (clay) – separates the upper and lower aquifers; and
- Zones D and E – Lower Aquifer.

First Water is depicted on ES-3 as the first 50 feet of water above sea level, while Zone C will be referred to as Upper Aquifer and Zone D/E will be referred to as Lower Aquifer in the rest of the Executive Summary and report. As shown in Figure ES-1, these aquifer layers are divided into the Western, Eastern, and Central areas to further delineate the storage volumes in each aquifer layer.

Figure ES-3. Aquifer Zone Characterization



Source: CHG & Wallace Group, 2016

Cross-section alignment shown in Figure 1

Explanation

- Perched Aquifer Water level
- Upper Aquifer Water level
- Lower Aquifer Water level

Figure ES-3
Basin Aquifers
Los Osos Groundwater Basin
2015 Annual Report

Hydrogeology

The hydrogeology of the Basin and water balance is based on Basin models and conceptual models. The Basin groundwater flow model was developed in MODFLOW utilizing various support models, such as the United States Geological Survey's SEAWAT program. Results from the MODFLOW model include (ISJ Group, 2015):

- Evaluation of seawater intrusion, sustainable yield, and hydrologic budget information;
- Total dissolved solids (TDS) isoconcentration maps to compare impacts on seawater intrusion and sustainable yield;
- Input parameters for individual model scenarios; and
- Steady-state model scenarios run using the SEAWAT program.

The Los Osos SNMP technical analysis in Chapter 5 was based on a conceptual model which used a collection and interpretation of available information for the physical system being modeled. The conceptual model includes a characterization of the Basin structure, boundary conditions, aquifer geometry, physical parameters, and components of inflow and outflow developed through a network of geologic cross-sections with deep well control points to contour elevations on the base of four layers in the model. The physical parameters for Basin sediments include hydraulic conductivity, porosity, specific yield, and storativity, which are based on field tests or adjusted through calibration within a plausible range of values.

The conceptual model includes the three following scenarios for the Los Osos SNMP:

1. 2012 Baseline scenario - pre-LOWRF construction with no implementation of projects/programs;
2. No Further Development scenario - no further development in terms of the population served by community purveyors; includes the operation of the LOWRF; and implementation of projects/programs by various entities (such as the Urban Water Use Efficiency Program, Urban Water Reinvestment Program, and Basin Infrastructure Program); and
3. Population Buildout scenario - population size increases to buildout, the operation of the LOWRF project, and the implementation of project/programs from the No Further Development scenario with implementation of additional projects/programs by various entities (such as the Agricultural Water Reinvestment Program and additional Basin Infrastructure Program).

The water balance for the No Further Development and Population Buildout scenarios includes the potential recycled water areas summarized in Table ES-1. This table includes the maximum permitted distribution allocation in the Basin.[1]

Table ES-1. Urban Water Reinvestment Program Recycled Water Uses

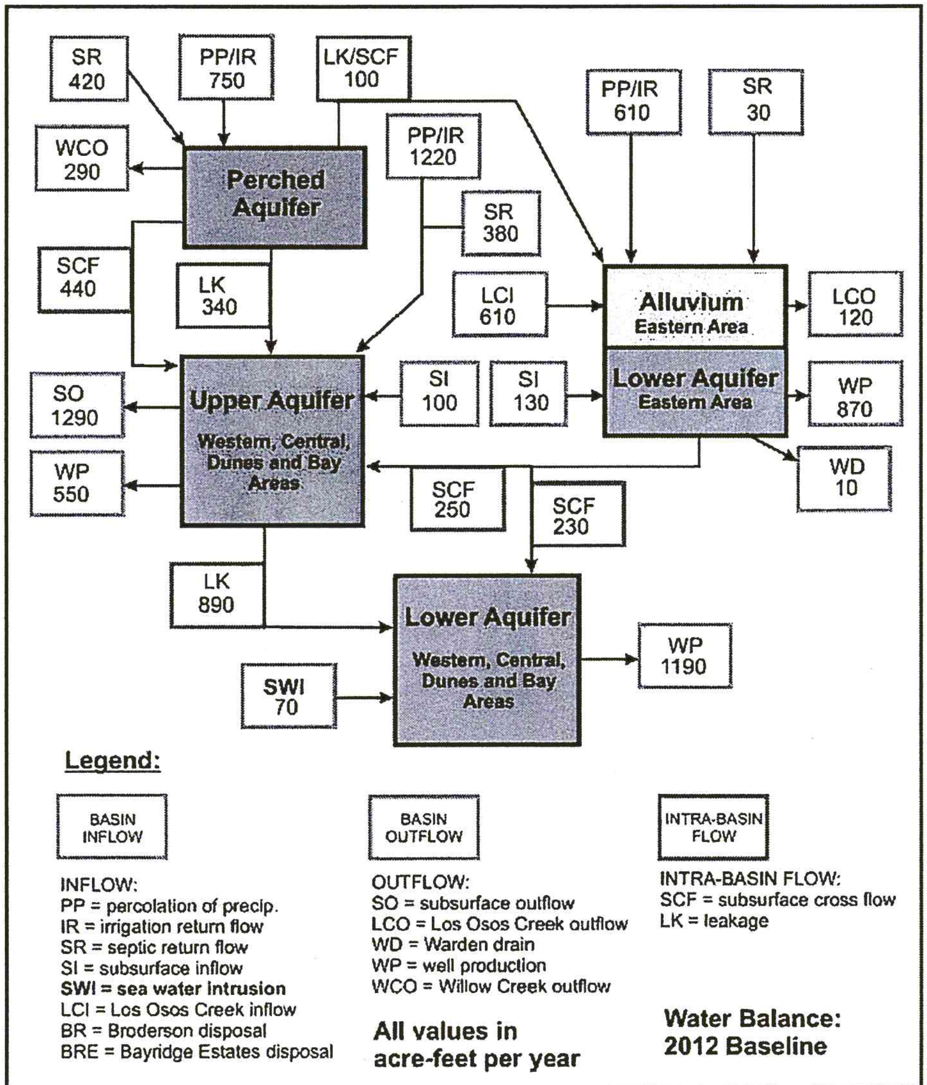
Potential Use	Quantity (AFY)	Percent of Total
Broderson Leachfields (disposal site)	448	40
Bayridge Estate Leachfields (disposal site)	33	2.9
Urban Reuse (irrigation)	63	5.6
Sea Pines Golf Course (irrigation)	40	3.6
Los Osos Valley Memorial Park (irrigation)	50	4.5
Agricultural Reuse (irrigation)[1]	486	43.4
Total	1,120	100

Source: ISJ Group, 2015
Abbreviations: acre-feet per year
Notes:
[1]Agricultural reuse - No Further Development scenario = up to 146 AFY

As an example, Figures ES-4 shows the water balance components of inflow and outflow from each of the Basin compartments for the 2012 Baseline scenario. The other two scenarios for water balance are discussed in Chapter 4.

[1] The No Further Development scenario distribution allocation for agricultural reuse is up to 146 AFY and the Population Buildout scenario distribution allocation for agricultural reuse is up to 486 AFY.

Figure ES-4. Water Balance: 2012 Baseline



SOURCE: 2015 LOBP

Figure 4-5

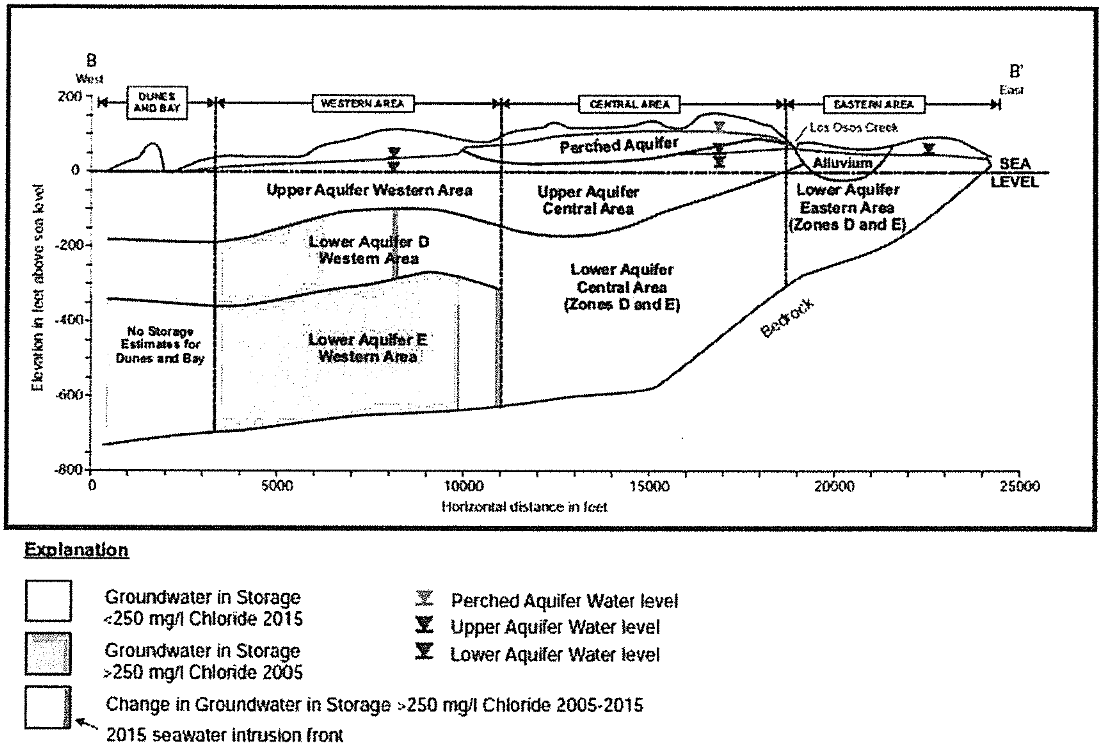
Water Balance: 2012 Baseline

Los Osos Groundwater Basin
Assimilation Capacity and
Antidegradation Analysis
County of San Luis Obispo

Cleath-Harris Geologists

The Basin reaches depths of several hundred feet below sea level and holds approximately 120,000 acre-feet, with approximately 15,000 acre-feet above sea level, excluding the Dunes and Bay area due to seawater intrusion (CHG & Wallace Group, 2016).[2] Groundwater storage for the Basin is estimated through a systematic approach of water level contouring, boundary definition, volume calculations, geology, and aquifer property estimation. Reported groundwater storage values may represent different types of storage or aquifer areas as defined by water quality or location (Figure ES-5). The total groundwater production in 2015 was approximately 2,170 acre-feet and the sustainable yield was estimated as 2,450 AFY (CHG & Wallace Group, 2016).

Figure ES-5. Basin Storage Compartments for Los Osos Groundwater Basin



Source: CHG & Wallace Group, 2016

Figure ES-5 shows the Basin divided into storage components. The Lower Aquifer (Zone D and Zone E) in the Western Area was further divided into the volume by seawater/brackish water intrusion front. Zone E in the Western Area is mostly seawater, while Zone D is mostly groundwater. Seawater volumes in the Lower Aquifer with chloride concentration of 250 mg/L or greater were removed from the Los Osos SNMP technical analysis due to water quality.

[2] Seawater intrusion is not included in the groundwater volume and water quality estimates because it is a non-potable water resource and would not reflect the average groundwater quality of the Basin.

The total decline in Basin storage between 2005 and 2015 is estimated at approximately 4,600 acre-feet, or 460 AFY on average, which includes a decline in potable groundwater storage (with less than 250 mg/L of chloride) of approximately 2,700 acre-feet, or 270 AFY. By comparison, Basin production between 2005 and 2015 averaged 2,760 AFY. Some of the storage decline is likely due to Basin pumping exceeding the safe yield, and some due to the drought conditions. (CHG & Wallace Group, 2016)

Water Quality

Constituents considered in the Los Osos SNMP were identified from the BMC's annual monitoring report for the Basin Plan and previous Basin studies that discussed known water quality issues with seawater intrusion and return flow from high-density residential septic systems. The three water quality constituents that are addressed in the Los Osos SNMP are TDS, chloride, and nitrate (as N). These constituents are defined as "indicator constituents" in the Los Osos SNMP. The Basin characterization established the baseline conditions for these constituents using water quality data from historical and current groundwater reports. The water quality analysis started with the review of Regional Water Board water quality objectives, EPA drinking water standards, LOWRF Title 22 permit requirements, BMC metrics, water quality databases used in the analysis, historical trends, and then estimated average constituent concentrations for each study area for the three indicator constituents.

Primary and secondary drinking water standards for TDS, nitrate (as N), and chloride, as established by the CDPH, Code of Regulations, Title 22, are presented for reference in Table ES-2. The Primary Maximum Contaminant Levels (MCL) are set to be protective of human health. Secondary MCLs address aesthetic issues related to taste, odor, or appearance of the water and are not related to health effects, although elevated TDS and chloride concentrations in water can damage crops, affect plant growth, and damage equipment.

The BMC metric for chloride is 100 mg/L and for nitrate is 10 mg/L. TDS is not included as a Basin metric. These metrics are discussed in the annual monitoring report for the Basin Plan.

Table ES-2. Title 22 Drinking Water Standards for Nitrate (as N), Chloride, and TDS

Water Quality Constituent	Primary Drinking Water Standard Recommended MCL (mg/L)	Secondary Drinking Water Standard Recommended MCL (mg/L)	Secondary Drinking Water Standard Upper Limit (mg/L)	Secondary Drinking Water Standard Short Term (mg/L)
Nitrate (as N)	10	--	--	--
Chloride	--	250	500	600
TDS	--	500	1,000	1,500

Abbreviations: Maximum Contaminant Levels (MCL) and milligrams per liter (mg/L)

The Regional Water Board has the authority to enforce the LOWRF WDR Order. The effluent requirements from the LOWRF will meet the WDR Order requirements, including:

- Total Nitrogen Monthly Average limit of 7 mg/L;
- Total Nitrogen Maximum Day limit of 10 mg/L; and
- California Code of Regulations for Title 22 standards for tertiary recycled water.

ES-4 Salt and Nutrient Loading Analysis

The salt and nutrient loading analysis considers the existing salt and nutrient mass in groundwater storage and the source water volumes of key inflows and outflows and their associated identified constituents. Salt and nutrient loading takes place at variable rates across the Basin. Every year, salts and nutrients leach into the groundwater system from various sources, including natural, agricultural, residential, and animal sources. Loading factors can be expressed as the amount of salt or nutrient added to the groundwater system over time. The mass associated with each loading factor is dissolved and transported into the groundwater system by recharge and return flows. There are four Basin compartments, or mixing cells, delineated for salt and nutrient loading calculations: the Perched Aquifer; the Upper Aquifer; the Western and Central Area Lower Aquifer; and the Eastern Area Alluvial and Lower Aquifer.

Simulating salt and nutrient loading for each mixing cell involves a mass balance spreadsheet model, which converts salt and nutrient loads to inflow concentrations, distributes flows according to the water balance, and provides for repeated cycles of loading. The model also allows salt and nutrient load calibration using Basin water quality data. The calibration process provides a rigorous approach to mass balance by evaluating the Basin-specific salt and nutrient loads for key sources, against known sources.

Identification of Salts and Nutrients

The primary identification of salt and nutrient indicators of mass loading are chloride and nitrate-nitrogen. These two constituents will be modeled and total dissolved solids will also be modeled as it is an indicator of total salt loading to the Basin. In addition, the Los Osos SNMP must consider all salt and nutrient constituents/parameters contained within the Central Coast Basin Plan with prescribed water quality objectives (WQOs) in the initial assessment (CCRWQCB, 2014). The initial assessment of other major dissolved ions potentially included in recycled water that reflect its salinity and nutrient content are many and varied, such as sodium, calcium, sulfate, chloride, nitrate, iron, boron and manganese.

To initially assess salt and nutrient constituents/parameters mentioned, the County analyzed the water quality data and constituent's chemical characteristics to further identify constituents for the Basin, see Chapter 4 for details. From this initial assessment, the constituents that meet the methodology criteria for additional modeling are chloride, nitrates and total dissolved solids. The other constituents will still be monitored and referenced in the Los Osos SNMP groundwater monitoring report, as appropriate.

Source Analysis

Natural systems, agricultural practices, residential sites, and animal waste are the principal sources of salt and nutrient loading in the Basin under the 2012 Baseline (pre-LOWRF construction) conditions. With LOWRF operation, recycled water reuse and disposal becomes another source of loading. Salt and nutrient mass loading factors for various sources are presented in Tables ES-3 and ES-4.

Table ES-3. Nitrates – Nitrogen (NO_3-N) Loading Factors (Source: CHG, 2017)

Source	Total Units (Baseline)	NO_3-N (lb/year)		
		Per unit (lb/year)	Attenuation (loss)	Total (lb/year)
Natural (Basin wide)[1]	4,000 acres	3.1	(incorporated)	12,400
Septic Tank Discharge[2]	830 acre-feet	152	41%	74,500
Agriculture/Turf Fertilizer[3]	400 acres	150	68%	19,200
Residential Landscape/Turf Fertilizer[3]	370 acres	45	80%	3,300
Animal Waste[4]	200 Horses	110	79%	4,600
	4,400 Dogs	2.9	92%	1,000
	6,600 Cats	1.4	92%	700

NOTES: [1] calibrated to pre-development conditions.
[2] influent quality to LOWRF, calibrated to baseline conditions.
[3] Viers et al. (2012) and M&E (1995)
[4] M&E (1995)

Table ES-4. Inflow Source Water Quality (Source: CHG, 2017)			
Source	**TDS (mg/L)**	**Chloride (mg/L)**	**NO_3-N (mg/L)**
Septic / LOWRF Influent (initial)[1]	790	200	56 [2]
Septic / LOWRF Influent (transient)[1]	WS+352	WS+115	56 [2]
Recycled Water (initial)[3]	713	200	6.6
Recycled Water (transient)[3]	IW-77	IW	6.6
Landscape Irrigation Return Flow[4]	WS*3.4+N load	WS*3.4	WS+N load
Agricultural Irrigation Return Flow[4]	WS*3.4+N load	WS*3.4	WS+N load
Perc. of Precip. with natural/animal[5]	146	36	3
Subsurface Bedrock Inflow[6]	493	50	0.2
Los Osos Creek Inflow[6]	540	53	0.2

NOTES: WS = domestic/irrigation water quality; IW = influent wastewater quality (same as septic discharge)
[1] based on initial water supply quality and LOWRF raw influent data (Appendix C, Table C14)
[2] mostly as ammonia-nitrogen (Appendix C, Table C14)
[3] based on LOWRF treated effluent data (Appendix C, Table C14)
[4] 3.4 evaporative enrichment factor calibrated to baseline conditions (Chapter 4, Section 4.3)
[5] natural loading calibrated to pre-development conditions (Chapter 4, Section 4.3 and Appendix D)
[6] based on water quality data (Appendix C, Table C10)

ES-5 Assimilative Capacity and Anti-Degradation Analysis

The Policy requires an assimilative capacity and anti-degradation analysis for recycled water use on basins and subbasins. The anti-degradation analysis evaluates the impacts of recycled water use and future Basin development on groundwater quality from various sources of salt and nutrient loading. The assimilative capacity analysis compares current groundwater Basin water quality data with WQOs.

Methodology

The methodology used to simulate salt and nutrient loading involves a mass balance spreadsheet model, which converts salt and nutrient loads to inflow concentrations, distributes flows according to the water balance, and provides for repeated cycles of loading. The spreadsheet model also allows salt and nutrient load calibration using Basin water quality data. The calibration process provides a rigorous approach to mass balance by evaluating the Basin-specific salt and nutrient loads for key sources, including natural sources and the evaporative enrichment of salts beneath agricultural fields.

For the anti-degradation and assimilative capacity analyses, the Basin has been divided into mass balance compartments, or mixing cells, that correspond to the aquifers and plan areas used for water balance and water quality. This data created an average value used in the anti-degradation and assimilative capacity analyses for water quality, as summarized below. To see details on storage volumes, water quality, anti-degradation and assimilative capacity analyses for each mixing cell refer to Chapter 5.

Assimilative Capacity

The Regional Water Board defines assimilative capacity as:

> *The capacity of a natural body of water to receive (a) wastewaters, without deleterious effects, (b) toxic materials, without damage to aquatic life or humans who consume the water, (c) Biochemical oxygen demand (BOD)[3], within prescribed dissolved oxygen limits.*

[3] BOD is the amount of dissolved oxygen needed by aerobic biological organisms to break down organic material present in a given water sample at certain temperature over a specific time period.

Based on the above definition, the assimilative capacity of a groundwater basin to receive recycled water and return flows from irrigation would be the difference between ambient (current) concentrations of a selected water quality constituent in groundwater and the maximum concentration (or water quality objective, if specified) of the constituent that would preclude deleterious effects.

The Regional Water Board has not published water quality data for median groundwater objectives for the Basin. The median groundwater objectives used for the assimilative capacity analysis are based on the Central Coast Basin Plan's highest existing median objectives for the Estero Bay Area: 1,000 mg/L TDS, 250 mg/L chloride, and 10 mg/L NO_3-N.

The resulting assimilative capacity for salt and nutrient loading is summarized in Table ES-5.

Table ES-5. Assimilative Capacity - Los Osos Groundwater Basin

Loading Constituent	Allowable[1] (mg/L)	Current[2] (mg/L)	Assimilative Capacity[3] (mg/L)	10% Assimilative Capacity (mg/L)	20% Assimilative Capacity (mg/L)
TDS	1000	440	560	56	112
Chloride	250	81	169	17	34
NO_3-N	10	6	4	0.4	0.8

Source: CHG, 2017

NOTES: [1]Allowable concentration equal to maximum existing median objective for Estero Bay planning area based on the Central Coast Basin Plan.
[2]Basin averages are weighted averages by volume for mixing cells, see Chapter 5 for additional mixing cell water quality data
[3] Formula: Allowable - Current = Assimilative Capacity

Anti-degradation Assessment

The anti-degradation analysis evaluates potential impacts to water quality under various scenarios as discussed in ES-3, the 2012 Baseline (pre-construction of LOWRF) scenario and the No Further Development and Population Buildout scenarios (construction of LOWRF with recycled water reuse), and compares those impacts to the current assimilative capacity of the Basin. The analysis is required under the Policy (State Water Board Resolution No. 2013-0003) for operating the LOWRF, which mandates compliance with State Water Board Resolution 68-16 (*Statement of Policy with Respect to Maintaining High Quality of Waters in California*). This anti-degradation analysis has been prepared to satisfy both the Los Osos SNMP requirements and operating permit requirements of the LOWRF. Results from the mass balance spreadsheet model and graphs of water quality trends for individual mixing cells are included in Appendix E and F.

Results of the antidegradation analysis indicate LOWRF operation over a 25-year period with No Further Development uses less than 2% of the assimilative capacity of the Basin for TDS and chloride, while providing a net gain in Basin assimilative capacity for NO_3-N. LOWRF operation over a 25-year period with Population Buildout (cumulative projects) uses less than 4 % of the assimilative capacity of the Basin for TDS and chloride, while providing a net gain in Basin assimilative capacity for NO_3-N. These results show compliance with antidegradation thresholds established by the State Water Board. Table ES-6 summarizes the antidegradation analysis.

Table ES-6. Basin Antidegradation Analysis - Los Osos Valley Groundwater Basin									
Constituent	Assimilative Capacity [mg/L]	Assimilative Capacity Used (+lost -gained)[1]							
		No Further Development (E+AC+U)				Population Buildout (E+ABC+UG)			
		10 Years		25 Years		10 Years		25 Years	
		mg/L	%	mg/L	%	mg/L	%	mg/L	%
TDS	560	1.7	0.3	7.0	1.3	7.8	1.4	20.7	3.7
Chloride	169	0.1	0.1	0.6	0.4	2.1	1.2	5.2	3.1
NO_3-N	4	-0.7	-18.7	-1.1	-26.5	-0.6	-15.4	-0.8	-20.1

(Source: CHG, 2017)
Note:

(1) Positive values of assimilative capacity use (in red) indicate a reduction in basin assimilative capacity, while negative values of use (in blue) indicate a gain, or improvement, in capacity.
(2) LOBP Projects and Programs includes: E = Urban Water Use Efficiency Program, U = Urban Water Reinvestment Program, A= Basin Infrastructure Program (designed to increase groundwater production in the upper aquifer), C - Basin Infrastructure Program (shift groundwater in lower aquifer production in the Western Area to the Central Area), G= Agricultural Water Reinvestment Program, B = Basin Infrastructure Program (maximize groundwater production from the Upper Aquifer)

The anti-degradation analysis for TDS, chloride, and nitrates demonstrated that the LOWRF Project satisfied the policy requirements for the State Water Board's Resolution No. 68-16.. Results show that the operations of the LOWRF, removal of septic systems in the wastewater service area, and programs implemented (e.g., water conservation) from the LOBP will improve groundwater quality over time with respect to nitrates. Also, with the operation of the LOWRF, pumping is reduced in the Basin due to the in lieu use of recycled water used for irrigation. Reduced pumping could infer a greater groundwater pressure head with the potential to reduce seawater intrusion in the Basin.

The Los Osos SNMP technical analyses indicate that the overall groundwater quality baseline would have continued to degrade (over the 25 year planning horizon) without the construction and operation of the LOWRF and removal of septic systems within the wastewater service area.

ES-6 SNMP Goals & Objectives

Groundwater basin management goals and objectives are summarized in the following governing mission statement for the County's recycled water facility:

> *To evaluate and develop a wastewater treatment system for Los Osos, in cooperation with the community water purveyors, to solve the Level III water resource shortage and groundwater pollution, in an environmentally sustainable and cost effective manner, while respecting community preferences and promoting participatory government, and addressing individual affordability challenges to the greatest extent possible.*

Basin management goals and objectives will aid in managing salt and nutrient loading to groundwater. Basin management practices with recycled water reuse will support in maintaining sustainable groundwater quality for the Basin. No new best management practices (BMPs) are therefore recommended as part of this Los Osos SNMP process. Goals and objectives will be updated in the Los Osos SNMP Monitoring Report when plans or BMPs are developed or revised in the future. However, one future anticipated document being prepared by the County Planning Department is the countywide Onsite Wastewater

Treatment Systems (OWTS) Local Agency Management Program (LAMP), which will outline the management of the septic systems outside the wastewater service area in the Basin (CCRWQCB, 2011a).

Basin Management Goals and Objectives

The Basin management goals and objectives were identified, developed and vetted during the development of the Basin Plan and updated or monitored in the Basin Plan 2015 Annual Groundwater Monitoring Report. The immediate goals are designed to balance supplies and demands in the Basin, and continuing goals will be implemented over time to promote and maintain the long-term balance and health of the Basin. The primary goals are to halt, and to the extent possible, reverse seawater intrusion into the Basin and to provide sustainable water supplies for existing and future residential, commercial, institutional, recreational and agricultural development within Los Osos. In addition to evaluating and tracking the status of groundwater quality and the impact of the Basin Plan programs in the Basin with objective, numerical metrics, management of the Basin will involve balancing economic, environmental, and social interests. Criteria for sustainable use of the Basin, as defined in the Basin Plan, is outlined in Chapter 6.

ES-7 Implementation Measures

Implementation of programs and measures will continue to support Basin management efforts toward reducing salt and nutrient loading and creating long-term sustainability for beneficial uses. Existing groundwater quality BMPs or measures already in place will continue. New implementation measures or BMPs developed in the future will be incorporated into the Los Osos SNMP, as appropriate, as part of the adaptive management strategies. Adaptive management strategies will be implemented in the Los Osos SNMP after securing all necessary approvals. The adaptive management approach will allow for modifications of the Los Osos SNMP over time in response to project monitoring to protect and enhance groundwater resources. This approach will allow flexibility to respond to changing conditions in the Basin.

Existing implementation programs and measures from the Basin Plan in the Basin are listed below and described in Chapter 7. Table ES-7 summarizes implementation or potential measures by the County and/or other agencies.

- Adaptive Management Plan
- Basin Metrics Implementation
- Groundwater Monitoring Program
- Urban Water Use Efficiency Program
- Urban and Agricultural Water Reinvestment Program
- Basin Infrastructure Programs A and C
- Wellhead Protection Program
- Nitrate Level Metric
- Water Level Metric
- Chloride Level Metric

Table ES-7. Potential and In Progress Implementation Measures for the SNMP			
Implementation Measures – Water Supply			
Status	**Specific Measure**	**Description**	**Effect**
Potential future measure	Softening of Groundwater Supplies	Advanced treatment to soften community water supplies	Reduces the need for self-regenerating water softeners. Fewer self-regenerating water softeners will reduce the salt load in residential wastewater stream
Implementation Measures – Recharge/Return Flow			
Status	**Specific Measure**	**Description**	**Effect**
In Progress[2]	Evaluate Study/ Recharge Projects using Recycled Water in creeks	Evaluate/optimize discharge to improve efficiency at reducing/reversing seawater intrusion	Increases freshwater head to limit seawater intrusion by reducing pumping in the Lower Aquifer.
In Progress[3]	Improve Stormwater Capture	Identify and consider new projects for additional capture/infiltration of stormwater	Increases recharge of low salt/nutrient concentration water
In Progress[4]	Agricultural Grower Education and Outreach	Optimize fertilization/irrigation techniques to minimize nitrate loading and improve irrigation efficiency	Reduce fertilizer use (nitrate loading), reduce water use and associated concentration of salts in soil
Potential future measure	Expand LOWRF Collection Area	Expand LOWRF connections to septic systems within Basin but outside current collection area	Reduces nitrate loading from septic discharges
Implementation Measures – Wastewater			
Status	**Specific Measure**	**Description**	**Effect**
Potential future measure	Source Control-Chloride	Education/outreach/regulation to reduce the number of self-regenerating water softeners	Fewer self-regenerating water softeners will reduce the salt load in residential wastewater
Potential future measure	Regulatory	Ordinance regulating or banning discharge of saltwater or brine from commercial or industrial activities	Reduces salt loading in wastewater stream
Potential future measure	Regulatory	Ordinance limiting or banning self-regenerating water softeners from discharging to the sanitary sewer	Reduces salt loading in wastewater stream
Potential future measure	Regulatory	Ordinance for management of the septic systems outside the wastewater service area	Reduce nutrient loading to groundwater

Source: CHG, 2017
NOTES: [1] Discharge to Los Osos Creek being evaluated
[2] Septic tank repurposing program in progress
[3] Regional Water Board Irrigated Lands Regulatory Program

Implementation actions for salt and nutrient management in the Basin include monitoring and evaluation, prevention, and planning activities to continue active management of the Basin for the long-term beneficial uses of the stakeholders. These activities have been developed to continue providing the data needed to base decisions on sound, scientific data and to provide short-term and long-term prevention and planning activities appropriate for the current and anticipated future salt and nutrient conditions in the Basin. The Los Osos SNMP will incorporate additional implementations for the OWTS LAMP in the future.

ES-8 Groundwater Quality Monitoring

A Los Osos SNMP Groundwater Quality Monitoring Program (SNMP Monitoring Program) is required for the LOWRF WDR Order as part of the Policy and is built on existing Basin monitoring programs. The SNMP Monitoring Program includes descriptions of the groundwater sampling locations, sampling frequency, constituents monitored, sampling protocols and associated quality assurance and quality control

(QA/QC) procedures, data analysis, evaluation criteria, and reporting procedures. The SNMP Monitoring Program includes a report with the above data for groundwater, as well as supplemental data for surface water and stormwater, as appropriate. The County will coordinate the data collection with the BMC and other stakeholders, and prepare the required SNMP Monitoring Report for the Regional Water Board every three years.

Constituents of Emerging Concern

As part of the SNMP Monitoring Program, the Policy requires that the Los Osos SNMP include "....a provision for annual monitoring of Constituents of Emerging Concern (CEC) consistent with recommendations by *California Department of Public Health* (CDPH) and consistent with any actions by the State Water Board...." CECs generally have no established water quality standards. These chemicals may be present in waters at very low concentrations and are now detectable as the result of more sensitive analytical methods. Information regarding their health significance is evolving with the development of acceptable daily intake levels and drinking water equivalent levels; however, information is lacking on the full spectrum of potential CECs and their health significance. CECs include several types of chemicals such as pesticides, pharmaceuticals and ingredients in personal care products, veterinary medicines, and endocrine disruptors. The Policy states, "each salt and nutrient management plan shall include [a] provision for annual monitoring of Emerging Constituents/Constituents of Emerging Concern consistent with recommendations by CDPH and consistent with any actions by the State Water Board taken pursuant to paragraph 10(b) of this Policy."

As the County is applying for the 2016 *General Water Reclamation Requirements for Recycled Water Use* (Order WQ 2016-0068-DDW) in 2018, this Order includes Policy requirements for the Los Osos SNMP including "... monitoring requirements for CECs for the use of recycled water for groundwater recharge by surface and subsurface application methods. The monitoring requirements and criteria for evaluating monitoring results in the Recycled Water Policy are based on recommendations from a Science Advisory Panel. Because this General Order is limited to non-potable uses and does not authorize groundwater replenishment activities, monitoring for CECs is not required." Because the LOWRF recycled water is for non-potable uses and is not injected into the Basin for recharge, monitoring for CECs in groundwater in the Basin is not required under the General Water Reclamation Requirements for Recycled Water Use (Order WQ 2016-0068-DDW). However, the LOWRF will test for CECs annually with an annual grab sample from the effluent of the water recycling facility under the Monitoring and Reporting Program WDR Order No. R3-2011-0001 (CCRWQCB, 2011a).

Existing Groundwater Quality and Level Monitoring Programs

The Los Osos SNMP monitoring requirements will be satisfied through existing groundwater monitoring programs implemented across the Basin area by the County, BMC, and other stakeholders. The data will be coordinated with key basin monitoring programs, including the LOWRF Monitoring and Reporting Program (MRP), Monitoring Program in the Recycled Water Management Plan (RWMP) for the California Coastal Commission Coastal Development Permit, the Basin Plan Annual Groundwater Monitoring Report for the BMC, California Statewide Groundwater Elevation Monitoring (CASGEM), and other monitoring programs, as appropriate.

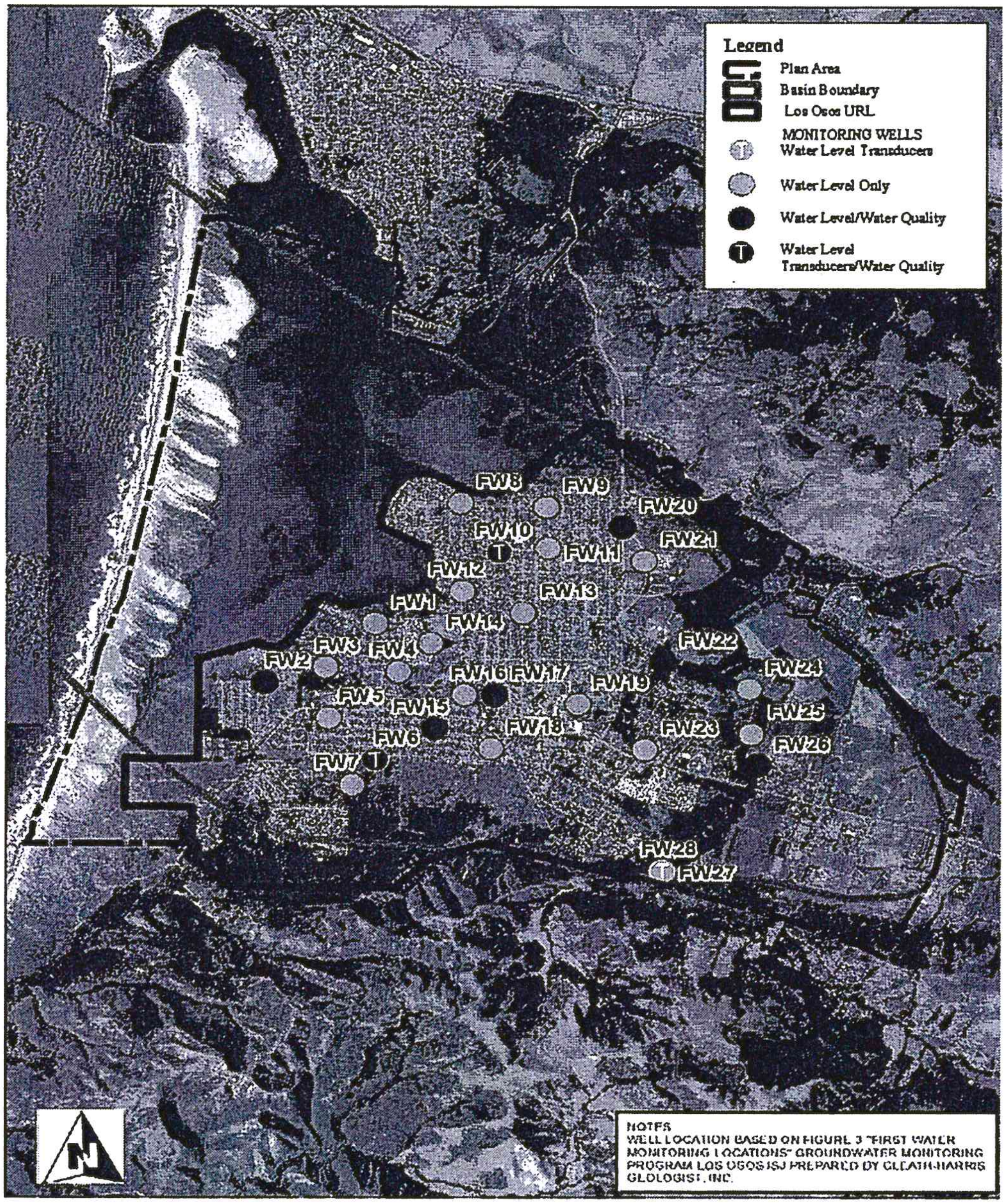
SNMP Groundwater Monitoring Network

The Los Osos SNMP will use the network monitoring locations from the BMC (73 wells) and the County LOWRF MRP (26 monitoring wells). Using the existing monitoring network locations will provide a reasonable, cost-effective means of monitoring the concentrations of salt, nutrients and other constituents of concern. Figures ES-6, ES-7, and ES-8 show the monitoring locations for each aquifer group (First Water, Upper Aquifer, and Lower Aquifer) from the Basin Plan. The current monitoring network provides a reference for identifying future wells that may be incorporated into the SNMP Monitoring Program.

Additionally, the "key wells" selected for the LOWRF MRP (Figure ES-9) will be used to optimize groundwater quality characterization.

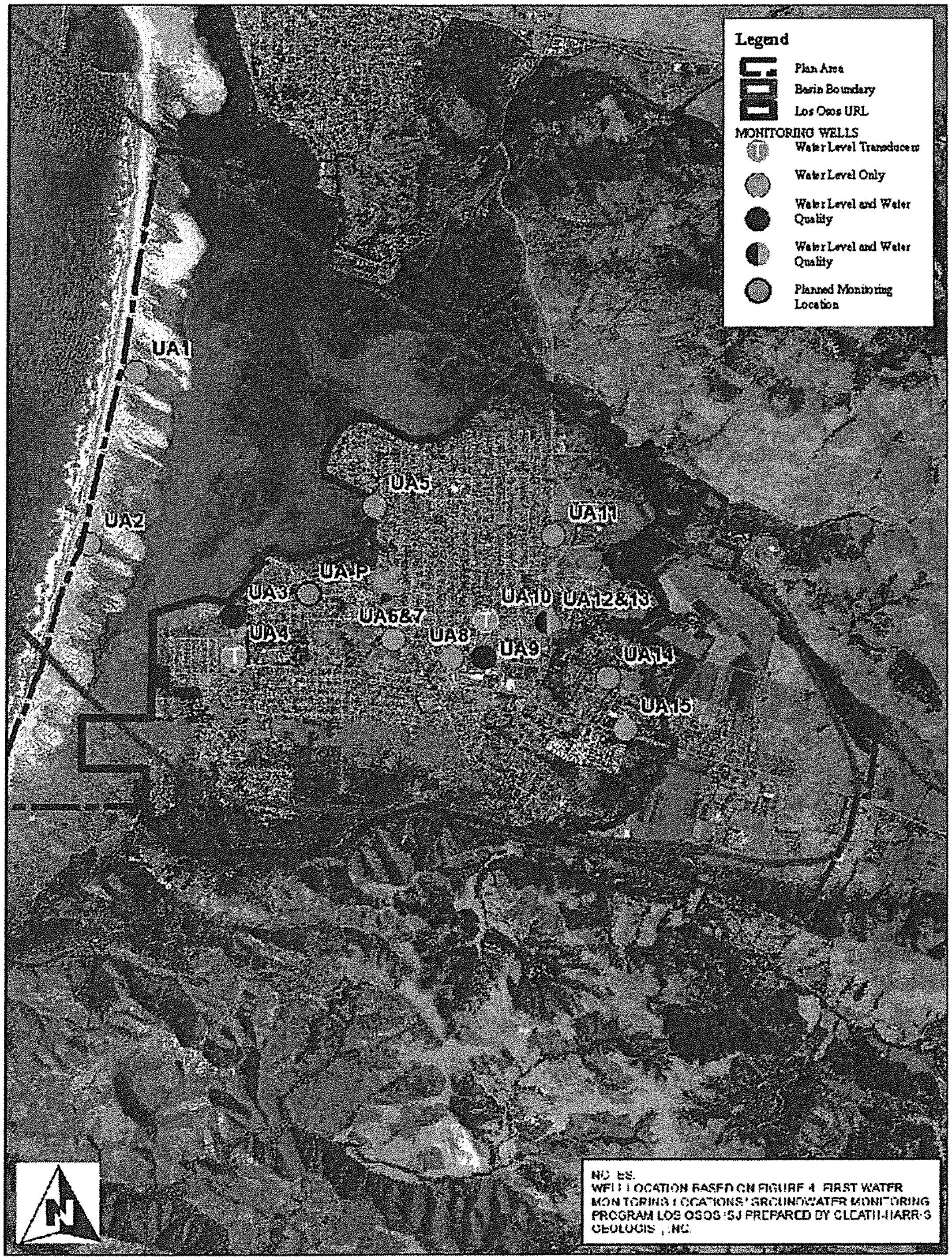
Recycled water will be discharged to the Broderson and Bayridge leachfields disposal sites (Figure ES-9). In preparation for groundwater monitoring during operations of the LOWRF, the County installed five vadose zone monitoring locations down-slope of the Broderson leachfield disposal site (Figure ES-10). These wells will be used to monitor groundwater conditions at the leachfields.

Figure ES-6. LOBP First Water Monitoring Network



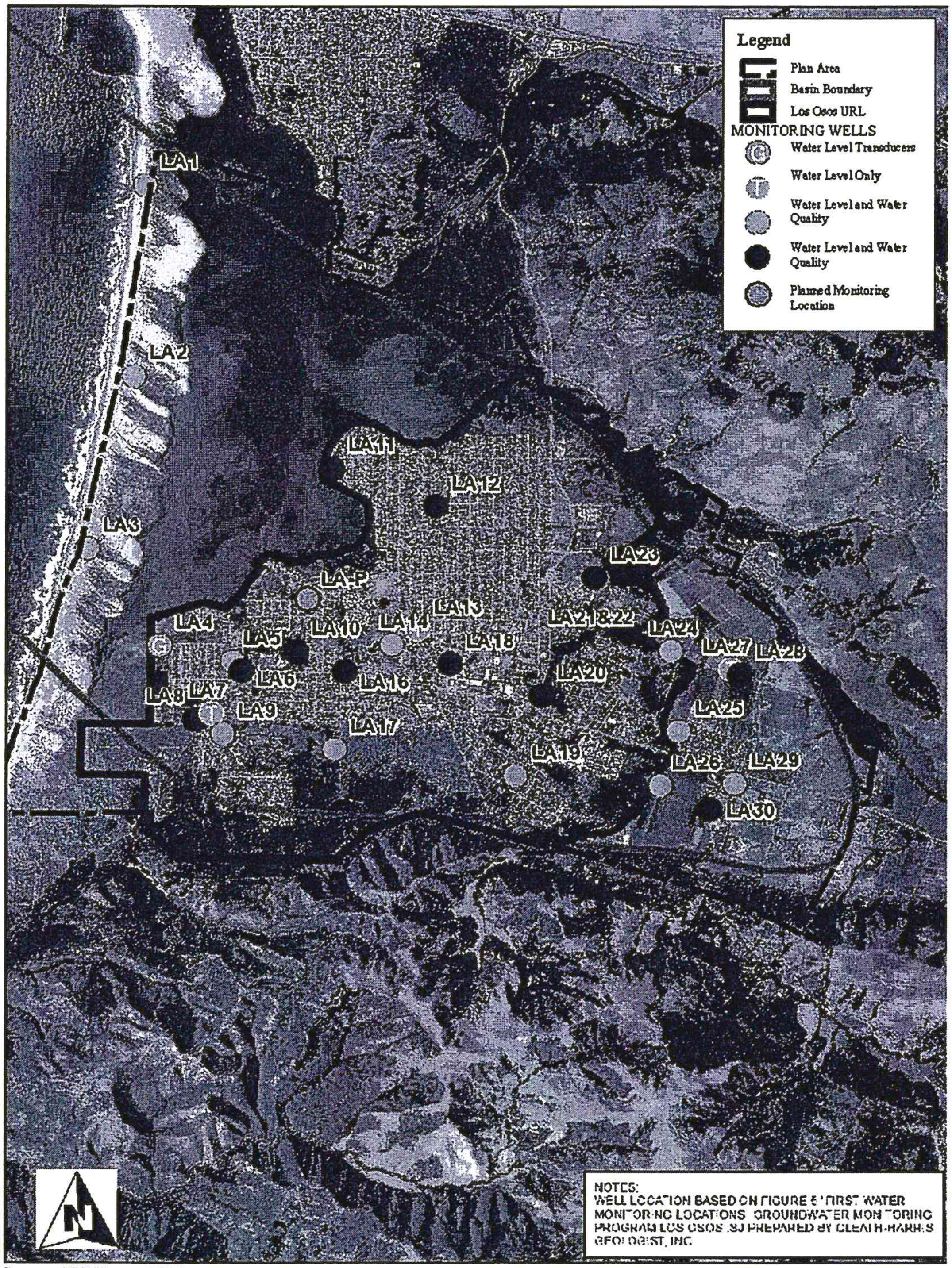
Source: ISJ Group, 2015

Figure ES-7. LOBP Upper Aquifer Monitoring Network



Source: ISJ Group, 2015

Figure ES-8. LOBP Lower Aquifer Monitoring Network



Source: ISJ Group, 2015

Figure ES-9. LOWRF Monitoring and Reporting Program Wells (Source: CCRWQCB, 2011a)

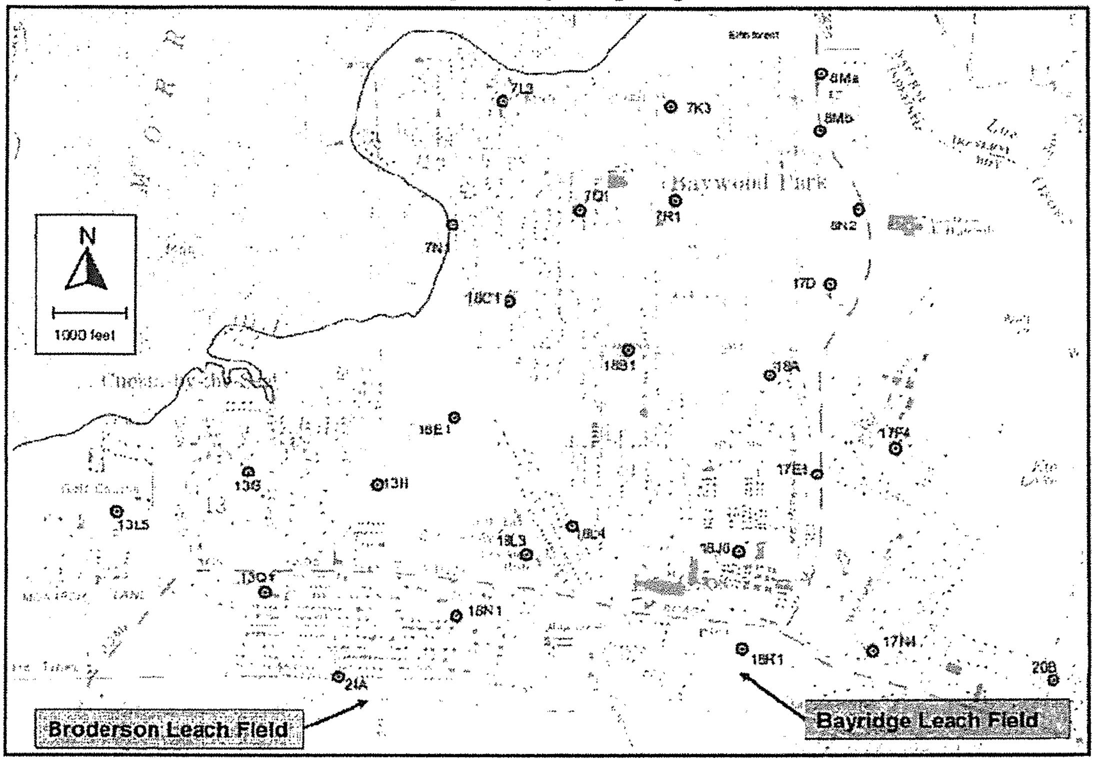
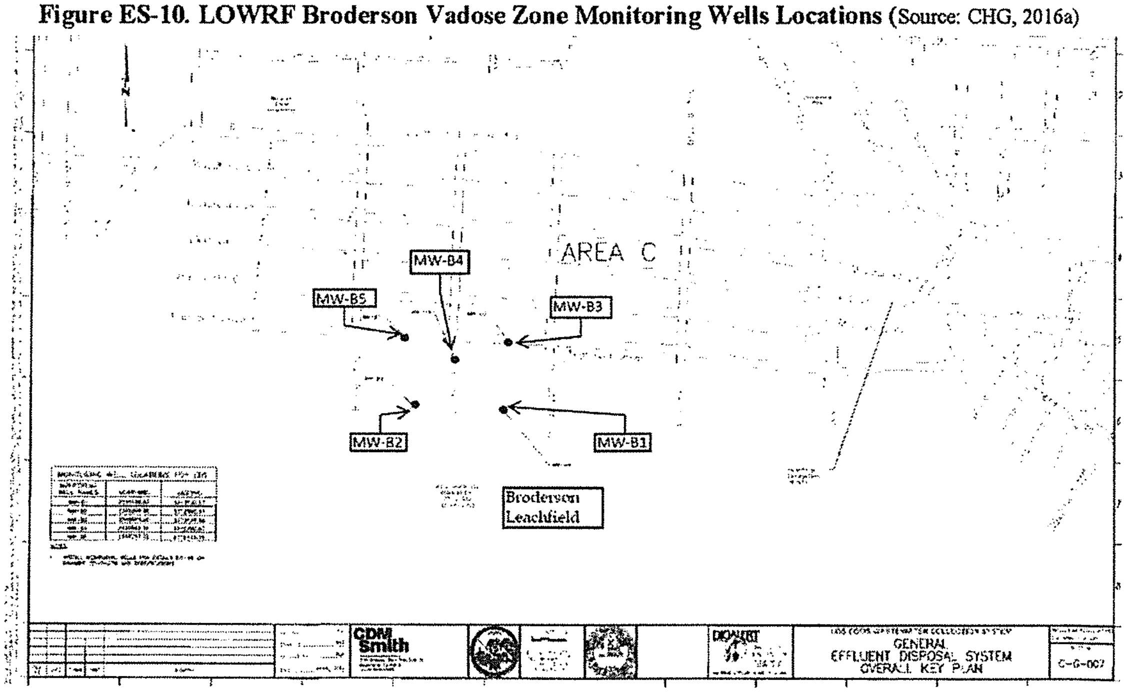


Figure ES-10. LOWRF Broderson Vadose Zone Monitoring Wells Locations (Source: CHG, 2016a)



SNMP Groundwater Quality Monitoring

Groundwater monitoring and reporting is essential for addressing many issues related to groundwater resources in the Basin, including determination of the groundwater level, water quality, sustainable yield, seawater intrusion, nitrate contamination, and future dynamic changes to the Basin. The Los Osos SNMP will also examine Basin water quality near water supply wells and areas proximate to large water recycling projects.

The monitoring report will include descriptions of the groundwater sampling locations, sampling frequency, constituents monitored, sampling protocols and associated quality assurance and quality control (QA/QC) procedures, data analysis, evaluation criteria, and reporting procedures. The Los Osos SNMP will combine information with the appropriate data from the Basin Plan annual groundwater monitoring report, LOWRF MRP, and other monitoring programs, if necessary.

The Los Osos SNMP will utilize historical total dissolved solids, chloride, and nitrate data from the County baseline water quality requirements for the LOWRF WDR Order (collected from 2012 to 2016), as well as the BMC constituents listed in their 2015 Annual Groundwater Monitoring Report. Other constituents collected by the County and BMC that will support the Los Osos SNMP include:

- Carbonate Alkalinity (BMC)
- Bicarbonate Alkalinity (BMC)
- Total Alkalinity (as $CaCO_3$) (BMC)
- Total dissolved solids (BMC, LOWRF)
- Ammonia as Nitrogen (LOWRF)
- Total Kjeldahl Nitrogen (LOWRF)
- Nitrite as Nitrogen (LOWRF)
- Nitrate as Nitrogen (LOWRF)
- Organic Nitrogen (BMC, LOWRF)
- Total Nitrogen (LOWRF)
- Boron (BMC, LOWRF)
- Calcium (BMC)
- Potassium (BMC)
- Sodium (BMC, LOWRF)
- Magnesium (BMC)
- Sulfate (BMC, LOWRF)
- Chloride (BMC, LOWRF)
- Electrical conductance (BMC, LOWRF)
- Temperature (BMC, LOWRF)
- pH (BMC, LOWRF)

Groundwater quality data should be evaluated on a regular basis for trends and exceedances of water quality objectives as discussed in ES-3. The Los Osos SNMP shall also report data collected from surface water and stormwater programs, as appropriate.

A Quality Assurance Project Plan (QAPP) was prepared to establish a general standard for sample collection procedures. This includes sampling that is conducted in accordance with industry accepted standard sampling protocols and analyses that are conducted by California-certified laboratories (see Appendix G).

ES-9 EXECUTIVE SUMMARY CONCLUSION

The County has prepared the Los Osos SNMP in accordance with the Policy. The objective of the Los Osos SNMP is to manage salts and nutrients within the Basin in a manner that ensures attainment of water quality objectives and protection of beneficial uses. The Basin area for the Los Osos SNMP is based on the court-approved Basin Plan Area established pursuant to the Stipulated Judgment approved by the San Luis Obispo Superior Court on October 15, 2015. The Basin Plan Area is part of the Los Osos Valley Groundwater Basin, the California Department of Water Resources (DWR), Bulletin 118 Basin No. 3-8. Known issues in the Basin include seawater intrusion and elevated nitrate concentrations from septic systems.

Indicator constituents for the Los Osos SNMP include chlorides, TDS, and nitrates. These constituents were analyzed in the anti-degradation analysis, which demonstrated that the LOWRF satisfies the requirements of the State Water Board's Resolution No. 68-16 - *Statement of Policy with Respect to*

Maintaining High Quality of Waters in California. The antidegradation analysis evaluated the potential impacts to water quality from the Basin Plan project's three scenarios, which included 2012 Baseline (no LOWRF), No Further Development, and Population Buildout. Results show that the operations of the LOWRF with removal of septic systems from the wastewater service area and implementing management programs (e.g. water conservation) from the Basin Plan will increase groundwater quality overtime with respect to nitrates. Additionally, the operation of the LOWRF will reduce groundwater pumping within the Basin, which infers that a greater pressure head can be created to reduce seawater intrusion in the Basin.

The SNMP Monitoring Program identified stakeholders responsible for conducting, compiling, and reporting the monitoring data. The County will coordinate with the BMC and other stakeholders to collect the required data and prepare a report for the Regional Water Board at least every three years. Groundwater monitoring locations for the Los Osos SNMP will be the same as those used in existing monitoring programs; specifically, the Basin Plan Annual Report and the LOWRF Annual Groundwater Monitoring and Reporting Program for the WDR Permit Order. The County and/or appropriate purveyors could implement adaptive management in the Basin to address issues that may develop.

The operation of the LOWRF, implementation of the SNMP Monitoring Program, along with the continuation of the Basin Plan programs will continue to improve the Basin water quality for beneficial uses. Storage capacity will be increased by reducing groundwater pumping. Nitrate loading will be reduced by the removal of septic systems in the wastewater service zone. Seawater intrusion will decline due to the increase in pressure head in the Basin from the reduced pumping. These programs take critical steps towards sustainability in the Basin.

APPENDIX B

Water Quality Data

Appendix B1 – 2015 Annual Report

Appendix B2 – Los Osos Water Recycling Facility Baseline Monitoring

Appendix B3 – 2016 Central Coast Basin Plan

APPENDIX B1

2015 Annual Report

Table 9. Fall 2015 Water Quality Results - First Water and Upper Aquifer (CHG & Wallace Group, 2016)

Basin Plan Well	State Well Number	Date	SC	pH (field)	TDS	Alkalinity			Cl	NO3-N	SO4	B	Ca	Mg	K	Na	T
						CO3	HCO3	Total as CaCO3									
			µS/cm	pH units	mg/L												°F
FW2	30S/10E-13L8	11/2	--	6.32	520	--	--	--	107	27.8	20	0.1	--	--	--	122	65.3
FW6	30S/10E-24A	11/5	--	6.64	430	--	--	--	140	18.6	7	<0.1	--	--	--	43	61.5
FW10	30S/11E-7Q1	11/9	--	6.70	490	--	--	--	119	23.4	45	0.3	--	--	--	79	63.9
FW15	30S/11E-18N2	11/4	--	6.32	410	--	--	--	86	24.8	42	0.2	--	--	--	59	66.2
FW17	30S/11E-18L12	11/2	--	6.80	510	--	--	--	104	32.6	36	0.2	--	--	--	61	65.8
FW20	30S/11E-8Mb	(DRY)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
FW22	PRIVATE																
FW26	PRIVATE																
FW28	PRIVATE																
UA3	30S/10E-13F1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
UA9	30S/11E-18K3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
UA13	30S/11E-17E10	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

NOTES: "--" = no result available; SC = specific conductance; TDS = total dissolved solids; CO3 = carbonate; HCO3= bicarbonate; CaCO3 = total alkalinity as calcium carbonate; Cl = chloride; NO3-N = nitrate as nitrogen; SO4 = sulfate; B = boron; Ca = calcium; Mg = magnesium; K = potassium; Na = sodium; T = temperature; µS/cm = microsiemens per centimeter; mg/L = milligrams per liter; °F = degrees Fahrenheit

Table 10. Spring 2015 Water Quality Results - Lower Aquifer (CHG & Wallace Group, 2016)

Basin Plan Well	State Well Number	Date	SC	pH (field)	TDS	Alkalinity			Cl	NO3-N	SO4	B	Ca	Mg	K	Na	T
						CO3	HCO3	Total as CaCO3									
			µS/cm	pH units	mg/L												°C
LA8	30S/10E-13N	4/21	445	--	280	<10	50	40	77	7.7	11	<0.1	16	14	2	38	18.6
LA9	30S/10E24C1	4/21	530	--	320	<10	70	60	95	5.5	16	<0.1	19	17	2	45	--
LA10	30S/10E-13J4	4/22	1230	--	750	<10	80	70	331	1.9	20	<0.1	69	63	2	39	--
LA11	30S/10E-12J1	4/22	1290	7.23	810	<10	360	300	112	<0.5	189	0.3	65	76	5	88	20.5
LA12	30S10E-7Q3	4/21	897	--	500	<10	290	240	101	<0.5	55	0.2	48	45	2	59	23.1
LA15	30S/11E-18L2	4/29	348	--	230	<10	80	60	43	5.0	10	<0.1	13	11	0	30	18.4
LA18	30S/11E-18K8	4/21	634	7.26	400	<10	290	240	33	<0.5	39	<0.1	55	31	2	27	22.9
LA20	30S/11E-17N10	4/22	653	--	360	<10	290	240	43	0.6	27	<0.1	36	35	2	42	--
LA22	30S/11E-17E8	4/21	481	7.08	270	<10	150	120	49	7.1	13	<0.1	25	23	1	28	19.9
LA23	PRIVATE																
LA28	PRIVATE																
LA31+	30S/10E-13M2	4/21	3430	--	1930	<10	60	50	950	0.5	180	0.2	113	111	5	378	18.2
LA32+	30S/11E-18K9	4/21	504	--	270	<10	190	160	38	1.6	20	<0.1	17	16	1	27	20.4

NOTES: "--" = no result available; SC = specific conductance; TDS = total dissolved solids; CO3 = carbonate; HCO3= bicarbonate; CaCO3 = total alkalinity as calcium carbonate; Cl = chloride; NO3-N = nitrate as nitrogen; SO4 = sulfate; B = boron; Ca = calcium; Mg = magnesium; K = potassium; Na = sodium; T = temperature; µS/cm = microsiemens per centimeter; mg/L = milligrams per liter; °C = Celsius (some values converted from degrees Fahrenheit as reported on field logs); + indicates proposed addition to monitoring program; < indicates less than Practical Quantitation Limit as listed in laboratory report.

Table 11. Fall 2015 Water Quality Results - Lower Aquifer Group (CHG & Wallace Group, 2016)																	
Basin Plan Well	State Well Number	Date	SC	pH (field)	TDS	Alkalinity			Cl	NO3-N	SO4	B	Ca	Mg	K	Na	T
						CO3	HCO3	Total as CaCO3									
			µs/cm	pH units	mg/L												°C
LA2	30S/10E-11A2	10/21	17700	7.44	13100	<10	150	130	6300	<0.2	740	<0.1	1030	990	31	1560	19.1
LA3	30S/10E-14B2	10/21	29500	11.55	24700	140	<10	360	10000	<0.4	530	<0.1	2830	20	80	4040	23.2
LA8	30S/10E-13N	10/6	422	8.12	310	<10	40	40	75	6.8	10	<0.1	16	14	1	38	18.6
LA9	30S/10E-24C1	10/5	349	--	270	<10	50	40	50	7.6	7	<0.1	12	11	1	34	--
LA10	30S/10E-13J4	10/5	1280	--	950	<10	70	60	329	1.7	19	<0.1	74	67	2	41	--
LA11	30S/10E-12J1	10/1	1280	7.38	840	<10	250	200	117	<0.5	188	0.3	68	77	4	85	21.2
LA12	30S10E-7Q3	10/6	828	7.52	490	<10	280	230	91	<0.5	46	0.2	47	44	2	55	21.1
LA15	30S/11E-18L2	10/28	782	7.65	420	<10	230	190	104	0.6	29	<0.1	46	42	<1	30	20.1
LA18	30S/11E-18K8	10/19	621	7.39	370	<10	230	190	29	<0.5	33	<0.1	53	30	2	26	23.6
LA20	30S/11E-17N10	10/5	614	--	370	<10	280	230	38	0.5	23	0.1	35	34	2	41	--
LA22	30S/11E-17E8	10/1	475	7.27	290	<10	120	100	44	6.6	10	<0.1	26	24	1	28	20.0
LA23	PRIVATE																
LA28	PRIVATE																
LA31+	30S/10E-13M2	10/6	3370	7.64	2140	<10	30	30	960	0.5	185	0.2	115	114	5	342	19.2
LA32+	30S/11E-18E9	10/6	248	7.49	190	<10	50	40	31	5.9	3	<0.1	10	9	<1	21	22.2

NOTES: "--" = no result available; SC = specific conductance; TDS = total dissolved solids; CO3 = carbonate; HCO3= bicarbonate; CaCO3 = total alkalinity as calcium carbonate; Cl = chloride; NO3-N = nitrate as nitrogen; SO4 = sulfate; B = boron; Ca = calcium; Mg = magnesium; K = potassium; Na = sodium; T = temperature; µS/cm = microsiemens per centimeter; mg/L = milligrams per liter; °C = degrees Celsius; + indicates proposed addition to monitoring program; < indicates less than Practical Quantitation Limit as listed in laboratory report.

APPENDIX B2

Los Osos Water Recycling Facility Baseline Monitoring (2012–2016)

CHG, 2012
August 2012 Water Quality Results

Well ID	Sample Date	pH units	TDS mg/l	Total N mg/l	NO_3-N mg/l	NO_2-N mg/l	NH_3-N mg/l	Org. N mg/l	TKN mg/l	Na mg/l	Cl mg/l	SO_4 mg/l	B mg/l	DTW feet
30S/10E-13G	8/15/12	6.2	330	12	11.7	ND	ND	ND	ND	41	70	15	ND	40.3
30S/10E-13H	8/15/12	6.5	140	2	2.3	ND	ND	ND	ND	12	21	12	ND	22.4
30S/10E-13L5	8/16/12	6.1	510	18	17.5	0.1	0.2	ND	ND	126	138	13	ND	27.1
30S/10E-13Q1	8/17/12	6.2	700	30	30.4	ND	ND	ND	ND	84	195	31	0.1	84.5
30S/10E-24A	8/17/12	6.5	330	17	17.0	ND	ND	ND	ND	38	74	6	ND	157.2
30S/11E-7K3	8/14/12	6.9	520	14	14.4	ND	ND	ND	ND	86	165	42	0.2	52.0
30S/11E-7L3	8/14/12	6.9	430	19	19.0	ND	ND	ND	ND	81	91	38	0.2	36.8
30S/11E-7N1	9/5/12	6.8	190	4	3.8	ND	ND	ND	ND	21	31	6	ND	3.5
30S/11E-7Q1	8/15/12	6.4	580	16	15.7	ND	0.5	ND	ND	99	173	46	0.3	5.7
30S/11E-7R1	8/13/12	6.5	450	13	13.1	ND	ND	ND	ND	60	107	39	0.2	22.0
30S/11E-8Ma	8/14/12	7.1	180	3	2.5	ND	ND	ND	ND	23	42	13	0.1	41.3
30S/11E-8Mb	8/14/12	6.8	790	33	32.5	ND	ND	ND	ND	63	214	57	0.2	41.9
30S/11E-8N2	8/14/12	7.1	100	2	2.1	ND	ND	ND	ND	7	14	4	ND	36.1
30S/11E-17D	8/14/12	6.9	350	19	19.1	ND	ND	ND	ND	54	81	25	0.1	–
30S/11E-17E9	8/16/12	6.7	390	17	16.6	ND	ND	ND	ND	41	65	24	ND	89.0
30S/11E-17F4	8/15/12	6.3	440	ND	0.6	ND	ND	ND	ND	63	122	15	ND	43.9
30S/11E-18A	8/13/12	6.6	360	11	10.9	ND	ND	ND	ND	41	77	31	0.1	–
30S/11E-18B1	8/13/12	6.4	400	7	7.1	ND	ND	ND	ND	43	89	40	0.1	19.3
30S/11E-18C1	8/13/12	6.8	540	16	16.1	ND	ND	ND	ND	78	137	40	0.1	17.4
30S/11E-18E1	8/16/12	6.2	260	9	8.7	ND	0.2	ND	ND	39	60	17	ND	25.9
30S/11E-18J6	8/15/12	6.6	370	7	3.5	ND	2.1	ND	3	50	52	39	0.1	23.9
30S/11E-18L3	8/14/12	6.6	200	4	4.2	ND	ND	ND	ND	28	37	21	ND	41.8
30S/11E-18L4	8/15/12	6.2	490	18	18.2	ND	ND	ND	ND	54	124	27	0.1	20.6
30S/11E-18N1	8/17/12	6.5	440	26	25.9	ND	ND	ND	ND	60	108	43	0.1	77.3
30S/11E-18R1	8/17/12	6.3	370	21	21.1	ND	ND	ND	ND	56	87	20	0.1	13.6

NOTES: TDS = Total Dissolved Solids; NO_3-N = Nitrate as Nitrogen; NO_2-N = Nitrite as Nitrogen; NH_3-N = Ammonia as Nitrogen; Org. N = Organic Nitrogen; TKN = Total Kjeldahl Nitrogen; Na = Sodium; Cl = chloride; SO_4 = Sulfate; B = Boron; DTW = depth to water; ND = Not Detected; See laboratory reports for practical quantitation limits.

CHG, 2013
June 2013 Water Quality Results

Well ID	Sample Date	pH units	TDS mg/l	Total N mg/l	NO_3-N mg/l	NO_2-N mg/l	NH_3-N mg/l	Org. N mg/l	TKN mg/l	Na mg/l	Cl mg/l	SO_4 mg/l	B mg/l	DTW feet
30S/10E-13G	6/12/13	6.3	290	10	9.7	ND	ND	ND	ND	45	74	18	ND	40.90
30S/10E-13H	6/19/13	6.7	110	2	2.2	ND	ND	ND	ND	14	14	20	ND	29.35
30S/10E-13L5	6/12/13	6.7	540	16	16.0	ND	ND	ND	ND	132	130	38	0.1	22.81
30S/10E-13Q1	6/12/13	6.4	650	27	25.7	ND	ND	1	1	77	183	33	0.1	85.20
30S/10E-24A	6/12/13	7.0	310	16	15.9	ND	ND	ND	ND	39	78	7	ND	157.77
30S/11E-7K3	6/17/13	6.9	600	17	17.3	ND	ND	ND	ND	91	177	40	0.2	52.96
30S/11E-7L3	6/13/13	6.7	430	19	18.7	ND	ND	ND	ND	73	89	41	0.1	37.60
30S/11E-7N1	6/19/13	7.1	190	5	5.2	ND	ND	ND	ND	22	34	9	ND	7.30
30S/11E-7Q1	6/19/13	6.5	500	18	18.4	ND	0.7	ND	ND	96	148	43	0.3	7.03
30S/11E-7R1	6/13/13	6.6	480	16	16.3	ND	ND	ND	ND	64	149	48	0.1	23.19
30S/11E-8Ma	6/19/13	7.1	190	4	2.8	ND	ND	1	1	26	51	12	ND	43.00
30S/11E-8Mb	6/14/13	7.0	970	78	77.6	0.3	ND	ND	ND	81	249	55	ND	43.84
30S/11E-8N2	6/14/13	7.0	70	3	2.8	ND	ND	ND	ND	8	16	7	ND	39.03
30S/11E-17D	6/18/13	6.6	400	20	19.8	ND	ND	ND	ND	58	97	27	ND	NA
30S/11E-17E9	6/17/13	6.9	370	16	15.5	ND	ND	ND	ND	45	65	26	ND	93.05
30S/11E-17F4	6/18/13	6.3	390	ND	0.7	ND	ND	ND	ND	70	136	16	ND	44.98
30S/11E-18A	6/18/13	6.4	380	13	13.1	ND	0.3	ND	ND	49	100	34	0.1	NA
30S/11E-18B1	6/20/13	6.5	460	12	11.7	ND	ND	ND	ND	61	133	33	0.1	20.90
30S/11E-18C1	6/13/13	6.3	520	17	17.3	ND	ND	ND	ND	75	148	49	0.1	18.56
30S/11E-18E1	6/17/13	6.5	290	10	9.9	ND	ND	ND	ND	45	66	22	ND	26.70
30S/11E-18J6	6/19/13	6.4	380	7	3.6	ND	2.9	ND	3	57	63	29	0.2	23.49
30S/11E-18L3	6/13/13	6.3	200	5	5.0	ND	ND	ND	ND	28	55	22	ND	44.63
30S/11E-18L4	6/13/13	6.5	490	27	27.4	ND	ND	ND	ND	57	133	31	ND	21.73
30S/11E-18N1	6/12/13	6.4	440	28	27.9	ND	ND	ND	ND	56	105	57	0.1	78.91
30S/11E-18R1	6/18/13	6.0	360	20	20.0	ND	ND	ND	ND	59	89	24	0.2	12.48

NOTES: TDS = Total Dissolved Solids; NO_3-N = Nitrate as Nitrogen; NO_2-N = Nitrite as Nitrogen; NH_3-N = Ammonia as Nitrogen; Org. N = Organic Nitrogen; TKN = Total Kjeldahl Nitrogen; Na = Sodium; Cl = chloride; SO_4 = Sulfate; B = Boron; DTW = depth to water; ND = Not Detected; See laboratory reports for practical quantitation limits.

Rincon Consultants, 2014a

January 2014 Water Quality Results

Well ID	Sample Date	pH	TDS mg/L	Total N mg/L	NO_3^- mg/L	NO_2^- mg/L	NH_3^+ mg/L	Org. N mg/L	TKN mg/L	Na mg/L	Cl mg/L	SO4 mg/L	B mg/L
13G	01/09/14	6.27	440	12	13	ND	ND	ND	ND	72	140	17	0.0529
13H	01/10/14	6.52	140	4.4	3.6	ND	ND	0.56	0.56	17.4	12	11	0.0489
13L5r	01/09/14	6.3	435	10	10	ND	ND	ND	ND	113	99	27	0.118
13Q1r	01/09/14	7.06	795	24	19	ND	0.11	2.1	2.2	128	160	66	0.132
17D	01/09/14	6.69	405	20	19	ND	ND	ND	ND	64.2	94	32	0.0893
17E9	01/09/14	10.49	375	18	14	ND	1.4	3.5	4.9	45.6	64	24	0.0581
17F4	01/07/14	6.61	350	1.1	0.92	ND	ND	ND	ND	69.1	130	16	0.0238
17N4	01/08/14	5.95	225	7.9	7.4	ND	ND	0.56	0.56	33	46	15	0.0469
18A	01/09/14	6.35	400	7.6	16	ND	ND	0.56	0.56	50.4	97	33	0.122
18B1r	01/08/14	6.17	580	22	20	ND	ND	ND	ND	80.2	170	33	0.183
18C1r	01/10/14	6.27	545	16	18	ND	ND	ND	ND	91.6	150	49	0.161
18E1	01/10/14	6.37	270	16	8.9	ND	ND	7.6	7.6	48.6	63	21	0.0749
18J6r	01/07/14	6.44	340	17	12	ND	2.4	0.70	3.1	53.4	55	28	0.127
18L3r	01/07/14	6.47	215	10	9.4	ND	ND	0.56	0.56	38	54	17	0.0642
18L4r	01/06/14	6.24	430	16	18	ND	ND	ND	ND	62.7	120	33	0.136
18N1r	01/10/14	6.31	475	26	28	ND	ND	0.98	0.98	62.7	96	42	0.151
18R1	01/09/14	6.04	365	18	18	ND	ND	ND	ND	58.5	89	23	0.162
24A	01/09/14	6.63	410	15	15	ND	ND	1.5	1.5	54.1	130	7.1	ND
7K3r	01/08/14	6.78	560	15	15	ND	ND	ND	ND	96.1	160	42	0.137
7L3r	01/08/14	6.74	520	21	21	ND	ND	0.56	0.56	82.6	150	41	0.269
7N1	01/09/14	6.9	200	6.0	5.5	ND	ND	0.56	0.56	24.3	33	8.6	0.0325
7Q1	01/08/14	6.83	525	18	18	ND	ND	0.56	0.56	111	160	42	0.266
7R1r	01/08/14	6.3	530	19	18	ND	ND	1.4	1.4	73.1	160	45	0.165
8Ma	01/07/14	7.09	205	3.3	2.5	ND	ND	0.70	0.7	27.6	51	9.2	0.0205
8Mb	01/07/14	6.69	775	58	57	ND	ND	0.56	0.56	90.8	220	68	0.0784
8N2r	01/07/14	7.1	95	2.9	2.8	ND	ND	ND	ND	8.93	13	4.9	ND

Notes: TDS=Total Dissolved Solids; NO_3^-=Nitrate as Nitrogen; NO_2^-=Nitrite as Nitrogen; NH_3^+=Ammonia as Nitrogen; Org. N=Organic Nitrogen; TKN=Total Kjeldahl Nitrogen; Na=Sodium; Cl=Chloride; SO_4=Sulfate; B=Boron; DTW=Depth to Water; ND=Not Detected; See laboratory reports for practical quantitation limits; mg/L = milligrams per liter

Rincon Consultants, 2014b

October 2014 Groundwater Quality Results

Well ID	Sample Date	pH	TDS (mg/L)	Total N (mg/L)	NO_3^- (mg/L)	NO_2^- (mg/L)	NH_3^+ (mg/L)	TKN (mg/L)	Na (mg/L)	Cl (mg/L)	SO_4 (mg/L)	B (mg/L)
	MCL	6.5-8.5*	500*	NE	10	1	NE	NE	NE	250*	250*	NE
13G	10/21/14	6.67	**580**	13	**12**	ND<0.40	0.40	0.80	74	160	21	ND<0.10
13H	10/21/14	6.88	200	4.6	3.7	ND<0.40	0.43	0.95	22	26	17	ND<0.10
13L5r	10/21/14	6.35	470	23	**22**	ND<0.40	0.12	1.3	110	200	16	ND<0.10
13Q1r	10/22/14	6.59	**670**	29	**29**	ND<0.40	0.34	0.60	90	150	24	0.12
17D	10/21/14	7.25	470	19	**18**	ND<0.40	0.25	1.0	61	87	28	ND<0.10
17E9	10/22/14	**9.63**	280	14	**13**	ND<0.40	0.37	0.62	47	52	23	ND<0.10
17F4	10/21/14	6.78	**530**	1.7	1.1	ND<0.40	0.33	0.62	68	110	18	ND<0.10
17N4	10/20/14	**6.27**	190	9.8	8.2	ND<0.40	ND<0.10	1.6	33	52	21	ND<0.10
18B1r	10/21/14	6.66	**640**	23	**22**	ND<0.40	0.93	1.0	68	100	46	0.17
18C1r	10/21/14	6.69	**690**	18	**17**	ND<0.40	0.34	0.80	90	130	45	0.17
18E1	12/4/2014**	6.67	250	10	8.3	ND<0.40	0.62	1.8	44	53	21	ND<0.10
18J6r	10/22/14	6.80	350	12	9.3	ND<0.40	2.3	2.8	52	46	25	0.13
18L3r	10/20/14	6.50	210	11	8.4	ND<0.40	0.12	2.2	34	51	23	ND<0.10
18L4r	10/20/14	6.51	**620**	32	**29**	ND<0.40	0.12	2.2	68	140	46	0.11
18N1r	12/4/2014**	6.84	420	28	**23**	ND<0.40	0.82	5.0	63	81	41	0.15
18R1	10/21/14	**6.31**	450	19	**18**	ND<0.40	0.35	0.88	59	70	26	0.19
24A	10/20/14	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
7K3r	10/21/14	7.25	**810**	22	**20**	ND<0.40	0.12	1.4	91	160	69	0.13
7L3r	10/20/14	6.98	490	23	**21**	ND<0.40	0.12	2.4	70	82	52	0.12
7N1	10/22/14	7.59	320	6.6	6.0	ND<0.40	0.36	0.65	33	71	15	ND<0.10
7Q1	12/4/2014**	6.75	**550**	31	**25**	ND<0.40	1.0	6.3	120	140	47	0.61
7R1r	10/20/14	6.66	**660**	20	**18**	ND<0.40	0.11	1.6	66	130	54	0.16
8Ma	10/20/14	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
8Mb	10/22/14	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
8N2r	10/20/14	6.84	120	7.4	4.5	ND<0.40	0.11	2.9	12	22	6.9	ND<0.10

Notes: TDS=Total Dissolved Solids; NO_3^-=Nitrate as Nitrogen; NO_2^-=Nitrite as Nitrogen; NH_3^+=Ammonia as Nitrogen; TKN=Total Kjeldahl Nitrogen; Na=Sodium; Cl=Chloride; SO_4=Sulfate; B=Boron; mg/L=milligrams per liter; ND=Not detected above associated laboratory practical quantitation limits; NE=not established; NM=not measured

MCL = Maximum contaminant level; EPA National Primary Drinking Water Regulations; * National Secondary Drinking Water Regulations

** Sample was mistakenly acidified at the laboratory during sample preparation for analysis. The metals (sodium and boron) results were not affected, however the wells were resampled on 12/4/14 and analyzed for the remainder of constituents.

- **bolded** values are above EPA MCL or National Secondary Drinking Water criteria

CHG, 2015a
May 2015 Water Quality Results

Well ID	Sample Date	pH units	TDS mg/l	Total N mg/l	NO_3-N mg/l	NO_2-N mg/l	NH_3-N mg/l	Org. N mg/l	TKN mg/l	Na mg/l	Cl mg/l	SO_4 mg/l	B mg/l
30S/10E-13G	5/18/15	6.2	660	13	13.1	ND	ND	ND	ND	78	254	42	ND
30S/10E-13H	5/18/15	6.8	230	3	3.4	ND	ND	ND	ND	18	44	49	ND
30S/10E-13L5	5/18/15	6.1	510	26	26.0	ND	ND	ND	ND	130	107	18	ND
30S/10E-13Q1	5/18/15	7.4	600	29	28.8	ND	ND	ND	ND	76	157	25	0.1
30S/10E-24A	5/20/15	6.7	490	13	13.4	ND	ND	ND	ND	60	194	8	ND
30S/11E-7K3	5/13/15	6.9	590	24	24.0	ND	ND	ND	ND	91	158	43	0.1
30S/11E-7L3	5/13/15	6.8	410	19	19.4	ND	ND	ND	ND	66	97	37	0.1
30S/11E-7N1	5/14/15	7.3	360	6	6.4	ND	ND	ND	ND	38	103	18	ND
30S/11E-7Q1	5/19/15	6.7	540	26	26.5	ND	0.8	ND	ND	101	138	45	0.4
30S/11E-7R1	5/12/15	6.8	470	18	17.6	ND	ND	ND	ND	62	116	40	0.2
30S/11E-8Ma	Well dry - not sampled												
30S/11E-8Mb	Well dry - not sampled												
30S/11E-8N2	5/14/15	7.3	150	8	8.3	ND	ND	ND	ND	13	29	5	ND
30S/11E-17D	5/12/15	7.2	460	24	24.2	ND	ND	ND	ND	76	116	35	0.1
30S/11E-17E9	5/13/15	6.7	340	14	14.4	ND	ND	ND	ND	41	59	21	ND
30S/11E-17F4	5/12/15	6.9	440	2	0.9	ND	ND	1	1	71	140	16	0.1
30S/11E-17N4	5/13/15	6.4	220	8	7.7	ND	ND	ND	ND	26	46	17	ND
30S/11E-18B1	5/12/15	6.6	380	14	14.5	ND	ND	ND	ND	58	70	55	0.1
30S/11E-18C1	5/12/15	6.6	510	17	16.8	ND	ND	ND	ND	98	143	45	0.2
30S/11E-18E1	5/19/15	7.0	290	11	10.6	ND	ND	ND	ND	41	66	19	ND
30S/11E-18J6	5/14/15	6.7	360	12	10.4	ND	2.1	ND	2	52	62	26	0.1
30S/11E-18L3	5/18/15	6.2	210	11	10.8	ND	ND	ND	ND	34	65	19	ND
30S/11E-18L4	5/14/15	6.5	520	30	29.6	ND	ND	ND	ND	66	117	36	0.1
30S/11E-18N1	5/14/15	6.4	410	25	25.4	ND	ND	ND	ND	51	80	42	0.2
30S/11E-18R1	5/21/15	6.2	330	17	17.2	ND	ND	ND	ND	56	74	21	0.2

NOTES: TDS = Total Dissolved Solids; NO_3-N = Nitrate as Nitrogen; NO_2-N = Nitrite as Nitrogen; NH_3-N = Ammonia as Nitrogen; Org. N = Organic Nitrogen; TKN = Total Kjeldahl Nitrogen; Na = Sodium; Cl = chloride; SO_4 = Sulfate; B = Boron; DTW = depth to water; ND = Not Detected; See laboratory reports for practical quantitation limits; mg/l = milligrams per liter

CHG, 2015b
November 2015 Water Quality Results

Well ID	Sample Date	pH units	TDS mg/l	Total N mg/l	NO_3-N mg/l	NO_2-N mg/l	NH_3-N mg/l	Org. N mg/l	TKN mg/l	Na mg/l	Cl mg/l	SO_4 mg/l	B mg/l
30S/10E-13G	11/2/2015	6	600	10	10	ND	ND	ND	ND	84	234	62	ND
30S/10E-13H	11/5/2015	7.5	220	5.1	5.1	ND	ND	ND	ND	17	37	27	ND
30S/10E-13L5	11/2/2015	5.8	520	28	27.8	ND	ND	ND	ND	122	107	20	0.1
30S/10E-13Q1	11/4/2015	7.2	610	29	28.8	ND	ND	ND	ND	73	152	23	0.2
30S/10E-24A	11/5/2015	6.6	430	18.6	18.6	ND	ND	ND	ND	43	140	7	ND
30S/11E-7K3	11/3/2015	6.9	570	22	21.9	ND	ND	ND	ND	90	145	41	0.2
30S/11E-7L3	11/3/2015	7.2	440	22	21.6	ND	ND	ND	ND	72	93	41	0.2
30S/11E-7N1	11/10/2015	7.1	390	7.2	7.2	ND	ND	ND	ND	48	119	22	ND
30S/11E-7Q1	11/9/2015	6.3	490	23.4	23.4	ND	0.5	ND	ND	79	119	45	0.3
30S/11E-7R1	11/3/2015	7	430	20	19.5	ND	ND	ND	ND	54	108	28	ND
30S/11E-8Ma	Well dry - not sampled												
30S/11E-8Mb	Well dry - not sampled												
30S/11E-8N2	11/3/2015	7.5	150	9	9.2	ND	ND	ND	ND	16	32	8	ND
30S/11E-17D	11/11/2015	7.5	450	23	22.7	ND	ND	ND	ND	60	109	36	0.1
30S/11E-17E9	11/5/2015	6.9	350	16.1	16.1	ND	ND	ND	ND	34	66	20	ND
30S/11E-17F4	11/4/2015	6.9	420	1	1	ND	ND	ND	ND	61	145	16	ND
30S/11E-17N4	11/9/2015	6.5	190	7.1	7.1	ND	ND	ND	ND	29	46	16	ND
30S/11E-18B1	11/3/2015	6.8	410	22	22	ND	ND	ND	ND	56	73	65	0.2
30S/11E-18C1	11/2/2015	6.8	540	17.5	17.5	ND	ND	ND	ND	83	154	44	0.2
30S/11E-18E1	11/9/2015	6.5	270	11.1	11.1	ND	ND	ND	ND	39	68	19	ND
30S/11E-18J6	11/5/2015	6.8	360	12.3	11.3	ND	2.4	ND	1	48	65	20	0.1
30S/11E-18L3	11/2/2015	6.2	280	8	7.9	ND	ND	ND	ND	35	77	18	0.1
30S/11E-18L4	11/2/2015	6	510	33	32.6	ND	ND	ND	ND	61	104	36	0.2
30S/11E-18N1	11/4/2015	7.2	410	25	24.8	ND	ND	ND	ND	59	86	42	0.2
30S/11E-18R1	No access - not sampled												

NOTES: TDS = Total Dissolved Solids; NO_3-N = Nitrate as Nitrogen; NO_2-N = Nitrite as Nitrogen; NH_3-N = Ammonia as Nitrogen; Org. N = Organic Nitrogen; TKN = Total Kjeldahl Nitrogen; Na = Sodium; Cl = chloride; SO_4 = Sulfate; B = Boron; DTW = depth to water; ND = Not Detected; See laboratory reports for practical quantitation limits; mg/l = milligrams per liter

CHG, 2016a
April-May 2016 Water Quality Results

Well ID	Sample Date	pH units	TDS mg/l	Total N mg/l	NO_3-N mg/l	NO_2-N mg/l	NH_3-N mg/l	Org. N mg/l	TKN mg/l	Na mg/l	Cl mg/l	SO_4 mg/l	B mg/l
30S/10E-13G	4/27/2016	5.8	490	13.3	13.3	ND	ND	ND	ND	65	178	55	ND
30S/10E-13H	5/3/2016	6.2	230	4	4.2	ND	ND	ND	ND	19	48	43	ND
30S/10E-13L5	4/25/2016	6	600	30.3	30.3	ND	ND	ND	ND	125	125	40	0.1
30S/10E-13Q1	4/28/2016	6.8	640	31	30.8	ND	ND	ND	ND	69	163	26	ND
30S/10E-24A	5/3/2016	6.6	520	16	15.5	ND	ND	ND	ND	43	159	9	ND
30S/11E-7K3	5/3/2016	6.7	510	20	19.6	ND	ND	ND	ND	78	108	45	0.2
30S/11E-7L3	4/27/2016	6.8	390	15	15	ND	ND	ND	ND	50	82	41	ND
30S/11E-7N1	4/27/2016	7.2	190	4.7	4.7	ND	ND	ND	ND	20	32	7	ND
30S/11E-7Q1	5/3/2016	6.2	500	21	21.4	ND	0.3	ND	ND	91	124	45	0.3
30S/11E-7R1	4/26/2016	6.4	250	11.6	11.6	ND	ND	ND	ND	32	49	24	ND
30S/11E-8Ma	Well dry - not sampled												
30S/11E-8Mb	Well dry - not sampled												
30S/11E-8N2	4/27/2016	6.6	120	4.8	4.8	ND	ND	ND	ND	11	20	17	ND
30S/11E-17D	4/27/2016	6.6	560	30	30	ND	ND	ND	ND	64	143	44	ND
30S/11E-17E9	4/28/2016	6.7	370	14.8	14.8	ND	ND	ND	ND	36	65	24	ND
30S/11E-17F4	4/27/2016	6.7	440	1	1.1	ND	ND	ND	ND	51	156	21	ND
30S/11E-17N4	5/5/2016	7.2	190	8	7.8	ND	ND	ND	ND	31	51	17	ND
30S/11E-18B1	4/26/2016	6.2	410	11.4	11.4	ND	ND	ND	ND	47	53	98	0.1
30S/11E-18C1	4/26/2016	6.4	560	18	18	ND	ND	ND	ND	73	167	47	0.1
30S/11E-18E1	5/4/2016	6.9	290	12	11.9	ND	ND	ND	ND	39	78	19	0.1
30S/11E-18J6	5/3/2016	6	400	11	8.7	ND	1	1	2	49	76	30	0.2
30S/11E-18L3	4/25/2016	6.3	300	13.5	13.5	ND	ND	ND	ND	33	80	23	ND
30S/11E-18L4	4/25/2016	6	530	32.3	32.3	ND	ND	ND	ND	50	108	42	0.1
30S/11E-18N1	4/28/2016	7.4	370	21.1	21.1	ND	ND	ND	ND	54	89	45	0.2
30S/11E-18R1	4/27/2016	6.1	330	19	18.8	ND	ND	ND	ND	50	80	23	0.1

NOTES: TDS = Total Dissolved Solids; NO_3-N = Nitrate as Nitrogen; NO_2-N = Nitrite as Nitrogen; NH_3-N = Ammonia as Nitrogen; Org. N = Organic Nitrogen; TKN = Total Kjeldahl Nitrogen; Na = Sodium; Cl = chloride; SO_4 = Sulfate; B = Boron; ND = Not Detected; See laboratory reports for practical quantitation limits; mg/l = milligrams per liter

Rincon Consultants, 2017

December 2016 Groundwater Quality Results

Los Osos Water Recycling Facility

Well ID	Sample Date	pH	TDS (mg/L)	Total N (mg/L)	NO_3^- (mg/L)	NO_2^- (mg/L)	NH_3^+ (mg/L)	TKN (mg/L)	Na (mg/L)	Cl (mg/L)	SO_4 (mg/L)	B (mg/L)	TOC (mg/L)	Total Coliform (MPN/100 mL)	E. Coli (MPN/100 mL)
	MCL	6.5-8.5*	500*	NE	10	1	NE	NE	NE	250*	250*	NE	NE	NE	NE
13G	12/20/16	6.74	**640**	8.7	8.7	ND<0.40	ND<0.10	ND<0.4	72	240	35	ND<0.10	NM	NM	NM
13H	12/20/16	7.16	320	6	5.3	ND<0.40	ND<0.10	0.69	16	35	27	ND<0.10	NM	NM	NM
13L5r	12/20/16	6.56	**670**	28	**28**	ND<0.40	ND<0.10	ND<0.4	120	120	28	0.14	NM	NM	NM
13Q1r	12/21/16	6.72	**570**	25	**25**	ND<0.40	ND<0.10	0.78	78	150	27	0.13	NM	NM	NM
17D	12/20/16	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
17E9	12/21/16	8.50	330	14	**14**	ND<0.40	ND<0.10	ND<0.4	47	60	24	ND<0.10	NM	NM	NM
17F4	12/22/16	7.20	410	1.1	1.1	ND<0.40	ND<0.10	ND<0.4	65	150	25	ND<0.10	NM	NM	NM
17N4	12/22/16	6.71	200	3.7	3.7	ND<0.40	0.16	ND<0.4	33	51	18	ND<0.10	NM	NM	NM
18B1r	12/21/16	6.93	350	14	**14**	ND<0.40	ND<0.10	0.47	43	71	36	0.16	NM	NM	NM
18C1r	12/22/16	6.87	330	12	**12**	ND<0.40	ND<0.10	0.48	87	110	23	0.14	NM	NM	NM
18E1	12/20/16	7.44	270	10	10	ND<0.40	ND<0.10	ND<0.4	47	75	21	ND<0.10	NM	NM	NM
18J6r	12/21/16	6.87	380	15	**12**	ND<0.40	3.2	3.4	61	69	41	0.18	NM	NM	NM
18L3r	12/21/16	6.86	380	21	**21**	ND<0.40	ND<0.10	0.68	51	76	22	ND<0.10	NM	NM	NM
18L4r	12/21/16	6.75	**550**	36	**36**	ND<0.40	ND<0.10	ND<0.4	63	95	50	0.15	NM	NM	NM
18N1r	12/21/16	6.70	450	22	**22**	ND<0.40	ND<0.10	ND<0.4	58	87	43	0.28	NM	NM	NM
18R1	12/22/16	6.64	290	15	**15**	ND<0.40	ND<0.10	ND<0.4	49	64	23	0.16	0.6	ND	ND
24A	12/22/16	7.0	370	15	**15**	ND<0.40	ND<0.10	0.78	47	110	11	ND<0.10	2.8	16	ND
7K3r	12/20/16	7.54	**580**	28	**28**	ND<0.40	ND<0.10	ND<0.4	76	120	56	0.13	NM	NM	NM
7L3r	12/20/16	7.30	430	15	**15**	ND<0.40	ND<0.10	0.41	55	110	43	0.11	NM	NM	NM
7N1	12/20/16	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
7Q1	12/20/16	7.09	**570**	31	**29**	ND<0.40	1.9	2.2	96	150	44	0.37	NM	NM	NM
7R1r	12/21/16	7.09	460	21	**21**	ND<0.40	ND<0.10	ND<0.4	61	99	35	0.12	NM	NM	NM
8Ma	12/21/16	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
8Mb	12/21/16	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
8N2r	12/21/16	7.38	120	2.5	2.5	ND<0.40	ND<0.10	ND<0.4	12	17	12	ND<0.10	NM	NM	NM

Notes: TDS=Total Dissolved Solids; NO_3^-=Nitrate as Nitrogen; NO_2^-=Nitrite as Nitrogen; NH_3^+=Ammonia as Nitrogen; TKN=Total Kjeldahl Nitrogen; Na=Sodium; Cl=Chloride; SO_4=Sulfate; B=Boron; mg/L=milligrams per liter; ND=Not detected above laboratory practical quantitation limits; NE=not established; NM=not measured; TOC= Total Organic Carbon; MPN/100 mL = most probable number per 100
MCL = Maximum contaminant level; EPA National Primary Drinking Water Regulations; * National Secondary Drinking Water Regulations
- **bolded** values are above EPA MCL or National Secondary Drinking Water criteria

Rincon Consultants, 2017

December 2016 Priority Pollutant Results
Los Osos Water Recycling Facility

Well ID	Sample Date	Metals (mg/L)												Chlorinated Pesticides and PCBs (µg/L)	Carbamates and Urea Pesticides (µg/L)	Fumigants (µg/L)	Perchlorate (µg/L)	Diquat (µg/L)	Endothall (µg/L)	Glyphosate (µg/L)	VOCs (µg/L)	SVOCs (µg/L)
		Aluminum	Antimony	Arsenic	Beryllium	Barium	Cadmium	Chromium	Lead	Mercury	Nickel	Selenium	Thallium									
18R1	12/22/16	ND<0.05	ND<0.001	ND<0.001	ND<0.001	0.0235	ND<0.001	0.00492	ND<0.001	ND<0.002	0.0165	ND<0.001	ND<0.001	ND	ND	ND<0.02	ND<2	ND<4	ND<45	ND<5	ND	ND
24A	12/22/16	**5.07**	0.00151	0.00246	ND<0.001	0.0951	0.00106	**0.0501**	0.00596	ND<0.002	0.0847	0.00176	ND<0.001	ND	ND	ND<0.02	ND<2	ND<4	ND<45	ND<5	ND	ND
MCL		0.2*	0.006	0.01	0.004	1	0.005	0.05	0.015	0.002	0.1	0.05	0.002	Varies	Varies	0.2	6	20	100	700	Varies	Varies

Notes: mg/L=milligrams per liter; µg/L= micrograms per liter; ND=Not detected above laboratory practical quantitation limits; PCBs= polychlorinated biphenyls; NE=not established; VOCs= Volatile organic compounds; SVOCs= Semivolatile organic compounds
MCL = Maximum contaminant level; EPA National Primary Drinking Water Regulations; * National Secondary Drinking Water Regulations
- **bolded** values are above EPA MCL or National Secondary Drinking Water criteria

APPENDIX B3

2016 Central Coast Basin Plan

Table 3-3. Guidelines for Interpretation of Quality of Water for Irrigation[a] (CCRWQCB, 2016)

Problem and Related Constituent	No Problem	Water Quality Guidelines Increasing Problems	Severe
Salinity[b]			
EC of irrigation water, mmho/cm	<0.75	0.75 - 3.0	>3.0
Permeability			
EC of irrigation water, mmho/cm	>0.5	<0.5	<0.2
SAR, adjusted[c]	<6.0	6.0 - 9.0	>9.0
Specific ion toxicity from root absorption [d]			
Sodium (evaluate by adjusted SAR)	<3	3.0 - 9.0	>9.0
Chloride			
me/l	<4	4.0 - 10	>10
mg/l	<142	142 - 355	>355
Boron, mg/l	<0.5	0.5 - 2.0	2.0 - 10.0
Specific ion toxicity from foliar absorption[e] (sprinklers)			
Sodium			
me/l	<3.0	>3.0	--
mg/l	<69	>69	--
Chloride			
me/l	<3.0	>3.0	--
mg/l	<106	>106	--
Miscellaneous[f]			
NH4 - N, mg/l for sensitive crops	<5	5 - 30	>30
NO3 - N, mg/l for sensitive crops	<5	5 - 30	>30
HCO3 (only with overhead sprinklers)			
me/l	<1.5	1.5 - 8.5	>8.5
mg/l	<90	90 - 520	>520
pH	Normal range	6.5 - 8.4	--

a Interpretations are based on possible effects of constituents on crops and/or soils. Guidelines are flexible and should be modified when warranted by local experience or special conditions of crop, soil, and method of irrigation.

b Assumes water for crop plus needed water for leaching requirement (LR) will be applied. Crops vary in tolerance to salinity. Refer to tables for crop tolerance and LR. The mmho/cm x 640 = approximate total dissolved solids (TDS) in mg/l or ppm; mmho x 1,000 = micromhos.

c Adjusted SAR (sodium adsorption ratio) is calculated from a modified equation developed by U.S. Salinity Laboratory to include added effects of precipitation and dissolution of calcium in soils and related to CO_3 + HCO_3 concentrations.

To evaluate sodium (permeability) hazard: Adjusted SAR = $Na/[1/2\ (Ca + Mg)]^{1/2}[1+ (8.4 - pHc)]$.
Refer to Appendix for calculation assistance.

SAR can be reduced if necessary by adding gypsum. Amount of gypsum required (GR) to reduce a hazardous SAR to any desired SAR (SAR desired) can be calculated as follows:

$$GR = \left[\frac{2(Na)^2}{SAR^2\ desired} - (Ca + Mg) \right] 234$$

Note: Na and Ca + Mg should be in me/L. GR will be in lbs. of 100 percent gypsum per acre foot of applied water.

d Most tree crops and woody ornamentals are sensitive to sodium and chloride (use values shown). Most annual crops are not sensitive (use salinity tolerance tables). For boron sensitivity, refer to boron tolerance tables.

e Leaf areas wet by sprinklers (rotating heads) may show a leaf burn due to sodium or chloride absorption under low humidity/high evaporation conditions. (Evaporation increases ion concentration in water films on leaves between rotations of sprinkler heads.)

f Excess N may affect production or quality of certain crops; e.g., sugar beets, citrus, avocados, apricots, etc. (1 mg/l NO_3 - N = 2.72 lbs. N/acre foot of applied water.) HCO_3 with overhead sprinkler irrigation may cause a white carbonate deposit to form on fruit and leaves.

Table 3-7. Surface Water Quality Objectives, mg/l[a] (CCRWQCB, 2016)

Sub-Basin/Sub-Area	TDS	Cl	SO4	B	Na
Santa Ynez					
Cachuma Reservoir	600	20	220	0.4	50
Solvang	700	50	250	0.4	60
Lompoc	1000	100	350	0.4	100
Santa Maria					
Cuyama River (Near Garey)	900	50	400	0.3	70
Sisquoc River (Near Garey)	600	20	250	0.2	50
Estero Bay					
Santa Rosa Creek	500	50	80	0.2	50
Chorro Creek	500	50	50	0.2	50
San Luis Obispo Creek	650	100	100	0.2	50
Arroyo Grande Creek	800	50	200	0.2	50
Salinas River					
Salinas River					
Above Bradley	250	20	100	0.2	20
Above Spreckles	600	80	125	0.2	70
Gabilan Tributary	300	50	50	0.2	50
Diablo Tributary	1200	80	700	0.5	150
Nacimiento River	200	20	50	0.2	20
San Antonio River	250	20	80	0.2	20
Carmel River	200	20	50	0.2	20
Monterey Coastal					
Big Sur River	200	20	20	0.2	20
Pajaro River					
at Chittenden	1000	250	250	1.0	200
San Benito River	1400	200	350	1.0	250
Llagas Creek	200	10	20	0.2	20
Big Basin					
Boulder Creek	150	10	10	0.2	20
Zayante Creek	500	50	100	0.2	40
San Lorenzo River					
Above Bear Creek	400	60	80	0.2	50
At Tait Street Check Dam	250	30	60	0.2	25

a Objectives shown are annual mean values. Objectives are based on preservation of existing quality or water quality enhancement believed attainable following control of point sources.

Table 3-8. Median Ground Water Objectives, mg/l[a] (CCRWQCB, 2016)

Sub-basin/Sub-Area	TDS	Cl	SO_4	B	Na	N[b]
South Coast						
Goleta	1000	150	250	0.2	150	5
Santa Barbara	700	50	150	0.2	100	5
Carpinteria	700	100	150	0.2	100	7
Santa Ynez						
Santa Ynez	600	50	10	0.5	20	1
Santa Rita	1500	150	700	0.5	100	1
Lompoc Plain[f]	1250	250	500	0.5	250	2
Lompoc Upland[f]	600	150	100	0.5	100	2
Lompoc Terrace[f]	750	210	100	0.3	130	1
San Antonio Creek	600	150	150	0.2	100	5
Santa Maria[c]						
Upper Guadalupe[f]	1000[d]	165	500[d]	0.5	230	1.4[e]
Lower Guadalupe[f]	1000[d]	85	500[d]	0.2	90	2.0[e]
Lower Nipomo Mesa[f]	710	95	250	0.15	90	5.7[e]
Orcutt[f]	740	65	300	0.1	65	2.3[e]
Santa Maria[f]	1000[d]	90	510	0.2	105	8.0[e]
Cuyama Valley	1500	80	--	0.4	--	5
Soda Lake	[e]	[e]	[e]	[e]	[e]	[e]
Estero Bay						
Santa Rosa	700	100	80	0.2	50	5
Chorro	1000	250	100	0.2	50	5
San Luis Obispo	900	200	100	0.2	50	5
Arroyo Grande	800	100	200	0.2	50	10
Salinas River						
Upper Valley[f]	600	150	150	0.5	70	5
Upper Forebay[f]	800	100	250	0.5	100	5
Lower Forebay[f]	1500	250	850	0.5	150	8
180 foot Aquifer[f]	1500	250	600	0.5	250	1
400 foot Aquifer[f]	400	50	100	0.2	50	1
Paso Robles[g]						
Central Basin[f]	400	60	45	0.3	80	3.4
San Miguel[f]	750	100	175	0.5	105	4.5
Paso Robles[f]	1050	270	200	2.0	225	2.3
Templeton[f]	730	100	120	0.3	75	2.7
Atascadero[f]	550	70	85	0.3	65	2.3
Estrella[f]	925	130	240	0.75	170	3.2
Shandon	1390	430	1025[h]	2.8	730	2.3
Pajaro River						
Hollister	1200	150	250	1.0	200	5
Tres Pinos	1000	150	250	1.0	150	5
Llagas	300	20	50	0.2	20	5
Big Basin						
Near Felton	100	20	10	0.2	10	1
Near Boulder Creek	250	30	50	0.2	20	5

a Objectives shown are median values based on data averages; objectives are based on preservation of existing quality or water quality enhancement believed attainable following control of point sources.
b Measured as Nitrogen
c Basis for objectives is in the "Water Quality Objectives for the Santa Maria Ground Water Basin Revised Staff Report, May 1985" and February 1986, Staff Report.
d These are maximum objectives in accordance with Title 22 of the Code of Regulations.
e Ground water basin currently exceeds usable mineral quality.
f Ground water basin boundary map available in appendix.
g Basis for objectives is in the report "A Study of the Paso Robles Ground Water Basin to Establish Best Management Practices and Establish Salt Objectives", Coastal Resources Institute, June 1993.
h Standard exceeds California Secondary Drinking Water Standards contained in Title 22 of the Code of Regulations. Water quality standard is based upon existing water quality. If water quality degradation occurs, the Regional Board may consider salt limits on appropriate discharges.

APPENDIX C

Antidegradation Analysis
(CHG, 2016)

TABLE C1
PERCHED AQUIFER WATER QUALITY- COUNTY BASELINE

Well ID	SAMPLE DATE						
	Aug-12	Jun-13	Jan-14	May-14	Oct-14	May-15	Nov-15
	NO3-N (mg/L)						
30S/11E-8Ma	2.5	2.8	2.5	2.3			
30S/11E-8Mb	32.5	77.6	57				
30S/11E-8N2	2.1	2.8	2.8	3.5	4.5	8.3	9.2
30S/11E-17F4	0.6	0.3	0.92	1	1.1	0.9	1
30S/11E-17N4			7.4	7.4	8.2	7.7	7.1
30S/11E-18B1	7.1	11.7	20	18.3	22	14.5	22
30S/11E-18J6	3.5	3.6	12	10.8	9.3	10.4	11.3
30S/11E-18L4	18.2	27.4	18	19.6	29	29.6	32.6
30S/11E-18N1	25.9	27.9	28	27.8	23	25.4	24.8
30S/11E-18R1	21.1	20	18	18	18	17.2	
AVERAGE NO3-N	**15**	**mg/L**					

Well ID	SAMPLE DATE						
	Aug-12	Jun-13	Jan-14	May-14	Oct-14	May-15	Nov-15
	TDS (mg/L)						
30S/11E-8Ma	180	190	205	190			
30S/11E-8Mb	790	970	775				
30S/11E-8N2	100	70	95	90	120	150	150
30S/11E-17F4	440	390	350	380	530	440	420
30S/11E-17N4			225	200	190	220	190
30S/11E-18B1	400	460	580	570	640	380	410
30S/11E-18J6	370	380	340	320	350	360	360
30S/11E-18L4	490	490	430	520	620	520	510
30S/11E-18N1	440	440	475	420	420	410	410
30S/11E-18R1	370	360	365	360	450	330	
AVERAGE TDS	**380**	**mg/L**					

Well ID	SAMPLE DATE						
	Aug-12	Jun-13	Jan-14	May-14	Oct-14	May-15	Nov-15
	CHLORIDE (mg/L)						
30S/11E-8Ma	42	51	170		53		
30S/11E-8Mb	214	249	150		46		
30S/11E-8N2	14	16	63	16	51	29	32
30S/11E-17F4	122	136	120	132	70	140	145
30S/11E-17N4			96	48		46	46
30S/11E-18B1	89	133	130	175	160	70	73
30S/11E-18J6	52	63	33	51	140	62	65
30S/11E-18L4	124	133	160	106		117	104
30S/11E-18N1	108	105	220	108		80	86
30S/11E-18R1	87	89	13	83	22	74	
AVERAGE CHLORIDE	**93**	**mg/L**					

DATA SOURCE: **County Baseline Groundwater Monitoring Program (2012-2015)**

TABLE C2
UPPER AQUIFER WATER QUALITY - COUNTY BASELINE

Well ID	SAMPLE DATE						
	Aug-12	Jun-13	Jan-14	May-14	Oct-14	May-15	Nov-15
	NO3-N (mg/L)						
30S/10E-13G	11.7	9.7	13	15.3	12	13.1	10
30S/10E-13H	2.3	2.2	3.6	4	3.7	3.4	5.1
30S/10E-13L5	17.5	16	10	17.2	22	26	27.8
30S/10E-13Q1	30.4	25.7	19	29.9	29	28.8	28.8
30S/10E-24A	17	15.9	15	17.4		13.4	18.6
30S/11E-7K3	14.4	17.3	15	19.2	20	24	21.9
30S/11E-7L3	19	18.7	21	22	21	19.4	21.6
30S/11E-7N1	3.8	5.2	5.5	6.3	6	6.4	7.2
30S/11E-7Q1	15.7	18.4	18	10.8	25	26.5	23.4
30S/11E-7R1	13.1	16.3	18	21.9	18	17.6	19.5
30S/11E-17D	19.1	19.8	19	19.6	18	24.2	22.7
30S/11E-17E9	16.6	15.5	14	17.1	13	14.4	16.1
30S/11E-18A	10.9	13.1	16				
30S/11E-18C1	16.1	17.3	18	18.7	17	16.8	17.5
30S/11E-18E1	8.7	9.9	8.9	10.9	8.3	10.6	11.1
30S/11E-18L3	4.2	5	9.4	5.6	8.4	10.8	7.9
AVERAGE NO3-N	**15**	**mg/L**					

Well ID	SAMPLE DATE						
	Aug-12	Jun-13	Jan-14	May-14	Oct-14	May-15	Nov-15
	TDS (mg/L)						
30S/10E-13G	330	290	440	420	580	660	600
30S/10E-13H	140	110	140	180	200	230	220
30S/10E-13L5	510	540	435	430	470	510	520
30S/10E-13Q1	700	650	795	580	670	600	610
30S/10E-24A	330	310	410	500		490	430
30S/11E-7K3	520	600	560	550	810	590	570
30S/11E-7L3	430	430	520	470	490	410	440
30S/11E-7N1	200	190	200	200	320	360	390
30S/11E-7Q1	580	500	525	560	550	540	490
30S/11E-7R1	450	480	530	500	660	470	430
30S/11E-17D	350	400	405	340	470	460	450
30S/11E-17E9	390	370	375	390	280	340	350
30S/11E-18A	360	380	400				
30S/11E-18C1	540	520	545	490	690	510	540
30S/11E-18E1	260	290	270	310	250	290	270
30S/11E-18L3	200	200	215	170	210	210	280
AVERAGE TDS	**424**	**mg/L**					

Well ID	SAMPLE DATE						
	Aug-12	Jun-13	Jan-14	May-14	Oct-14	May-15	Nov-15
	CHLORIDE (mg/L)						
30S/10E-13G	70	74	140	129	160	254	234
30S/10E-13H	21	14	12	99	26	44	37
30S/10E-13L5	138	130	99	176	200	107	107
30S/10E-13Q1	195	183	160	173	150	157	152
30S/10E-24A	74	78		153	87	194	140
30S/11E-7K3	165	177	94	132	52	158	145
30S/11E-7L3	91	89	64	37	110	97	93
30S/11E-7N1	31	34	130	171	52	103	119
30S/11E-7Q1	173	148	46	151	100	138	119
30S/11E-7R1	107	149	97	48	130	116	108
30S/11E-17D	81	97	55	85	140	116	109
30S/11E-17E9	65	65	54	61	81	59	66
30S/11E-18A	77	100	89				
30S/11E-18C1	137	148	160	163	82	143	154
30S/11E-18E1	60	66	150	71	71	66	68
30S/11E-18L3	37	55	160	32	130	65	77
AVERAGE CHLORIDE	**107**	**mg/L**					

DATA SOURCE: **County Baseline Groundwater Monitoring Program (2012-2015)**

TABLE C3

UPPER AQUIFER WATER QUALITY - LOCSD TASK 3

Well ID	Sample date	NO3-N	TDS	Cl
		mg/L		
30S/10E-13F1	5/6/2006	19	354	92
30S/10E-13Q1	4/7/2006	18	454	60
30S/11E-7Q1	5/6/2006	18	432	76
30S/11E-17E9	4/6/2006	12	302	88
30S/11E-18F1	5/8/2006	5	146	28
AVERAGE		**14**	**338**	**69**

DATA SOURCE: **Cleath & Associates (2006)**

TABLE C4

UPPER AQUIFER WATER QUALITY BASELINE SCENARIO MIX

Source	NO3-N	TDS	Cl
	mg/L		
COUNTY BASELINE	15	424	107
LOCDS TASK 3	14	338	69
AVERAGE	**15**	**381**	**88**

DATA SOURCES: **County Baseline Groundwater Monitoring Program (2012-2015)**
Cleath & Associates (2006)

TABLE C5

WESTERN AREA LOWER AQUIFER WATER QUALITY (NON-INTRUDED ZONE D)

Well ID	Sample Date	TDS	Cl	NO3-N
		mg/L		
30S/10E-13J1	1/14/2010	435	200	1.6
	7/24/2014	910	303	1.7
	4/22/2015	750	331	1.9
	10/5/2015	950	329	1.7
30S/10E-24C1	11/20/2009	347	130	4.1
	7/24/2014	240	46	8.4
	4/22/2015	320	95	5.5
	10/5/2015	270	50	7.6
30S/11E-18L2	11/19/2009	890	360	0.4
	7/23/2014	390	90	0.4
	10/28/2015	420	104	0.6
30S/10E-13N	11/19/2009	267	73	6.1
	7/24/2014	270	76	7
	4/21/2015	280	77	7.7
	10/6/2015	310	75	6.8
AVERAGE WESTERN ZONE D		**470**	**156**	**4.1**

DATA SOURCE: LOCSD Lower Aquifer Groundwater Monitoring Program (2009-2015)

TABLE C6

CENTRAL AREA LOWER AQUIFER WATER QUALITY

Well ID	Sample Date	TDS	Cl	NO3-N*
		mg/L		
30S/11E-7Q3	11/19/2009	465	92	0
	7/23/2014	460	91	0
	4/21/2015	500	101	0
	10/6/2015	490	91	0
30S/11E-17N10	11/20/2009	357	41	0.5
	7/24/2014	370	37	0.5
	4/22/2015	360	43	0.6
	10/5/2015	370	38	0.5
30S/11E-17K9	11/20/2009	307	36	1
	7/23/2014	300	32	1
	4/21/2015	270	38	1.6
20S/10E-12J1	11/20/2009	732	83	0
	7/24/2014	780	105	0
	4/22/2015	810	112	0
	10/1/2015	840	117	0
30S/11E-17E8	11/20/2009	255	42	4.3
	7/23/2014	270	43	6.3
	4/21/2015	270	49	7.1
	10/1/2015	290	44	6.6
30S/11E-18K8	11/20/2009	378	32	0
	7/24/2014	380	28	0
	4/21/2015	400	33	0
	10/19/2015	370	29	0
AVERAGE CENTRAL		**436**	**59**	**1**

*0 = not detected at laboratory practical quantitation limit

DATA SOURCE: LOCSD Lower Aquifer Groundwater Monitoring Program (2009-2015)

TABLE C7

WESTERN AND CENTRAL AREA LOWER AQUIFER WATER QUALITY MIX

AREA	VOLUME	TDS	Cl	NO3-N
	ACRE-FEET	mg/L		
WESTERN	14300	470	156	4.1
CENTRAL	56100	436	59	1
WEIGHTED AVERAGE		**443**	**79**	**2**

DATA SOURCE: LOCSD Lower Aquifer Groundwater Monitoring Program (2009-2015)

TABLE C8

EASTERN AREA - ALLUVIAL / LOWER AQUIFER WATER QUALITY

Well ID	Sample Date	NO3-N	TDS	Cl
		mg/L		
30S/11E-17R1	3/10/1982	3.4	450	76.2
30S/11E-20A2	3/3/1982	0.1	328.5	64.6
30S/11E-20E1	3/10/1982	13.4	230	47.8
30S/11E-21M5	3/3/1982	0	546	70.5
30S/11E-21D9	3/1/1995	0.2	854	101
30S/11E-21E3	3/3/1982	0	606	121
30S/11E-20Aa	2/1/2005	0.7	380	55
30S/11E-21D13	1/6/2005	31.7	880	98
30S/11E-20La	1/12/2005	0	510	40
AVERAGE		**6**	**532**	**75**

DATA SOURCES: **Cleath & Associates (2005)**
Baywood Groundwater Study (County, 1998)

TABLE C9

BEDROCK INFLOW QUALITY

Well ID	Sample Date	NO3-N	TDS	Cl
		mg/L		
30S/11E-20G2	8/7/1985	0	446	43
30S/11E-21P	2/14/2005	0	540	57
AVERAGE		**0**	**493**	**50**

DATA SOURCES: **Cleath & Associates (2005)**
Baywood Groundwater Study (County, 1998)

TABLE C10

LOS OSOS CREEK INFLOW QUALITY

Location	Sample Date	NO3-N	TDS	Cl
		mg/L		
Los Osos Creek upstream	Oct-83	0.79	495	47
	Jan-84	0	418	33
	May-84	0	477	43
	Aug-84	0.29	573	65
	Feb-87	0		48
	Jun-87	0	494	56
	Dec-87	0	519	54
	Dec-88	0	556	53.3
	Mar-89	0	583	57
	Jun-89	0	590	57
	Mar-90	0.79	700	54
	Mar-92	0	538	41
	Jun-92	0	652	55
	Dec-92	0.94	726	72
	Mar-93	0.18	434	51
	Jun-93	0	474	49
	Sep-93	0	646	74
	Dec-93	0.22	658	82
	Mar-94	0	476	46
	Jun-94	0	556	58
	Sep-94	0.76	606	54.8
	Mar-95	0	446	26.7
	Jun-95	0	540	47.6
	Sep-95	0	536	67.3
	Dec-95	0.56	620	74.6
	Mar-96	0	445	30.6
	Jun-96	0	502	48.7
	Sep-96	0.13	622	60
	Mar-97	0.09	397	35
	Jun-97	0.36	552	50.7
	Sep-97	0	680	67.7
	Dec-97	0.74	614	63
	Mar-98	0.25	386	30
	Jun-98	0	430	36
	Sep-98	0	510	50
	Dec-98	0	540	55
	Dec-04	0	540	62
AVERAGE		**0.17**	**543**	**53**

DATA SOURCES: **Cleath & Associates (2005)**
Baywood Groundwater Study (County, 1998)

TABLE C11
PERCHED AND UPPER AQUIFER
PRE-DEVELOPMENT WATER QUALITY

Well ID	Sample Date	NO3-N	TDS	Cl
		mg/L		
30S/10E-13P1	10/2/1954	4.9	171	34
30S/11E-07J1	3/5/1957	2.9	122	30
30S/11E-7N1	10/2/1954	1	201	41
	8/30/1957	2.9	130	28
	9/30/1958	0	204	36
	7/28/1959	0.4	197	35
30S/11E-7Q1	12/30/1959	0.3	109	30
30S/11E-17H1	6/16/1955	0.7	332	51
30S/11E-18H1	12/30/1959	0.4	125	32
30S/11E-18Q1	6/11/1954	2	125	39
	8/30/1957	2.5	141	37
	9/30/1958	5.8	109	47
	7/28/1959	0.9	165	46
WEIGHTED AVERAGE		**1.9**	**165**	**37**

DATA SOURCE: **DWR (1973)**

TABLE C12
WESTERN AND CENTRAL AREA LOWER AQUIFER PRE-DEVELOPMENT WATER QUALITY

Well ID	Sample Date	NO3-N	TDS	Cl
		mg/L		
30S/10E-12J1	11/19/1970	0	679	87
30S/10E-13J1	5/16/1980	1.3	110	28
30S/10E-13L4	3/25/1977	1	269	41.5
30S/11E-18L2	8/9/1982	0	316	51
30S/11E-19H2	8/6/1985	0	315	35
30S/11E-20G2	8/7/1985	0	446	43
AVERAGE		**0.4**	**356**	**48**

DATA SOURCE: **DWR (1972)**
Brown & Caldwell (1983)
USGS (1987)

TABLE C13
EASTERN AREA ALLUVIUM / LOWER AQUIFER PRE-DEVELOPMENT WATER QUALITY

Source	Description	Sample Date	NO3-N	TDS	Cl
			mg/L		
30S/11E-17H1	Pre-1960 lower creek valley	6/16/1955	0.7	332	51
30S/11E-20Aa	Lower Aquifer (low N)	2/1/2005	0	380	55
30S/11E-20G2	Bedrock influence	8/7/1985	0	446	43
30S/11E-20L1	Alluvial aquifer	3/26/1970	0.9	517	57
Upper/perched aquifer	Upper/perched influence	1954-1959	1.9	165	37
Los Osos Creek	Creek influence	1983-2004	0.17	543	53
AVERAGE			**0.6**	**397**	**49**

DATA SOURCE: **DWR (1972)**
DWR (1973)
USGS (1987)
Cleath & Associates (2005)

TABLE C14
SEPTIC DISCHARGE / LOWRF INFLOW WATER QUALITY

Agency/Project	Sample Site	Collected Date/Time	NH3-N, mg/L	Nitrite as N, mg/L	Nitrate as N, mg/L	TDS, mg/L	Alkalinity as CaCO3, mg/L	Chloride, mg/L
LOS OSOS WATER RECYCLING FACILITY	Influent	8/1/2016 10:20	57.2			750	397	196
		8/5/2016 10:53						
		8/8/2016 10:25	49.8				310	
		8/15/2016 10:25	74.8				442	
		8/22/2016 8:57	56				453	
		8/29/2016 10:00	51.2				390	
		9/6/2016 9:35	52.1			820	414	223
		9/7/2016						
		9/9/2016 11:20	53.5				420	
		9/12/2016 9:30	50.8	0.159	0.6	800	415	182
AVERAGE			**55.7**	**0.2**	**0.6**	**790**	**405**	**200**

DATA SOURCE: **LOWRF Monitoring Data**

TABLE C15
SEPTIC DISCHARGE / LOWRF OUTFLOW WATER QUALITY

Agency/Project	Sample Site	Collected Date/Time	NH3-N, mg/L	Nitrite as N, mg/L	Nitrate as N, mg/L	TDS, mg/L	Alkalinity as CaCO3, mg/L	Chloride, mg/L
LOS OSOS WATER RECYCLING FACILITY	Effluent	8/1/2016 10:30	0.072		6.47		197	
		8/2/2016 9:42	0.101		6.17			
		8/3/2016 9:03	0.092		5.45			
		8/4/2016 9:51	0.039		5.27			
		8/5/2016 9:06	0.052		5.49			
		8/6/2016 11:35			5.51			
		8/7/2016 9:43			5.66			
		8/8/2016 10:00	0.07		5.64		180	
		8/9/2016 11:16	0.057		4.89			
		8/10/2016 9:16	0.044		5.34			
		8/11/2016 10:50	0.026		5.71			
		8/12/2016 10:05	0.038		6.41			
		8/15/2016 10:00	0.05		7.05		169	
		8/16/2016 9:43	0.051		7.43			
		8/17/2016 9:04	0.073	< 0.013	7.04			
		8/18/2016 10:36	0.059		9.83			
		8/19/2016 9:23	0.059		11.3			
		8/22/2016 8:50	0.051		9.47		191	
		8/23/2016 10:28	0.126		8.64	720		
		8/24/2016 8:35	0.06		8.32			
		8/25/2016 11:10	0.104		8.25			
		8/27/2016 7:55			7.3			
		8/29/2016 9:00	0.046		6.55		199	
		8/30/2016 9:51	0.046		5.15			
		8/31/2016 9:45	0.09		4.59			
		9/1/2016 9:45	0.047		5.36			
		9/2/2016 10:09	0.056		5.47			
		9/6/2016 8:55			5.53		205	
		9/7/2016 8:35				700		197
		9/9/2016 10:30	0.041		5.31	690		160
		9/12/2016 9:15	0.037	0.028	6.4	740	199	191
		9/14/2016 11:32	0.039		6			
		9/16/2016 10:18	0.039		6.27		193	
		9/20/2016 9:40						
AVERAGE			**0.06**	**0**	**7**	**713**	**191**	**183**

DATA SOURCE: **LOWRF Monitoring Data**

APPENDIX D

Natural Loading and Evaporative Enrichment Calibration
(CHG, 2016)

TABLE D1

MASS BALANCE SPREADSHEET RESULTS - NATURAL LOADING CALIBRATION

Perched Aquifer				Eastern Area Alluvial / Lower Aquifer				Upper Aquifer				Western and Central Area Lower Aquifer				Basin Average			
Year	TDS [mg/L]	Chloride [mg/L]	Nitrate as N [mg/L]	Year	TDS [mg/L]	Chloride [mg/L]	Nitrate as N [mg/L]	Year	TDS [mg/L]	Chloride [mg/L]	Nitrate as N [mg/L]	Year	TDS [mg/L]	Chloride [mg/L]	Nitrate as N [mg/L]	Year	TDS [mg/L]	Chloride [mg/L]	Nitrate as N [mg/L]
1	165.00	37.00	1.90	1	397.00	49.00	0.60	1	165.00	37.00	1.90	1	356.00	48.00	0.40	1	246.06	41.36	1.38
2	165.00	37.00	1.90	2	396.98	48.70	0.61	2	165.02	36.99	1.90	2	355.99	47.99	0.42	2	246.07	41.29	1.39
3	164.99	37.00	1.90	3	396.95	48.73	0.61	3	165.04	36.98	1.90	3	355.99	47.98	0.44	3	246.07	41.28	1.39
4	164.99	37.00	1.89	4	396.93	48.74	0.62	4	165.05	36.96	1.90	4	355.99	47.97	0.46	4	246.07	41.28	1.40
5	164.99	37.00	1.89	5	396.91	48.76	0.63	5	165.07	36.95	1.91	5	355.98	47.96	0.48	5	246.08	41.27	1.40
6	164.99	37.00	1.89	6	396.89	48.78	0.63	6	165.08	36.94	1.91	6	355.98	47.95	0.49	6	246.08	41.27	1.41
7	164.98	37.00	1.89	7	396.88	48.79	0.64	7	165.09	36.93	1.91	7	355.97	47.94	0.51	7	246.08	41.27	1.41
8	164.98	37.00	1.89	8	396.86	48.81	0.64	8	165.10	36.93	1.91	8	355.97	47.93	0.53	8	246.08	41.26	1.42
9	164.98	37.00	1.89	9	396.84	48.82	0.65	9	165.11	36.92	1.91	9	355.97	47.92	0.55	9	246.08	41.26	1.42
10	164.98	37.00	1.89	10	396.83	48.83	0.65	10	165.12	36.91	1.92	10	355.96	47.91	0.57	10	246.09	41.26	1.43
11	164.98	37.00	1.89	11	396.82	48.85	0.66	11	165.13	36.91	1.92	11	355.96	47.90	0.58	11	246.09	41.26	1.43
12	164.98	37.00	1.89	12	396.81	48.86	0.66	12	165.13	36.90	1.92	12	355.95	47.89	0.60	12	246.09	41.25	1.43
13	164.98	37.00	1.89	13	396.80	48.87	0.66	13	165.14	36.90	1.92	13	355.95	47.88	0.62	13	246.09	41.25	1.44
14	164.98	37.00	1.89	14	396.79	48.88	0.67	14	165.14	36.89	1.92	14	355.95	47.87	0.63	14	246.09	41.25	1.44
15	164.98	37.00	1.89	15	396.78	48.88	0.67	15	165.15	36.89	1.92	15	355.94	47.86	0.65	15	246.09	41.25	1.45
16	164.98	37.00	1.89	16	396.77	48.89	0.67	16	165.15	36.88	1.92	16	355.94	47.86	0.67	16	246.09	41.25	1.45
17	164.98	36.99	1.89	17	396.76	48.90	0.67	17	165.16	36.88	1.92	17	355.94	47.85	0.68	17	246.09	41.24	1.45
18	164.98	36.99	1.89	18	396.75	48.91	0.68	18	165.16	36.88	1.92	18	355.94	47.84	0.70	18	246.09	41.24	1.46
19	164.98	36.99	1.89	19	396.74	48.91	0.68	19	165.16	36.88	1.93	19	355.93	47.83	0.71	19	246.09	41.24	1.46
20	164.98	36.99	1.89	20	396.74	48.92	0.68	20	165.17	36.87	1.93	20	355.93	47.82	0.73	20	246.09	41.24	1.46
21	164.98	36.99	1.89	21	396.73	48.92	0.68	21	165.17	36.87	1.93	21	355.93	47.81	0.74	21	246.09	41.24	1.47
22	164.98	36.99	1.89	22	396.73	48.93	0.68	22	165.17	36.87	1.93	22	355.92	47.80	0.76	22	246.09	41.24	1.47
23	164.98	36.99	1.89	23	396.72	48.93	0.69	23	165.17	36.87	1.93	23	355.92	47.80	0.77	23	246.09	41.24	1.47
24	164.98	36.99	1.89	24	396.72	48.94	0.69	24	165.18	36.87	1.93	24	355.92	47.79	0.79	24	246.09	41.24	1.48
25	164.98	36.99	1.89	25	396.71	48.94	0.69	25	165.18	36.86	1.93	25	355.92	47.78	0.80	25	246.09	41.24	1.48

NOTE: Results in Table D1 are for concentrations of natural loading that match pre-development water quality from Appendix C (Tables C11, C12, and C13)

TABLE D2

CALIBRATED NATURAL LOADING CONCENTRATIONS

Aquifer	Perc. of Precip. and Leakage[1]	Loading Concentration to match pre-development quality[2]		
		TDS	Cl	NO3-N
	AFY	mg/L		
Perched	685	165	37	1.9
Eastern Area Alluvium / Lower Aquifer	490	240	35	1.3
Upper Aquifer	1155	85	33	2.3
Western and Central Lower Aquifer (leakage)*	890	180	10	--
Basin Average perc. of precip load (weighted)		141	35	2

*salt load from Leakage through regional aquitard

[1] From Baseline Water Balance

[2] Results of using these natural loads are listed in Table D1 and shown in Figures D1-D3

Figure D1
TDS Concentration Trends
Basin Average
Natural Loading Calibration

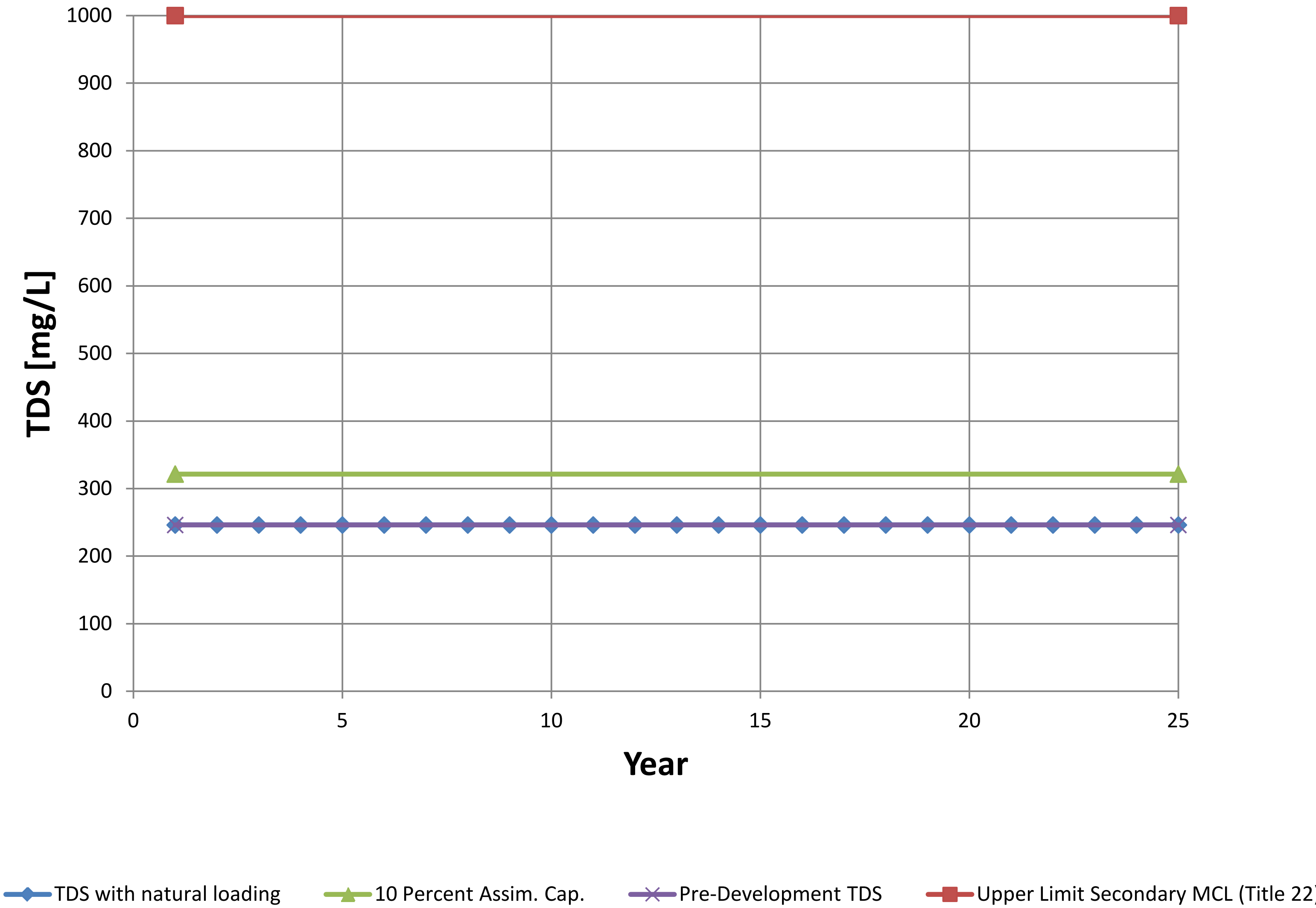


Figure D2
Chloride Concentration Trends
Basin Average
Natural Loading Calibration

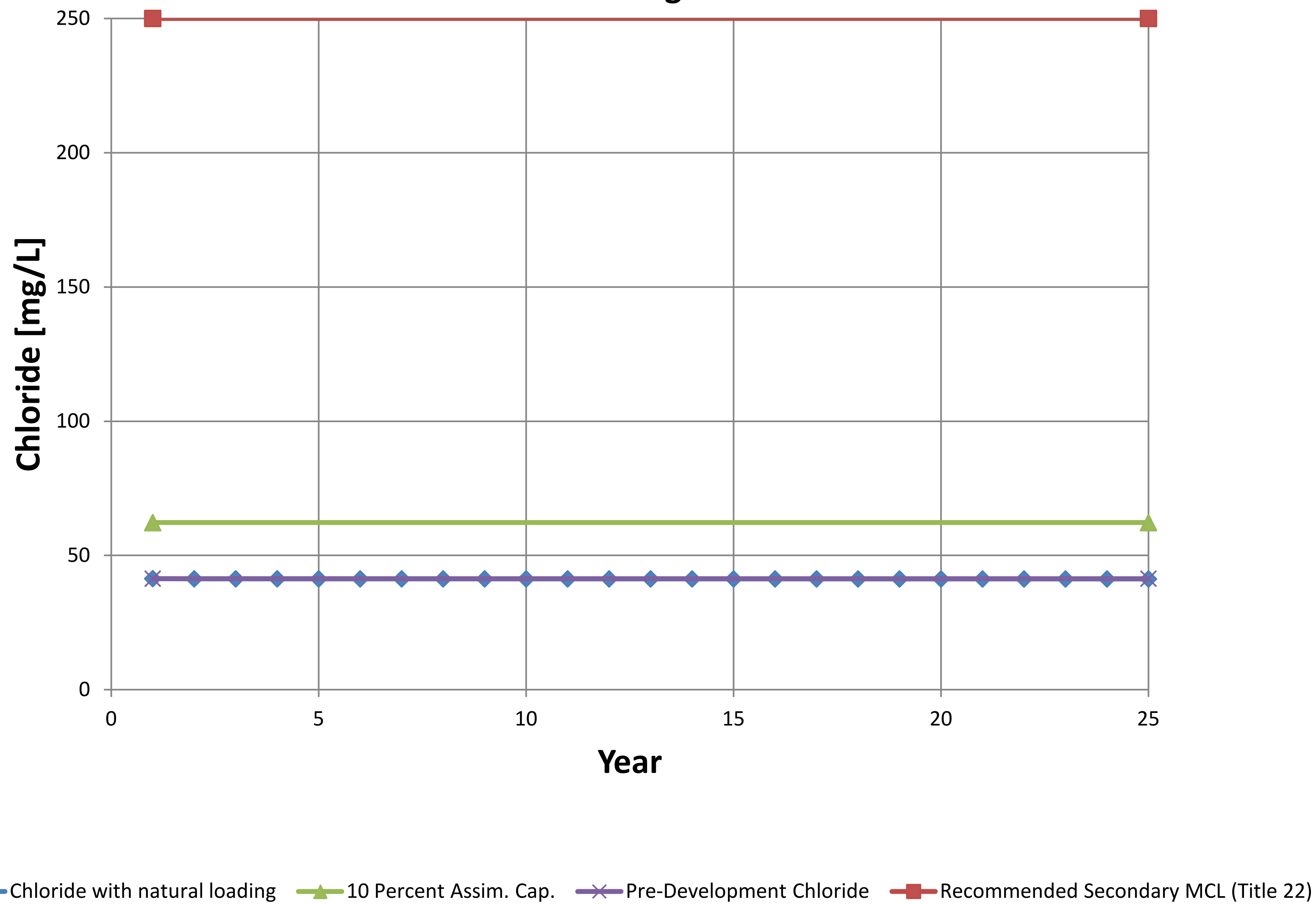


Figure D3
NO_3-N Concentration Trends
Basin Average
Natural Loading Calibration

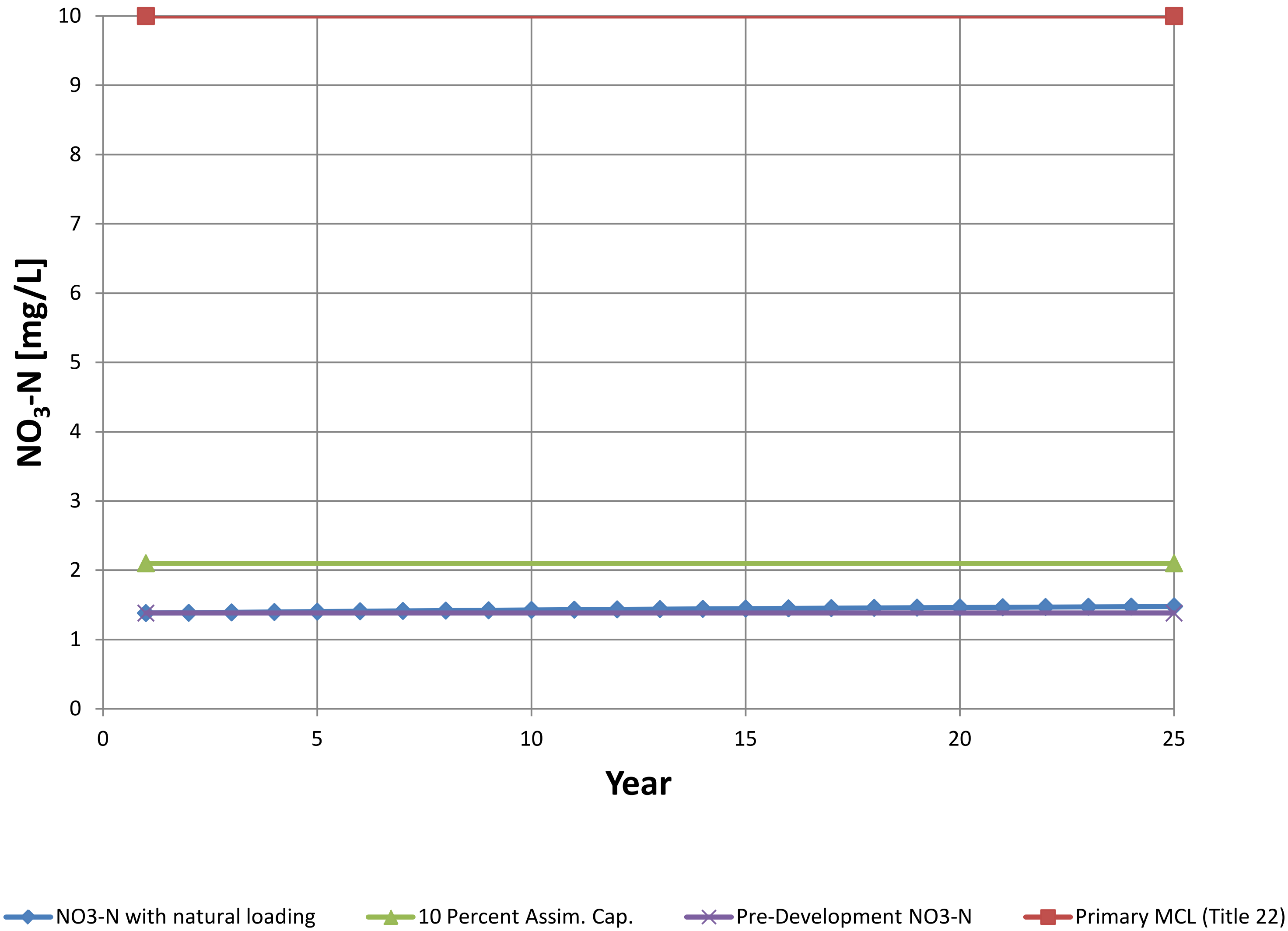


TABLE D3
Evaporative Enrichment Calibration

Eastern Area Alluvial / Lower Aquifer			
Year	TDS [mg/L]	Chloride [mg/L]	Nitrate as N [mg/L]
1	532.00	75.00	6.00
2	532.00	74.78	6.09
3	532.00	74.87	6.21
4	532.00	74.96	6.25
5	532.00	75.04	6.28
6	532.00	75.11	6.32
7	532.00	75.18	6.35
8	532.00	75.25	6.37
9	532.00	75.31	6.40
10	532.00	75.37	6.42
11	532.00	75.43	6.44
12	532.00	75.48	6.47
13	532.00	75.53	6.48
14	532.00	75.58	6.50
15	532.01	75.62	6.52
16	532.01	75.66	6.53
17	532.01	75.70	6.55
18	532.01	75.74	6.56
19	532.01	75.77	6.57
20	532.01	75.81	6.58
21	532.01	75.84	6.59
22	532.01	75.87	6.60
23	532.01	75.89	6.61
24	532.01	75.92	6.62
25	532.01	75.94	6.63

NOTE: Results for 3.4 multiplier on irrigation return flow water quality (calibrated to Baseline water quality shown in Table C8)

Figure D4
TDS Concentration Trends
Eastern Area Alluvial Aquifer / Lower Aquifer
Evaporative Enrichment Calibration

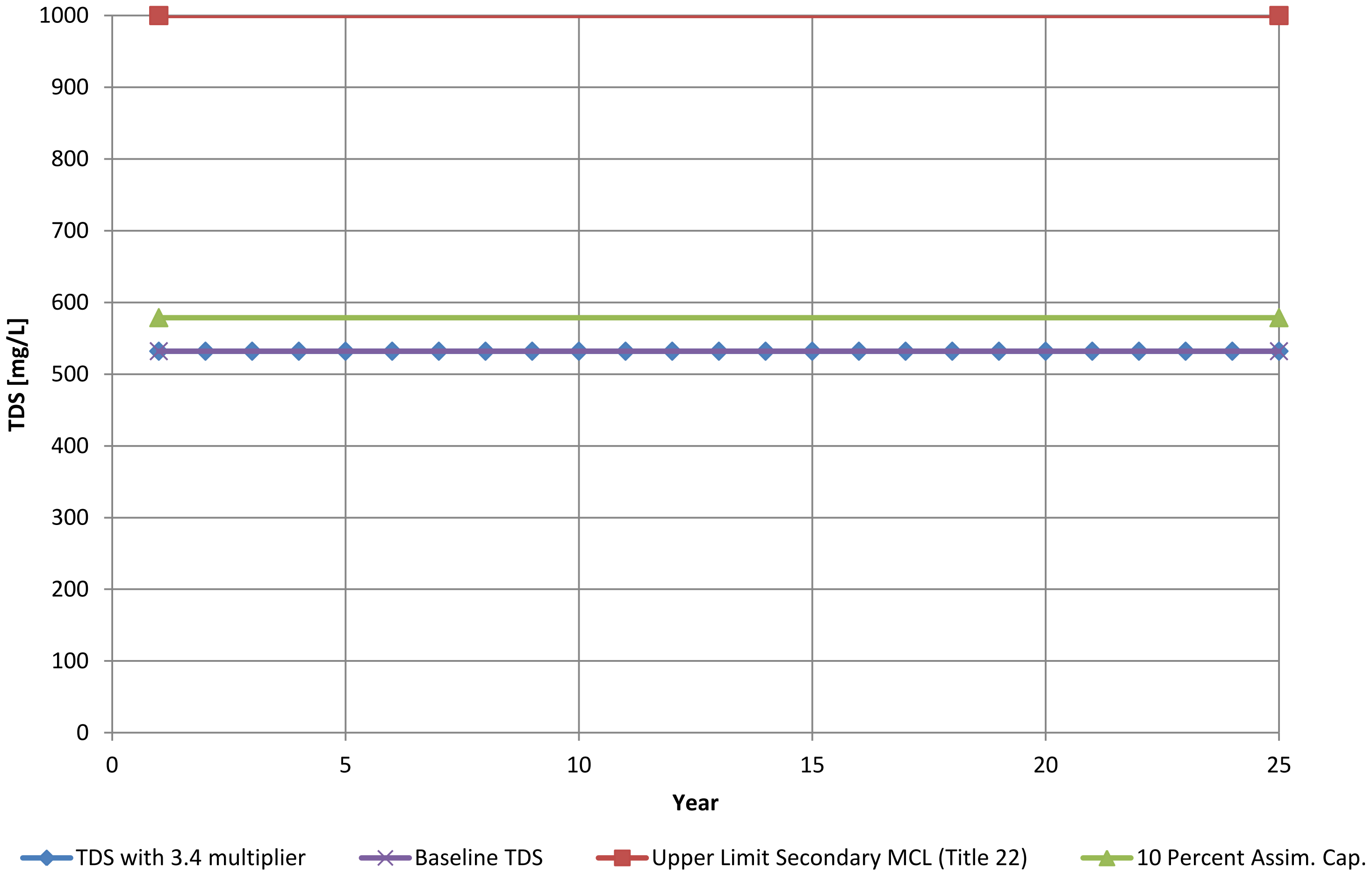


Figure D5
Chloride Concentrations
Eastern Area Alluvial Aquifer / Lower Aquifer
Evaporative Enrichment Calibration

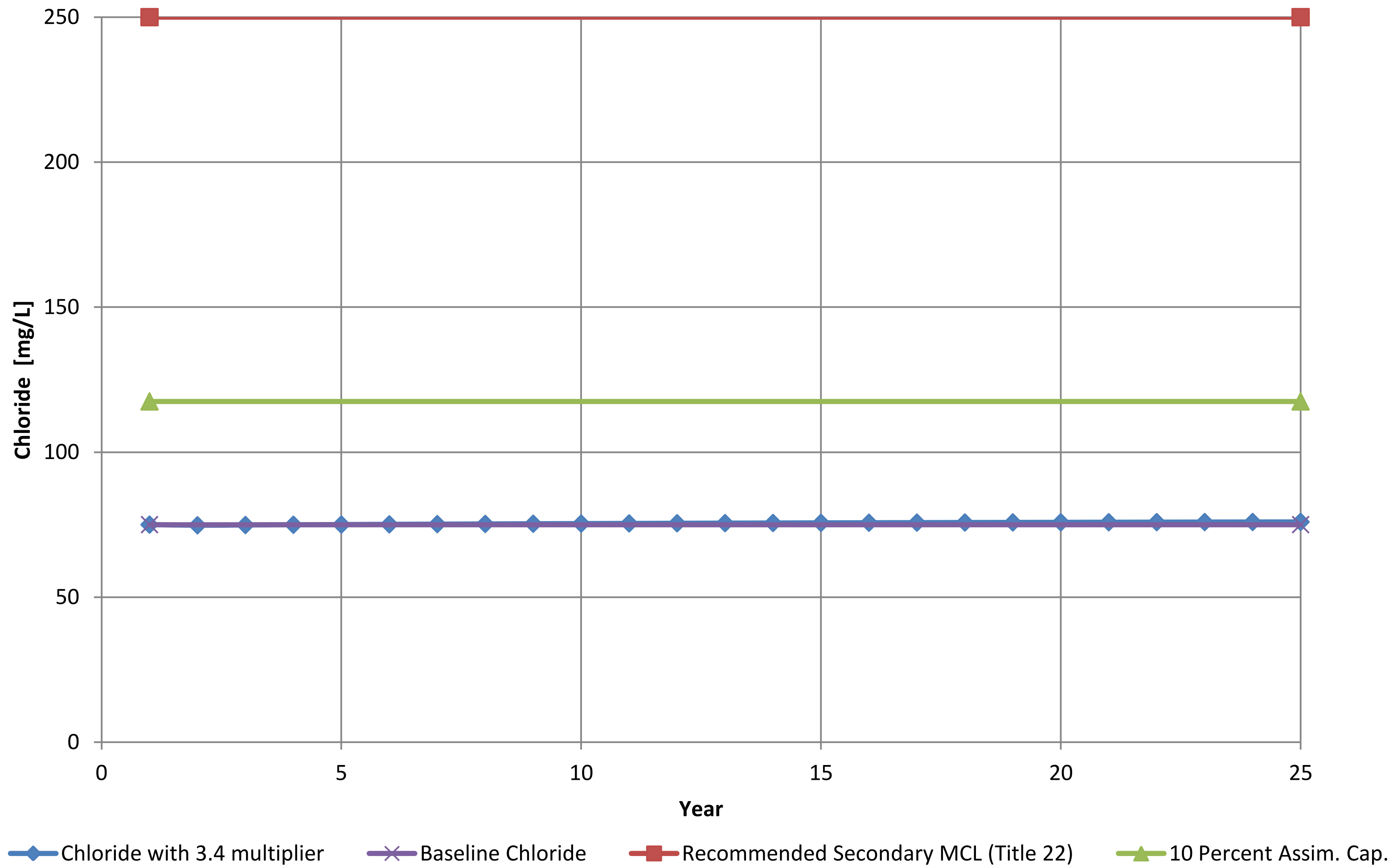
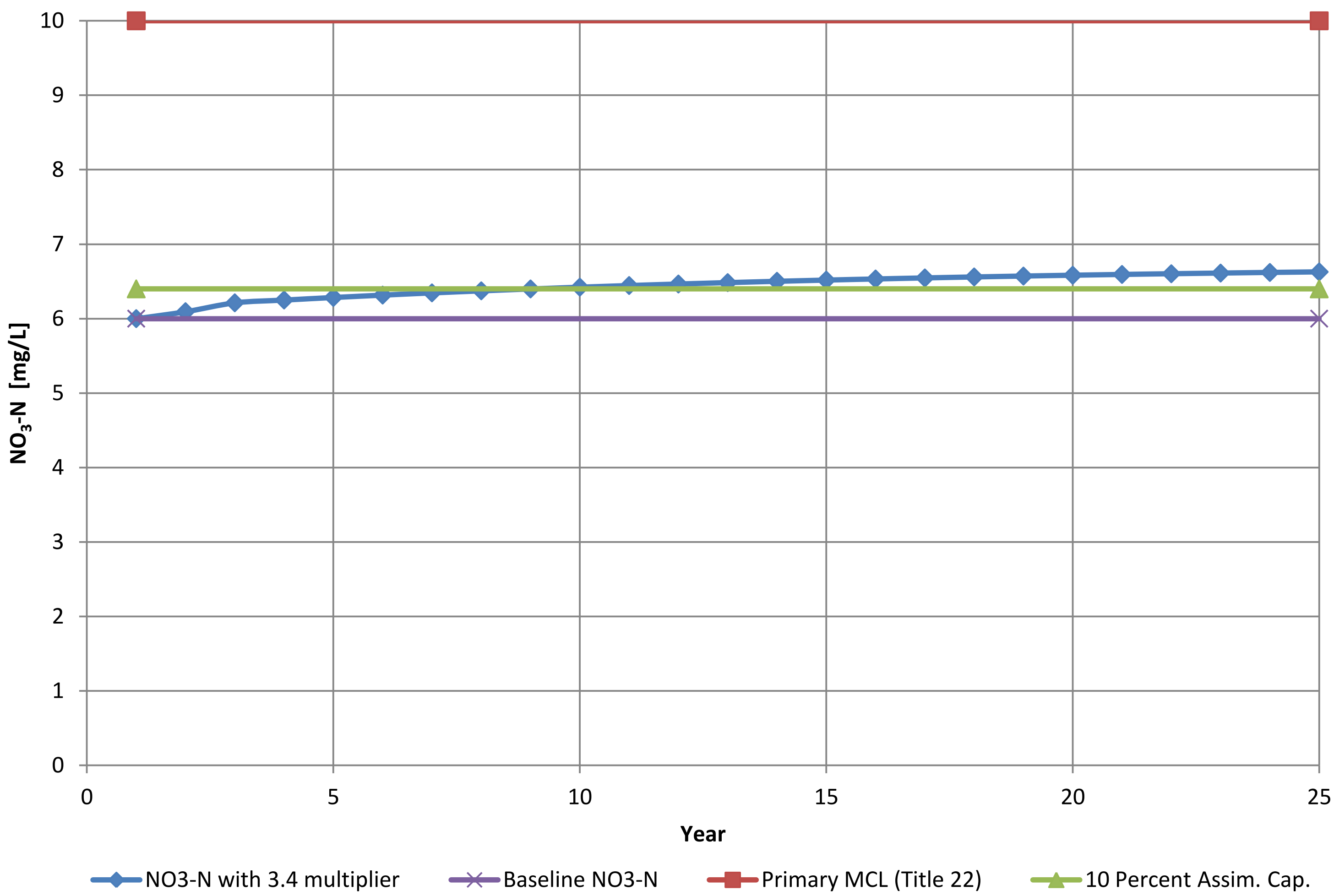


Figure D6
NO_3-N Concentrations
Eastern Area Alluvial Aquifer / Lower Aquifer
Evaporative Enrichment Calibration



APPENDIX E

Mass Loading Spreadsheet Model Results – Tables with Sample Calculations
(CHG, 2016)

TABLE E1

MASS BALANCE SPREADSHEET MODEL RESULTS - BASELINE (NO PROJECT)

Perched Aquifer				Eastern Area Alluvial/Lower Aquifer				Upper Aquifer				Western and Central Area Lower Aquifer				Basin Average (weighted by volume)			
Year	TDS [mg/L]	Chloride [mg/L]	Nitrate as N [mg/L]	Year	TDS [mg/L]	Chloride [mg/L]	Nitrate as N [mg/L]	Year	TDS [mg/L]	Chloride [mg/L]	Nitrate as N [mg/L]	Year	TDS [mg/L]	Chloride [mg/L]	Nitrate as N [mg/L]	Year	TDS [mg/L]	Chloride [mg/L]	Nitrate as N [mg/L]
1	380.00	92.00	15.00	1	532.00	75.00	6.00	1	381.00	88.00	15.00	1	443.00	79.00	2.00	1	440.12	80.89	5.99
2	399.87	96.25	14.85	2	533.15	74.52	6.12	2	379.00	87.58	14.65	2	480.12	97.45	2.17	2	462.40	91.74	6.03
3	417.88	101.05	14.73	3	534.48	74.37	6.26	3	378.24	87.59	14.32	3	516.60	115.59	2.34	3	484.55	102.57	6.07
4	434.49	106.18	14.64	4	535.84	74.25	6.39	4	378.57	87.97	14.03	4	552.46	133.42	2.50	4	506.53	113.32	6.12
5	450.05	111.56	14.58	5	537.22	74.17	6.51	5	379.84	88.71	13.77	5	587.73	150.96	2.66	5	528.34	123.99	6.16
6	464.82	117.12	14.53	6	538.60	74.12	6.63	6	381.92	89.77	13.53	6	622.43	168.21	2.81	6	549.98	134.58	6.21
7	479.00	122.83	14.49	7	539.98	74.10	6.73	7	384.73	91.14	13.31	7	656.57	185.18	2.95	7	571.43	145.08	6.26
8	492.73	128.65	14.46	8	541.36	74.11	6.82	8	388.16	92.77	13.11	8	690.19	201.89	3.09	8	592.69	155.50	6.31
9	506.11	134.55	14.43	9	542.74	74.16	6.91	9	392.16	94.66	12.93	9	723.28	218.34	3.22	9	613.76	165.83	6.36
10	519.24	140.42	14.42	10	544.11	74.23	6.99	10	396.64	96.77	12.77	10	755.88	234.54	3.35	10	634.64	176.06	6.42
11	532.09	146.35	14.40	11	545.48	74.33	7.06	11	401.56	99.08	12.63	11	787.99	250.49	3.48	11	655.32	186.20	6.47
12	544.80	152.25	14.39	12	546.84	74.46	7.13	12	406.86	101.57	12.50	12	819.63	266.20	3.60	12	675.80	196.25	6.52
13	557.33	158.20	14.39	13	548.19	74.61	7.19	13	412.49	104.23	12.38	13	850.82	281.69	3.72	13	696.08	206.20	6.57
14	569.70	164.10	14.38	14	549.53	74.79	7.25	14	418.42	107.03	12.27	14	881.55	296.94	3.84	14	716.16	216.05	6.63
15	581.88	170.05	14.38	15	550.86	74.98	7.30	15	424.59	109.97	12.18	15	911.84	311.98	3.95	15	736.02	225.81	6.68
16	593.98	175.95	14.37	16	552.19	75.20	7.35	16	430.99	113.02	12.09	16	941.71	326.80	4.06	16	755.69	235.47	6.73
17	605.93	181.80	14.37	17	553.50	75.44	7.39	17	437.59	116.17	12.02	17	971.17	341.41	4.17	17	775.14	245.03	6.78
18	617.85	187.62	14.37	18	554.81	75.69	7.44	18	444.36	119.41	11.95	18	1000.22	355.82	4.27	18	794.39	254.49	6.84
19	629.65	193.41	14.37	19	556.11	75.97	7.47	19	451.28	122.73	11.88	19	1028.87	370.03	4.38	19	813.44	263.85	6.89
20	641.28	199.09	14.37	20	557.40	76.25	7.51	20	458.31	126.11	11.83	20	1057.13	384.04	4.48	20	832.27	273.11	6.94
21	652.84	204.76	14.37	21	558.67	76.56	7.54	21	465.46	129.55	11.78	21	1085.01	397.86	4.57	21	850.91	282.27	6.99
22	664.27	210.35	14.37	22	559.94	76.87	7.57	22	472.68	133.02	11.73	22	1112.51	411.49	4.67	22	869.33	291.33	7.04
23	675.58	215.94	14.37	23	561.20	77.20	7.60	23	479.98	136.55	11.69	23	1139.65	424.94	4.76	23	887.55	300.29	7.09
24	686.80	221.46	14.37	24	562.45	77.54	7.62	24	487.33	140.10	11.66	24	1166.43	438.21	4.85	24	905.56	309.15	7.14
25	697.94	226.91	14.37	25	563.69	77.89	7.65	25	494.73	143.68	11.62	25	1192.86	451.30	4.94	25	923.38	317.92	7.19

TABLE E2

MASS BALANCE SPREADSHEET MODEL RESULTS - NO FURTHER DEVELOPMENT (LOWRF PROJECT)

Perched Aquifer				Eastern Area Alluvial/Lower Aquifer				Upper Aquifer				Western and Central Area Lower Aquifer				Basin Average (weighted by volume)			
Year	TDS [mg/L]	Chloride [mg/L]	Nitrate as N [mg/L]	Year	TDS [mg/L]	Chloride [mg/L]	Nitrate as N [mg/L]	Year	TDS [mg/L]	Chloride [mg/L]	Nitrate as N [mg/L]	Year	TDS [mg/L]	Chloride [mg/L]	Nitrate as N [mg/L]	Year	TDS [mg/L]	Chloride [mg/L]	Nitrate as N [mg/L]
1	380.00	92.00	15.00	1	532.00	75.00	6.00	1	381.00	88.00	15.00	1	443.00	79.00	2.00	1	440.12	80.89	5.99
2	366.82	87.83	13.32	2	533.44	75.08	6.09	2	379.24	88.10	14.30	2	444.43	79.17	2.14	2	440.32	80.88	5.87
3	355.26	84.41	11.93	3	534.73	75.37	6.20	3	377.06	88.04	13.64	3	445.84	79.34	2.27	3	440.44	80.89	5.77
4	345.68	81.59	10.78	4	535.89	75.63	6.30	4	374.83	87.91	13.00	4	447.21	79.50	2.39	4	440.58	80.90	5.67
5	337.76	79.27	9.84	5	536.93	75.86	6.38	5	372.60	87.75	12.40	5	448.54	79.67	2.51	5	440.74	80.91	5.58
6	331.19	77.35	9.05	6	537.87	76.06	6.45	6	370.41	87.56	11.84	6	449.84	79.83	2.61	6	440.92	80.92	5.50
7	325.74	75.77	8.41	7	538.71	76.25	6.51	7	368.29	87.34	11.31	7	451.10	79.98	2.72	7	441.12	80.94	5.43
8	321.21	74.47	7.87	8	539.48	76.42	6.57	8	366.25	87.11	10.82	8	452.33	80.14	2.81	8	441.34	80.96	5.36
9	317.45	73.40	7.43	9	540.18	76.57	6.61	9	364.31	86.87	10.36	9	453.53	80.29	2.90	9	441.58	80.97	5.30
10	314.31	72.51	7.06	10	540.81	76.71	6.65	10	362.47	86.63	9.93	10	454.69	80.43	2.98	10	441.83	81.00	5.25
11	311.70	71.76	6.76	11	541.39	76.83	6.69	11	360.74	86.39	9.54	11	455.82	80.58	3.06	11	442.11	81.02	5.20
12	309.53	71.15	6.51	12	541.93	76.95	6.72	12	359.13	86.16	9.18	12	456.93	80.72	3.14	12	442.40	81.05	5.16
13	307.71	70.64	6.30	13	542.43	77.05	6.75	13	357.64	85.94	8.85	13	458.01	80.85	3.21	13	442.70	81.07	5.12
14	306.20	70.21	6.13	14	542.88	77.15	6.77	14	356.24	85.73	8.54	14	459.06	80.98	3.27	14	443.02	81.10	5.09
15	304.94	69.87	5.99	15	543.30	77.24	6.80	15	354.96	85.53	8.26	15	460.08	81.11	3.34	15	443.35	81.13	5.06
16	303.88	69.58	5.87	16	543.69	77.32	6.82	16	353.76	85.34	8.00	16	461.08	81.24	3.40	16	443.69	81.17	5.04
17	302.99	69.34	5.77	17	544.04	77.40	6.83	17	352.67	85.17	7.76	17	462.06	81.36	3.45	17	444.04	81.20	5.01
18	302.25	69.13	5.69	18	544.38	77.47	6.85	18	351.68	85.00	7.55	18	463.01	81.48	3.50	18	444.41	81.24	5.00
19	301.64	68.95	5.62	19	544.69	77.53	6.86	19	350.76	84.85	7.35	19	463.95	81.60	3.55	19	444.78	81.28	4.98
20	301.12	68.81	5.56	20	544.98	77.59	6.88	20	349.93	84.71	7.17	20	464.86	81.71	3.60	20	445.15	81.32	4.97
21	300.70	68.69	5.51	21	545.25	77.65	6.89	21	349.17	84.58	7.01	21	465.76	81.82	3.65	21	445.53	81.36	4.96
22	300.35	68.59	5.48	22	545.51	77.70	6.90	22	348.49	84.46	6.86	22	466.64	81.93	3.69	22	445.92	81.40	4.95
23	300.06	68.51	5.44	23	545.74	77.75	6.91	23	347.87	84.35	6.72	23	467.50	82.03	3.73	23	446.32	81.44	4.94
24	299.84	68.44	5.42	24	545.96	77.80	6.92	24	347.31	84.25	6.60	24	468.34	82.14	3.77	24	446.71	81.48	4.94
25	299.64	68.39	5.39	25	546.18	77.84	6.92	25	346.82	84.15	6.49	25	469.17	82.24	3.81	25	447.12	81.53	4.94

TABLE E3

SAMPLE ANTIDEGRADATION CALCULATIONS FOR NO FURTHER DEVELOPMENT SCENARIO USING MASS BALANCE RESULTS TABLE D2

SAMPLE CALCULATIONS FOR TABLE 10 (TDS ANTIDEGRADATION ANALYSIS)

PERCHED AQUIFER No Further Development at 10 Years:
Change in TDS: 314.31 mg/L (TDS at Year 10) - 380 mg/L (TDS at Year 1) = -65.7 mg/L (lower TDS)
Percent TDS Assimilative Capacity Used: -65.7 mg/L (change in TDS) ÷ 620 mg/L (TDS assimilative capacity) = -10.6 % (TDS assimilative capacity used)

UPPER AQUIFER - No Further Development at 25 Years:
Change in TDS: 346.82 mg/L (TDS at Year 25) - 381 mg/L (TDS at Year 1) = -34.2 mg/L (lower TDS)
Percent TDS Assimilative Capacity Used: -34.2 mg/L (change in TDS) ÷ 620 mg/L (TDS assimilative capacity) = -5.5 % (TDS assimilative capacity used)

BASIN TOTAL No Further Development at 25 Years (Refer to Table 10 for compartment values and Table 3 for compartment volumes):
Average Change in TDS (weighted by volume): ((-80.4 mg/L * 5.18E9 L) + (-34.2 mg/L * 3.33E10 L) + (26.2 mg/L * 8.68E10 L) + (14.2 mg/L* 2.21E10 L)) ÷ 1.47E11 L = 7 mg/L (greater TDS)
Percent TDS Basin Assimilative Capacity Used: 7 mg/L (change in TDS) ÷ 560 mg/L (TDS assimilative capacity) = 1.3 % (TDS assimilative capacity used)

SAMPLE CALCULATIONS FOR TABLE 11 (CHLORIDE ANTIDEGRADATION ANALYSIS)

PERCHED AQUIFER No Further Development at 10 Years:
Change in Chloride: 72.51 mg/L (Cl at Year 10) - 92 mg/L (Cl at Year 1) = -19.5 mg/L (lower Cl)
Percent Chloride Assimilative Capacity Used: -19.5 mg/L (change in Cl) ÷ 157 mg/L (Cl assimilative capacity) = -12.4 % (Cl assimilative capacity used)

UPPER AQUIFER -No Further Development at 25 Years:
Change in Chloride: 84.15 mg/L (Cl at Year 25) - 88 mg/L (Cl at Year 1) = -3.85 mg/L (lower Cl)
Percent Chloride Assimilative Capacity Used: -3.85 mg/L (change in Cl) ÷ 162 mg/L (Cl assimilative capacity) = -2.4 % (Cl assimilative capacity used)

BASIN TOTAL No Further Development at 25 Years (Refer to Table 11 for compartment values and Table 3 for compartment volumes):
Average Change in Chloride (weighted by volume): ((-12.8 mg/L * 5.18E9 L) + (0.4 mg/L * 3.33E10 L) + (1.4 mg/L * 8.68E10 L) + (10.8 mg/L* 2.21E10 L)) ÷ 1.47E11 L = 2.1 mg/L (greater Cl)
Percent Chloride Basin Assimilative Capacity Used: 2.1 mg/L (change in Cl) ÷ 169 mg/L (TDS assimilative capacity) = 1.2 % (Cl assimilative capacity used)

SAMPLE CALCULATIONS FOR TABLE 12 (NO_3-N ANTIDEGRADATION ANALYSIS)

PERCHED AQUIFER No Further Development at 10 Years:
Change in NO3-N: 7.06 mg/L (NO3-N at Year 10) - 15 mg/L (NO3-N at Year 1) = -7.94 mg/L (lower NO3-N)
Percent NO3-N Assimilative Capacity Used: -7.94 mg/L (change in NO3-N) ÷ -5 mg/L (NO3-N assimilative capacity) = 159 % (NO3-N assimilative capacity used)
NOTE: The 159% is a use of negative NO_3-N capacity, or effectively a gain of assimilative capacity, and is expressed as -159% in Table 12 to be consistent with TDS and Cl analyses

UPPER AQUIFER No Further Development at 10 Years:
Change in NO3-N: 6.49 mg/L (NO3-N at Year 10) - 15 mg/L (NO3-N at Year 1) = -8.51 mg/L (lower NO3-N)
Percent NO3-N Assimilative Capacity Used: -8.51 mg/L (change in NO3-N) ÷ -5 mg/L (NO3-N assimilative capacity) = 170 % (NO3-N assimilative capacity used)
NOTE: The 170 % is a use of negative NO_3-N capacity, or effectively a gain of assimilative capacity, and is expressed as -170 % in Table 12 to be consistent with TDS and Cl analyses

BASIN TOTAL No Further Development at 25 Years (Refer to Table 12 for compartment values and Table 3 for compartment volumes):
Average Change in NO3-N (weighted by volume): ((-7.5 mg/L * 5.18E9 L) + (-5 mg/L * 3.33E10 L) + (1 mg/L * 8.68E10 L) + (1.1 mg/L* 2.21E10 L)) ÷ 1.47E11 L = -0.64 mg/L (lower NO3-N)
Percent NO3-N Basin Assimilative Capacity Used: -0.64 mg/L (change in NO3-N) ÷ 4 mg/L (NO3-N assimilative capacity) = -15.4 % (NO3-N assimilative capacity used)

TABLE E4

MASS BALANCE SPREADSHEET MODEL RESULTS - POPULATION BUILDOUT (CUMULATIVE PROJECTS)

Perched Aquifer				Eastern Area Alluvial/Lower Aquifer				Upper Aquifer				Western and Central Area Lower Aquifer				Basin Average (weighted by volume)			
Year	TDS [mg/L]	Chloride [mg/L]	Nitrate as N [mg/L]	Year	TDS [mg/L]	Chloride [mg/L]	Nitrate as N [mg/L]	Year	TDS [mg/L]	Chloride [mg/L]	Nitrate as N [mg/L]	Year	TDS [mg/L]	Chloride [mg/L]	Nitrate as N [mg/L]	Year	TDS [mg/L]	Chloride [mg/L]	Nitrate as N [mg/L]
1	380.00	92.00	15.00	1	532.00	75.00	6.00	1	381.00	88.00	15.00	1	443.00	79.00	2.00	1	440.12	80.89	5.99
2	373.39	89.16	13.38	2	535.53	76.42	6.16	2	380.14	88.22	14.31	2	444.54	79.12	2.13	2	441.13	81.12	5.88
3	367.30	86.86	12.05	3	538.52	77.84	6.32	3	378.79	88.35	13.65	3	446.08	79.25	2.25	3	441.97	81.36	5.78
4	362.31	85.01	10.96	4	541.29	79.17	6.46	4	377.46	88.43	13.02	4	447.61	79.39	2.37	4	442.81	81.59	5.69
5	358.20	83.49	10.06	5	543.86	80.43	6.59	5	376.18	88.47	12.43	5	449.12	79.53	2.48	5	443.65	81.83	5.61
6	354.82	82.26	9.32	6	546.25	81.62	6.71	6	374.95	88.48	11.88	6	450.62	79.69	2.59	6	444.49	82.05	5.54
7	352.04	81.25	8.71	7	548.47	82.74	6.81	7	373.79	88.48	11.36	7	452.10	79.85	2.69	7	445.34	82.28	5.48
8	349.77	80.43	8.21	8	550.53	83.81	6.90	8	372.71	88.47	10.88	8	453.57	80.01	2.78	8	446.19	82.50	5.42
9	347.89	79.76	7.79	9	552.44	84.81	6.98	9	371.69	88.44	10.44	9	455.02	80.18	2.88	9	447.04	82.73	5.37
10	346.36	79.22	7.45	10	554.22	85.76	7.05	10	370.75	88.42	10.03	10	456.46	80.35	2.96	10	447.88	82.95	5.33
11	345.87	78.75	7.17	11	555.90	86.66	7.12	11	369.90	88.39	9.65	11	457.88	80.53	3.05	11	448.76	83.17	5.29
12	345.48	78.37	6.94	12	557.46	87.52	7.18	12	369.15	88.37	9.30	12	459.28	80.71	3.13	12	449.64	83.38	5.26
13	345.18	78.07	6.75	13	558.93	88.33	7.23	13	368.47	88.37	8.98	13	460.67	80.90	3.20	13	450.51	83.60	5.24
14	344.94	77.82	6.59	14	560.31	89.10	7.28	14	367.89	88.36	8.69	14	462.04	81.09	3.28	14	451.39	83.82	5.22
15	343.98	77.65	6.46	15	561.60	89.82	7.33	15	367.38	88.37	8.42	15	463.40	81.28	3.35	15	452.23	84.03	5.20
16	344.00	77.49	6.35	16	562.80	90.52	7.37	16	366.91	88.37	8.18	16	464.75	81.47	3.41	16	453.10	84.25	5.19
17	344.04	77.36	6.26	17	563.94	91.17	7.41	17	366.52	88.38	7.96	17	466.07	81.66	3.48	17	453.97	84.46	5.18
18	344.09	77.27	6.18	18	565.01	91.79	7.44	18	366.19	88.39	7.76	18	467.39	81.86	3.54	18	454.83	84.66	5.17
19	344.16	77.19	6.12	19	566.02	92.39	7.48	19	365.92	88.41	7.57	19	468.69	82.06	3.60	19	455.69	84.87	5.17
20	344.24	77.14	6.06	20	566.97	92.95	7.50	20	365.69	88.43	7.40	20	469.97	82.26	3.66	20	456.54	85.08	5.17
21	344.34	77.10	6.02	21	567.88	93.48	7.53	21	365.52	88.45	7.25	21	471.24	82.46	3.72	21	457.39	85.28	5.17
22	344.45	77.07	5.98	22	568.72	93.99	7.56	22	365.39	88.47	7.11	22	472.50	82.66	3.77	22	458.23	85.48	5.17
23	344.57	77.06	5.95	23	569.53	94.47	7.58	23	365.30	88.52	6.99	23	473.74	82.86	3.82	23	459.06	85.68	5.18
24	344.70	77.06	5.93	24	570.30	94.93	7.60	24	365.25	88.57	6.87	24	474.97	83.07	3.87	24	459.90	85.88	5.18
25	344.84	77.06	5.91	25	571.02	95.36	7.62	25	365.22	88.62	6.77	25	476.19	83.27	3.92	25	460.72	86.07	5.19

TABLE E5

SAMPLE ANTIDEGRADATION CALCULATIONS FOR POPULATION BUILDOUT SCENARIO USING MASS BALANCE RESULTS TABLE D4

SAMPLE CALCULATIONS FOR TABLE 10 (TDS ANTIDEGRADATION ANALYSIS)

LOWER AQUIFER - WESTERN AND CENTRAL AREA Population Buildout at 10 Years:
Change in TDS: 456.46 mg/L (TDS at Year 10) - 443 mg/L (TDS at Year 1) = 13.5 mg/L (greater TDS)
Percent TDS Assimilative Capacity Used: 13.5 mg/L (change in TDS) ÷ 560 mg/L (TDS assimilative capacity) = 2.4 % (TDS assimilative capacity used)

LOWER AQUIFER AND ALLUVIAL AQUIFER - EASTERN AREA Population Buildout at 25 Years
Change in TDS: 571.02 mg/L (TDS at Year 25) - 532 mg/L (TDS at Year 1) = 39 mg/L (greater TDS)
Percent TDS Assimilative Capacity Used: 39 mg/L (change in TDS) ÷ 470 mg/L (TDS assimilative capacity) = 8.3 % (TDS assimilative capacity used)

BASIN TOTAL Population Buildout at 25 Years (Refer to Table 10 for compartment values and Table 3 for compartment volumes):
Average Change in TDS (weighted by volume): ((-35.2 mg/L * 5.18E9 L) + (-15.8 mg/L * 3.33E10 L) + (33.2 mg/L * 8.68E10 L) + (39 mg/L* 2.21E10 L)) ÷ 1.47E11 L = 20.7 mg/L (greater TDS)
Percent TDS Basin Assimilative Capacity Used: 20.7 mg/L (change in TDS) ÷ 560 mg/L (TDS assimilative capacity) = 3.7 % (TDS assimilative capacity used)

SAMPLE CALCULATIONS FOR TABLE 11 (CHLORIDE ANTIDEGRADATION ANALYSIS)

LOWER AQUIFER - WESTERN AND CENTRAL AREA Population Buildout at 10 Years:
Change in Chloride: 80.35 mg/L (Cl at Year 10) - 79 mg/L (Cl at Year 1) = 1.4 mg/L (greater Cl)
Percent Chloride Assimilative Capacity Used: 1.4 mg/L (change in Cl) ÷ 171 mg/L (Cl assimilative capacity) = 0.8 % (Cl assimilative capacity used)

LOWER AQUIFER AND ALLUVIAL AQUIFER - EASTERN AREA Population Buildout at 25 Years
Change in Chloride: 95.36 mg/L (Cl at Year 25) - 75 mg/L (Cl at Year 1) = 20.4 mg/L (greater Cl)
Percent Chloride Assimilative Capacity Used: 20.4 mg/L (change in Cl) ÷ 175 mg/L (Cl assimilative capacity) = 11.7 % (Cl assimilative capacity used)

BASIN TOTAL Population Buildout at 25 Years (Refer to Table 11 for compartment values and Table 3 for compartment volumes):
Average Change in Chloride (weighted by volume): ((-14.9 mg/L * 5.18E9 L) + (0.6 mg/L * 3.33E10 L) + (4.3 mg/L * 8.68E10 L) + (20.4 mg/L* 2.21E10 L)) ÷ 1.47E11 L = 5.2 mg/L (greater Cl)
Percent Chloride Basin Assimilative Capacity Used: 5.2 mg/L (change in Cl) ÷ 169 mg/L (TDS assimilative capacity) = 3.1 % (Cl assimilative capacity used)

SAMPLE CALCULATIONS FOR TABLE 12 (NO_3-N ANTIDEGRADATION ANALYSIS)

LOWER AQUIFER - WESTERN AND CENTRAL AREA Population Buildout at 10 Years:
Change in NO3-N: 2.96 mg/L (NO3-N at Year 10) - 2 mg/L (NO3-N at Year 1) = 0.96 mg/L (greater NO3-N)
Percent NO3-N Assimilative Capacity Used: 0.96 mg/L (change in NO3-N) ÷ 8 mg/L (NO3-N assimilative capacity) = 12 % (NO3-N assimilative capacity used)

LOWER AQUIFER AND ALLUVIAL AQUIFER - EASTERN AREA Population Buildout at 25 Years
Change in NO3-N: 7.62 mg/L (NO3-N at Year 25) - 6 mg/L (NO3-N at Year 1) = 1.62 mg/L (greater NO3-N)
Percent NO3-N Assimilative Capacity Used: 1.62 mg/L (change in NO3-N) ÷ 4 mg/L (NO3-N assimilative capacity) = 40.5 % (NO3-N assimilative capacity used)

BASIN TOTAL Population Buildout at 25 Years (Refer to Table 12 for compartment values and Table 3 for compartment volumes):
Average Change in NO3-N (weighted by volume): ((-9.1 mg/L * 5.18E9 L) + (-8.2 mg/L * 3.33E10 L) + (1.9 mg/L * 8.68E10 L) + (1.6 mg/L* 2.21E10 L)) ÷ 1.47E11 L = -0.82 mg/L (lower NO3-N)
Percent NO3-N Basin Assimilative Capacity Used: -0.82 mg/L (change in NO3-N) ÷ 4 mg/L (NO3-N assimilative capacity) = -20.5 % (NO3-N assimilative capacity used)

APPENDIX F

Mass Loading Spreadsheet Model Results – Graphs
(CHG, 2016)

Figure F1
TDS Concentration Trends
Basin Average

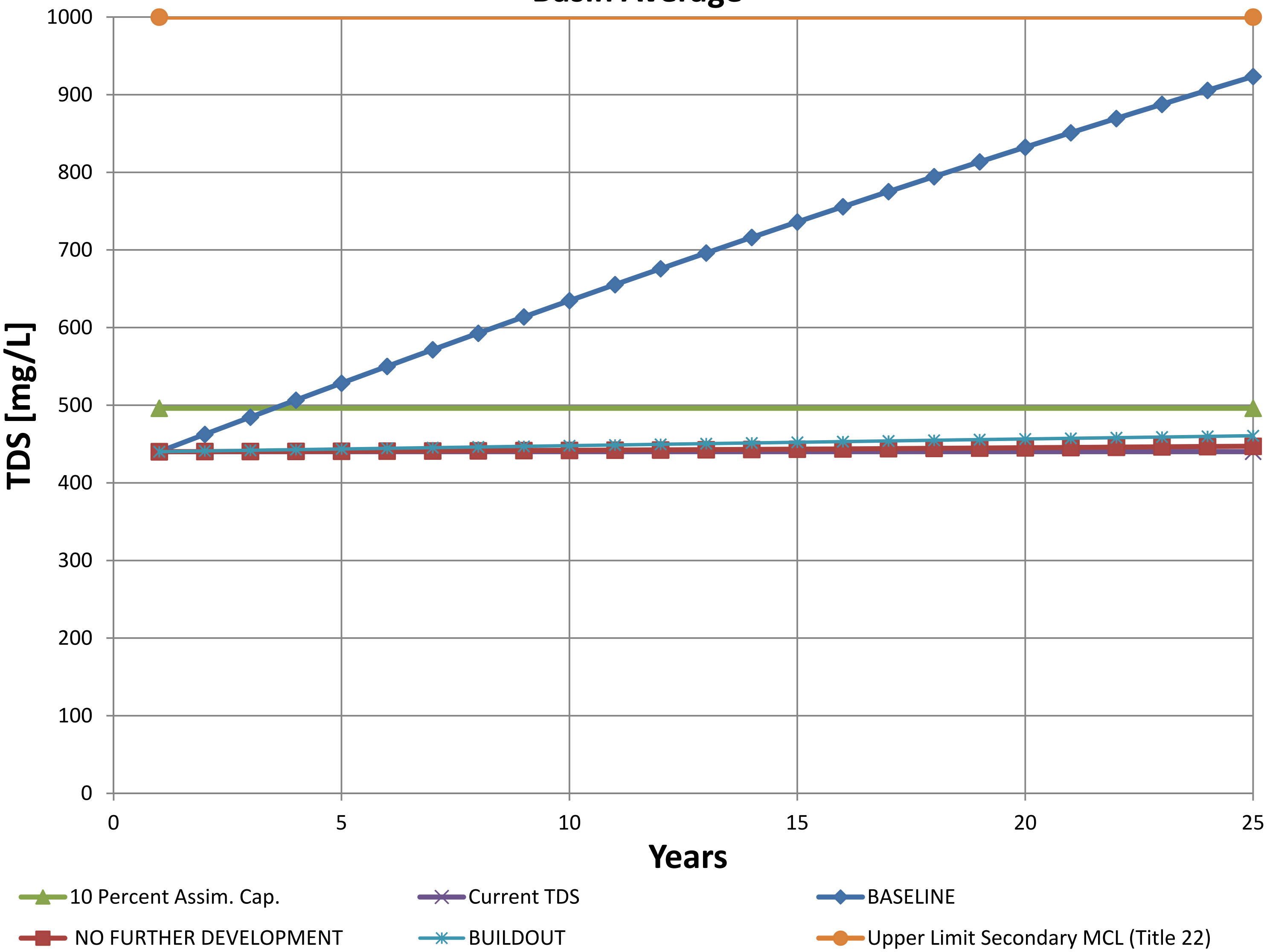


Figure F2
TDS Concentration Trends
Perched Aquifer

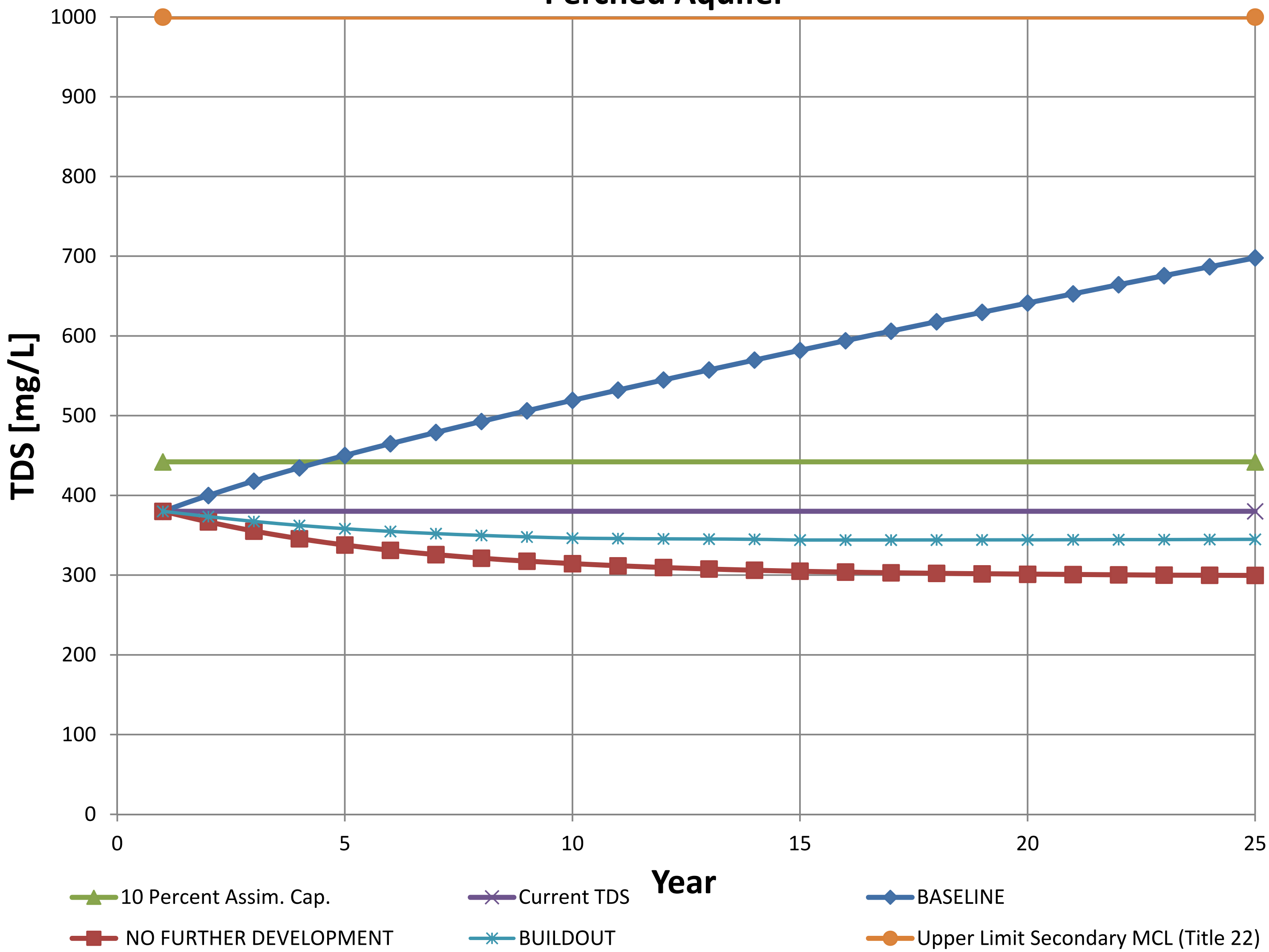
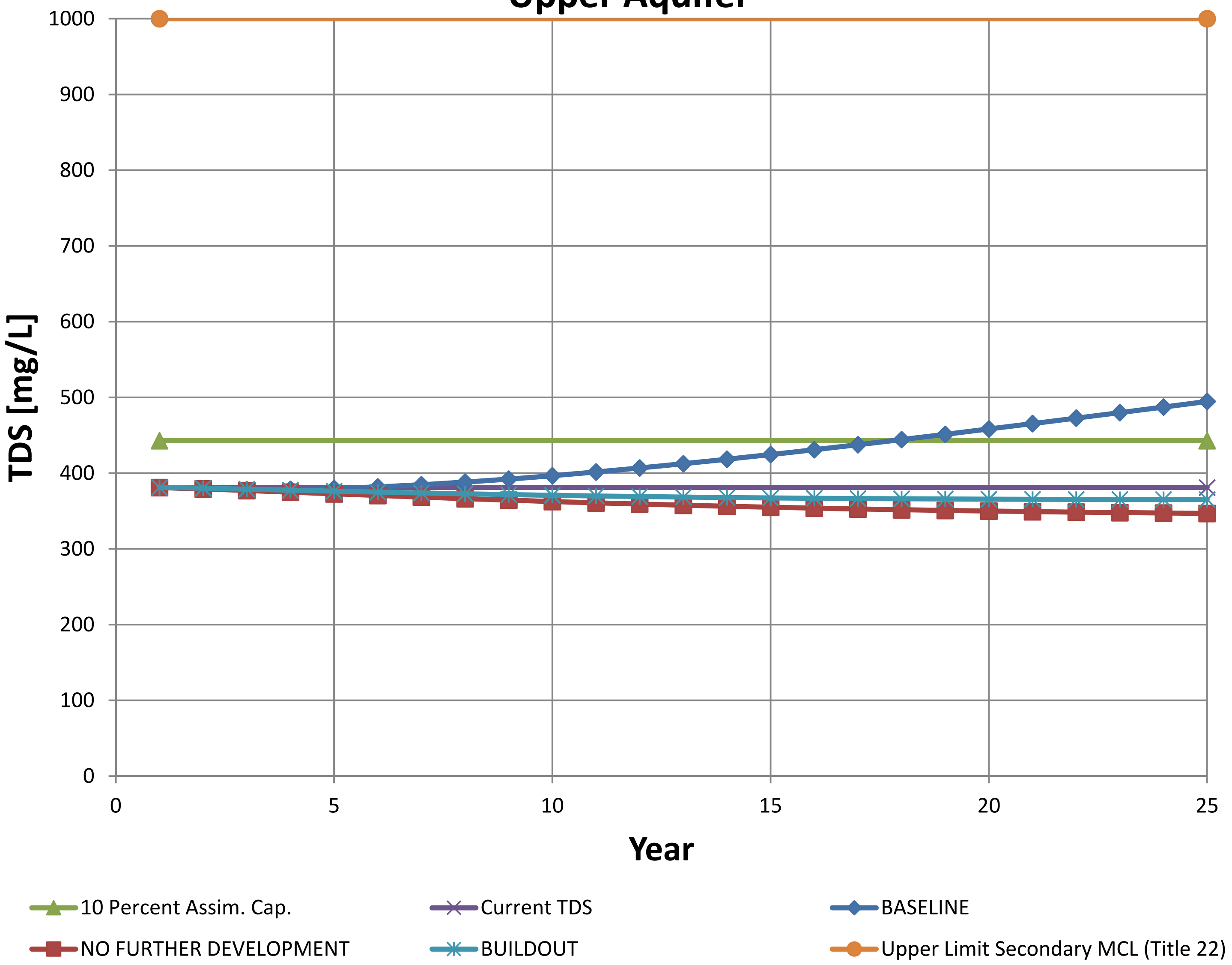


Figure F3
TDS Concentration Trends
Upper Aquifer



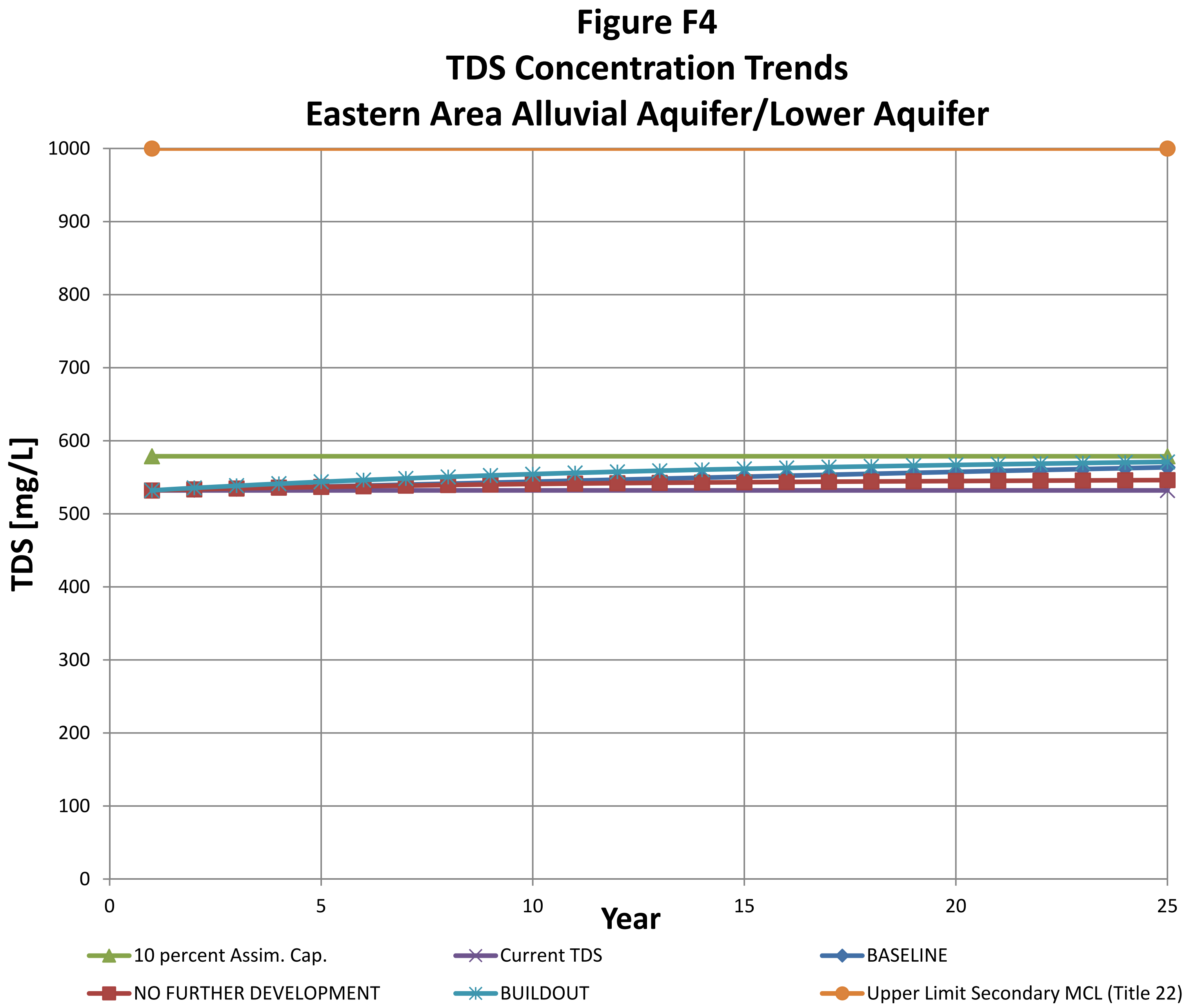


Figure F4
TDS Concentration Trends
Eastern Area Alluvial Aquifer/Lower Aquifer
TDS [mg/L]
1000
900
800
700
600
500
400
300
200
100
0
0
5
10
15
20
25
Year
10 percent Assim. Cap.
Current TDS
BASELINE
NO FURTHER DEVELOPMENT
BUILDOUT
Upper Limit Secondary MCL (Title 22)

Figure F5
TDS Concentration Trends
Western and Central Area Lower Aquifer

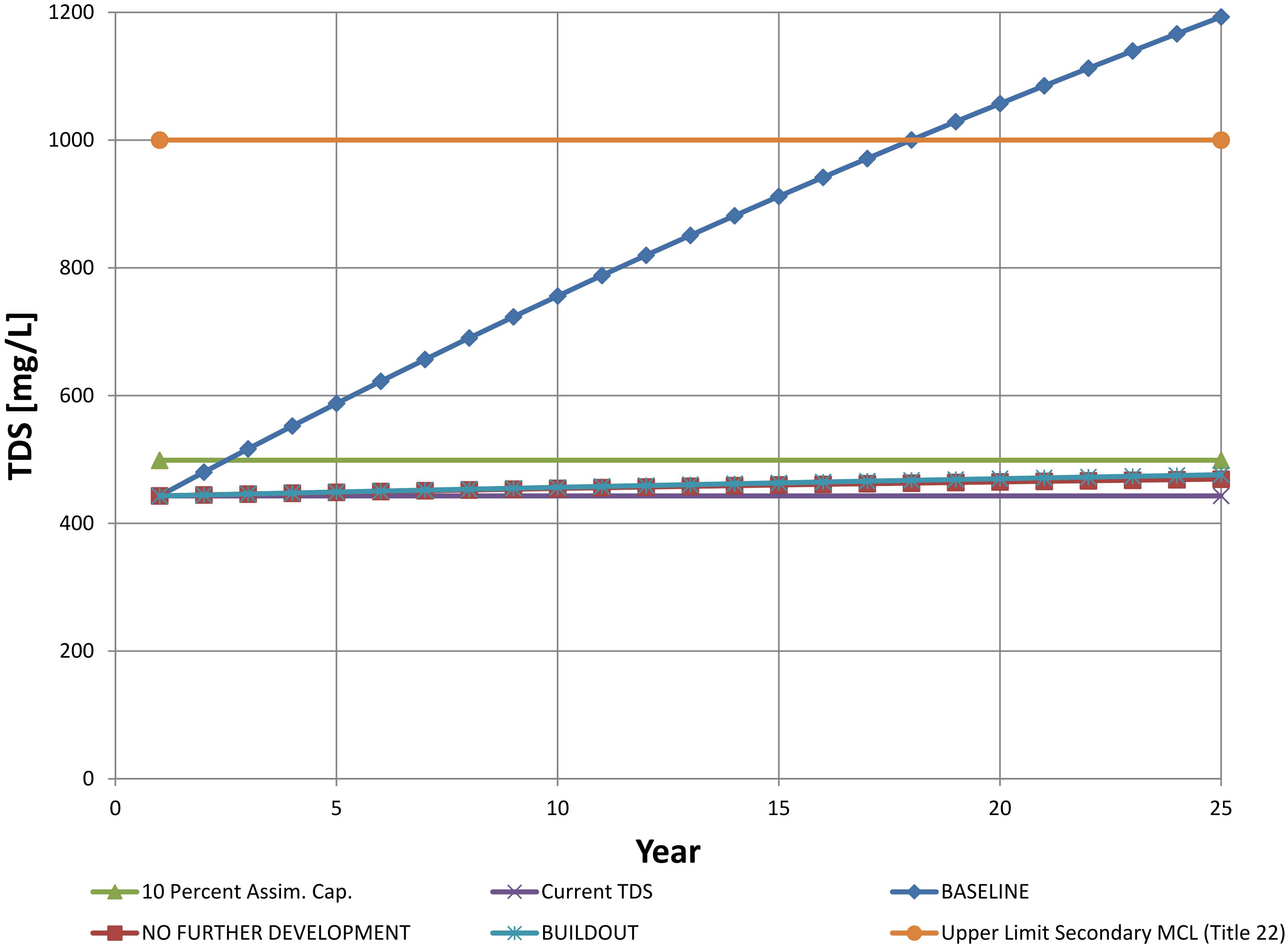


Figure F6
Chloride Concentration Trends
Basin Average

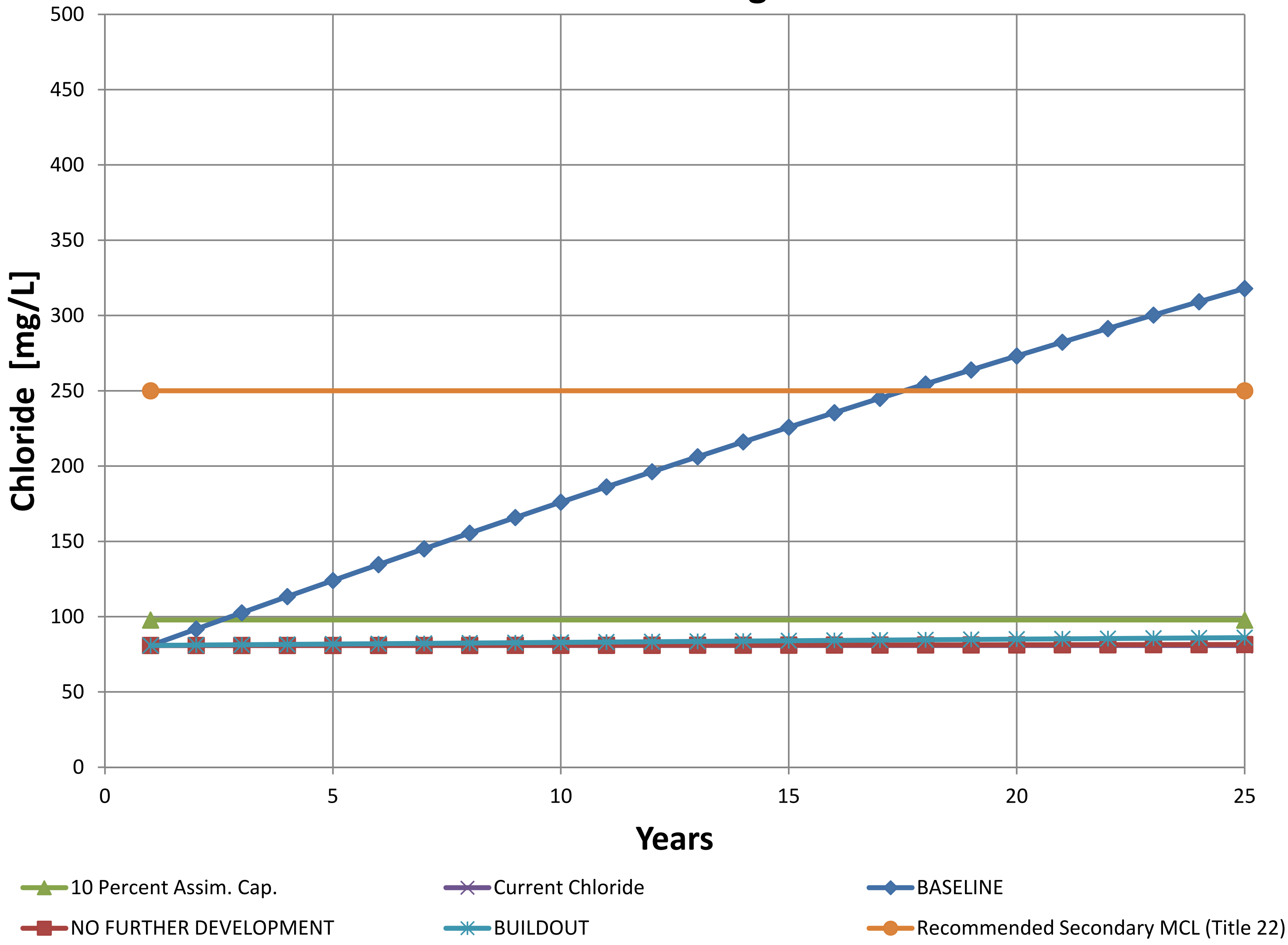


Figure F7
Chloride Concentration Trends
Perched Aquifer

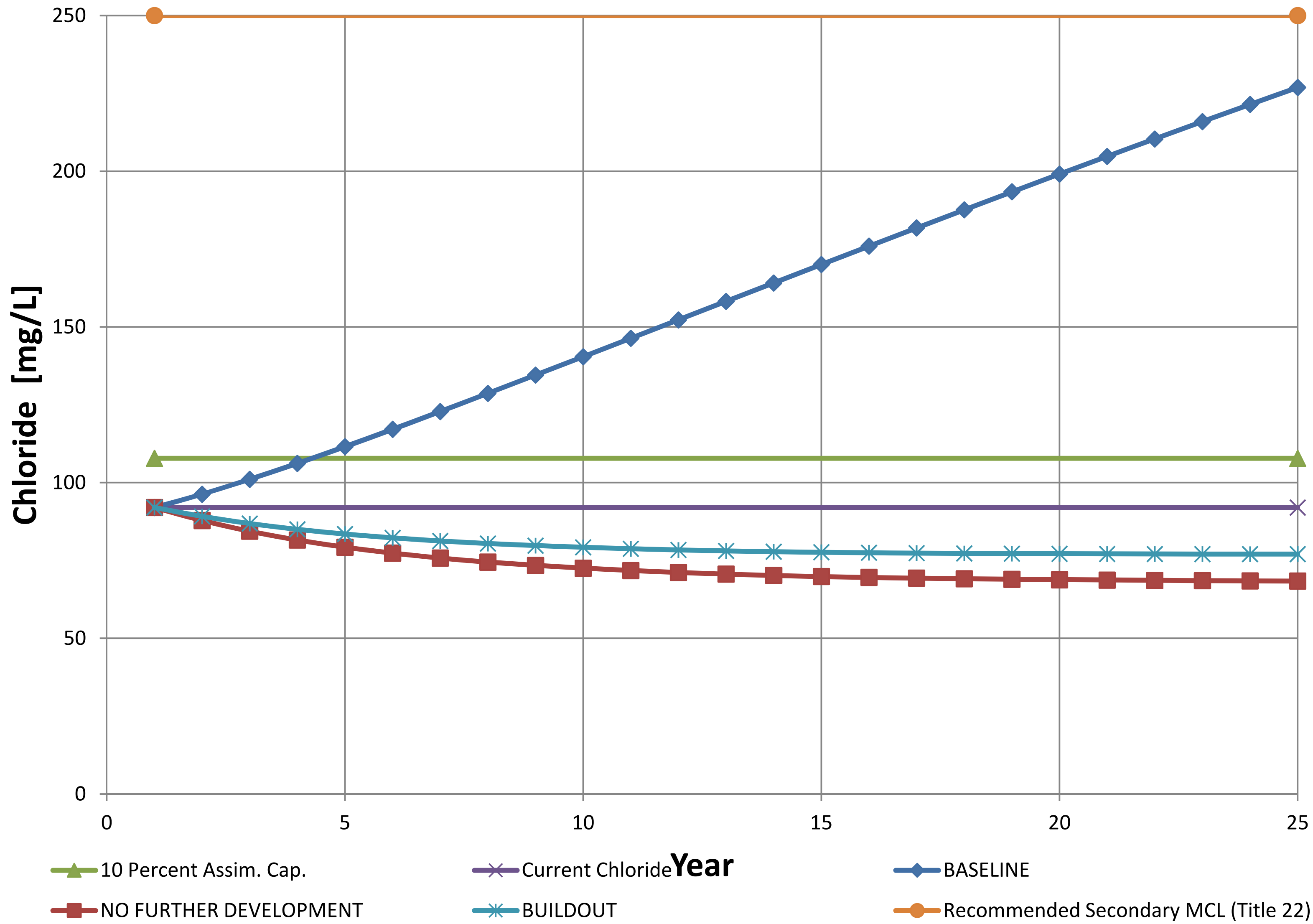
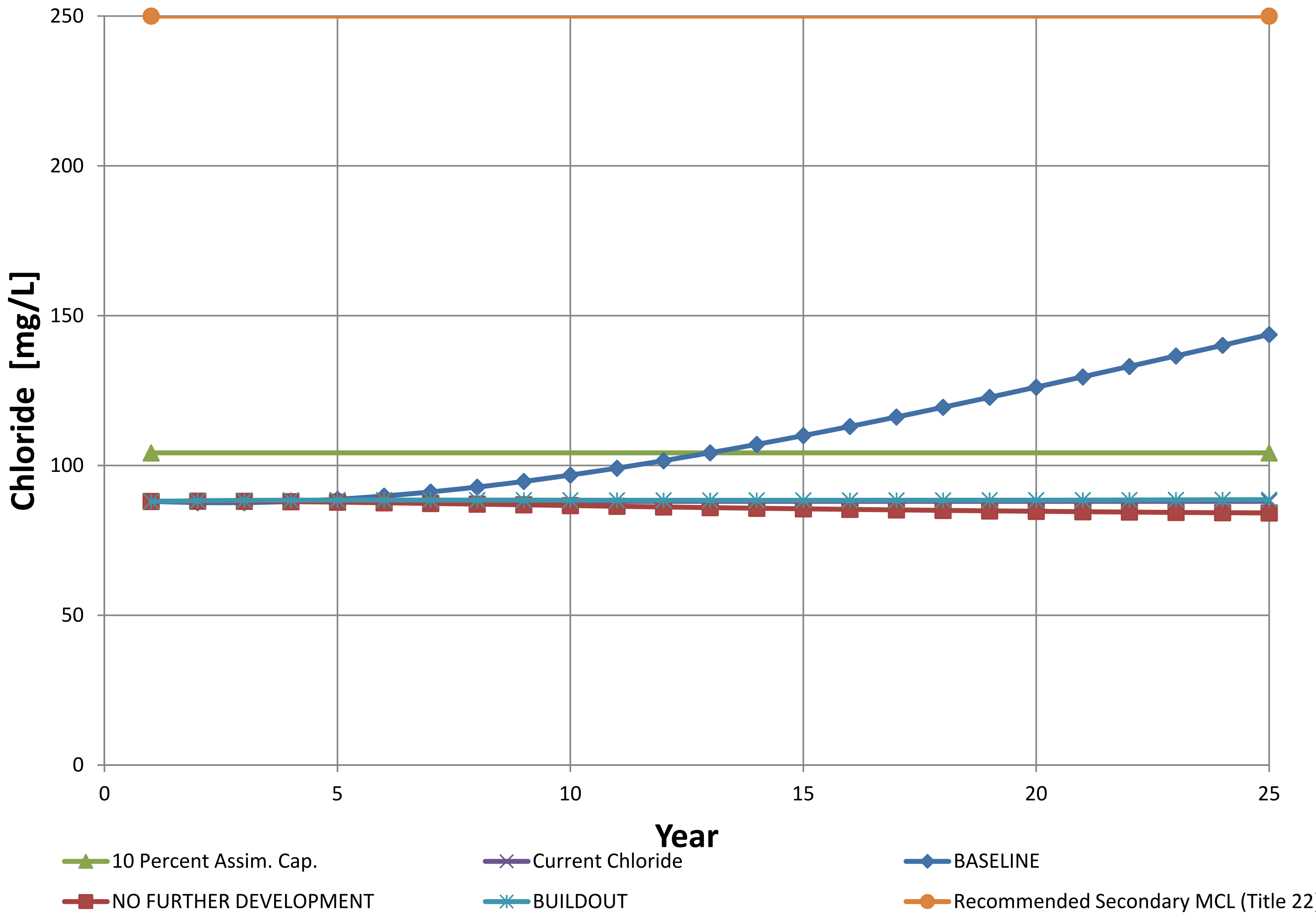


Figure F8
Chloride Concetration Trends
Upper Aquifer



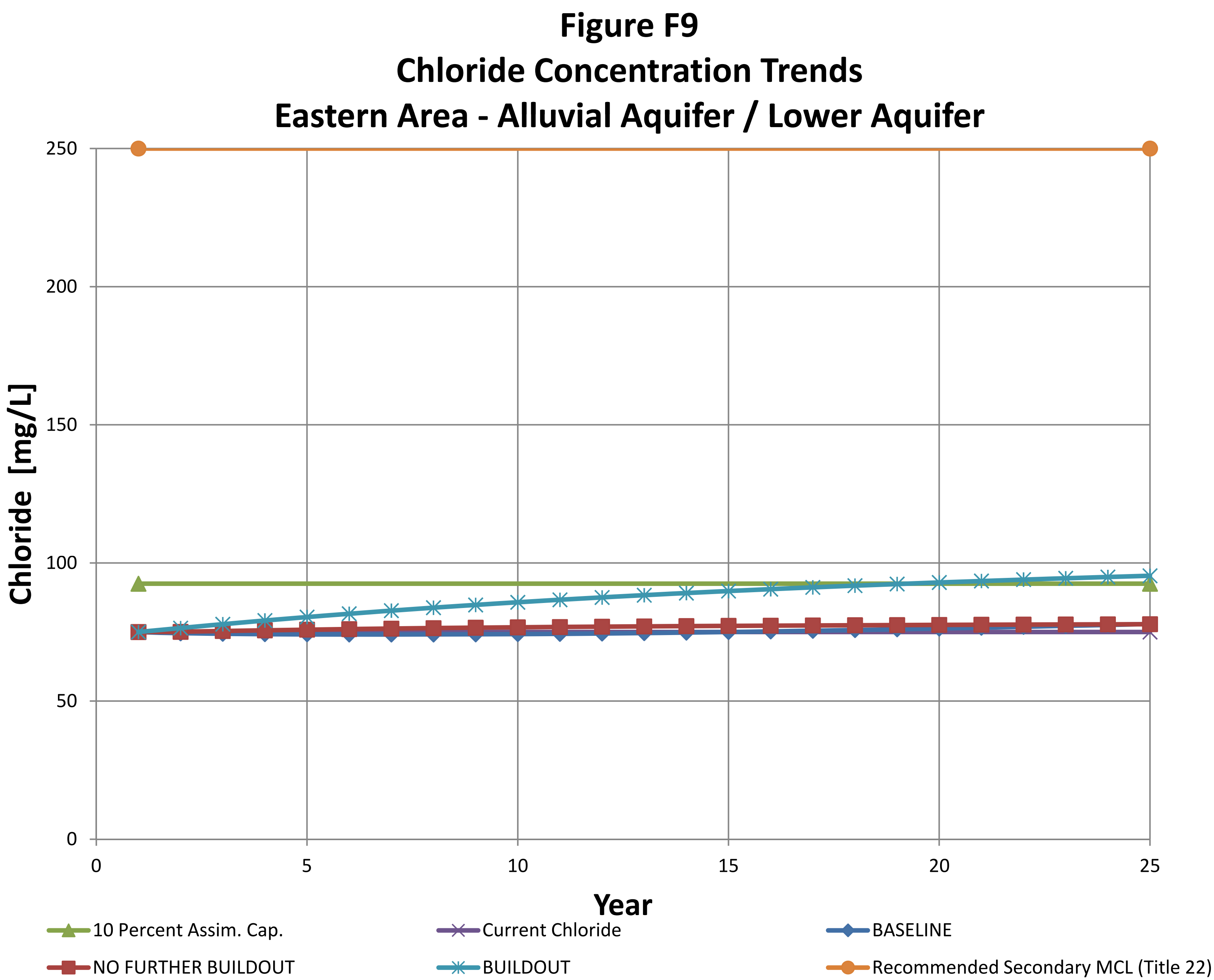


Figure F9
Chloride Concentration Trends
Eastern Area - Alluvial Aquifer / Lower Aquifer
Chloride [mg/L]
250
200
150
100
50
0
0
5
10
15
20
25
Year
10 Percent Assim. Cap.
Current Chloride
BASELINE
NO FURTHER BUILDOUT
BUILDOUT
Recommended Secondary MCL (Title 22)

Figure F10
Chloride Concentration Trends
Western and Central Area Lower Aquifer

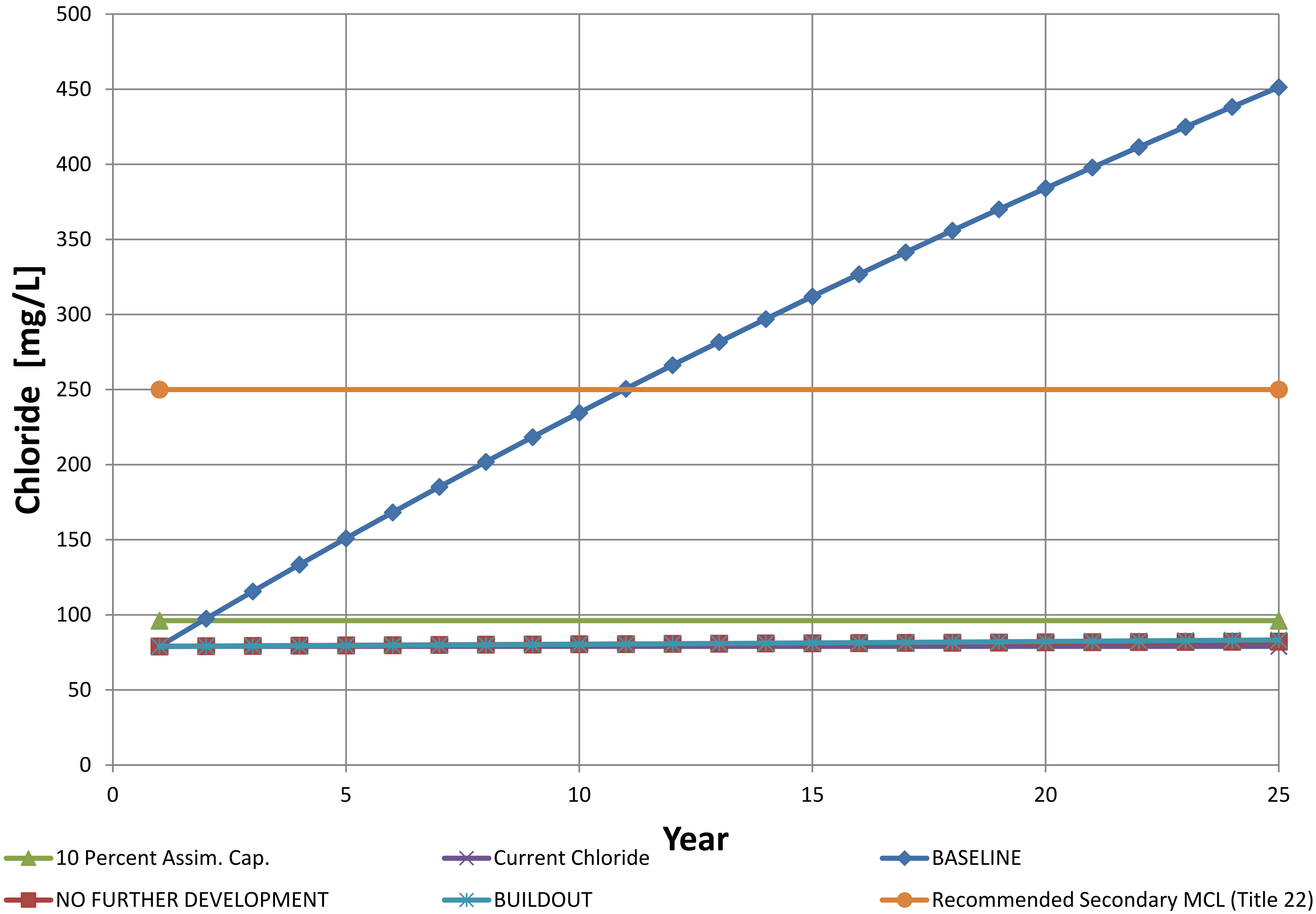
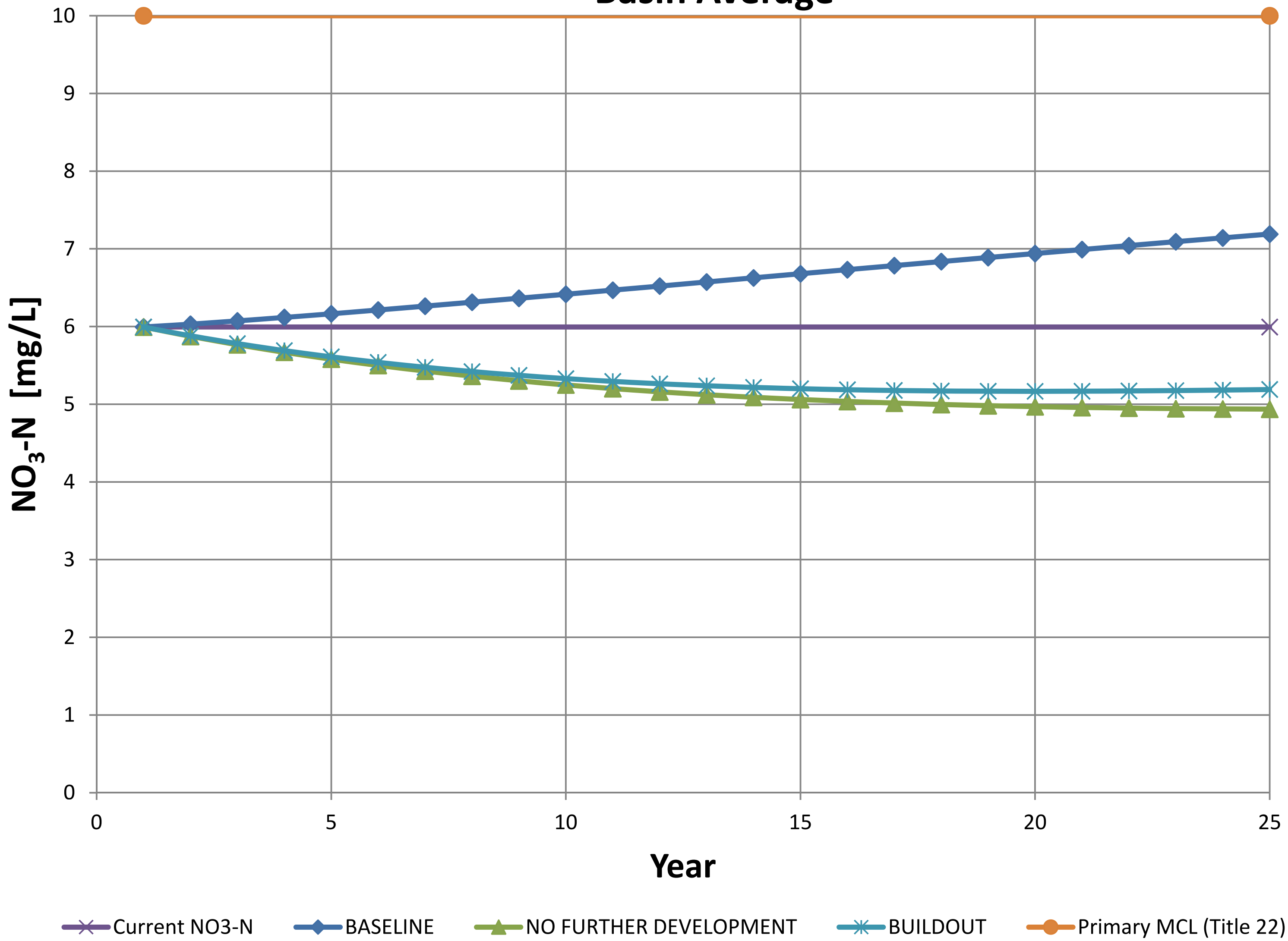


Figure F11
NO_3-N Concentration Trends
Basin Average



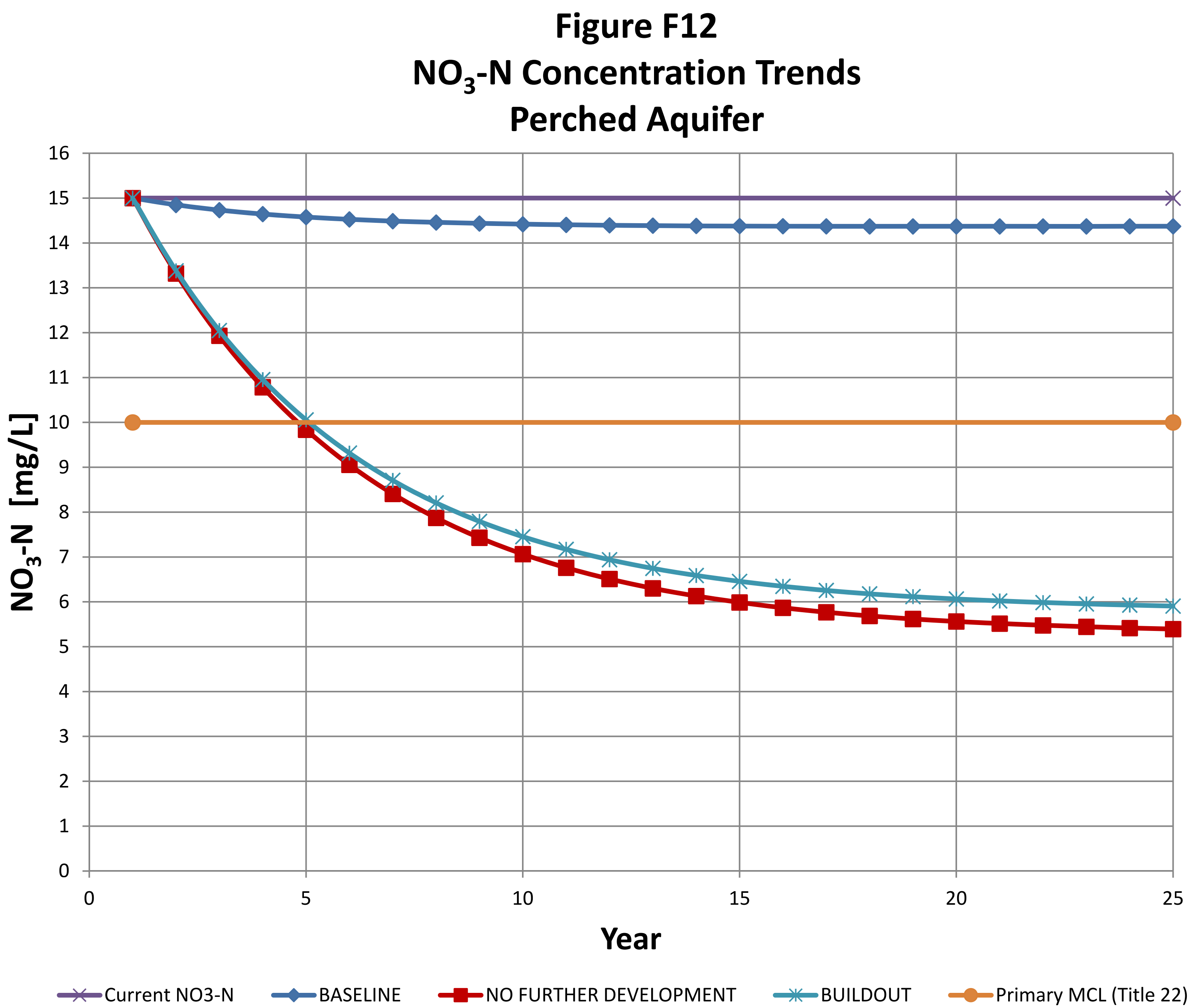


Figure F12
NO3-N Concentration Trends
Perched Aquifer
NO3-N [mg/L]
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
0
5
10
15
20
25
Year
Current NO3-N
BASELINE
NO FURTHER DEVELOPMENT
BUILDOUT
Primary MCL (Title 22)

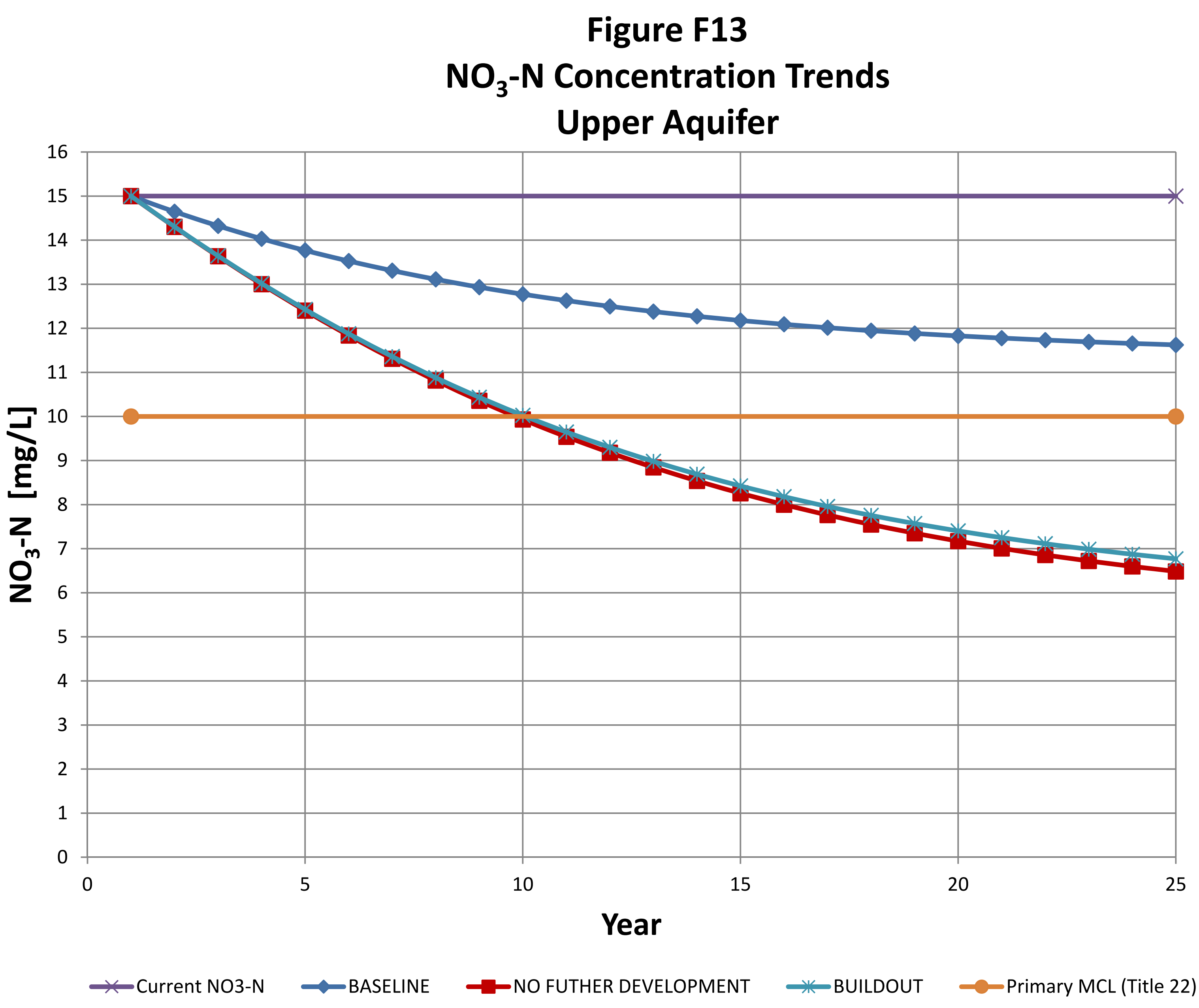


Figure F13
NO3-N Concentration Trends
Upper Aquifer
NO3-N [mg/L]
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
0
5
10
15
20
25
Year
Current NO3-N
BASELINE
NO FUTHER DEVELOPMENT
BUILDOUT
Primary MCL (Title 22)

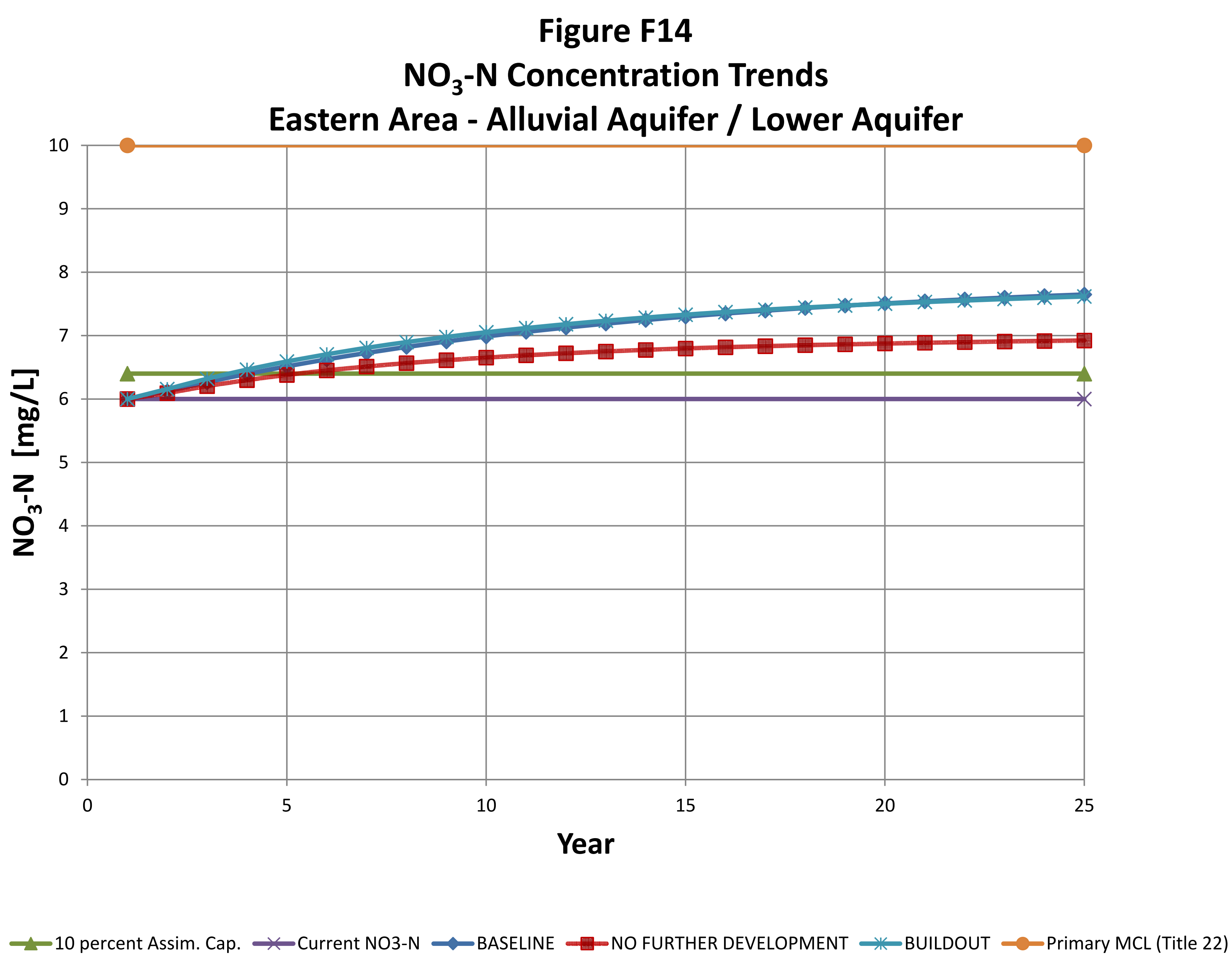
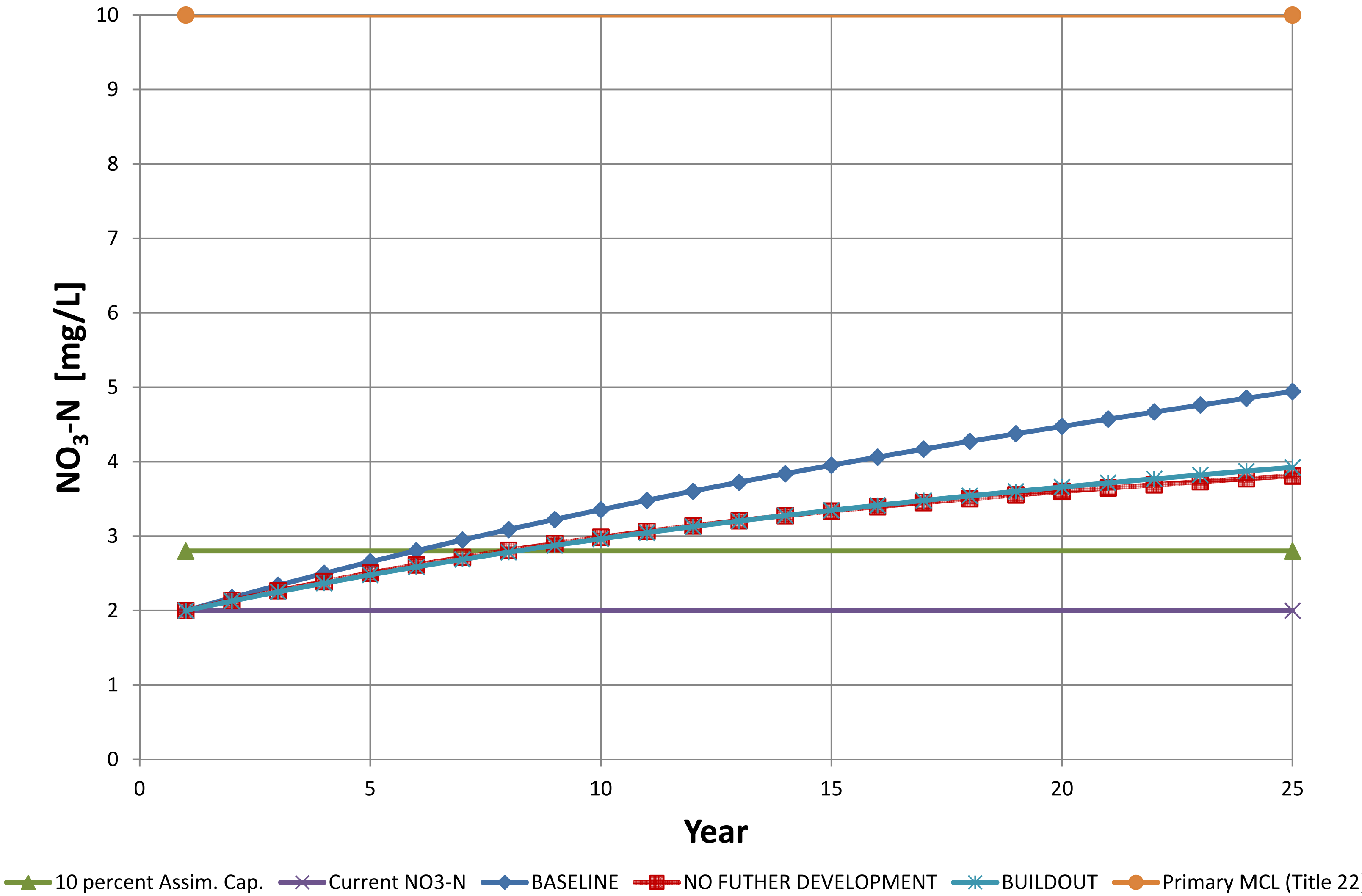


Figure F14
NO_3-N Concentration Trends
Eastern Area - Alluvial Aquifer / Lower Aquifer
NO_3-N [mg/L]
0
1
2
3
4
5
6
7
8
9
10
0
5
10
15
20
25
Year
10 percent Assim. Cap.
Current NO3-N
BASELINE
NO FURTHER DEVELOPMENT
BUILDOUT
Primary MCL (Title 22)

Figure F15
NO_3-N Concentration Trends
Western and Central Area Lower Aquifer



APPENDIX G

Quality Assurance Project Plan

Quality Assurance Project Plan

1.0 Introduction

This Quality Assurance Project Plan (QAPP) describes the County's groundwater sampling activities in the Los Osos Basin. This QAPP is intended to establish best management practices related to quality assurance and quality control for collecting and analyzing groundwater samples. The QAPP is a companion document to Field Sampling in Appendix H of the Los Osos Basin Groundwater Monitoring Program for the SNMP. As discussed in Chapter 8, the SNMP will utilize existing groundwater monitoring reports to prepare the SNMP Monitoring Report for the Central Coast Regional Water Quality Control Board (CCRWQCB) every three years. This includes the annual groundwater monitoring reports from the Los Osos BMC and the LOWRF Monitoring and Reporting Program.

A summary of quality assurance best management practices is discussed below.

2.0 Quality Objectives and Criteria for Measurement Data

Basic definitions of accuracy, precision, resolution, bias, and other indicators of data quality are provided in Exhibit A.

3.0 Special Training Needs/Certification

Proper training of field personnel represents a critical aspect of quality control. Although no certifications are required for sampling personnel, training will be provided on the job and prior to the first sampling experience. Additional training of staff will be conducted by experienced staff as needed.

Labs shall conduct training as appropriate to minimally ensure that they retain their status as a California ELAP certified laboratory. Copies of all certifications are retained at the applicable laboratory and are available upon request.

4.0 Documents and Records

The Project Manager should collect records for sample collection, including field data sheets and chain of custody forms. Each lab will generate records for sample receipt and storage, analyses, and reporting. Copies of all records held by each lab will be provided to the Project Manager and stored in a project file.

5.0 Sample Process Design

This section provides a summary description of quality control activities for this project. Definitions of QC terms can be found in Exhibit A of the QAPP.

The goal of this program is to determine if recycled water is influencing the Los Osos Groundwater Basin plan area by collecting groundwater quality samples semi-annually. Data results will be compared to Water Quality Objectives (WQO) for the Basin, which includes TDS, chloride and nitrate for the Los Osos SNMP. Other constituents will be analyzed for groundwater per the Waste Discharge/Recycled Water Requirements Order No. R3-2011- 0001(WDR Order).

SNMP Water Quality Objectives (WQO) provides a reference for assessing groundwater quality in the Los Osos Basin. Primary and secondary drinking water standards for TDS, nitrate, and chloride as established by the Code of Regulations, Title 22, Sections 64435 and 64473. The Primary Maximum Contaminant Levels (MCL) are set to be protective of human health. Secondary MCLs address aesthetic issues related to taste, odor, or appearance of the water and are not related to health effects, although elevated TDS concentrations in water can damage crops, affect plant growth, and damage municipal and industrial equipment. The U.S. Environmental Protection Agency (EPA) recommended Secondary MCL for TDS is 500 mg/L. The EPA has also set the Secondary MCL for chloride at 250 mg/L.

The CCRWQCB Division has the authority to enforce the LOWRF waste discharge requirements as defined in the WDR Order. The waste discharge requirements comply with the recycled water requirements of Code of Regulations, Title 22, Sections 64435 and 64473 for unrestricted use.

6.0 Sampling Locations and Frequencies

Sampling locations were predetermined by existing monitoring programs that will be used to prepare the Los Osos SNMP every three years, see Chapter 8 SNMP Monitoring Program. Thresholds are based on a combination of the Central Coast Basin Plan water quality objectives and in accordance with the LOWRF WDR Order, Title 22 permit.

- Sampling frequency is semi-annual (fall and spring) or annually of each year.

7.0 Sampling Methods

Groundwater samples should be pre-labeled with site name, collection date, laboratory, and required analysis. Sampler initials and sample time will be added on site at the time of collection.

Analyte and method for the LOWRF Baseline Sample is shown in Table 1. Volatile organic compounds and metals are shown with sampling methods for the LOWRF Baseline Groundwater Monitoring in Tables 2 and 3, respectively.

Table 1. Baseline LOWRF Sampling Methods

Constituent Metals	Method	Required Holding Time
Boron	200.7	6 months
Sodium	200.7	6 months
Wet Chem Solids, Total Dissolved	2540CE	7 days
Chloride	300.0	28 days
Nitrate	300.0	48 hours
Nitrite	300.0	48 hours
Sulfate	300.0	28 days
Nitrogen, Total Kjeldahl	351.2	28 days
pH	4500-H B	15 minutes
Ammonia Nitrogen	4500NH3B/ 4500NH3G	28 days

Table 2. Baseline Volatile Organic Compound LOWRF Sampling Methods[1]

Parameter/Method Name	EPA/SM Method Number	Sample Holding Time
1,1,1,2-Tetrachloroethane	EPA 524.2	14 days
1,1,1-Trichloroethane	EPA 524.2	14 days
1,1,2,2-Tetrachloroethane	EPA 524.2	14 days
1,1,2-Trichloroethane	EPA 524.2	14 days
1,1-Dichloroethane	EPA 524.2	14 days
1,1-Dichloroethene	EPA 524.2	14 days
1,1-Dichloropropene	EPA 524.2	14 days
1,2,3-Trichlorobenzene	EPA 524.2	14 days
1,2,3-Trichloropropane	EPA 524.2	14 days

[1] VOCs – Preservation conditions for drinking water:
Preservative – 25 mg Ascorbic Acid, then HCl pH<2, Cool, 4 ± 2°C;
Recommended minimum sample size – 2x40 mL;
Suggested type of container – Teflon Lined Septum.

1,2,4-Trichlorobenzene	EPA 524.2	14 days
1,2,4-Trimethylbenzene	EPA 524.2	14 days
1,2-Dichloroethane	EPA 524.2	14 days
1,2-Dichloropropane	EPA 524.2	14 days
1,3,5-Trimethylbenzene	EPA 524.2	14 days
1,3-Dichloropropane	EPA 524.2	14 days
1,3-Dichloropropene, Total	EPA 524.2	14 days
2,2-Dichloropropane	EPA 524.2	14 days
2-Butanone	EPA 524.2	14 days
2-Chloroethyl vinyl ether	EPA 524.2	14 days
2-Chlorotoluene	EPA 524.2	14 days
2-Hexanone	EPA 524.2	14 days
4-Chlorotoluene	EPA 524.2	14 days
4-Methyl-2-pentanone	EPA 524.2	14 days
Benzene	EPA 524.2	14 days
Bromobenzene	EPA 524.2	14 days
Bromochloromethane	EPA 524.2	14 days
Bromodichloromethane	EPA 524.2	14 days
Bromoform	EPA 524.2	14 days
Bromomethane	EPA 524.2	14 days
Carbon tetrachloride	EPA 524.2	14 days
Chlorobenzene	EPA 524.2	14 days
Chloroethane	EPA 524.2	14 days
Chloroform	EPA 524.2	14 days
Chloromethane	EPA 524.2	14 days
cis-1,2-Dichloroethene	EPA 524.2	14 days
cis-1,3-Dichloropropene	EPA 524.2	14 days
Dibromochloromethane	EPA 524.2	14 days
Dibromomethane	EPA 524.2	14 days
Dichlorodifluoromethane (Freon 12)	EPA 524.2	14 days
Di-isopropyl ether	EPA 524.2	14 days
Ethyl tert-butyl ether	EPA 524.2	14 days
Ethylbenzene	EPA 524.2	14 days
Freon 113	EPA 524.2	14 days
Hexachlorobutadiene	EPA 524.2	14 days
Isopropylbenzene	EPA 524.2	14 days
m,p-Xylene	EPA 524.2	14 days
m-Dichlorobenzene	EPA 524.2	14 days
Methyl tert-butyl ether (MTBE)	EPA 524.2	14 days
Methylene chloride	EPA 524.2	14 days
Naphthalene	EPA 524.2	14 days
n-Butylbenzene	EPA 524.2	14 days
n-Propylbenzene	EPA 524.2	14 days
o-Dichlorobenzene	EPA 524.2	14 days
o-Xylene	EPA 524.2	14 days
p-Dichlorobenzene	EPA 524.2	14 days
p-Isopropyltoluene	EPA 524.2	14 days
sec-Butylbenzene	EPA 524.2	14 days

Styrene	EPA 524.2	14 days
Tert-amyl methyl ether	EPA 524.2	14 days
tert-Butylbenzene	EPA 524.2	14 days
Tetrachloroethene	EPA 524.2	14 days
THMs, Total	EPA 524.2	14 days
Toluene	EPA 524.2	14 days
trans-1,2-Dichloroethene	EPA 524.2	14 days
trans-1,3-Dichloropropene	EPA 524.2	14 days
Trichloroethene	EPA 524.2	14 days
Trichlorofluoromethane	EPA 524.2	14 days
Vinyl chloride	EPA 524.2	14 days
Xylenes, Total	EPA 524.2	14 days

Table 3. Baseline Metals LOWRF Sampling Methods [2]

Parameter/Method Name	EPA/SM Method Number	Sample Holding Time
Aluminum	EPA200.8	6 months
Antimony	EPA200.8	6 months
Arsenic	EPA200.8	6 months
Barium	EPA200.8	6 months
Beryllium	EPA200.8	6 months
Cadmium	EPA200.8	6 months
Chromium	EPA200.8	6 months
Lead	EPA200.8	6 months
Nickel	EPA200.8	6 months
Selenium	EPA200.8	6 months
Thallium	EPA200.8	6 months

7.1 Field Methods

Additionally, field blanks should be included to check cross-contamination during sample collection, sample shipment and in the laboratory, as well as to check sample containers. The field blank will be submitted blind to the lab, if performed.

Clean sampling techniques will be utilized in sample collection to minimize contamination. Staff will wear clean, powder-free nitrile gloves when handling samples. The only environmental media from which samples will be collected is water. It is the responsibility of the sampling personnel to determine if the performance requirements of the specific sampling method have been met, and to collect an additional sample if required.

Sample personnel should carry a copy of the QAPP and any relevant standard operating procedures (SOPs) with them in the field for reference during sampling. Descriptions of specific sampling methods and requirements are provided below.

[2] Metals – Preservation conditions for drinking water:
Preservative – 0.5 mL HNO_3, pH<2;
Recommended minimum sample size – 1 L;
Suggested type of container – Plastic.

7.2 Field Safety Procedures

Field personnel have the authority to ensure their safety. Reviewing environmental conditions for safety will always be a priority before accessing a sampling site or conducting flow measurements. Personnel can refuse to proceed if they belief safety hazards are present.

7.3 Grab Samples Procedures

All water quality samples will be collected using techniques that minimize sample contamination. Prior to grab sample collection, bottles will be labeled with the site identification, date, and time of sample. Site identification, sampling time, field/lab replicates, and other field observation comments will be recorded on the field data sheet. Site numbers, date, and time sampled will be transcribed for each sample to the Chain of Custody form prior to submitting samples to the laboratory.

7.4 Sample Custody and Documentation

Water samples will be placed on ice in a cooler immediately after collection. Samples will be delivered to an ELAP-certified laboratory with a Chain-of-Custody form.

The Chain-of-Custody and associated sample bottle labels are used to document sample identification, specify the analyses to be performed, and trace possession and handling of a sample from the time of collection through delivery to the analytical laboratory. The sampler should fill out the sample identification labels and affix them to the sample bottles prior to, or upon, sample collection. A Chain-of-Custody form should be filled out by the sampler. A signature and date/time of sample transfers are required for each relinquishing and receiving party between sample collection and laboratory delivery.

Samples will be analyzed by the laboratory within sample collection timeframe. Custody forms will be placed in a plastic zip lock bag and taped to the inside of the ice chest lid. The receiving laboratory will have sample custodian(s) who examines the samples for correct documentation, proper preservation and holding times. All samples remaining after successful completion of analysis will be disposed of properly. It is the responsibility of the personnel of each analytical laboratory to ensure that all applicable regulations are followed in the disposal of samples or related chemicals. Chain-of-Custody procedures require that possession of samples be traceable from the time the samples are collected until completion and submittal of analytical results. A complete Chain-of-Custody form is to accompany the transfer of samples to the analyzing laboratory.

7.5 Field Log

Field crews shall be required to keep a field log of each sampling event, see example in Exhibit C. The following items should be recorded in the field log for each sampling event:

- Project Name
- Date
- Site Name
- Name of Lead Sampler
- Analyte
- Time of sample collection;
- Sample ID numbers, including unique IDs for replicate or blank samples;
- Depth to water, well depth, water column, casing diameter, casing volume, pump rate, pumping water level, pump setting and time of purge.
- Populated sampling parameters for purging (Time, gallons, EC, pH and Temperature) and comments
    - Qualitative descriptions of relevant water conditions (e.g., color, flow, level, clarity) or weather (e.g., wind, rain) at time of sample collection.

- A description of any unusual occurrences associated with the sampling event, particularly those that affect sample or data quality

A groundwater monitoring field log will be filled out at each well record.

The project lead will provide training for anyone who is assisting with field work. This will include discussion of quality assurance and contamination prevention. Upon completion of sampling at each site, the notes will be reviewed by the project lead to ensure all activities were performed and records are legible.

The crews shall have custody of samples during field sampling. Chain-of-Custody forms will accompany all samples during shipment to contract laboratories. All water quality samples will be transported to the analytical laboratory by field crew.

7.6 Laboratory Custody Log

Laboratories shall maintain custody logs sufficient to track each sample submitted to verify that samples are preserved, extracted and analyzed within specified holding times.

8.0 QC Sample Collection

Variability that comes from field sampling and from laboratory analyses should be assessed by collecting replicate samples and by performing replicate analyses, as determine by the Project Manager.

8.1 Decontamination Procedures

All field and sampling equipment that may contact samples must be decontaminated after each use in a designated area. The minimal decontamination procedures generally require washing with a detergent followed by rinsing with de-ionized water. All waste materials must be collected during the sampling effort and properly disposed of upon return to the laboratory.

8.2 Field Documentation

All field activities must be adequately and consistently documented to support data interpretation and ensure defensibility of any data used for decision-making. Specific data sheets (Exhibit B) for the Chain-of-Custody form will be required to be completed by the field crew for each field monitoring sampling event. Field personnel must record the following information:

- Name(s) of field personnel;
- Site/sampling location identification, including site tag;
- Data and time of sample collection;
- Observation of weather and conditions that can influence sample results;
- Any problems encountered during sampling;
- Sample ID for each sample;
- Sample Custody and Documentation.

Sample possession during all sampling efforts must be traceable from the time of collection until results are reported and verified by the laboratory and samples are disposed. Sample custody procedures provide a mechanism for documenting information related to sample collection and handling.

The field sampling team must document when samples cannot be collected and why. Any deviation from a sampling protocol must be documented on the field log book.

9.0 Sample Handling and Custody

Procedures, forms, and custody are discussed in the following sections.

9.1 Documentation Procedures

The Lab Program Coordinator or Project Manager is responsible for ensuring that field sampling personnel adhere to proper custody and documentation procedures. Field data sheets are completed for all samples collected during each sampling activity. Field personnel have the following responsibilities:

- Keep an accurate written record of sample collection activities on field forms;
- Ensure that all entries are legible, written in waterproof ink and contain accurate and inclusive documentation of the field activities;
- Date and initial daily entries;
- Note errors or changes using a single line to cross out the entry and date and initial the changes;
- Complete the Chain-of-Custody forms accurately and legibly;
- Label is affixed to each sample collected. Sample labels uniquely identify samples with an identification number, date and time of sample collection and the initials of the sampling crew.

9.2 Chain-of-Custody Form

A Chain-of-Custody form is completed after sample collection, and prior to sample shipment or release. The Chain-of-Custody form, sample labels, and field documentation are cross-checked to verify sample identification, type of analysis, and number of containers, sample volume, preservatives and type of containers.

Information to be included in the Chain-of-Custody forms includes:

- Sample identification;
- Date and time of collection;
- Sample(s) names;
- Analytical method(s) requested;
- Sample matrix;
- Signature blocks for release and acceptance of samples;
- Any comments to identify special conditions or requests.

Sample transfer between field staff and laboratory is documented by signing and dating “relinquished by” and “received by” blocks whenever sample possession changes. An example Chain-of-Custody form is provided in Exhibit B.

10.0 Sample Shipments and Handling

All sample shipments are accompanied by the Chain-of-Custody form, which identifies the content. The original form accompanies the shipment and a copy is retained in the project file. All shipping containers are secured with the Chain-of-Custody seals for transportation to the laboratory. If ice is packed with the samples, the ice must contact each sample and be approximately 2 inches deep at the top and bottom of the cooler. The ice may be contained in re-closable bags, but must contact the samples to maintain temperature. The method(s) of shipments, courier name, and other pertinent information is entered in the “Received By” or “Remark” section of the Chain-of-Custody form.

The following procedures are used to prevent bottle breakage and cross-contamination:

- Prior to packaging, outside of the bottles need to be rinsed off with DI water;
- Bubble wrap or foam pouches are used to keep glass bottles from contacting one another to prevent breakage;
- All samples are transported inside hard plastic coolers or other contamination free shipping containers;
- The coolers are taped shut and sealed with Chain-of-Custody seals to prevent accidental opening;
- If pre-arrangements are not made, prior to shipment of the samples field staff must notify laboratory sample control.

11.0 Laboratory Custody Procedures

The following sample control activities must be conducted in the laboratory:

- Initial log-in and verification of samples received with the Chain-of-Custody form;
- Document any discrepancies noted during log-in on the Chain-of-Custody;
- Verify sample preservation such as temperature;
- Notify the project coordinator if any problems or discrepancies are identified;
- Ensure proper sample storage, including daily refrigerator temperature monitoring and sample security;
- Distribute samples or notify the laboratory of sample arrival; and
- Return shipment cooler

12.0 Quality Control

The Project Manager is responsible for reviewing field data for QC compliance, whereas each laboratory QA Officer is responsible for maintaining compliance with the QC requirements described in the following sections. As required by their ELAP, each laboratory QA Officer is responsible for generating corrective actions for violations of QC protocols. The laboratory QA Officers must also notify the Project Manager of deviations from QC protocols that are related to samples collected for this assessment.

Field Procedures

Quality control samples to be prepared in the field will consist of field blanks, field duplicates, temperature blanks, and trip blanks (if sampling for VOCs). Field procedures will be dependent on the chemical analyte being sampled.

Field Blanks and Duplicates

The purpose of analyzing field blanks is to demonstrate that sampling procedures do not result in contamination of the environmental samples. The purpose of analyzing field duplicates is to check reproducibility of laboratory and field procedures.

Laboratory Analysis

For basic water quality analysis, quality control samples prepared in the contract laboratory(s) will typically consist of equipment blanks, method blanks, certified reference materials, laboratory duplicates, matrix spikes, and matrix duplicates.

13.0 Instrument/Equipment Testing, Inspection, and Maintenance Laboratory Equipment Procedures

Laboratory equipment will be inspected, tested, and maintained by the contract laboratories according to the procedures documented in their Quality Assurance Manuals. The laboratory QA manuals are available for review at each laboratory.

14.0 Instrumentation/equipment calibration and frequency Laboratory Analytical Equipment

Frequency of calibration and procedures for calibration of analytical equipment used by each contract laboratory is documented in the Quality Assurance Manual for each contract laboratory. Laboratory QA Manuals are made available for review at the analyzing laboratory. Any deficiencies in equipment calibration performance should be managed in accordance with the individual laboratories QA Plan. Any equipment calibration issues that affect the quality of the data generated for samples collected under this QAPP must be reported to the Program QA Officer.

15.0 Inspection/Acceptance of Supplies and Consumables

The procurement of supplies, equipment, and services must be controlled to ensure that specifications are met for the high quality and reliability required for each field and laboratory function. It is the responsibility of each staff person doing the ordering to inspect the equipment and materials for quality and to ensure that sample bottles have no defects and have been prepared properly. All supplies are to be stored appropriately and discarded upon expiration.

15.1 Field Supplies

Gloves, sample containers, and other consumable equipment will be inspected upon purchase/delivery by laboratory staff and sampling technician. Coolers and ice quantities will be checked prior to each event to determine adequate supply. Any signs of damage, breakage, or contamination will result in the responsible party being notified and the item being sent back or disposed of, as applicable and a replacement item will be obtained.

15.2 Lab Supplies

All equipment and material specifications used by contract laboratories are outlined in the laboratories' operating procedures and policies. Equipment and materials are purchased independently by each contract laboratory.

16.0 Data Management

Field data will be recorded into site-specific field notebooks and transferred into an electronic event summary which will be stored on the County network drive. Information from the sampling summaries will be compiled in the annual report, which will be stored on the County network drive and ultimately compiled in a report at least every three years to the Water Board.

17.0 Assessment & Response Actions

Field sampling crews will assess the performance of sampling procedures and equipment before, during, and after each sampling event and will perform corrective actions as necessary. Field staff members are subject to ongoing peer review and any corrective action deemed necessary will be undertaken by the Project Manager.

Assessments for compliance with quality control procedures will be undertaken for each sampling event during the data collection phase of this project:

- The field sampling crew will conduct a performance assessment of the sampling procedure the following day. Corrective actions shall be carried out by field sampling crew, recorded on field logs, and reported to the Project Manager.
- The Project Manager will review the field logs, associated Chain of Custody forms and laboratory reports within 14 days to require corrective actions if necessary.

Any non-conformance with the QAPP will be corrected and documented.

The chemistry laboratory will participate in proficiency testing at least two times per year to meet the requirements of their ELAP certification. The laboratory's QA Officer is responsible for ensuring compliance with the proficiency testing requirements and for reporting any necessary corrective action to the laboratory manager. Any issues will be resolved by laboratory staff and any affected results will be flagged by the laboratory for County staff review. County staff members have the authority to issue a stop-work order if it is determined that the quality of the data is impaired.

Table 4. Corrective Action

Laboratory Quality Control	Corrective Action
Sterility Checks	Identify contamination source and take appropriate action; discard membrane filter/pad or prepared media lot; discard sample results if checks made during analysis
Laboratory Duplicate	Verify results; qualify data as appropriate
Laboratory Blank	Identify contamination source and take appropriate action; qualify data as needed
Field Quality Control	**Corrective Action**
Field Blank, Equipment Blank	Examine field log; identify potential contamination source; qualify data as needed

Prior to the submittal of the final report, an audit should be performed to assess the handling of all data and to correct any errors found in the project database. A data quality assessment should also be performed in which statistical tools will be used to determine whether the data met all of the assumptions that the data quality objectives and data collection design were developed under, and whether the total error in the data is tolerable.

18.0 Data review, verification, and validation requirements

Data verification involves examining the data for errors, omissions, and compliance with quality control (QC) acceptance criteria. Once measurement results have been recorded, they are verified to ensure that:

- Data are consistent, correct, and complete, with no errors or omissions.
- Results for QC samples accompany the sample results.
- Established criteria for QC results were met.
- Data qualifiers are properly assigned where necessary.
- Data specified in Sampling Process Design were obtained.
- Methods and protocols specified in the QA Project Plan were followed.

The Project Manager is responsible for verifying that field data entries are complete and correct (e.g., decimal point missing from an entry or something doesn’t look right, based on experience).

18.1 Laboratory Data Review, Validation, and Verification

Analytical data generated by each laboratory will be reviewed, verified, and validated according to the procedures stated in the laboratory’s QA manual. The laboratory QA manual contains a detailed explanation of the laboratory’s QA procedures. Data for the Project will be reviewed by laboratory staff prior to being sent to the Project Manager. The Project Manager should also review laboratory data and communicate with lab any concerns in a timely fashion.

18.2 Field Data Review, Validation, and Verification

After each sampling event, the Project Manager will review the field notes and field data generated to assess adherence to the project sampling design in terms of the spatial distribution the sampling locations. Departures from the sampling design will be considered in the design of each subsequent phase of sampling. Deviations from the sampling design may change the data needed to characterize the system. Departures from the sampling design may also be due to unforeseen field conditions, which may require adjustment of the sampling design.

Significant departures from the project sampling design and responses to those departures will be noted in the project database, as well as the in the final report.

In the data quality assessment, the Project Manager will consider the effects of any departures from the sampling design on the overall completeness of the data generated, and thus the usability of the data set for drawing conclusions.

18.4 Data Usability

Data usability determination will follow verification. This determination is parameter-specific and involves a detailed examination of the data package. Professional judgment will be used to determine whether data quality objectives have been met. The project lead will examine the complete data package in detail to determine whether the procedures in the methods and procedures specified in this QAPP were followed. The usability determination will entail evaluation of field and laboratory results and relative standard deviation between field replicates. Adherence to established sampling standards should eliminate most sources of bias. Laboratory duplicates help estimate laboratory precision. Field replicates should indicate overall variability (environmental + sampling + laboratory).

Laboratory values below the detection limit will be assumed to be the detection limit for analysis purposes. Data from field replicates will be arithmetically averaged for data analysis.

19.0 Verification and Validation methods

Data will be verified at all stages of the collection process including sample collection, receipt, preparation, analysis, and report generation. Data will be checked for multiple factors including adherence to the SOPs, transcription errors, dilution factors, conversion factors, and units of measurement. SOPs are available at the laboratories for all laboratory analytical procedures. County field staff members are responsible for reviewing and verifying the data that they generate. Additional verification will be performed by different staff members as the data is transcribed, entered into the database, and reported. Any discrepancies that are found will be brought to the attention of the responsible staff member, who will correct the error if possible, and write an explanation for the discrepancy if it cannot be rectified.

Chemistry laboratory data validation includes internal equipment checks (where applicable) and an in-house sequential review process (of at least three tiers) which includes a 100% review by the analyst, followed by a review by a technically qualified person such as a supervisor or another chemist, and an overall administrative review of the complete data package by the Project Manager. If a discrepancy is noted in any stage of the reviewing process, the package is returned to the primary analyst for corrective action. Any data that does not meet data quality objectives will be flagged with an explanation in the report.

20.0 Reconciliation with user requirements

This Project is designed to gather information about the quality of groundwater in Los Osos Basin. Data that meets the QA requirements will be considered to meet the user’s requirements.

The Project Manager will be responsible for validation and final approval of all data for use in this study. The final project report will contain a discussion of relevant information obtained through the audit about the quality, validity, completeness and limitations of the data obtained in this study. The final project report will also contain a discussion of the results of statistical analyses performed on the data set in the data quality assessment, and a final conclusion as to the adequacy of the data set for making a final determination of the impacts of recycled water use in the study area.

Data objectives for this project do not require a full, formal, and independent data validation. Although the data is considered legally defensible as presented herein, all records will be available for independent evaluation should the need arise at a later date.

EXHIBIT A
Basic Definitions of Measurement Quality Objectives

This exhibit also includes several other common terminologies associated with quality assurance.

Analyte is a generic term for the chemical being analyzed by the laboratory. It is sometimes used interchangeably with "parameter", but also implies involvement of an analytical process (rather than a field measurement).

Accuracy is determined for field measures by field equipment calibration before and after sample measurement using appropriate standards. Instrument drift that exceeds objectives should be flagged as "estimated". For laboratory measures, accuracy is determined by lab matrix spikes, certified reference material, and laboratory control samples. Data should be flagged as appropriate when RPD exceeds objectives. Use the following formula to calculate RPD between the two samples:

RPD = ([A - B] /B) x 100%

Where:
RPD = the relative percent difference
A = the instrument measurement after sampling
B= the instrument measurement before sampling

Precision measurements are typically determined by the resolution of the instrument, and by evaluation of field and laboratory duplicates (or splits). Field duplicates account for both precision of sampling techniques, laboratory analysis, as well as environmental variability. Field splits consist of two aliquots from the same composite sample, and field duplicates will consist of two grab samples collected in rapid succession. Laboratory duplicates are used to evaluate precision of the laboratory process. RPD is expressed as:

RPD = ([D - P]/P) x 100%

Where:
RPD = the relative percent difference
D = the measured value in the duplicate sample
P= the measured value of the primary sample

Recovery measurements will be determined by laboratory spiking of a replicate sample with a known concentration of the analyte (the parameter being analyzed). The target level of addition should be at least twice the original sample concentration.

Completeness is the number of analyses generating useable data for each analysis divided by the number of samples collected for that analysis. So for example, if one bottle was broken in transit, and 10 samples were collected in total, the completeness is 9/10 X 100 = 90%.

Sensitivity is addressed by utilizing SWAMP Target RLs, where such values exist. No target RLs are set for field analyses. For these, method sensitivity is dependent upon the field instruments used.

Bias is the systematic or persistent distortion of a measurement process that causes errors in one direction.

Resolution is the smallest amount of change that an instrument can detect reliably.

Reporting Limit is used interchangeably here with **Practical Quantitation Limit** and is used to mean the lowest quantifiable value of the instrument or method.

Laboratory Control Samples
The purpose of laboratory control samples is to demonstrate accuracy and precision of the analytical methods. Laboratory control samples are typically analyzed at the rate of one per sample batch. Recovery is a measure of the accuracy of an analytical test through the addition of a known quantity of an analyte to a sample. Recovery is calculated as follows:

Recovery = (Measured Concentration/ Spiked Concentration) X 100

If recovery of any analyte is outside the acceptable range for accuracy (e.g. 80% to 120% recovery), the analytical process is not being performed adequately for that analyte. In this case, the sample batch should be prepared again, and the laboratory control sample should be reanalyzed.

Laboratory Duplicates
The purpose of analyzing laboratory duplicates is to demonstrate the precision of the analytical method. Laboratory duplicates are typically analyzed at the rate of one pair per sample batch, or one in 20 samples. If the RPD for any analyte is greater than the precision criterion (e.g. 25% for conventional constituents) *and* the absolute difference between duplicates is greater than the RL, the analytical process is not being performed adequately for that analyte. Should this occur, the batch should be prepared again, and laboratory duplicates should be reanalyzed. If reanalysis doesn't improve performance, data needs to be flagged with an "IL" flag, as described in Section 23.

Matrix Spikes and Matrix Spike Duplicates
The purpose of analyzing matrix spikes and matrix spike duplicates is to demonstrate accuracy (matrix spike) and precision (matrix spike duplicate) of the analytical method in a particular sample matrix. Matrix spikes and matrix spike duplicates are to be analyzed by the laboratory at the rate of one pair per sample batch, or one in 20 samples, whichever is more frequent. Each matrix spike and matrix spike duplicate will consist of an aliquot of laboratory-fortified environmental sample. Spiked analytes should be added to achieve concentrations between 2 and 10 times the expected sample value. Recovery is the accuracy of an analytical test measured against a known analyte addition to a sample.

If matrix spike recovery of any analyte is outside the acceptable range (e.g. 80% to 120% recovery), the results for that analyte will be determined not to meet the acceptance criteria. If recovery of laboratory control samples (i.e. those using blank water rather than sample matrix) is acceptable, the analytical process is being performed adequately for that analyte, and the problem is attributable to the sample matrix. An attempt should be made to correct the problem (by dilution, concentration, etc.), followed by re-analysis of the samples and the matrix spikes. If the matrix problem can't be corrected, the results should be flagged a "GB" flag, which means the matrix spike recovery is not within control limits.

If matrix spike duplicate RPD for any analyte is greater than the precision criterion (25%), the results for that analyte will be determined not to meet the acceptance criteria. If the RPD for laboratory duplicates (i.e. those using blank water rather than sample matrix) is acceptable, the analytical process is being performed adequately for that analyte, and the problem is attributable to the sample matrix. An attempt should be to correct the problem (by dilution, concentration, etc.), followed by re-analysis of the samples and the matrix spike duplicates. If the matrix problem can't be corrected, the results for that analyte should be flagged with a "IL" flag, which means the RPD exceeds the laboratory control limit.

EXHIBIT B
Example of a Chain-of-Custody Form

San Luis Obispo County Public Works and Transportation Department - Water Quality Laboratory

Sampling and Analysis Request - Chain of Custody Sheet

Sampling/Analysis Requester Completes Light Boxed Entries

Lab Phone #: (805) 781-5111

Sampler Completes Bold Boxed Entries

Analysis Number:

Order ID:

Project ID:

Sample Scheduled for Collection on

Month: **Week:** **Day:**

Date and Time Sample Collected:

Agency/Project:

Sample Site:

Site Alias Name:

Sample Collected by:

Sample Type:

Sampling Pcode:

Assigned Sampler:

Containers:

Reason:

Assigned Lab:

Analysis Pcode:

Additional Sample Site Information and Instructions

Field Log Required?

Field Analyses/Measurements and Results:

Desired Analyses:

Check here and comment below if SOP NOT followed or attention needed.

Send Reports to:

SHD: EDT:

L-SHD: L-CHD:

CHD: RWQCB:

Other 1:

Other 2:

Field measurements entered into computer by:

Comments:

Relinquished by:	Relinquished by:
Date and Time:	Date and Time:
Received by:	Received by:
Date and Time:	Date and Time:

EXHIBIT C
Example of a Groundwater Monitoring Field Log

Groundwater Monitoring Field Log
Los Osos Baseline

Date:	8/15/2012
Operator:	SH
Well number and location:	30S/10E-13G South Court
Site and wellhead conditions:	Coastal fog, cool.
	Vault damaged (needs replacement), casing locked, plug intact.

Static water depth (feet):	40.25
Well depth (feet):	52
Water column (feet):	11.75
Casing diameter (inches):	2
Borehole vol. W/pack (gal):	13
Purge rate (gpm):	1.7
Pumping water level (feet):	41.5
Pump setting (feet):	48
Minimum purge time (min):	8
Time begin purge:	11:13

Time	Gallons	EC	pH	Temp.	Comments*
11:17	5	475	6.57	17.7	Slightly turbid, light brown, odorless
11:20	10	455	6.48	17.7	Clear, colorless, odorless
11:24	15	452	6.39	17.8	Clear, colorless, odorless
11:28	20	452	6.38	17.9	Clear, colorless, odorless
11:32	25	452	6.37	17.8	Clear, colorless, odorless
11:36	30	452	6.37	17.9	Clear, colorless, odorless

*Turbidity, color, odor, sheen, debris, etc.

APPENDIX H

Field Methods
(CHG & Wallace Group, 2016)

Groundwater Level Measurement Procedures for the
Los Osos Basin Plan Groundwater Monitoring Program

Introduction

This document establishes procedures for measuring and recording groundwater levels for the Los Osos Basin Plan (LOBP) Groundwater Monitoring Program, and describes various methods used for collecting meaningful groundwater data.

Static groundwater levels obtained for the LOBP Groundwater Monitoring Program are determined by measuring the distance to water in a non-pumping well from a reference point that has been referenced to sea level. Subtracting the distance to water from the elevation of the reference point determines groundwater surface elevations above or below sea level. This is represented by the following equation:

$$E_{GW} = E_{RP} - D$$

Where:

E_{GW} = Elevation of groundwater above mean sea level (feet)
E_{RP} = Elevation above sea level at reference point (feet)
D = Depth to water (feet)

References

Procedures for obtaining and reporting water level data for the LOBP Groundwater Monitoring Program are based on a review of the following documents.

- State of California, Department of Water Resources, 2010, *Groundwater Elevation Monitoring Guidelines*, prepared for use in the California Statewide Groundwater Elevation Monitoring (CASGEM) program, December. http://www.water.ca.gov/groundwater/casgem/pdfs/CASGEM%20DWR%20GW%20Guidelines%20Final%20121510.pdf
- State of California, Department of Water Resources, 2014, *Addendum to December 2010 Groundwater Elevation Monitoring Guidelines for the Department of Water Resources' California Statewide Groundwater Elevation Monitoring (CASGEM) Program,* October 2. www.water.ca.gov/groundwater/casgem/pdfs/PSW_addendum.pdf
- U.S. Geological Survey, 1977, *National Handbook of Recommended Methods for Water-Data Acquisition*, a Unites States contribution to the International Hydrological Program. https://pubs.usgs.gov/chapter11/

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- U.S. Geological Survey, Office of Ground Water, 1997, *Ground Water Procedure Document 4, Water-level measurement using an electric tape, draft stand-alone procedure document.* http://pubs.usgs.gov/tm/1a1/pdf/GWPD4.pdf
- U.S. Geological Survey, Office of Ground Water, 1997, *Ground Water Procedure Document 13, Water-level measurement using an air line, draft stand-alone procedure document.* http://pubs.usgs.gov/tm/1a1/pdf/GWPD13.pdf
- U.S. Geological Survey, 2001, *Introduction to Field Methods for Hydrologic and Environmental Studies*, Open-File Report 2001-50, 241 p. https://pubs.er.usgs.gov/publication/ofr0150

Well Information

Table 1 below lists important well information to be maintained in a well file or in a field notebook. Additional information that should be available to the person collecting water level data include a description of access to the property and the well, the presence and depth of cascading water, or downhole obstructions that could interfere with a sounding cable.

Table 1
Well File Information

Well Completion Report	Hydrologic Information	Additional Information to be Recorded
Well name	Map showing basin boundaries and wells	Township, Range, and ¼ ¼ Section
Well Owner	Name of groundwater basin	Latitude and Longitude (Decimal degrees)
Drilling Company	Description of aquifer	Assessor's Parcel Number
Location map or sketch	Confined, unconfined, or mixed aquifers	Description of well head and sounding access
Total depth	Pumping test data	Reference point elevations
Perforation interval	Hydrographs	Well use and pumping schedule if known
Casing diameter	Water quality data	Date monitoring began
Date of well completion	Property access instructions/codes	Land use

Reference Points and Reference Marks

Reference point (RP) elevations are the basis for determining groundwater elevations relative to sea level. The RP is generally that point on the well head that is the most convenient place to measure the water level in a well. In selecting an RP, an additional consideration is the ease of surveying either by Global Positioning System (GPS) or by leveling.

The RP must be clearly defined, well marked, and easily located. A description, sketch, and photograph of the point should be included in the well file. Additional Reference Marks (RMs) may be established near the wellhead on a permanent object. These additional RMs can serve as a benchmark by which the wellhead RP can be checked or re-surveyed if necessary. All RMs should be marked, sketched, photographed, and described in the well file.

All RPs for Groundwater Monitoring Program wells should be reported based on the same horizontal and vertical datum by a California licensed surveyor to the nearest tenth of one foot vertically, and the nearest one foot horizontally. The surveyor's report should be maintained in the project file.

In addition to the RP survey, the elevation of the ground surface adjacent to the well should also be measured and recorded in the well file. Because the ground surface adjacent to a well is rarely uniform, the average surface level should be estimated. This average ground surface elevation is referred to in the U.S.G.S. Procedural Document (GWPD-1, 1997) and DWR guidelines as the Land Surface Datum (LSD).

Water Level Data Collection

Prior to beginning the field work, the field technician should review each well file to determine which well owners require notification of the upcoming site visit, or which well pumps need to be turned off to allow for sufficient water level recovery. Because groundwater elevations are used to construct groundwater contour maps and to determine hydraulic gradients, the field technician should coordinate water level measurements to be collected within as short a period of time as practical. Any significant changes in groundwater conditions during monitoring events should be noted in the Annual Monitoring Report. For an individual well, the same measuring method and the same equipment should be used during each sampling event where practical.

A static water level should represent stable, non-pumping conditions at the well. When there is doubt about whether water levels in a well are continuing to recover following a pumping cycle, repeated measurements should be made. If an electric sounder is being used, it is possible to hold the sounder level at one point slightly above the known water level and wait for a signal that would indicate rising water. If applicable, the general schedule of pump operation should be determined and noted for active wells. If the well is capped but not vented, remove the cap and wait several minutes before measurement to allow water levels to equilibrate to atmospheric pressure.

When lowering a graduated steel tape (chalked tape) or electric tape in a well without a sounding tube in an equipped well, the tape should be played out slowly by hand to minimize the chance of the tape end becoming caught in a downhole obstruction. The tape should be held in such a way that any change in tension will be felt. When withdrawing a sounding tape, it should also be brought up slowly so that if an obstruction is encountered, tension can be relaxed so that the tape can be lowered again before attempting to withdraw it around the obstruction.

Despite all precautions, there is a small risk of measuring tapes becoming stuck in equipped wells without dedicated sounding tubes. If a tape becomes stuck, the equipment should be left on-site and re-checked after the well has gone through a few cycles of pumping, which can free the tape due to movement/vibration of the pump column. If the tape remains stuck, a pumping contractor will be needed to retrieve the equipment. A dedicated sounding tube may be installed by the pumping contractor at that time.

All water level measurements should be made to an accuracy of 0.01 feet. The field technician should make at least two measurements. If measurements of static levels do not agree to within 0.02 feet of each other, the technician should continue measurements until the reason for the disparity is determined, or the measurements are within 0.02 feet.

Record Keeping in the Field

The information recorded in the field is typically the only available reference for the conditions at the time of the monitoring event. During each monitoring event it is important to record any conditions at a well site and its vicinity that may affect groundwater levels, or the field technician's ability to obtain groundwater levels. Table 2 lists important information to record, however, additional information should be included when appropriate.

Table 2
Information Recorded at Each Well Site

Well name	Changes in land use	Presence of pump lubricating oil in well
Name and organization of field technician	Changes in RP	Cascading water
Date & time	Nearby wells in use	Equipment problems
Measurement method used	Weather conditions	Physical changes in wellhead
Sounder used	Recent pumping info	Comments
Reference Point Description	Measurement correction(s)	Well status

Measurement Techniques

Four standard methods of obtaining water levels are discussed below. The chosen method depends on site and downhole conditions, and the equipment limitations. In all monitoring situations, the procedures and equipment used should be documented in the field notes and in final reporting. Additional detail on methods of water level measurement is included in the reference documents.

<u>Graduated Steel Tape</u>
This method uses a graduated steel tape with a brass or stainless steel weight attached to its end. The tape is graduated in feet. The approximate depth to water should be known prior to measurement.

- Estimate the anticipated static water level in the well from field conditions and historical information;
- Chalk the lower few feet of the tape by applying blue carpenter's chalk.
- Lower the tape to just below the estimated depth to water so that a few feet of the chalked portion of the tape is submerged. Be careful not to lower the tape beyond its chalked length.
- Hold the tape at the RP and record the tape position (this is the "hold" position and should be at an even foot);
- Withdraw the tape rapidly to the surface;
- Record the length of the wetted chalk mark on the graduated tape;
- Subtract the wetted chalk number from the "hold" position number and record this number in the "Depth to Water below RP" column;
- Perform a check by repeating the measurement using a different RP hold value;
- All data should be recorded to the nearest 0.01 foot;
- Disinfect the tape by wiping down the submerged portion of the tape with single-use, unscented disinfectant wipe, or let stand for one minute in a dilute chlorine bleach solution and dry with clean cloth.

The graduated steel tape is generally considered to be the most accurate method for measuring static water levels. Measuring water levels in wells with cascading water or with condensing water on the well casing causes potential errors, or can be impossible with a steel tape.

<u>Electric Tape</u>
An electric tape operates on the principle that an electric circuit is completed when two electrodes are submerged in water. Most electric tapes are mounted on a hand-cranked reel equipped with batteries and an ammeter, buzzer or light to indicate when the circuit is completed. Tapes are graduated in either one-foot intervals or in hundredths of feet depending on the manufacturer. Like graduated steel tapes, electric tapes are affixed with brass or stainless steel weights.

- Check the circuitry of the tape before lowering the probe into the well by dipping the probe into water and observe if the ammeter needle or buzzer/light signals that the circuit is completed;
- Lower the probe slowly and carefully into the well until the signal indicates that the water surface has been reached;
- Place a finger or thumb on the tape at the RP when the water surface is reached;
- If the tape is graduated in one-foot intervals, partially withdraw the tape and measure the distance from the RP mark to the nearest one-foot mark to obtain the depth to water below the RP. If the tape is graduated in hundredths of a foot, simply record the depth at the RP mark as the depth to water below the RP;
- Make all readings using the same needle deflection point on the ammeter scale (if equipped) so that water levels will be consistent between measurements;
- Make check measurements until agreement shows the results to be reliable;

- All data should be recorded to the nearest 0.01 foot;
- Disinfect the tape by wiping down the submerged portion of the tape with single-use, unscented disinfectant wipe, or let stand for one minute in a dilute chlorine bleach solution and dry with clean cloth;
- Periodically check the tape for breaks in the insulation. Breaks can allow water to enter into the insulation creating electrical shorts that could result in false depth readings.

The electric tape may give slightly less accurate results than the graduated steel tape. Errors can result from signal "noise" in cascading water, breaks in the tape insulation, tape stretch, or missing tape at the location of a splice. All electric tapes should be calibrated semi-annually against a steel tape that is maintained in the office and used only for calibration.

Air Line

The air line method is usually used only in wells equipped with pumps. This method typically uses a 1/8 or 1/4-inch diameter, seamless copper tubing, brass tubing, stainless steel tubing, or galvanized pipe with a suitable pipe tee for connecting an altitude or pressure gage. Plastic (i.e. polyethylene) tubing may also be used, but is considered less desirable because it can develop leaks as it degrades. An air line must extend far enough below the water level that the lower end remains submerged during pumping of the well. The air line is connected to an altitude gage that reads directly in feet of water, or to a pressure gage that reads pressure in pounds per square inch (psi). The gage reading indicates the length of the submerged air line.

The formula for determining the depth to water below the RP is: **d = k – h** where d = depth to water; k = constant; and h = height of the water displaced from the air line. In wells where a pressure gage is used, h is equal to 2.31 ft/psi multiplied by the gage reading. The constant value for k is approximately equivalent to the length of the air line.

- Calibrate the air line by measuring an initial depth to water (d) below the RP with a graduated steel tape. Use a tire pump, air tank, or air compressor to pump compressed air into the air line until all the water is expelled from the line. When all the water is displaced from the line, record the stabilized gage reading (h). Add d to h to determine the constant value for k.
- To measure subsequent depths to water with the air line, expel all the water from the air line, subtract the gage reading (h) from the constant k, and record the result as depth to water (d) below the RP.

The air line method is not as accurate as a graduated steel tape or electric and is typically accurate to the nearest one foot at best. Errors can occur from leaky air lines, or when tubing becomes clogged with mineral deposits or bacterial growth. The air line method is not desirable for use in the Groundwater Monitoring Program.

Pressure Transducer

Electrical pressure transducers make it possible to collect frequent and long-term water level or pressure data from wells. These pressure-sensing devices, installed at a fixed depth in a well, sense the change in pressure against a membrane. The pressure changes occur in response to changes in the height of the water column in the well above the transducer membrane. To compensate for atmospheric changes, transducers may have vented cables or they can be used in conjunction with a barometric transducer that is installed in the same well or a nearby observation well above the water level.

Transducers are selected on the basis of expected water level fluctuation. The smallest range in water levels provides the greatest measurement resolution. Accuracy is generally 0.01 to 0.1 percent of the full scale range.

Retrieving data in the field is typically accomplished by downloading data through a USB connection to a portable computer or data logger. A site visit to retrieve data should involve several steps designed to safeguard the stored data and the continued useful operation of the transducer:

- Inspect the wellhead and check that the transducer cable has not moved or slipped (the cable can be marked with a reference point that can be used to identify movement);
- Ensure that the instrument is operating properly;
- Measure and record the depth to water with a graduated steel or electric tape;
- Document the site visit, including all measurements and any problems;
- Retrieve the data and document the process;
- Review the retrieved data by viewing the file or plotting the original data;
- Recheck the operation of the transducer prior to disconnecting from the computer.

A field notebook with a checklist of steps and measurements should be used to record all field observations and the current data from the transducer. It provides a historical record of field activities. In the office, maintain a binder with field information similar to that recorded in the field notebook so that a general historical record is available and can be referred to before and after a field trip.

Quality Control

The field technician should compare water level measurements collected at each well with the available historical information to identify and resolve anomalous and potentially erroneous measurements prior to moving to the next well location. Pertinent information, such as insufficient recovery of a pumping well, proximity to a pumping well, falling water in the casing, and changes in the measurement method, sounding equipment, reference point, or groundwater conditions should be noted. Office review of field notes and measurements should also be performed by a second staff member.

Groundwater Sampling Procedures for the
Los Osos Basin Plan Groundwater Monitoring Program

Introduction

This document establishes groundwater sampling procedures for the Los Osos Basin Plan (LOBP) Groundwater Monitoring Program. Groundwater sampling procedures facilitate obtaining a representative groundwater sample from an aquifer for water quality analysis. The water sampling procedures for general mineral and dissolved nitrogen sampling are presented below, along with special procedures for collecting samples for analyzing Constituents of Emerging Concern (CECs).

References

The procedures used for the LOBP Groundwater Monitoring Program have been developed through consideration of the constituents of analysis, well construction and type, and a review of the following references:

- U.S. Environmental Protection Agency, 1999, *Compendium of ERT Groundwater Sampling Procedures*, EPA/540/P-91/007, January 1999. https://www.epa.gov/sites/production/files/2015-06/documents/fieldsamp-ertsops.pdf
- Wilde, F. D., 2004, *Cleaning of Equipment for Water Sampling* (ver 2.0): U.S. Geological Survey Techniques of Water-Resources Investigations, Book 9, Chapter A3, revised April 2004. http://water.usgs.gov/owq/FieldManual/chapter3/Ch3_contents.html
- Wilde, F. D., 2008, *Guidelines for Field-Measured Water Quality Properties* (ver. 2.0): U.S. Geological Survey Techniques of Water-Resources Investigations, Book 9, Chapter A6, Section 6, October 2008. http://water.usgs.gov/owq/FieldManual/Chapter6/6.0_contents.html

Well Information

Table 1 below lists important well information to be maintained in a well file or in a field notebook. Additional information that should be available to the person collecting groundwater samples include a description of access to the property and the well, the presence and depth of cascading water, or downhole obstructions that could interfere with sampling equipment.

Table 1
Well File Information

Well Completion Report	Hydrologic Information	Additional Information to be Recorded
Well name	Map showing basin boundaries and wells	Township, Range, and ¼ ¼ Section
Well Owner	Name of groundwater basin	Latitude and Longitude (Decimal degrees)
Drilling Company	Description of aquifer	Assessor's Parcel Number
Location map or sketch	Confined, unconfined, or mixed aquifers	Description of well head and sounding access
Total depth	Pumping test data	Reference point elevations
Perforation interval	Hydrographs	Well use and pumping schedule if known
Casing diameter	Water quality data	Date monitoring began
Date of well completion	Property access instructions/codes	Land use

Groundwater Sampling Procedures

<u>Non-equipped wells</u>

1) Calibrate field monitoring instruments each day prior to sampling;
2) Inspect wellhead condition and note any maintenance required (perform at earliest convenience);
3) Measure depth to static water (record to 0.01 inches) from surveyed reference point;
4) Install temporary purge pump to at least three feet below the water surface (deeper setting may be needed if water level draw down is too great);
5) Begin well purge, record flow rate;
6) Measure discharge water EC (measured to 10 µmhos/cm), pH (measured to 0.01 units), and temperature (measured to 0.1 degrees C) at regular intervals during well purging. Record time and gallons purged. Note discharge water color, odor, and turbidity (visual);
7) A minimum of three casing volumes of water should be removed during purging, or one borehole volume opposite perforated interval, whichever is greater*. In addition, a set of at least three consecutive field monitoring measurements with stable values should be recorded. For EC, stability within 5 percent of the first value in the set is sufficient (typically within 20-50 µmhos/cm). For pH, stability within 0.3 units is sufficient. For temperature, stability within 0.2 degrees C is sufficient;
8) Collect sample directly from discharge tube, note sample color, odor, turbidity (visual). Use only laboratory-provided containers. Wear powder-free nitrile gloves when collecting groundwater samples;
9) Place samples on-ice for transport to the laboratory;
10) Remove temporary pump and rinse with clean water;
11) Close well and secure well box lid;

*note: If well is pumped dry at the minimum pumping rate, the well may be allowed to recover and then sampled by bailer within 24 hours.

Equipped wells

The sampling port for an equipped well must be upstream of any water filtration or chemical feeds. Sample from the discharge line as close to the wellhead as possible. Sampling procedures for equipped wells will vary. For active wells (i.e. wells used daily), the need for purging three casing volumes is unnecessary. Flush supply line from well or holding tank to sampling port, and record one set of EC, pH, and temperature readings prior to sampling. For inactive wells, a field monitoring procedure similar to that described for non-equipped wells above is appropriate. Static water level measurements should also be taken before sampling. Water samples should always be transported on-ice to the laboratory.

Chain-of-Custody

The chain-of-custody and associated sample bottle labels are used to document sample identification, specify the analyses to be performed, and trace possession and handling of a sample from the time of collection through delivery to the analytical laboratory. The sampler should fill out the sample identification labels and affix them to the sample bottles prior to, or upon, sample collection. A chain-of-custody form should be filled out by the sampler and a signature and date/time of sample transfers are required for each relinquishing and receiving party between sample collection and laboratory delivery.

Groundwater Sampling Equipment Decontamination

Field equipment should be cleaned prior to the sampling event and between sampling locations. Sampling pumps and hand bailers should be brushed with a nylon-bristle brush using a solution of 0.1 to 0.2-percent (volume/volume) non-phosphate soap in municipal-source tap water. The equipment should then be triple-rinsed with deionized water. Purge the pump hose of well water between sampling locations by pumping deionized through the hose. Groundwater sampling equipment should be protected from contact with the ground, or other potentially contaminating materials, at all times.

Special procedures for sampling for CEC compounds from unequipped well:

1) A new, teflon-lined polyethylene discharge hose or bailer will be used at each unequipped well sampling location;
2) The sampling pump will be decontaminated prior to each well sampled: Decontamination will consist of brushing pump body, inlet screen, and submerged portion of power cable in a phosphate-free cleaning solution, followed by rinsing, pumping distilled water, and final rinse;

3) Personnel collecting the sample will use powder-free nitrile gloves and observe special precautions for testing as directed by the laboratory (such as no caffeinated drink consumption on day of sampling, standing downwind of sampling port during sample collection, double-bag sample bottles, etc.);
4) Equipment blanks of distilled water pumped through the sampling pump are recommended;
5) A clean water/travel blank of distilled water (from the same source used for pump decontamination) is recommended.

APPENDIX I

Los Osos Groundwater Basin Assimilation Capacity and Antidegradation Analysis

LOS OSOS GROUNDWATER BASIN
ASSIMILATION CAPACITY AND
ANTIDEGRADATION ANALYSIS

Prepared for

SAN LUIS OBISPO COUNTY
DEPARTMENT OF PUBLIC WORKS

APRIL 2017

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ES. EXECUTIVE SUMMARY

This report presents an assimilative capacity and antidegradation analysis as part of a Salt and Nutrient Management Plan for the Los Osos Groundwater Basin, and for operation of the Los Osos Wastewater Recycling Facility (LOWRF). The assimilative capacity analysis compares current groundwater basin water quality data with water quality objectives. The antidegradation analysis compares basin assimilative capacity to future basin water quality under a Baseline scenario and two Los Osos Groundwater Basin Plan (LOBP) project scenarios.

ES.1 Salt and Nutrient Loading

Seawater intrusion and high-density residential septic systems have historically been the largest sources of salt and nutrient loading to the Los Osos Groundwater Basin. The primary indicators of mass loading from these sources are total dissolved solids (TDS), chloride, and nitrate-nitrogen (NO_3-N), which are the three constituents used for the assimilative capacity and antidegradation analyses.

Salt and nutrient loading takes place at variable rates across the Los Osos Groundwater Basin. Every year, salts and nutrients leach into the groundwater system from various sources, including natural, agricultural, residential, and animal sources. Surface and subsurface inflows to the groundwater basin also contribute to salt and nutrient loading. Salt and nutrient mass is also removed every year through surface and subsurface outflow.

Loading factors can be expressed as the amount of salt or nutrient added to the groundwater system over time, per source unit. The mass associated with each loading factor is dissolved and transported into the groundwater system by recharge and return flows. There are four basin compartments, or mixing cells, delineated for salt and nutrient loading calculations: the Perched Aquifer, the Upper Aquifer; the Western and Central Area Lower Aquifer; and the Eastern Area Alluvial and Lower Aquifer.

The methodology used to simulate salt and nutrient loading for each mixing cell involves a mass balance spreadsheet model, which converts salt and nutrient loads to inflow concentrations, distributes flows according to the water balance, and provides for repeated cycles of loading. The spreadsheet model also allows salt and nutrient load calibration using basin water quality data. The calibration process provides a rigorous approach to mass balance by evaluating the basin-specific salt and nutrient loads for key sources, including natural sources and the evaporative enrichment of salts beneath agricultural fields.

ES.2 Source Analysis

Natural sources, agricultural sources, residential sources, and animal waste are the principal sources of salt and nutrient loading in the basin under Baseline (pre-LOWRF) conditions. With LOWRF operation, recycled water reuse becomes another principal source of loading. Salt and Nutrient mass loading factors for various sources are presented in Tables ES-1 and ES-2.

Table ES-1. NO_3-N Loading Factors

Source	Total Units (Baseline)	NO_3-N (lb/year)		
		Per unit (lb/year)	Attenuation (loss)	Total (lb/year)
Natural (Basin wide)[1]	4,000 acres	3.1	(incorporated)	12,400
Septic Tank Discharge[2]	830 acre-feet	152	41%	74,500
Agriculture/Turf Fertilizer[3]	400 acres	150	68%	19,200
Residential Landscape/Turf Fertilizer[3]	370 acres	45	80%	3,300
Animal Waste[4]	200 Horses	110	79%	4,600
	4,400 Dogs	2.9	92%	1,000
	6,600 Cats	1.4	92%	700

NOTES: [1] calibrated to pre-development conditions.
[2] influent quality to LOWRF, calibrated to baseline conditions.
[3] Viers et al. (2012) and M&E (1995)
[4] M&E (1995)

Table ES-2. Inflow Source Water Quality			
Source	**TDS (mg/L)**	**Chloride (mg/L)**	**NO_3-N (mg/L)**
Septic / LOWRF Influent (initial)[1]	790	200	56[2]
Septic / LOWRF Influent (transient)[1]	WS+352	WS+115	56[2]
Recycled Water (initial)[3]	713	200	6.6
Recycled Water (transient)[3]	IW-77	IW	6.6
Landscape Irrigation Return Flow[4]	WS*3.4+N load	WS*3.4	WS+N load
Agricultural Irrigation Return Flow[4]	WS*3.4+N load	WS*3.4	WS+N load
Perc. of Precip. with natural/animal[5]	146	36	3
Subsurface Bedrock Inflow[6]	493	50	0.2
Los Osos Creek Inflow[6]	540	53	0.2

NOTES: WS = domestic/irrigation water quality
IW = influent wastewater quality (same as septic discharge)
[1] based on initial water supply quality and LOWRF raw influent data (Appendix B, Table B14)
[2] mostly as ammonia-nitrogen (Appendix B, Table B14)
[3] based on LOWRF treated effluent data (Appendix B, Table B15)
[4] 3.4 evaporative enrichment factor calibrated to baseline conditions (Section 3.3)
[5] natural loading calibrated to pre-development conditions (Section 3.2)
[6] based on water quality data (Appendix B, Table B10)

ES.3 Basin Assimilative Capacity

The Central Coast Regional Water Quality Control Board (Regional Board) defines assimilative capacity as:

> *The capacity of a natural body of water to receive (a) wastewaters, without deleterious effects, (b) toxic materials, without damage to aquatic life or humans who consume the water, (c) BOD, within prescribed dissolved oxygen limits.*

Based on the above definition, the assimilative capacity of a groundwater basin to receive recycled water and return flows from irrigation would be the difference between ambient (current) concentrations of a selected water quality constituent in groundwater and the maximum concentration (or water quality objective, if specified) of the constituent that would preclude deleterious effects.

There are no published median groundwater objectives for Los Osos. As a basin with documented nitrate and seawater intrusion problems, the median groundwater objectives used for the assimilative capacity analysis are based on the highest existing median objectives for the Estero Bay Area: 1,000 mg/L TDS, 250 mg/L chloride, and 10 mg/L NO_3-N. The resulting assimilative capacity of the Los Osos Groundwater Basin for salt and nutrient loading is summarize in Table ES-3.

Table ES-3. Assimilative Capacity - Los Osos Groundwater Basin					
Loading Constituent	Allowable[1] [mg/L]	Current[2] [mg/L]	Assimilative Capacity[3] [mg/L]	10% Assimilative Capacity [mg/L]	20% Assimilative Capacity [mg/L]
TDS	1000	440	560	56	112
Chloride	250	81	169	17	34
NO_3-N	10	6	4	0.4	0.8

[1]Allowable concentration equal to maximum existing median objective for Estero Bay planning area
[2]Basin averages are weighted averages by volume for mixing cells
[3]Allowable - Current = Assimilative Capacity

ES.3 Basin Antidegradation Analysis

The antidegradation analysis evaluates potential impacts to water quality from the LOBP project scenarios, which include No Further Development and Population Buildout. These impacts are then compared to the current assimilative capacity of the groundwater basin.

Results of the antidegradation analysis indicates LOWRF operation over a 25-year period with No Further Development uses less than 2 percent of the assimilative capacity of the basin for TDS and chloride, while providing a net gain in basin assimilative capacity for NO_3-N. LOWRF operation over a 25-year period with Population Buildout (cumulative projects) uses less than 4 percent of the assimilative capacity of the basin for TDS and chloride, while providing a net gain in basin assimilative capacity for NO_3-N. These results show compliance with antidegradation thresholds established by the State Water Resources Control Board. Table ES-4 summarizes the antidegradation analysis.

Table ES-4. Basin Antidegradation Analysis - Los Osos Valley Groundwater Basin									
Constituent	Assimilative Capacity [mg/L]	Assimilative Capacity Used (+lost -gained)							
		No Further Development (E+AC+U)				Population Buildout (E+ABC+UG)			
		10 Years		25 Years		10 Years		25 Years	
		mg/L	%	mg/L	%	mg/L	%	mg/L	%
TDS	560	1.7	0.3	7.0	1.3	7.8	1.4	20.7	3.7
Chloride	169	0.1	0.1	0.6	0.4	2.1	1.2	5.2	3.1
NO_3-N	4	-0.7	-18.7	-1.1	-26.5	-0.6	-15.4	-0.8	-20.1

ES.4 Implementation Measures

Existing and potential future implementation measures for the management of salt and nutrient loading on a basin-wide scale are presented following the antidegradation analysis. Implementation measures associated with the community water supply, basin recharge, and wastewater quality are included. The status of implementation measures are listed in Section 6 as in progress or as potential future measures.

1. INTRODUCTION

This report presents an assimilative capacity and antidegradation analysis as part of a Salt and Nutrient Management Plan for the Los Osos Groundwater Basin, and for operation of the Los Osos Wastewater Recycling Facility (LOWRF). The report has been organized into five sections: Salt and Nutrient Loading; Source Analysis; Basin Assimilative Capacity; Antidegradation Analysis; and Implementation Measures. The main purpose of this analysis is to evaluate the impacts on basin water quality from various sources of salt and nutrient loading.

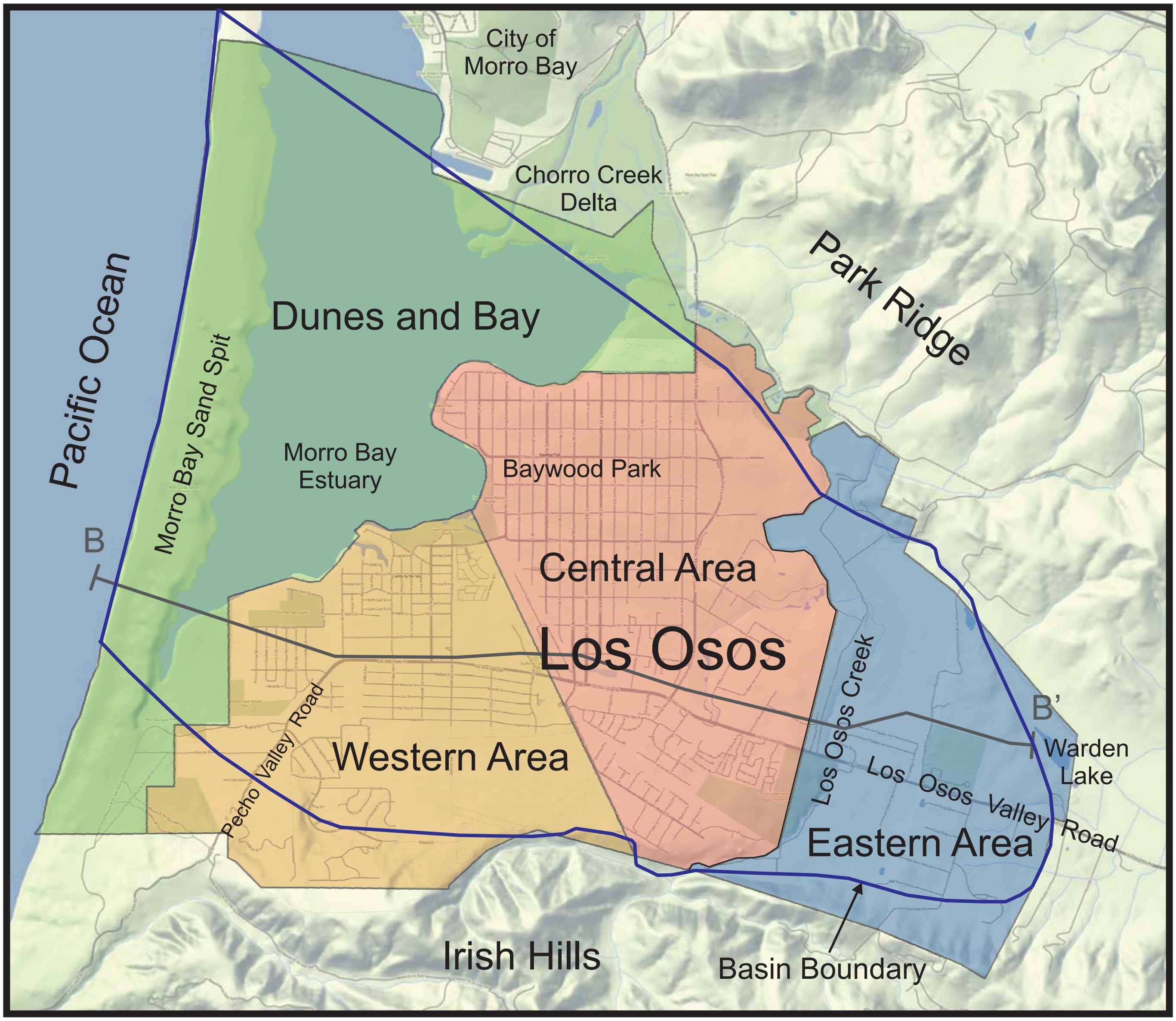
In April 2013, the State of California approved an amended Recycled Water Policy that requires assimilative capacity and antidegradation analyses to be developed to manage salts, nutrients, and other significant chemical compounds on a watershed- or basin-wide basis. Recycled water reuse is an integral part of water resource management, and the Recycled Water Policy establishes a mandate to encourage and increase the use of recycled water in California.

The County of San Luis Obispo (County) has recently completed construction of the LOWRF, which began receiving and treating wastewater in 2016 from areas with high-density residential parcels overlying the Los Osos Groundwater Basin. Recycled water from the treatment facility will meet Waste Discharge/Recycled Water Requirement Order R3-2011-2001 prior to being discharged to land at community leach fields and available for reuse at locations across the basin. Completion of the assimilative capacity and antidegradation analysis is a critical step toward meeting the requirements of the Recycled Water Policy and partnering with the State to increase recycled water use in California.

The assimilative capacity analysis compares current groundwater basin water quality data with water quality objectives. The basin has been divided into mass balance compartments, or mixing cells, that correspond to aquifers and plan areas used for water balance in the 2015 Los Osos Groundwater Basin Plan (LOBP). Figure 1 shows the location of the Los Osos Groundwater Basin and the plan areas. Figure 2 is a hydrogeologic cross-section depicting the basin aquifers.

The antidegradation analysis compares basin assimilative capacity to future basin water quality under a Baseline scenario and two LOBP project scenarios. The Baseline scenario evaluates trends in salt and nutrient loading under pre-LOWRF conditions with current land use and no further development. The LOBP project scenarios evaluate trends in salt and nutrient loading under LOWRF operation with No Further Development and with Population Buildout, based on the LOBP. Information developed for these analyses includes:

- Water quality for basin mass balance compartments
- Water quality for basin inflow sources
- Water quality for raw effluent received by LOWRF
- Recycled water quality
- Groundwater in storage volumes for basin mass balance compartments
- Current land use and cumulative projects land use
- Salt and nutrient loading factors for land uses



Base Image: Stamen-Terrain

0 2000 4000 6000 8000 ft

Scale: 1 inch ≈ 4,000 feet

Explanation

Basin Plan Areas:

- Dunes and Bay Area
- Western Area
- Central Area
- Eastern Area

B — B' Cross-section alignment (Figure 2 and 5)
Labeled B-B' to be consistent with LOBP

Basin Boundary from 2015 LOBP

Figure 1

Basin Location and Plan Areas

Los Osos Groundwater Basin
Assimilation Capacity and
Antidegradation Analysis
County of San Luis Obispo

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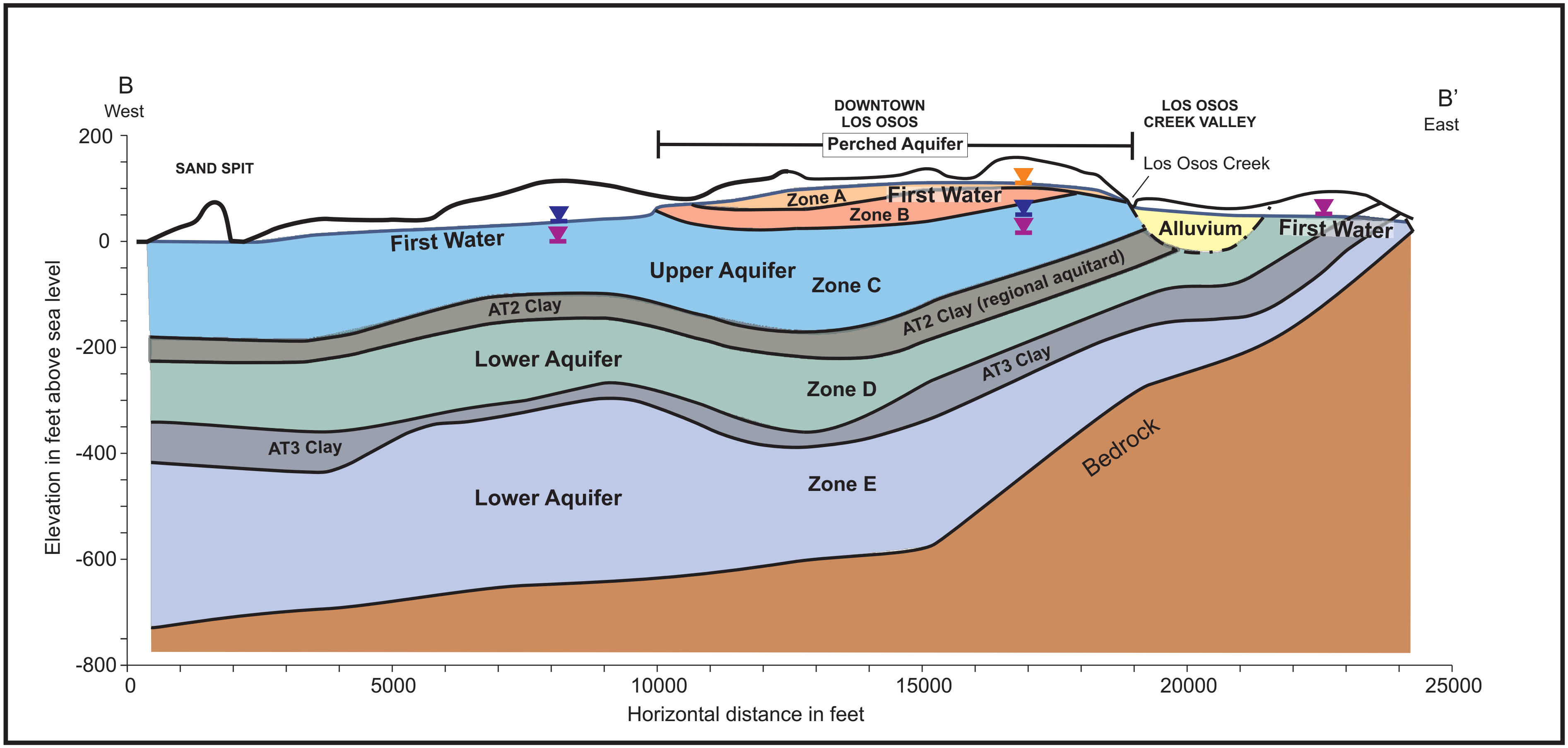

SOURCE: 2015 Los Osos Groundwater Basin Annual Report

Cross-section alignment shown in Figure 1

Explanation

- Perched Aquifer Water level
- Upper Aquifer Water level
- Lower Aquifer Water level

Figure 2

Basin Aquifers

Los Osos Groundwater Basin
Assimilation Capacity and
Antidegradation Analysis
County of San Luis Obispo

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- Basin water balance for Baseline (2012) conditions
- Basin water balance for LOWRF operation with No Further Development and Population Buildout Development (cumulative projects)

Subsurface inflow of seawater has historically been the largest source of salt loading to the basin. Return flow from high-density residential septic systems has historically been the largest source of nutrient loading to the basin. Both sources are designed to be mitigated by the combination of LOWRF operation and cumulative projects under the 2015 LOBP.

2. SALT AND NUTRIENT LOADING

Salt and nutrient loading refers to the accumulation of dissolved salt and nutrient mass in surface water and groundwater. In a dynamic system, mass loading and mass removal varies by location and changes over time. This section describes the conceptual model and methodology for salt and nutrient transport, identifies the primary constituents of salt and nutrient loading, compiles current water quality data for various aquifers and water sources, and presents groundwater storage volumes for mass balance calculations.

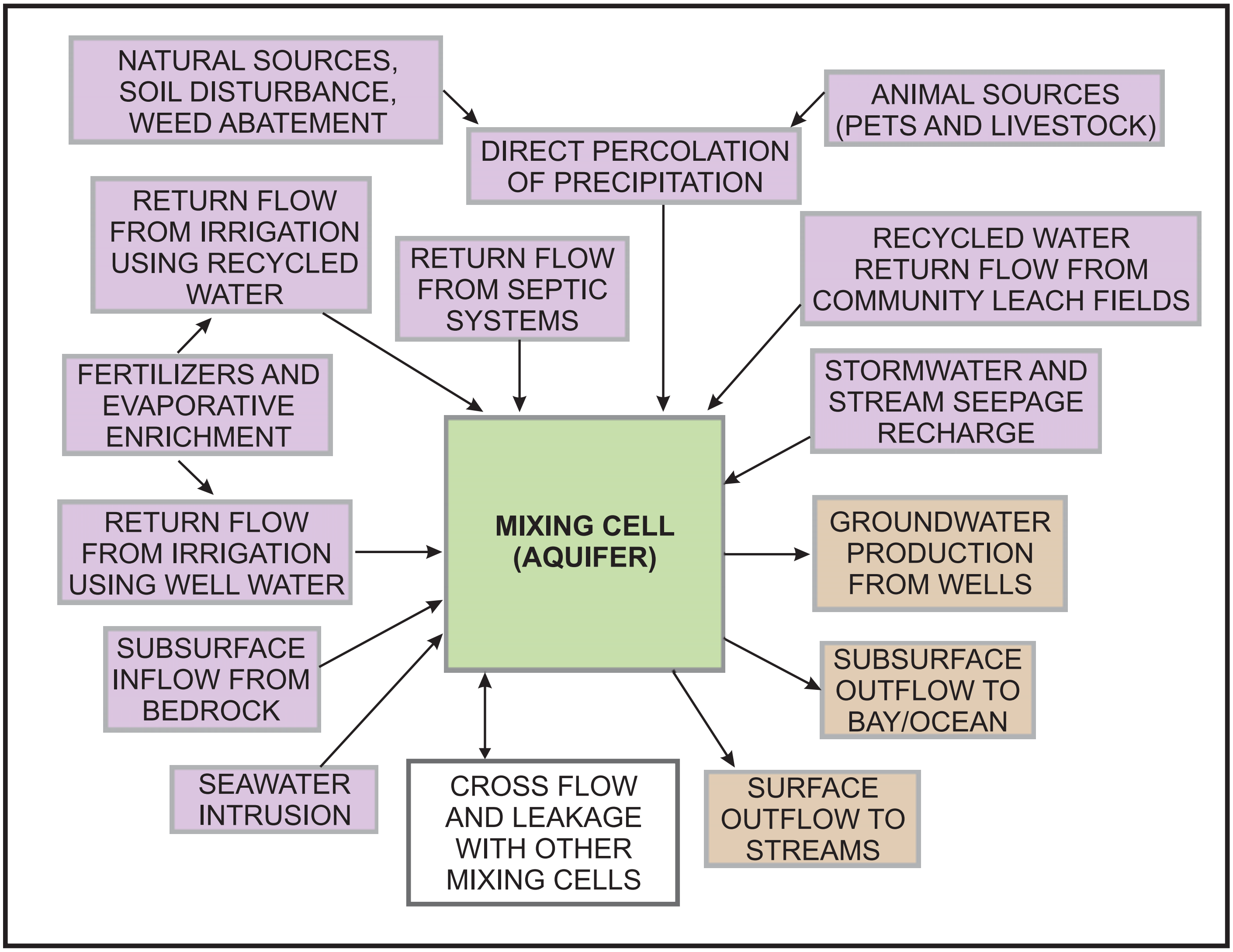
2.1 Conceptual Model

Salt and nutrient loading takes place at variable rates across the Los Osos Groundwater Basin. Every year, salts and nutrients leach into the groundwater system from various sources, including natural, agricultural, residential, and animal sources. Loading factors can be expressed as the amount of salt or nutrient added to the groundwater system over time, per source unit. The mass associated with each loading factor is dissolved and transported into the groundwater system by recharge or return flows.

Surface and subsurface inflows to the groundwater basin also contribute to salt and nutrient loading. These sources have received mass loading from areas outside the basin and transport salts and nutrients into the basin as recharge. Salt and nutrient mass is also removed every year through surface and subsurface outflow. Removal of mass from the basin is variable in location and changes over time.

Figure 3 presents the various components of salt and nutrient loading and removal from a conceptual mixing cell (aquifer) within the groundwater basin. Figures 4 depicts the areal extent of the mass balance mixing cells used for this study. Figure 5 presents a cross-section that, when compared with Figure 2, shows the relationship between the basin aquifers and the basin areas used as mixing cells for mass balance calculations. There are four mixing cells delineated by the conceptual model: the Perched Aquifer, the Upper Aquifer; the Western and Central Area Lower Aquifer; and the Eastern Area Alluvial Aquifer and Lower Aquifer (Figure 4).

As shown on Figure 4 and 5, the Dunes and Bay Area and portions of the Lower Aquifer impacted by seawater intrusion have been removed from the assimilative capacity and antidegradation analysis. The concentration of TDS in Lower Aquifer groundwater in the Western Area has been



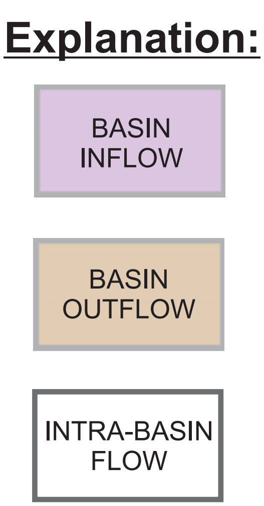


Figure 3

Conceptual Model of Salt and Nutrient Loading Sources

Los Osos Groundwater Basin Assimilation Capacity and Antidegradation Analysis
County of San Luis Obispo

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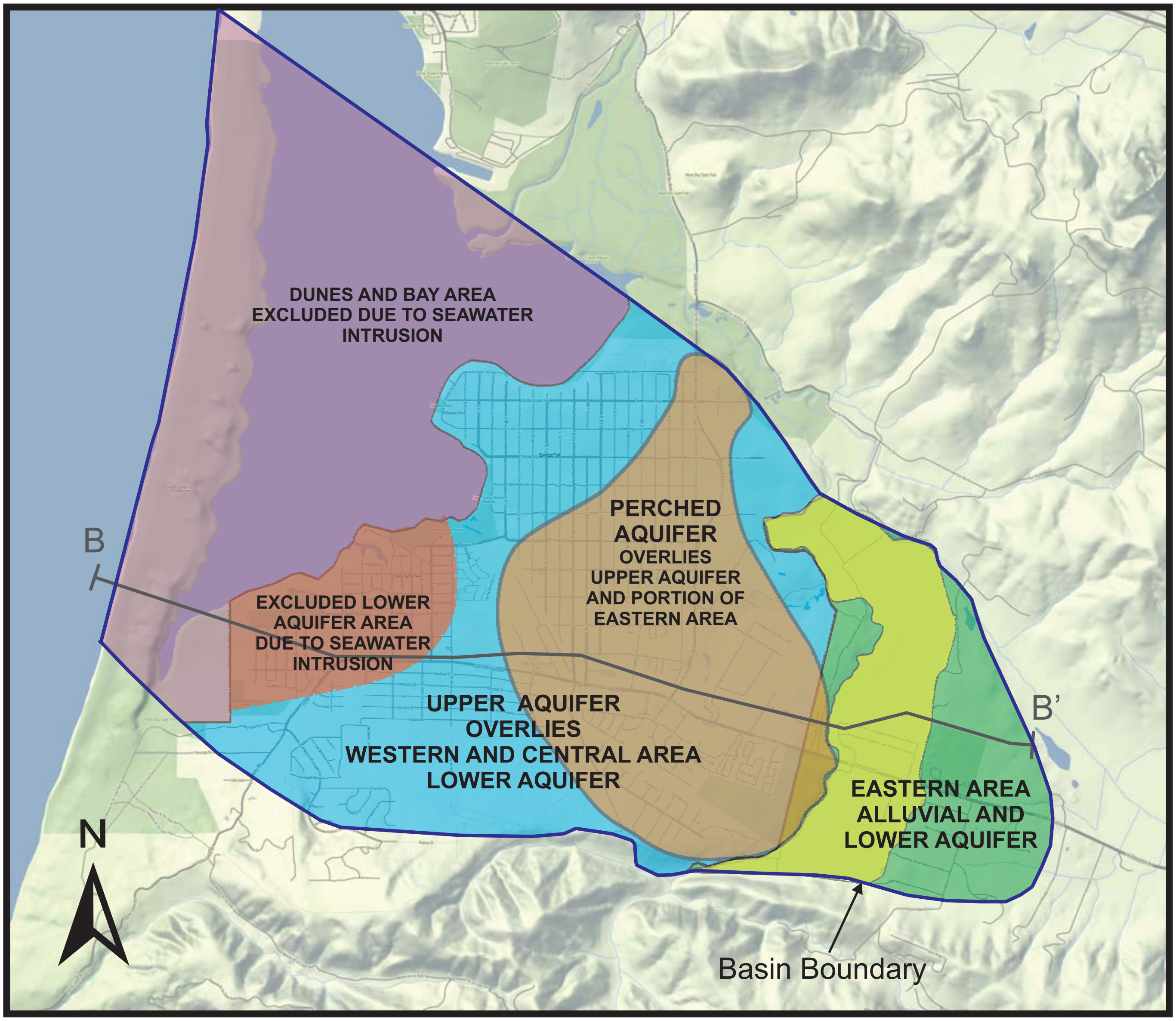

Base Image: Stamen-Terrain

0 2000 4000 6000 8000 ft

Scale: 1 inch ≈ 4,000 feet

Explanation

PERCHED AQUIFER

UPPER AQUIFER (ON TOP)

WESTERN AND CENTRAL AREA
LOWER AQUIFER (UNDERNEATH)

EXCLUDED LOWER AQUIFER
AREA DUE TO SEAWATER
INTRUSION IN ZONE D. ZONE E
EXCLUDED IN ALL WESTERN AREA
(SEE FIGURE 5)

EASTERN AREA
ALLUVIAL AQUIFER (YELLOW)
LOWER AQUIFER (GREEN)

B–B' Cross-section alignment (Figure 2 and 5)
Labeled B-B' to be consistent with LOBP

Basin Boundary from 2015 LOBP

Figure 4

Aerial Extent of Mass Balance
Mixing Cells

Los Osos Groundwater Basin
Assimilation Capacity and
Antidegradation Analysis
County of San Luis Obispo

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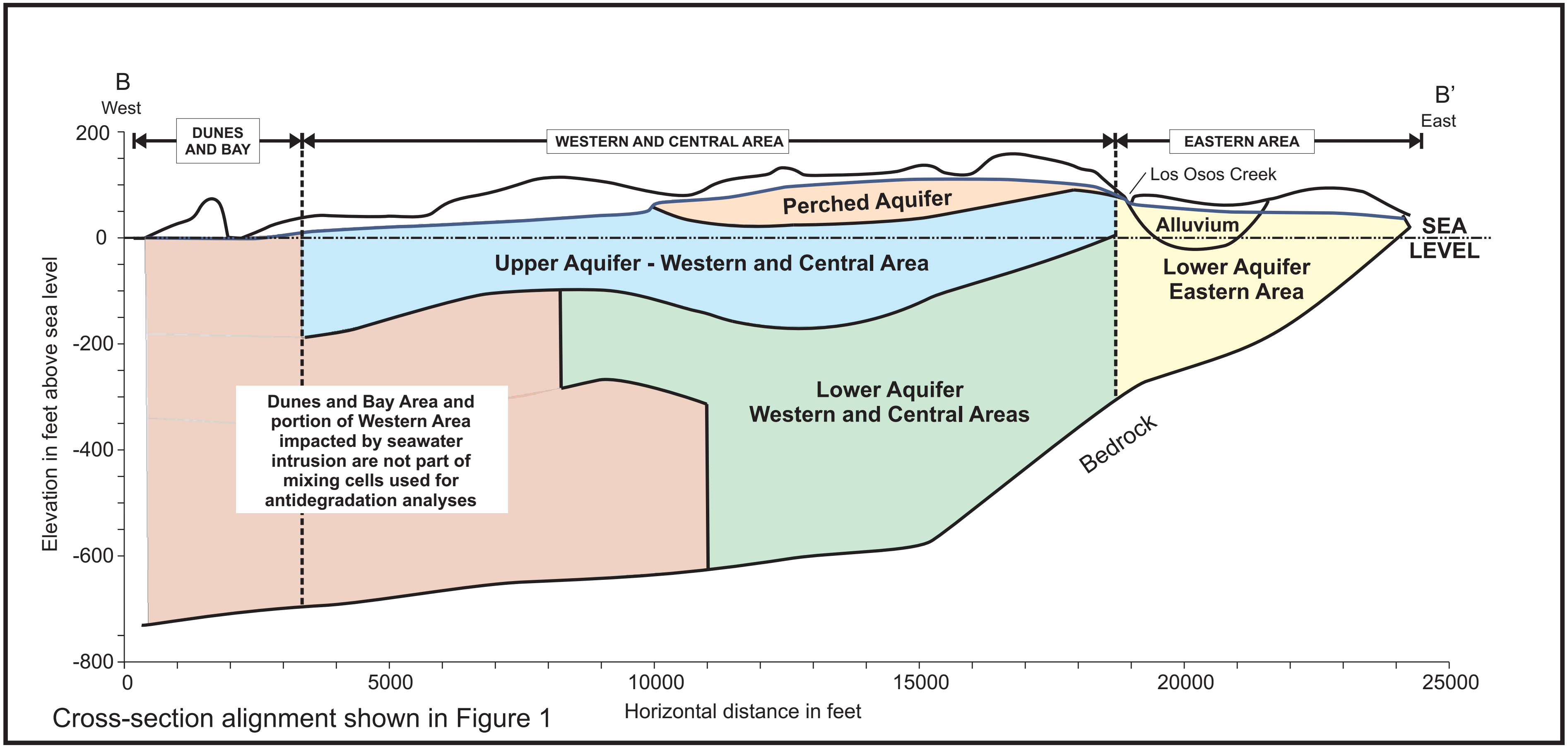

Explanation

- Perched Aquifer
- Upper Aquifer - Western and Central Areas
- Lower Aquifer and Alluvial Aquifer - Eastern Area
- Lower Aquifer - Western and Central Area
- No mixing cells for antidegradation analyses

Figure 5

Mass Balance Mixing Cells

Los Osos Groundwater Basin
Assimilation Capacity and
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County of San Luis Obispo

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measured as high as 35,000 milligrams per liter (mg/L), with 17,000 mg/L chloride, which is effectively seawater (Cleath & Associates, 2005). Incorporating the salt mass from intruded areas into assimilative capacity and antidegradation calculations would interfere with evaluating the impacts on water quality from other sources of salt loading. The extent that project scenarios mitigate seawater intrusion into the freshwater portion of the Lower Aquifer, however, can be shown in the water balance and incorporated into the impacts analysis.

Figures 6, 7, and 8 show the components of inflow and outflow from each of the basin compartments for the Baseline scenario, for the LOBP No Further Development scenario (E+U+AC), and for the LOBP Population Buildout scenario (E+UG+ABC), respectively. These scenarios are briefly described below.

2012 Baseline Scenario

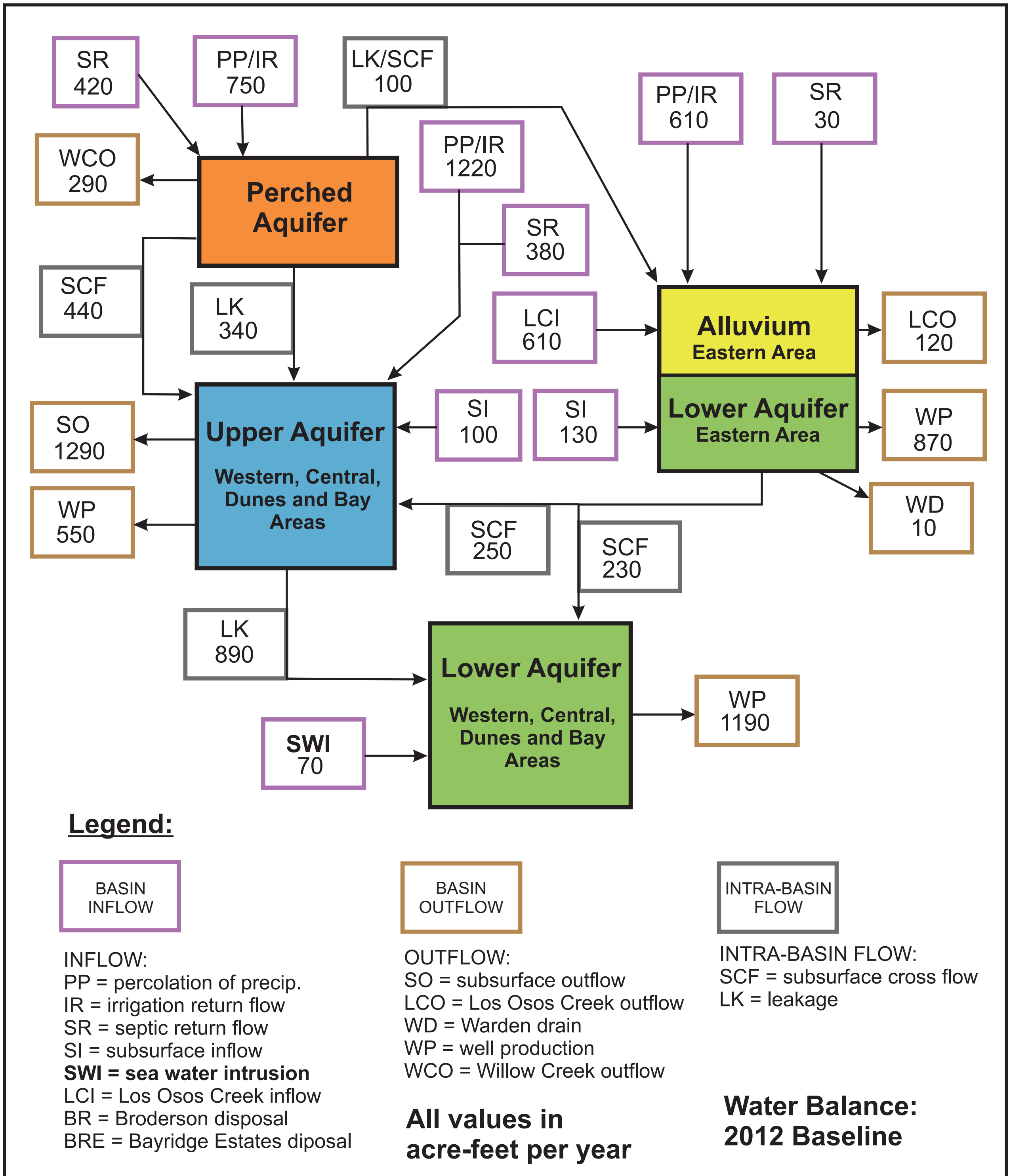
The baseline scenario is equivalent to LOBP program N (no management programs), and assumes a continuation of the land use and water balance present in 2012. As shown in Figure 6, seawater intrusion is occurring in the basin, along with high density septic system discharges.

LOBP No Further Development (E+U+AC)

As shown in Figure 7, the No Further Development scenario (E+U+AC) incorporates the Urban Water Use Efficiency Program (E), Urban Water Reinvestment Program (U), and Basin Infrastructure Programs A and C (AC), but with no further development in terms of the population served by community purveyors. Seawater intrusion is mitigated, and high density septic system discharges are replaced by wastewater collection and treatment at the LOWRF, followed by recycled water reuse and disposal. This scenario is compared to the baseline scenario for evaluating the effectiveness of the LOWRF for salt and nutrient management in Section 5.

Urban Water Use Efficiency Program E refers to water conservation measures with respect to indoor residential and commercial water use, indoor and outdoor water use surveys, public outreach and education, and water use metering.

Urban Water Reinvestment Program U refers to recycled water use for irrigation in the urban area. Table 1 summarizes the potential recycled water areas and distribution allocation. The urban area options include landscaping and playing fields at school sites, the community park, and Sea Pines golf course, as shown in LOBP Figure 54 (Appendix A). There is also up to 146 acre-feet per year (AFY) of agricultural reuse included in the LOBP No Further Development scenario, as presented in Table 1.



SOURCE: 2015 LOBP

Figure 6

Water Balance: 2012 Baseline

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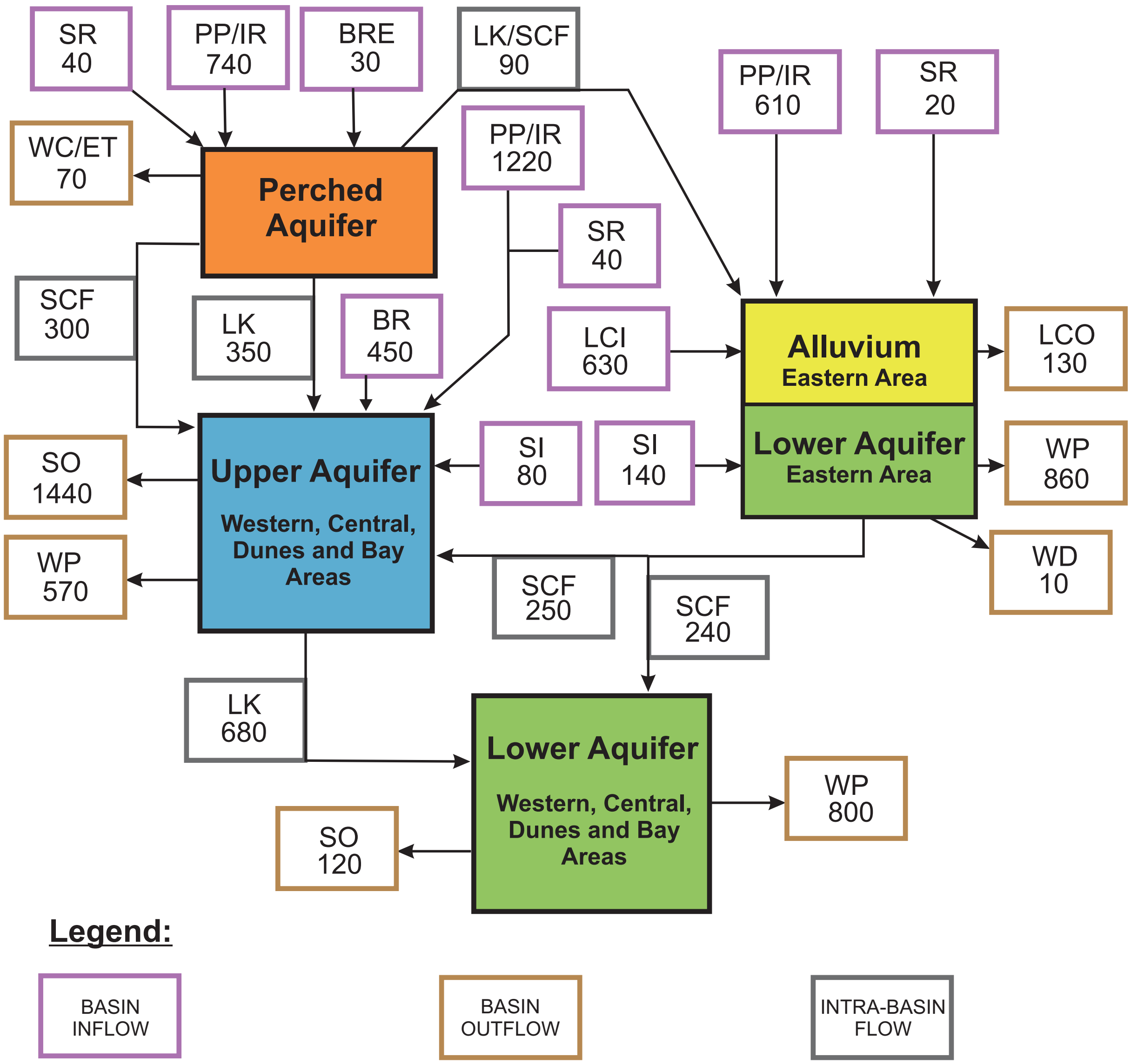

INFLOW:
PP = percolation of precip.
IR = irrigation return flow
SR = septic return flow
SI = subsurface inflow
LCI = Los Osos Creek inflow
BR = Broderson disposal
BRE = Bayridge Estates diposal

OUTFLOW:
SO = subsurface outflow
LCO = Los Osos Creek outflow
WD = Warden drain
WP = well production
WCO = Willow Creek outflow

INTRA-BASIN FLOW:
SCF = subsurface cross flow
LK = leakage

All values in acre-feet per year

Water Balance:
No Further Development
Scenario E+U+AC

SOURCE: 2015 LOBP

Figure 7

Water Balance:
LOBP No Further Development

Los Osos Groundwater Basin
Assimilation Capacity and
Antidegradation Analysis
County of San Luis Obispo

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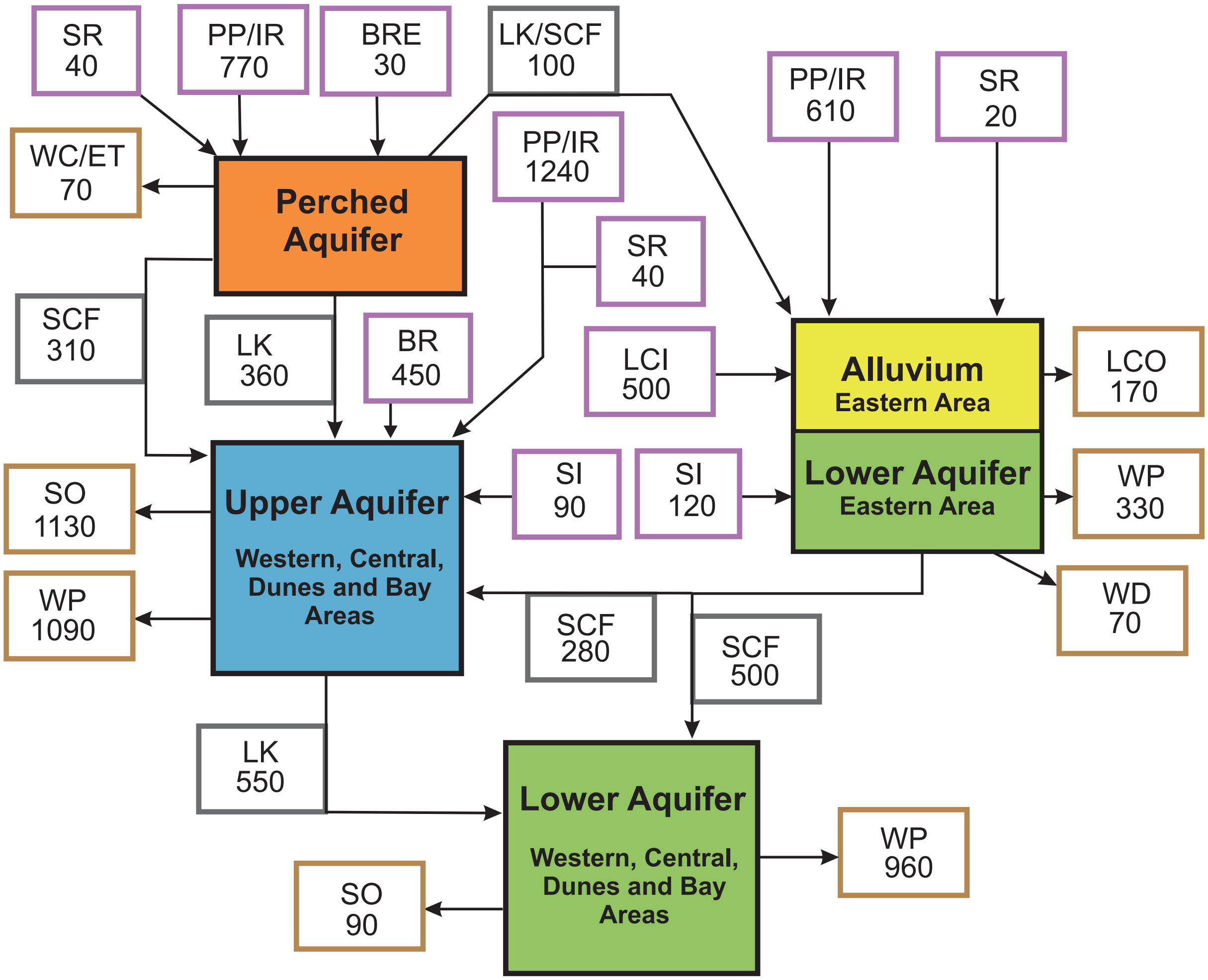

Legend:

BASIN INFLOW	BASIN OUTFLOW	INTRA-BASIN FLOW

INFLOW:
PP = percolation of precip.
IR = irrigation return flow
SR = septic return flow
SI = subsurface inflow
LCI = Los Osos Creek inflow
BR = Broderson disposal
BRE = Bayridge Estates diposal

OUTFLOW:
SO = subsurface outflow
LCO = Los Osos Creek outflow
WD = Warden drain
WP = well production
WCO = Willow Creek outflow

INTRA-BASIN FLOW:
SCF = subsurface cross flow
LK = leakage

All values in acre-feet per year

Water Balance: Buildout Development Scenario E+UG+ABC

SOURCE: 2015 LOBP

Figure 8

Water Balance:
LOBP Population Buildout

Los Osos Groundwater Basin
Assimilation Capacity and
Antidegradation Analysis
County of San Luis Obispo

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Table 1. Urban Water Reinvestment Program Recycled Water Uses		
Potential Use	**Quantity (AFY)**	**Percent of Total**
Broderson Leach Fields	448	57.4
Bayridge Estate Leach Fields	33	4.2
Urban Reuse	63	8.1
Sea Pines Golf Course	40	5.1
Los Osos Valley Memorial Park	50	6.4
Agricultural Reuse	146	18.7
Total	780	100

Reference: 2015 LOBP

Basin Infrastructure Program A is designed to increase groundwater production from the Upper Aquifer by purveyors to the greatest extent practicable without construction of large-scale nitrate removal facilities. Program A projects include water system inter-ties, Upper Aquifer well construction, a Lower Aquifer well modification, local nitrate removal and water blending, and water meters.

Basin Infrastructure Program C is designed to shift some lower aquifer production from the Western Area of the basin to the Central Area, which is one of the strategies to mitigate seawater intrusion. There are three wells planned for Program C, along with pipeline improvements.

Population Buildout Scenario (E+UG+ABC)

Figure 8 presents the water balance for the Population Buildout scenario, for which the population size increases by 36 percent from 14,600 to 19,850[1]. Agricultural Water Reinvestment Program G and Basin Infrastructure Program B have also been added.

Agricultural Water Reinvestment Program G prioritizes agricultural reuse deliveries that create overall benefits to the Basin and help mitigate seawater intrusion. The program includes added wastewater treatment capacity and storage, along with outreach to the agricultural community.

Basin Infrastructure Program B is designed to maximize groundwater production from the Upper Aquifer, and includes new wells and a community-scale nitrate removal facility.

The amount of agricultural reuse in the Program G component of Scenario E+UG+ABC is 486 AFY (Table 2). The total potential recycled water use at population buildout is 1,120 AFY (1.0 million gallons per day).

1 The Population Buildout is referenced from the 2015 LOBP. The County of San Luis Obispo is re-evaluating the buildout potential within the Urban Reserve line in the Draft Los Osos Community Plan. The current Population Buildout number of 19,950 is anticipated to decrease under a lower projected density and revised dwelling unit count, resulting in a lower projected community water demand and decreased waste stream to the LOWRF.

Table 2. Potential Recycled Water Use at Population Buildout		
Potential Use	**Quantity (AFY)**	**Percent of Total**
Broderson Leach Fields	448	40
Bayridge Estate Leach Fields	33	2.9
Urban Reuse	63	5.6
Sea Pines Golf Course	40	3.6
Los Osos Valley Memorial Park	50	4.5
Agricultural Reuse	486	43.4
Total	1,120	100

Reference: 2015 LOBP

2.2 Salt and Nutrient Loading Constituents

As previously mentioned, seawater intrusion and high-density residential septic systems have historically been the largest sources of salt and nutrient loading to the Los Osos Groundwater Basin. The primary indicators of mass loading from these sources are total dissolved solids (TDS), chloride, and nitrate-nitrogen (NO_3-N), which are the three constituents used for the assimilative capacity and antidegradation analyses.

2.2.1 Total Dissolved Solids

The TDS concentration is a common measure of groundwater salinity, and represents the overall mineral content. All forms of salt and nutrient loading contribute to TDS mass accumulation.

The State of California has established a secondary standard Maximum Contaminant Level (MCL) for TDS. Secondary standards are based on customer acceptance levels and are not associated with public health concerns. The recommended secondary MCL for TDS is 500 mg/L. There is also an upper MCL for TDS of 1,000 mg/L, and a short-term maximum MCL of 1,500 mg/L.

2.2.2 Chloride

Chloride is typically associated with salt compounds formed with sodium, potassium, or calcium. Chloride is also one of the general mineral ions found in groundwater. Once dissolved, it is a conservative species that does not interact significantly with the aquifer matrix or form ionic complexes with other solutes. Chloride is the primary indicator of seawater intrusion.

The State of California has established secondary standards for chloride. The recommended secondary MCL for chloride is 250 mg/L. There is also an upper MCL for chloride of 500 mg/L, and a short-term maximum MCL of 600 mg/L.

2.2.3 NO_3-N

Nitrate (NO_3) is an oxidized form of nitrogen, which is one of the primary nutrients used by plants. Nitrogen cycles between the atmosphere, soils, and groundwater through alterations in its chemical state. In groundwater, nitrogen compounds are typically oxidized to nitrate. Nutrient loads may be in other forms, and are often compounds based on ammonia (NH_3). For consistency with reporting requirements for public drinking water systems, nitrate values will be expressed as NO_3-N.

The State of California has established a primary standard MCL for NO_3-N. Primary standards are based on protecting public health. Ingestion of water containing elevated nitrate concentrations can interfere with oxygen transport by red blood cells. The recommended primary MCL for NO_3-N is 10 mg/L.

2.3 Fate and Transport

Transport of salt and nutrient loads through the vadose zone between surface sources and groundwater can involve a complex series of chemical and soil processes which affect both the load concentration and transit time. Nitrogen loads, in particular, generally attenuate before reaching groundwater through processes of nitrification and denitrification, assimilation, fixation and transformation. In groundwater, both nitrate and chloride anions are relatively conservative, and do not interact significantly with the aquifer matrix. TDS, which is primarily composed of general mineral cations and anions, is also relatively conservative. Ion exchange processes, however, can alter the character of the water as it moves through basin sediments, particularly in response to seawater intrusion. Salt and nutrients within the Los Osos Groundwater Basin that are not removed, recycled, or immobilized would discharge into Morro Bay, the Pacific Ocean, or Los Osos Creek.

Prior to being discharged from the groundwater basin, the salt and nutrients move through aquifers that are assumed to equilibrate in concentration within their respective basin compartments. The time the salt or nutrient takes to enter, equilibrate with, and exit a compartment is a function of the initial groundwater concentration and compartment volume, inflow concentrations and volumes, permeability, homogeneity, point of discharge, and outflow rates and concentrations. Locally there can be considerable variation in mixing and loading. For purposes of antidegradation analyses, salt and nutrient concentrations are assumed to fully mix and equilibrate, and the compartment is considered homogenous.

2.4 Methodology

The methodology used to simulate salt and nutrient loading involves a mass balance spreadsheet model, which converts salt and nutrient loads to inflow concentrations, distributes flows according to the water balance, and provides for repeated cycles of loading. The spreadsheet model also allows salt and nutrient load calibration using basin water quality data. The calibration process provides a rigorous approach to mass balance by evaluating the basin-specific salt and nutrient loads for key sources, including natural sources and the evaporative enrichment of salts beneath agricultural fields.

Water quality trends from the Baseline scenario may be compared to corresponding trends from the LOBP No Further Development scenario and Population Buildout scenario. Demonstrating antidegradation under LOWRF project conditions involves the comparison of LOBP project scenarios with the current basin assimilative capacity. The Baseline scenario is included for perspective on the importance of salt and nutrient management.

<u>Mixing Equations</u>

For each basin compartment, herein referred to as mixing cells for mass balance purposes, two equations were used to determine the mass balance at equilibrium and at a specified interval of years (Larry Walker Associates et al., 2015).

Equation 1:

$$C_{t=\infty} = \left(\frac{\sum_{i=1}^{n} C_i * Q_i}{\sum_{i=1}^{n} Q_i} \right)$$

Where:
C = concentration [mg/L],
Q = volume [L],
t = time in years,
i = an inflowing constituent
n = total number of inflowing constituents

Equation 2:

$$C_t = C_{t=\infty} + (C_o - C_{t=\infty}) * e^{\frac{-\sum_t^n Q_t * t}{V}}$$

Where:
C = concentration [mg/L],
Q = inflow volume [L],
t = time in years,
V = mixing cell volume [L]
n = total number of inflowing constituents
o = mixing cell starting concentration
e = Euler's number (constant)

For each mixing cell, the fully mixed equilibrium concentration ($t = \infty$) was calculated for the salt and nutrient loads of each scenario. This equilibrium concentration was used in conjunction with Equation 2 to calculate loading for a period of 25 annual salt and nutrient loading cycles, which exceeds the minimum ten year time frame required for impacts analyses under the state Recycled Water Policy. The annual cycles of loading are referred to as years, but due to local variations in groundwater mixing, mass loading, and migration of salts through the vadose zone, there can be a significant lag time between the annual loads and the projected trends in water quality. Equation 2 accounts for the residence time for a solute mass in the mixing cell.

The mass balance equations only require inflow volumes and concentrations to project water quality trends. The assumption is that the mixing cell is a fixed volume, therefore outflow is always equal to inflow. This is also true for the basin water balance at steady state (equilibrium). The concentration of outflow is equal to the concentration of the mixing cell at the beginning of a loading cycle.

Scenario Operations

Salt and nutrient loads were combined with the scenario water balances and mass balance equations to calculate concentration trends. The loading concentrations, evaporative enrichment, and attenuation factors used for selected constituents were based on literature review (see References), LOWRF influent and effluent data, and calibration to basin groundwater quality data. Concentration trends from the mass balance spreadsheet model were compared to assimilative capacity estimates for each mixing cell and average basin assimilative capacity.

State Recycled Water Policy requires assimilative capacity and antidegradation to be evaluated for basins and subbasins. The compartments used herein for mixing cells are not subbasins. Use of assimilative capacity and associated antidegradation thresholds has been evaluated using groundwater basin average concentrations. Concentration trends for individual mixing cells are provided, however, and may be useful to salt and nutrient management when considering implementation measures for mitigating salt and nutrient loading impacts.

2.5 Vadose Zone Transit Time

Accumulation of salt and nutrients can occur within the vadose zone, and accounts for variable transit times for applied salt and nutrient loads to reach groundwater. Salts, particularly within agricultural areas, are concentrated in soils by evapotranspiration processes (evaporative enrichment). Based on the relative difference between applied and deep percolating water, salts in applied irrigation water will concentrate due to a lack of significant consumptive uptake by plants. A portion of this concentrated salt is returned with the irrigation water that normally percolates to the aquifer, but a portion is stored in the soil until sufficient rainfall infiltration, or the addition of a leaching fraction to irrigation[2], flushes it into the aquifer. Transit time is a function of soil type and

2 Leaching fraction is the amount of water needed to flush excess salts from the root zone that would otherwise impact crop production.

chemistry, vadose zone thickness, irrigation methods, and rainfall quantity and distribution. For purposes of mass balance in this study, vadose zone transit time is assumed to be zero and the concentrated salt load is returned with irrigation infiltration.

2.6 Mixing Cell Water Quality

Current representative water quality for each basin compartment of the conceptual model is needed for evaluating assimilative capacity and establishing the initial conditions for mass balance calculations. Data from groundwater monitoring programs in the Los Osos Groundwater Basin, along with water quality studies, were used for assigning current water quality. Current water quality estimates are shown in Table 3 below. Data used for developing the estimates is included in Appendix B.

Table 3. Current Water Quality

Mixing Cell	TDS (mg/L)	Chloride (mg/L)	NO_3-N (mg/L)
Perched Aquifer[1]	380	93	15
Upper Aquifer[1]	380	88	15
Lower Aquifer - Western and Central Areas[2]	440	79	2
Lower Aquifer and Alluvial Aquifer - Eastern Area[3]	530	75	6
Basin Average (weighted)[4]	440	81	6

NOTES:
[1]Appendix B, Tables B1-B4
[2]Appendix B, Tables B5-B7
[3]Appendix B, Table B8
[4]by volume - sample calculation below

The basin average concentrations in Table 3 and in subsequent tables is weighted by volume in accordance with *Equation 1* above and the mixing cell storage volumes in Table 4 below. For example, the Basin average TDS in Table 3 is calculated as follows:

$$\frac{(380\text{ mg/L}*5.19\text{E}9\text{ L}) + (380\text{ mg/L}*3.33\text{E}10\text{ L}) + (440\text{ mg/l}*8.68\text{E}10\text{ L}) + (530\text{ mg/L}*2.21\text{E}10\text{ L}}{(5.19\text{E}9\text{ L} + 3.33\text{E}10\text{ L} + 8.68\text{E}10\text{ L} + 2.21\text{E}10\text{ L})} = 440\text{ mg/L}$$

2.7 Mixing Cell Storage Volumes

Mixing cell groundwater storage volumes are used in the mass balance equations. Groundwater in storage for basin areas and aquifers was estimated through a systematic approach of water level contouring, boundary definition, volume calculations, and aquifer property estimation (CHG, 2015). Table 4 summarizes the Spring 2015 groundwater storage volumes for the mass balance mixing cells.

Table 4. Groundwater in Storage[1]

Mixing Cell	Groundwater in Storage (Spring 2015)	
	Acre-Feet	Liters[3]
Perched Aquifer	4,200	5.18E9
Upper Aquifer	27,000	3.33E10
Lower Aquifer - Western and Central Areas[2]	70,400	8.68E10
Lower Aquifer and Alluvial Aquifer - Eastern Area	17,900	2.21E10
Total	119,500	1.47E11

NOTES: [1]LOBP Groundwater Monitoring Program 2015 Annual Report (CHG, 2015).
[2]excludes seawater intruded area
[3]Liters are used for weighted average calculations (e.g. Table 3)

3. SOURCE ANALYSIS

Natural sources, agricultural sources, residential sources, and animal waste are the principal sources of salt and nutrient loading in the basin under Baseline (pre-LOWRF) conditions. With LOWRF operation, recycled water reuse becomes another principal source of loading.

For mass balance calculations and antidegradation analysis, all salt and nutrient loads need to be converted into inflow concentrations. For example, the loads for agricultural fertilizer applications are represented as concentrations in irrigation return flows, and loads for natural sources and animal waste are represented as concentrations in percolation of precipitation. Some of the estimates for salt and nutrient loading, such as agricultural fertilizer applications, originate as a mass load per source unit per year. Other estimates, such as septic tank discharges or recycled water applications, originate as a concentration per source unit volume per year. A summary of NO_3-N loading factors along with salt and nutrient loading factors for inflow water quality are presented below.

3.1 Salt and Nutrient Loading Factors

Loading factors refer to the amount of salt or nutrient added to the groundwater system over time, per source unit. Loading factors for various sources are presented in Tables 5 and 6.

While total dissolved solids and chloride are relatively conservative in the vadose zone and groundwater, nitrates from residential fertilizer use, animal waste, and septic systems undergo varying degrees of attenuation through volatilization, plant uptake, and denitrification. Table 5 includes the per unit nitrogen loads, along with the attenuation factor used in the spreadsheet model.

As previously mentioned, salt and nutrient loading factors may also be described as concentrations for inflow source quality, as presented in Table 6. For example, the NO_3-N load for septic tank discharge is presented in both tables. For 830 AFY of septic tank discharge to leach fields (from Table 5), and a concentration of 56 mg/L nitrate as N (from Table 6), the resulting load is 152 pounds of nitrogen per acre-foot, which after 41% attenuation due to denitrification, would add a total of 74,500 pounds of nitrogen per year (lb/yr) to the groundwater basin[3].

Table 5. NO_3-N Loading Factors

Source	Total Units (Baseline)	NO_3-N (lb/year)		
		Per unit (lb/year)	Attenuation (loss)	Total (lb/year)
Natural (Basin wide)[1]	4,000 acres	3.1	(incorporated)	12,400
Septic Tank Discharge[2]	830 acre-feet	152	41%	74,500
Agriculture/Turf Fertilizer[3]	400 acres	150	68%	19,200
Residential Landscape/Turf Fertilizer[3]	370 acres	45	80%	3,300
Animal Waste[4]	200 Horses	110	79%	4,600
	4,400 Dogs	2.9	92%	1,000
	6,600 Cats	1.4	92%	700

NOTES: [1] calibrated to pre-development conditions.
[2] influent quality to LOWRF, calibrated to baseline conditions.
[3] Viers et al. (2012) and M&E (1995)
[4] M&E (1995)

3 Sample calculations:

56 mg/L NO_3-N * 1.23E6 L/AF * 2.20E-6 lb/mg = 152 lb/AF NO_3-N

830 AF/yr *152 lb/AF NO_3-N * (1-0.41) = 7.45E4 lb/yr NO_3-N

Table 6. Inflow Source Water Quality			
Source	**TDS (mg/L)**	**Chloride (mg/L)**	**NO_3-N (mg/L)**
Septic / LOWRF Influent (initial)[1]	790	200	56[2]
Septic / LOWRF Influent (transient)[1]	WS+352	WS+115	56[2]
Recycled Water (initial)[3]	713	200	6.6
Recycled Water (transient)[3]	IW-77	IW	6.6
Landscape Irrigation Return Flow[4]	WS*3.4+N load	WS*3.4	WS+N load
Agricultural Irrigation Return Flow[4]	WS*3.4+N load	WS*3.4	WS+N load
Perc. of Precip. with natural/animal[5]	146	36	3
Subsurface Bedrock Inflow[6]	493	50	0.2
Los Osos Creek Inflow[6]	540	53	0.2

NOTES: WS = domestic/irrigation water quality
IW = influent wastewater quality (same as septic discharge)
[1] based on initial water supply quality and LOWRF raw influent data (Appendix B, Table B14)
[2] mostly as ammonia-nitrogen (Appendix B, Table B14)
[3] based on LOWRF treated effluent data (Appendix B, Table B15)
[4] 3.4 evaporative enrichment factor calibrated to baseline conditions (Section 3.3)
[5] natural loading calibrated to pre-development conditions (Section 3.2)
[6] based on water quality data (Appendix B, Table B10)

Initial water quality for septic discharges and LOWRF influent are based on current water quality analyses (Appendix B, Table B14). The transient (time-dependent) water quality for septic discharges and LOWRF influent are expressed as a salt pick-up concentration added to the water supply quality. The water supply source is groundwater and quality will vary over time in accordance with the mixing equations. The salt pick-up, however, is from residential indoor activities and is relatively constant over time.

As shown in Table 6, there is also a salt loss component in transient recycled water TDS. Wastewater treatment at the LOWRF results in a reduction of influent water alkalinity during nitrification of ammonia (LOWRF influent and effluent data in Appendix B, Table B14 and B15). The LOWRF water quality data in Appendix B also show a slight decrease in chloride concentrations between the influent and effluent waste streams. The conservative assumption for salt and nutrient loading, however, is that no chloride is removed by the LOWRF.

3.2 Natural Sources

Natural sources of salt and nutrient loading include contributions from soils and rock, native vegetation and wildlife, and sea spray. An evaluation of natural nutrient loads was performed by determining the loads required to create historical water quality, as represented by available water quality results for TDS, chloride, and nitrate from the 1950s for the Upper Aquifer and from the 1970s and 1980s for the Lower Aquifer (pre-development water quality in Appendix B, Tables B11-B13). This pre-development hydrologic budget assumes that salt and nutrient loading from septic, fertilizer, domestic animals, and other anthropogenic sources are negligible. Percolation of precipitation is used by the mass balance spreadsheet model for transporting natural salt and nutrient loads to groundwater.

The historical background NO_3-N concentration ranged from 0.4 mg/L in the Lower Aquifer to 1.9 mg/L in the Perched and Upper Aquifer (Appendix B, Table B11 and B12). A nitrogen load of 12,500 pounds per year was necessary to produce similar background concentration in the mixing cells. Spread over approximately 4,000 acres of basin inland of the bay, the natural nutrient load is estimated at 3.1 pounds nitrogen per acre per year (Table 5). Using percolation of precipitation as the natural load transport mechanism resulted in an average NO^3-N concentration of 2 mg/L for recharge (Appendix C, Table C2).

Natural background (pre-development) TDS and chloride concentrations for the Perched and Upper Aquifer averaged 165 mg/L TDS and 37 mg/L chloride (Appendix B, Table B11). Lower Aquifer background quality averaged 356 mg/L TDS and 48 mg/L chloride (Appendix B, Table B12). Eastern Area alluvial and Lower Aquifer background quality averaged 397 mg/L TDS and 49 mg/L chloride (Appendix B, Table B13).

Using percolation of precipitation as the natural transport mechanism, an average TDS concentration of 141 mg/L and an average chloride of concentration of 35 mg/L was required to produce similar background concentrations in the mixing cells. Natural sources calibration results are presented in Appendix C, Table C1 and C2.

Although significant land use changes have occurred during development that would replace some of the natural load, the pre-development natural loading was added to all scenarios as a conservative measure to address uncertainty and account for minor loads associated with soil disturbance and weed abatement.

3.3 Agricultural Sources

Fertilizer is the main source of nitrogen loading from agricultural operations. Values of nitrogen loading for agricultural fertilizer in Los Osos was estimated by M&E (1995) at approximately 150 pounds nitrogen per acre (lbs N/acre) per year, with an attenuation factor of 80 percent, mostly due to volatilization and plant uptake. A review of more recent literature confirms an average typical application rate for crops of 150 lbs N/acre with an average nitrogen removal during harvest of 90 lbs N/acre (UC Davis, 2012). The remaining 60 lbs N/acre left in the field is assumed to undergo an additional 20 percent loss from denitrification prior to loading groundwater (M&E, 1995), for a net 68 percent total attenuation of applied nitrogen (48 lbs N/acre net loading).

Agricultural fertilizers do not represent a significant source of either dissolved solids or chloride. However, irrigation water drawn from basin aquifers contains a salt load. The bulk of irrigation water applied on fields is consumed via evapotranspiration, which results in increased concentration of salts in the soil. Over time, the salts left over from evaporation and crop evapotranspiration leach to groundwater where they add to the salinity of existing water quality. With each cycle of irrigation return flow, a significant portion of the salts are left behind in the fields through the evaporative enrichment process. A mass loading factor (multiplier) of 3.4 was derived by calibrating the salt and nutrient spreadsheet model to best match the baseline TDS, chloride, and NO_3-N concentrations in the Eastern Area, where agricultural return flows occur. This multiplication factor is applied to irrigation return flow concentrations and is used for evaporative enrichment of both agricultural and residential irrigation water (Table 6). Evaporative enrichment calibration results are presented in Appendix C, Table C3 and Figures C4, C5, and C6.

Figure 9 presents the basin areas with agricultural irrigation and LOWRF project recycled water use. Cross-referencing Figure 9 with Figure 4 shows that salt and nutrient loading sources associated with agriculture overlie the Eastern Area alluvial aquifer and Lower Aquifer.

3.4 Residential Sources

Residential sources include salt and nutrients associated with human waste, water softeners, residential fertilizer, household products, and domestic pets waste. The bulk of these salt and nutrients currently enter the groundwater basin via septic return flows. Residential fertilizer can leach to groundwater with irrigation return flow, and domestic pet waste and livestock loads are incorporated into the percolation of precipitation.

Attenuation of loads for septic system discharges can vary significantly due to site conditions, and was calibrated to provide a best fit to the average NO_3-N concentrations measured in the Perched Aquifer (15 mg/L, Table 3) under baseline conditions. The resulting attenuation factor was a 41 percent net removal of the nitrogen load due to subsurface denitrification processes (Table 5). The same attenuation rate also resulted in a close match with the average NO_3-N concentration in the Eastern Area mixing cell (6 mg/L, Table 3).

The major residential contribution to salt loading occurs during domestic indoor water use. Water is delivered by purveyors to customers, who introduce salts through softeners, detergents, household products, or waste. In order to isolate the residential salt loading component for the Los Osos Groundwater Basin, the TDS and chloride concentrations of the community water supply was subtracted from the corresponding concentrations of influent raw wastewater to the LOWRF. The resulting average salt pickup for the domestic indoor use cycle is estimated at 352 mg/L TDS and 115 mg/L chloride (Table 6).

Figure 10 depicts the residential salt and nutrient loading areas. Under baseline (2012) conditions, all residential areas were on septic systems, except for one housing tract that treats wastewater for use at Sea Pines golf course. The distribution of urban residential areas over the mixing cells (labeled Urban Perched, Urban Eastern, and Urban Upper) are shown, along with the LOWRF collection area (labeled Prohibition Zone). Recycled water use areas and disposal fields for wastewater treated at the LOWRF is also shown in Figure 9 and LOBP Figure 54 (Appendix A).

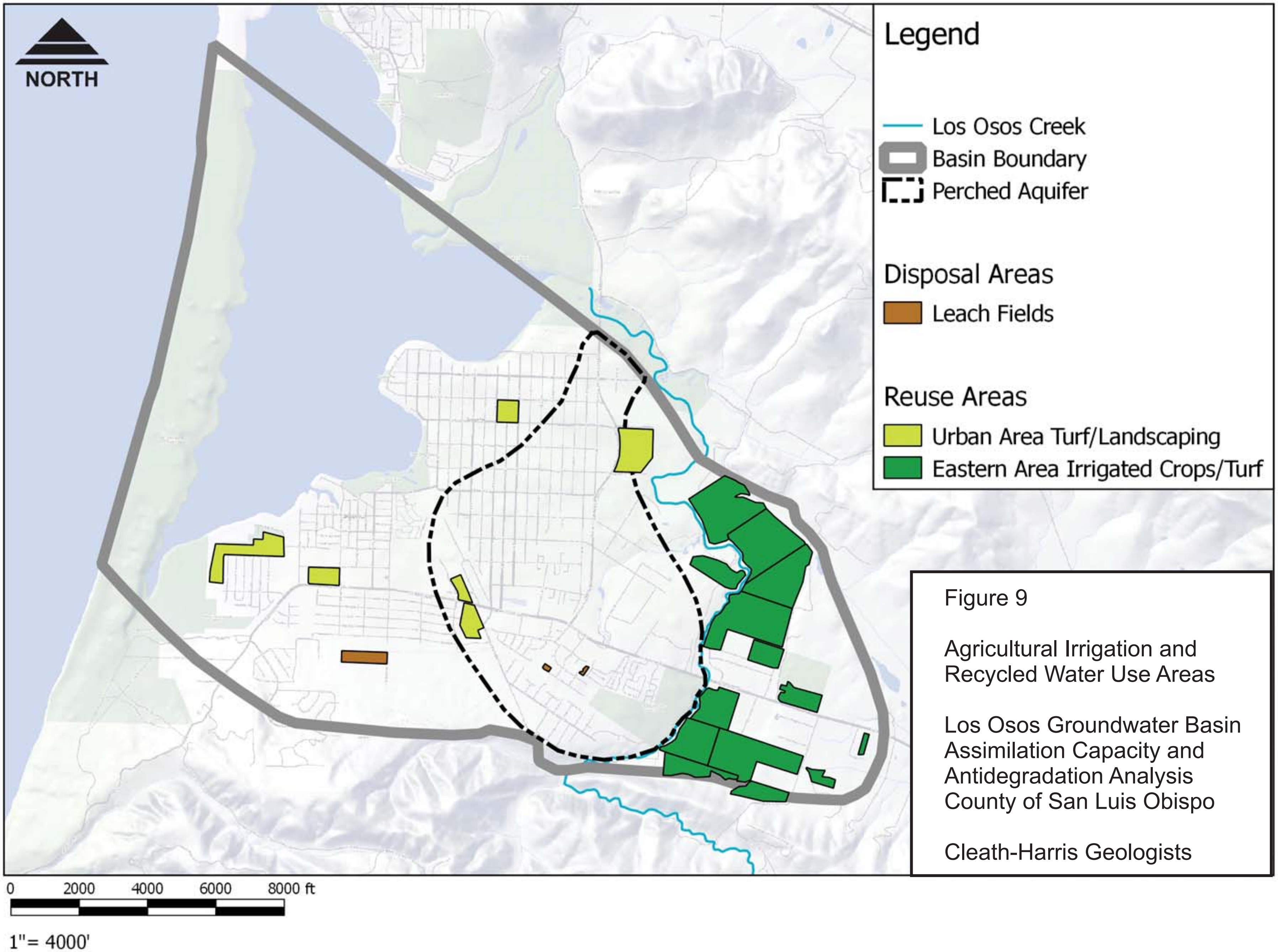

Figure 9

Agricultural Irrigation and Recycled Water Use Areas

Los Osos Groundwater Basin Assimilation Capacity and Antidegradation Analysis
County of San Luis Obispo

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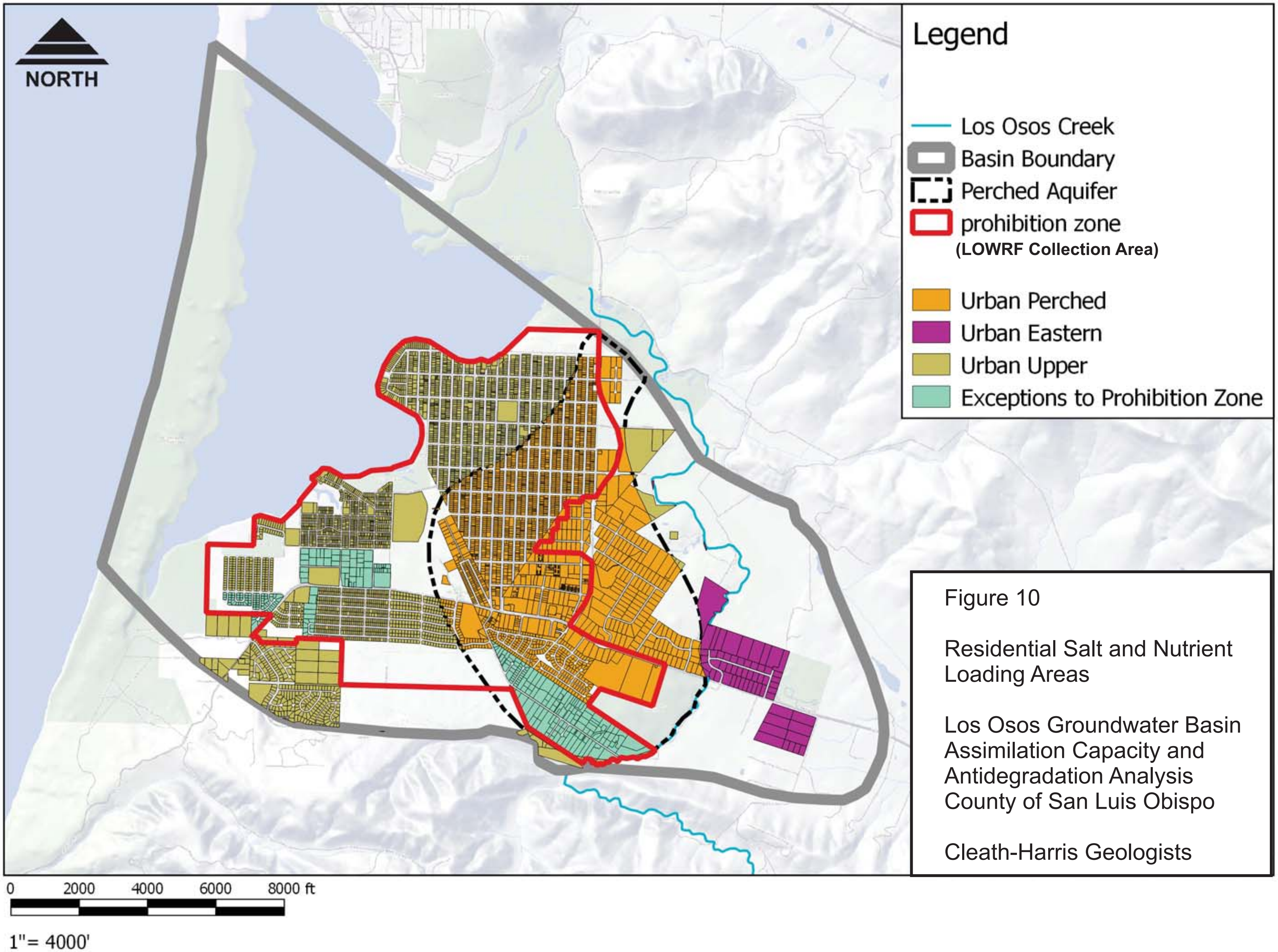

Figure 10

Residential Salt and Nutrient Loading Areas

Los Osos Groundwater Basin Assimilation Capacity and Antidegradation Analysis
County of San Luis Obispo

Cleath-Harris Geologists

3.5 Animal Waste

Animal waste is a diffuse nitrogen source, associated with both urine (primarily) and uncollected feces. Within the mass balance spreadsheet model, salt and nutrient loading from animal waste is added as a constituent of percolation of precipitation, which is the most likely mechanism to transport nutrients associated with animal waste to groundwater. As the residential population has not changed significantly over the last 20 years due to the building moratorium, Metcalf and Eddy's 1995 estimate of 200 horses, 4,400 dogs, and 6,600 cats is considered to be representative of the baseline domestic animal population (Table 5). These pet population estimates were based on San Luis Obispo County Health Department records for communal stables and dog registration, with adjustments for unregistered pets based on recommendations from the American Humane Society (M&E, 1995). After attenuation, the animal waste would create a mass load of 6,400 pounds of NO_3-N for the basin. Using percolation of precipitation for carrying the mass flux yields a concentration of 1 mg/L NO3-N[4]. The volume of percolation of precipitation used is 2,330 acre-feet per year (equivalent to 2.87E9 liters per year), which is derived from the basin water balance (Figure 6).

The National Academy of Sciences lists a recommended daily intake of chloride at 300 mg per day per dog, 60 mg per day per cat and 15,000 mg per day for each horse (NAS, 2006, 2007). If the totality of this daily load is conserved in the basin, then pets and livestock add approximately 1,720 kg/year chloride, or a concentration of 0.6 mg/L chloride to the percolation of precipitation flux load[5]. To calculate total dissolved solid load, daily dietary requirements for adult dogs, cats and horses were examined (NAS, 2006, 2007). It is assumed that in an adult animal, mass is conserved so daily intake is equal to daily output over time. Thus TDS is approximately equal to the sum of dietary major ions and cations for an average adult animal. Based on NAS dietary recommendations for soluble minerals, daily TDS contribution is estimated at 2785 mg/dog, 765 mg/cat, and 99,000 mg/horse. This would add 4.7 mg/L TDS to the percolation of precipitation flux load.

There is no change to salt and nutrient loading from animal sources under the No Further Development scenario (E+AC+U). For the buildout population scenario (E+ABC+UG), a conservative 36 percent increase salt and nutrient loads from animal waste is projected, which is proportional to the population increase at buildout. As previously mentioned, the buildout population is being re-evaluated by the County and is anticipated to decrease from the estimate presented in the LOBP.

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4 Calculations: 200 horses * 110 lb/yr NO3-N * (1-0.79) = 4,620 lb/yr
4,400 dogs * 2.9 lb/yr NO3-N * (1-0.92) = 1,020 lb/yr
6,600 cats * 1.4 lb/yr NON3-N * (1-0.92) = 740 lb/yr
Perc. of Precip loading: 6,380 lb/yr NO_3-N * 453593 mg/lb ÷ 2.87E9 L/yr = 1 mg/L NO_3-N

5 Calculations: 200 horses * 15,000 mg/d Cl * 365 d/yr ÷ 1E6 mg/kg = 1,095 kg/yr
4,400 dogs * 300 mg/d Cl * 365 d/yr ÷ 1E6 mg/kg = 482 kg/yr
6,600 cats * 60 mg/d Cl * 365 d/yr ÷ 1E6 mg/kg = 145 kg/yr
Perc. of Precip loading: 1,722 kg/yr Cl * 1E6 mg/kg ÷ 2.87E9 L/yr = 0.6 mg/L Cl

3.6 Seawater Intrusion

Seawater is a virtually unlimited, but highly undesirable, source of recharge to the groundwater basin. Both Upper and Lower Aquifers in the Los Osos Groundwater Basin extend offshore and are hydraulically connected to the Pacific Ocean. Seawater intrusion into the freshwater portion of the Lower Aquifer has been occurring for decades in the Western Area (CHG, 2016).

As shown in Figure 6, under steady state Baseline scenario conditions, approximately 70 acre-feet of seawater intrusion is estimated to occur annually (LOBP). This leads to elevated levels of both TDS and chloride in the Western Area Lower Aquifer. The salt and nutrient spreadsheet model calculates purveyor water supply quality based on the source aquifer quality and pumping distribution.

The Lower Aquifer is a major source of community water supply. Under the Baseline scenario with seawater intrusion occurring, TDS and chloride concentrations rise significantly in the water supply over time. The salt and nutrient loads of the domestic use cycle are added to the water supply, which then serves customers throughout the urban area, including those overlying the Perched Aquifer (Figure 4). Since a portion of the Perched Aquifer groundwater spills into the creek valley Alluvial Aquifer (Figure 6), salt loading from seawater intrusion can affect water quality in the Eastern Area.

Both the LOBP No Further Development and Population Buildout scenarios are designed to be sustainable, and eliminate the estimated 70 acre-feet of seawater intrusion under Baseline conditions. The LOWRF is an integral component of achieving sustainability, through the use of recycled water to reduce pumping, that will reduce the salt load to the basin by mitigating seawater intrusion.

4. BASIN ASSIMILATIVE CAPACITY

The Central Coast Regional Water Quality Control Board (Regional Board) website (http://www.waterboards.ca.gov/centralcoast/publications_forms/publications/basin_plan/bp_glossary.shtml) defines assimilative capacity as:

> *The capacity of a natural body of water to receive (a) wastewaters, without deleterious effects, (b) toxic materials, without damage to aquatic life or humans who consume the water, (c) BOD, within prescribed dissolved oxygen limits.*

Based on the above definition, the assimilative capacity of a groundwater basin to receive recycled water and return flows from irrigation would be the difference between ambient concentrations of a selected water quality constituent in groundwater and the maximum concentration (or water quality objective, if specified) of the constituent that would preclude deleterious effects. Assimilative capacity for salt loading has been evaluated using TDS and chloride concentrations, and nutrient loading has been evaluated using NO_3-N concentrations.

The Los Osos Groundwater Basin is in the Estero Bay planning area. The Regional Board 2016 Water Quality Control Plan lists median groundwater objectives for the following sub-basin/sub-areas of the Estero Bay planning area: Santa Rosa, Chorro, San Luis Obispo, and Arroyo Grande. The existing groundwater objectives for TDS ranges from 700 mg/L for Santa Rosa to 1,000 mg/L for Chorro. Groundwater objectives for chloride range from 100 mg/L liter in Santa Rosa and Arroyo Grande to 250 mg/L in Chorro. Groundwater objectives for NO_3-N range from 5 mg/L for Santa Rosa, San Luis Obispo, and Chorro to 10 mg/L for Arroyo Grande. Existing water quality objectives are shown in Table 7.

Table 7. Existing Median Groundwater Objectives

Area	TDS	Chloride	NO_3-N
	Mg/L		
Santa Rosa	700	100	5
Chorro	1,000	250	5
San Luis Obispo	900	200	5
Arroyo Grande	800	100	10

Source: RWQCB, 2016

There are no published median groundwater objectives for Los Osos. As a basin with documented nitrate and seawater intrusion problems, the median groundwater objectives used for the assimilative capacity analysis are based on the highest existing median objectives for the Estero Bay Area: 1,000 mg/L TDS, 250 mg/L chloride, and 10 mg/L NO_3-N.

A TDS concentration of 1,000 mg/L is the Upper Limit of the Secondary Maximum Contaminant Level (MCL) for drinking water in California. A chloride concentration of 250 mg/L is the Recommended Limit of the Secondary MCL for drinking water in California. An NO_3-N concentration of 10 mg/L is the Primary MCL for drinking water in California (CCR Title 22, Division 45, Chapter 15, Article 4 (Primary Standards - Inorganic Chemicals), Table 64431-A, and Article 16 (Secondary Drinking Water Standards), Table 64449-B.

Using the current water quality for the aquifers from Table 3, the assimilative capacity of each mixing call has been calculated, along with a weighted basin average according the storage volumes of each mixing cell. Results of the assimilative capacity calculations are presented in Tables 8, 9 and 10.

Table 8. TDS Assimilative Capacity - Los Osos Groundwater Basin					
Mass Mixing Cell	**Allowable TDS[1] [mg/L]**	**Current TDS[2] [mg/L]**	**Assimilative Capacity[3] [mg/L]**	**10% Assimilative Capacity [mg/L]**	**20% Assimilative Capacity [mg/L]**
Perched Aquifer	1000	380	620	62	124
Upper Aquifer	1000	380	620	62	124
Lower Aquifer-Western and Central Area	1000	440	560	56	112
Lower Aquifer and Alluvial Aquifer - Eastern Area	1000	530	470	47	94
BASIN AVERAGE (weighted)[4]	**1000**	**440**	**560**	**56**	**112**

[1]Allowable TDS from maximum existing median objective for Estero Bay planning area.
[2]Current TDS from Appendix C
[3]Allowable TDS - Current TDS = Assimilative Capacity; 1000 mg/L - 380 mg/L = 620 mg/L for Perched Aquifer.
[4]Basin averages weighted by volume (sample calculation in Section 2.6).

The 10 percent and 20 percent assimilative capacity values are thresholds established by the State Water Resources Control Board (SWRCB) with respect to demonstrating compliance with SWRCB Resolution No. 68-10 (Statement of Policy with Respect to Maintaining High Quality of Waters in California) for recycled water projects:

> *"A project that utilizes less than 10 percent of the available assimilative capacity in a basin/sub-basin (or multiple projects utilizing less than 20 percent of the available assimilative capacity in a basin/sub-basin) need only conduct an antidegradation analysis verifying the use of the assimilative capacity.* (SWRCB Resolution 2009-0011).

Table 9. Chloride Assimilative Capacity - Los Osos Groundwater Basin					
Mass Mixing Cell	Allowable Chloride[1] [mg/L]	Current Chloride[2] [mg/L]	Assimilative Capacity[3] [mg/L]	10% Assimilative Capacity [mg/L]	20% Assimilative Capacity [mg/L]
Perched Aquifer	250	93	157	16	31
Upper Aquifer	250	88	162	16	32
Lower Aquifer-Western and Central Area	250	79	171	17	34
Lower Aquifer and Alluvial Aquifer - Eastern Area	250	75	175	18	35
BASIN AVERAGE (weighted)[4]	**250**	**81**	**169**	**17**	**34**

[1] Allowable chloride from maximum existing median objective for Estero Bay planning area.
[2] Current chloride from Appendix C
[3]Allowable chloride - Current chloride = Assimilative Capacity; 250 mg/L - 93 mg/L = 157 mg/L for Perched Aquifer.
[4] Basin averages weighted by volume (sample calculation in Section 2.6).

Table 10. NO_3-N Assimilative Capacity - Los Osos Groundwater Basin					
Mass Mixing Cell	Allowable NO_3-N[1] [mg/L]	Current NO_3-N[2] [mg/L]	Assimilative Capacity[3] [mg/L]	10% Assimilative Capacity [mg/L]	20% Assimilative Capacity [mg/L]
Perched Aquifer	10	15	-5 (none)	0 (none)	0 (none)
Upper Aquifer	10	15	-5 (none)	0 (none)	0 (none)
Lower Aquifer-Western and Central Area	10	2	8	0.8	1.6
Lower Aquifer and Alluvial Aquifer - Eastern Area	10	6	4	0.6	1.2
BASIN AVERAGE (weighted)[4]	**10**	**6**	**4**	**0.4**	**0.8**

[1] Allowable NO_3-N from maximum existing median objective for Estero Bay planning area.
[2] Current NO_3-N from Appendix C
[3]Allowable NO_3-N - Current NO_3-N = Assimilative Capacity; 10 mg/L - 15 mg/L = -5 mg/L for Perched Aquifer. A negative assimilative capacity is equivalent to no capacity.
[4] Basin averages weighted by volume (sample calculation in Section 2.6).

5. ANTIDEGRADATION ANALYSIS

The antidegradation analysis evaluates potential impacts to water quality from the LOBP project scenarios, which include the LOWRF, and compares those impacts to the current assimilative capacity of the groundwater basin. The analysis is required under state Recycled Water Policy (SWRCB Resolution No. 2013-0003) for operating the LOWRF, which mandates compliance with SWRCB Resolution 68-16 (Statement of Policy with Respect to Maintaining High Quality of Waters in California). An antidegradation analysis is required for irrigation with recycled water or for groundwater recharge with recycled water, and is also performed as part of a Salt and Nutrient Management Plan. This antidegradation analysis has been prepared to satisfy both the Salt and Nutrient Management Plan requirements and operating permit requirements of the LOWRF. Tables of results from the mass balance spreadsheet model are in Appendix D. Graphs of water quality trends for individual mixing cells, and for the Baseline scenario, are included in Appendix E.

5.1 Total Dissolved Solids Trends

Table 11 presents the assimilative capacity of TDS used by the LOBP No Further Development scenario (E+AC+U) and the assimilative capacity used by the LOBP Population Buildout scenario (E+ABC+UG). Positive values of assimilative capacity use indicate a reduction in capacity, while negative values of use indicate a gain, or improvement, in capacity.

Table 11. TDS Antidegradation Analysis - Los Osos Groundwater Basin[1]

Mass Mixing Cell	Assimilative Capacity [mg/L]	Assimilative Capacity Used (+lost -gained)							
		No Further Development (E+AC+U)				Population Buildout (E+ABC+UG)			
		10 Years		25 Years		10 Years		25 Years	
		mg/L	%	mg/L	%	mg/L	%	mg/L	%
Perched Aquifer	620	-65.7	-10.6	-80.4	-13.0	-33.6	-5.4	-35.2	-5.7
Upper Aquifer	620	-18.5	-3.0	-34.2	-5.5	-10.2	-1.7	-15.8	-2.5
Lower Aquifer-Western and Central Area	560	11.7	2.1	26.2	4.7	13.5	2.4	33.2	5.9
Lower Aquifer and Alluvial Aquifer - Eastern Area	470	8.8	1.9	14.2	3.0	22.2	4.7	39.0	8.3
BASIN TOTAL	**560**	1.7	0.3	7.0	1.3	7.8	1.4	20.7	3.7

[1]Data tables with sample calculations in Appendix D, Tables D3 and D5.

Gains of up to 13 percent assimilative capacity are achieved for TDS in the Perched and Upper Aquifer, due primarily to the collection, treatment and redistribution of septic discharges within the prohibition zone for No Further Development at 25 years. Conversely, use of up to 8.3 percent of the assimilative capacity for TDS, corresponding to 39 mg/L, is projected in the Eastern Area for the Population Buildout scenario after 25 years. The Eastern Area would receive a net increase in salt loading under Population Buildout due to recycled water use in lieu of groundwater pumping (the TDS of recycled water is greater than current Eastern Area water quality). The weighted average use of TDS assimilative capacity in the basin is 1.3 percent with the LOWRF operating and No Further Development, and 3.7 percent with the LOWRP operating at Population Buildout (cumulative projects) after 25 years.

Figure 11 shows the basin average trends in TDS concentrations under LOBP project scenarios for No Further Development and Population Buildout. Trends in TDS for individual mixing cells are included in Appendix E. The Baseline scenario water quality trend is also included in Appendix E, for TDS trends comparison (Figures E1-E5). Seawater intrusion, along with continued septic tank discharges results in a much greater level of water quality degradation under the 2012 Baseline (pre-LOWRF) conditions than under the sustainable LOBP scenarios.

5.2 Chloride Trends

Table 12 presents the assimilative capacity of chloride used by the LOBP No Further Development scenario (E+AC+U) and the assimilative capacity used by the LOBP Population Buildout scenario (E+ABC+UG). Positive values of assimilative capacity use indicate a reduction in capacity, while negative values of use indicate a gain, or improvement, in capacity.

Table 12. Chloride Antidegradation Analysis - Los Osos Groundwater Basin[1]

Mass Mixing Cell	Assimilative Capacity [mg/L]	Assimilative Capacity Used (+lost -gained)							
		Scenario E+AC+U				Scenario E+ABC+UG			
		10 Years		25 Years		10 Years		25 Years	
		mg/L	%	mg/L	%	mg/L	%	mg/L	%
Perched Aquifer	157	-19.5	-12.4	-23.6	-15.0	-12.8	-8.1	-14.9	-9.5
Upper Aquifer	162	-1.4	-0.8	-3.8	-2.4	0.4	0.3	0.6	0.4
Lower Aquifer-Western and Central Area	171	1.4	0.8	3.2	1.9	1.4	0.8	4.3	2.5
Lower Aquifer and Alluvial Aquifer - Eastern Area	175	1.7	1.0	2.8	1.6	10.8	6.2	20.4	11.6
BASIN TOTAL	**169**	0.1	0.1	0.6	0.4	2.1	1.2	5.2	3.1

[1]Data tables with sample calculations in Appendix D, Tables D3 and D5.

Gains of up to 15 percent assimilative capacity are achieved for chloride in the Perched and Upper Aquifer for No Further Development at 25 years, due primarily to the collection, treatment and

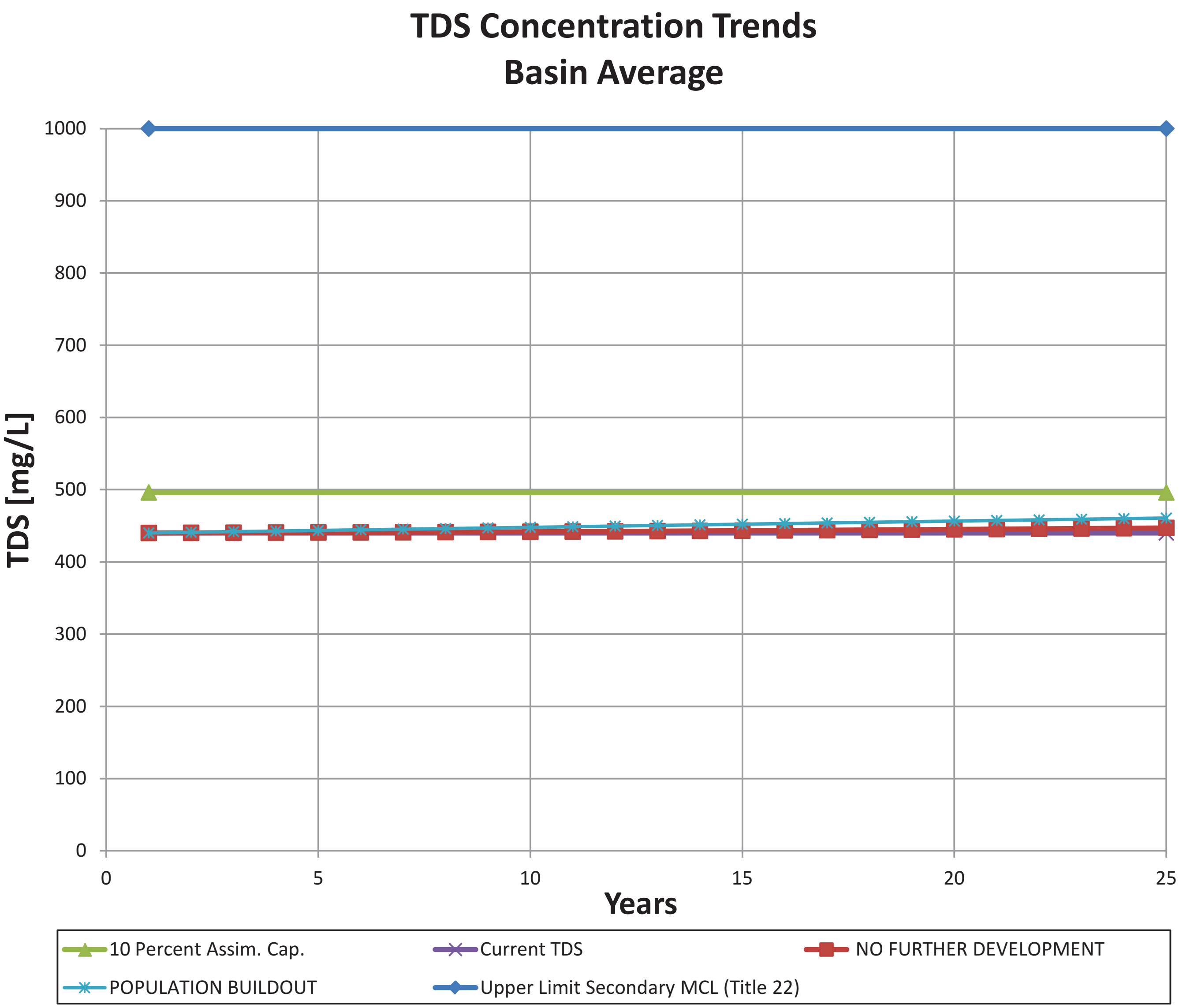

Figure 11

Basin Average TDS Concentration Trends

Los Osos Groundwater Basin
Assimilation Capacity and
Antidegradation Analysis
County of San Luis Obispo

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redistribution of septic discharges within the prohibition zone. Use of up to 11.6 percent of the assimilative capacity for chloride, corresponding to 20.4 mg/L, is projected in the Eastern Area for the Population Buildout scenario after 25 years. As with the TDS increase in the Eastern Area, a net increase in chloride is projected due to the use of recycled water in place of groundwater for irrigation. The weighted average use of assimilative capacity of chloride in the basin is 0.4 percent with the LOWRF operating after 25 years with No Further Development, and 3.1 percent with the LOWRP operating at 25 years with Population Buildout.

Figure 12 shows the basin average trends in chloride concentrations under LOBP project scenarios for No Further Development and Population Buildout. Trends in chloride for individual mixing cells are included in Appendix E (Figures E6-E10). The Baseline scenario water quality trend is also included in Appendix E, for chloride trends comparison. As with the TDS Baseline trend, seawater intrusion, along with continued septic tank discharges results in a much greater level of water quality degradation under the 2012 Baseline (pre-LOWRF) conditions than under the sustainable LOBP scenarios.

5.3 NO_3-N Trends

Table 13 presents the assimilative capacity of NO_3-N used by the LOBP No Further Development scenario (E+AC+U) and the assimilative capacity used by the LOBP Population Buildout scenario (E+ABC+UG). Positive values of assimilative capacity use indicate a reduction in capacity, while negative values of use indicate a gain, or improvement, in capacity.

Table 13. NO_3-N Antidegradation Analysis - Los Osos Groundwater Basin[1]

Mass Mixing Cell	Assimilative Capacity [mg/L]	Assimilative Capacity Used (+lost -gained)							
		No Further Development (E+AC+U)				Population Buildout (E+ABC+UG)			
		10 Years		25 Years		10 Years		25 Years	
		mg/L	%	mg/L	%	mg/L	%	mg/L	%
Perched Aquifer	-5	-7.9	-159	-9.6	-192	-7.5	-151	-9.1	-182
Upper Aquifer	-5	-5.1	-101	-8.5	-170	-5.0	-99.5	-8.2	-165
Lower Aquifer-Western and Central Area	8	1.0	12.3	1.8	22.6	1.0	12.0	1.9	24.0
Lower Aquifer and Alluvial Aquifer - Eastern Area	4	0.7	16.3	0.9	23.1	1.1	26.3	1.6	40.5
BASIN TOTAL	**4**	-0.7	-18.7	-1.1	-26.5	-0.6	-15.4	-0.8	-20.5

[1]Data tables with sample calculations in Appendix D, Tables D3 and D5.

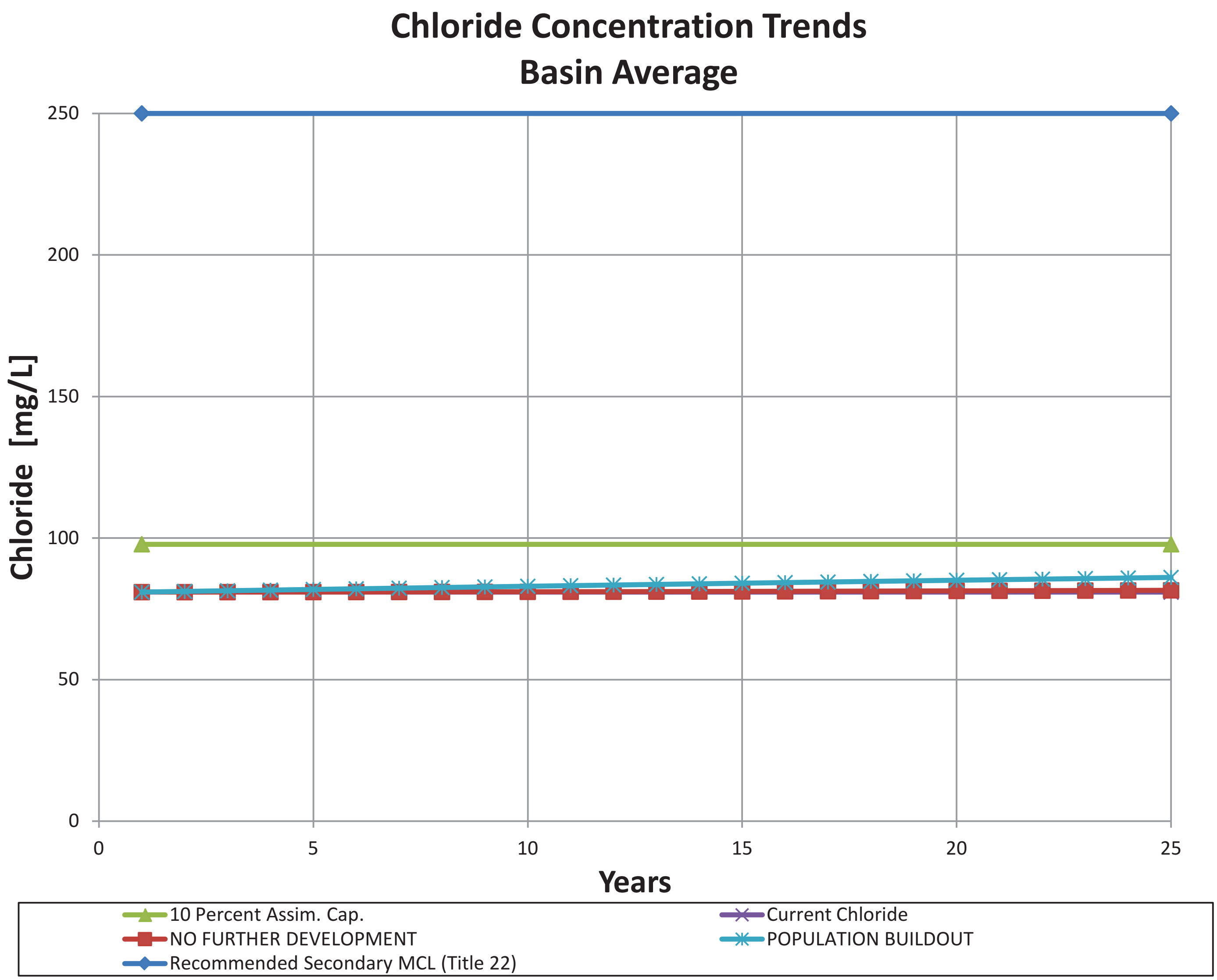

Figure 12

Basin Average Chloride ConcentrationTrends

Los Osos Groundwater Basin
Assimilation Capacity and
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Gains of up to 192 percent assimilative capacity (from negative effective capacity to positive capacity) are achieved for NO_3-N in the Perched and Upper Aquifer after 25 years of No Further Development, due primarily to the collection, treatment and redistribution of septic discharges within the prohibition zone. Use of up to 41 percent of the assimilative capacity for NO_3-N, corresponding to 1.6 mg/L, is projected in the Eastern Area for the Population Buildout scenario after 25 years. Unlike TDS and chloride increases in the Eastern Area, the net increase in NO_3-N is not due to the use of recycled water in place of groundwater for irrigation (both have similar NO_3-N concentrations), but due to on-going nitrogen loading, primarily from fertilizer applications. The NO_3-N concentrations in the Western and Central Area Lower Aquifer also increase under Baseline and LOBP project scenarios, primarily due to the low initial concentration in the lower aquifer, which over time moves closer toward the average basin NO_3-N concentration. The weighted average use of assimilative capacity of NO_3-N in the basin is a 26.5 percent gain in assimilative capacity with the LOWRF operating after 25 years of No Further Development, and a 20.5 percent gain with the LOWRP operating for 25 years at Population Buildout.

Figure 13 shows the basin average trends in NO3-N concentrations under LOBP project scenarios for No Further Development and Population Buildout. Trends in NO3-N for individual mixing cells are included in Appendix E (Figures E11-E15). The Baseline water quality trend is also included in Appendix E for NO3-N trend comparison. Continued septic tank discharges would result in a much greater level of water quality degradation with respect to NO_3-N under the 2012 baseline (pre-LOWRF) conditions than under the sustainable LOBP scenarios.

5.4 Conclusions

State Recycled Water Policy requires assimilative capacity and antidegradation to be evaluated for basins and subbasins. The compartments used herein for mixing cells are not subbasins, therefore, use of assimilative capacity and associated antidegradation thresholds has been evaluated using groundwater basin average concentrations.

Results of the antidegradation analysis indicates LOWRF operation over a 25-year period with No Further Development uses less than 2 percent of the assimilative capacity of the basin for TDS and chloride, while providing a net gain in basin assimilative capacity for NO_3-N. LOWRF operation over a 25-year period with Population Buildout (cumulative projects) uses less than 4 percent of the assimilative capacity of the basin for TDS and chloride, while providing a net gain in basin assimilative capacity for NO_3-N. These results show compliance with antidegradation criteria for recycled water projects established by the State Water Resources Control Board (SWRCB Resolution 2009-0011). Table 14 summarizes the antidegradation analysis from Tables 11 - 13.

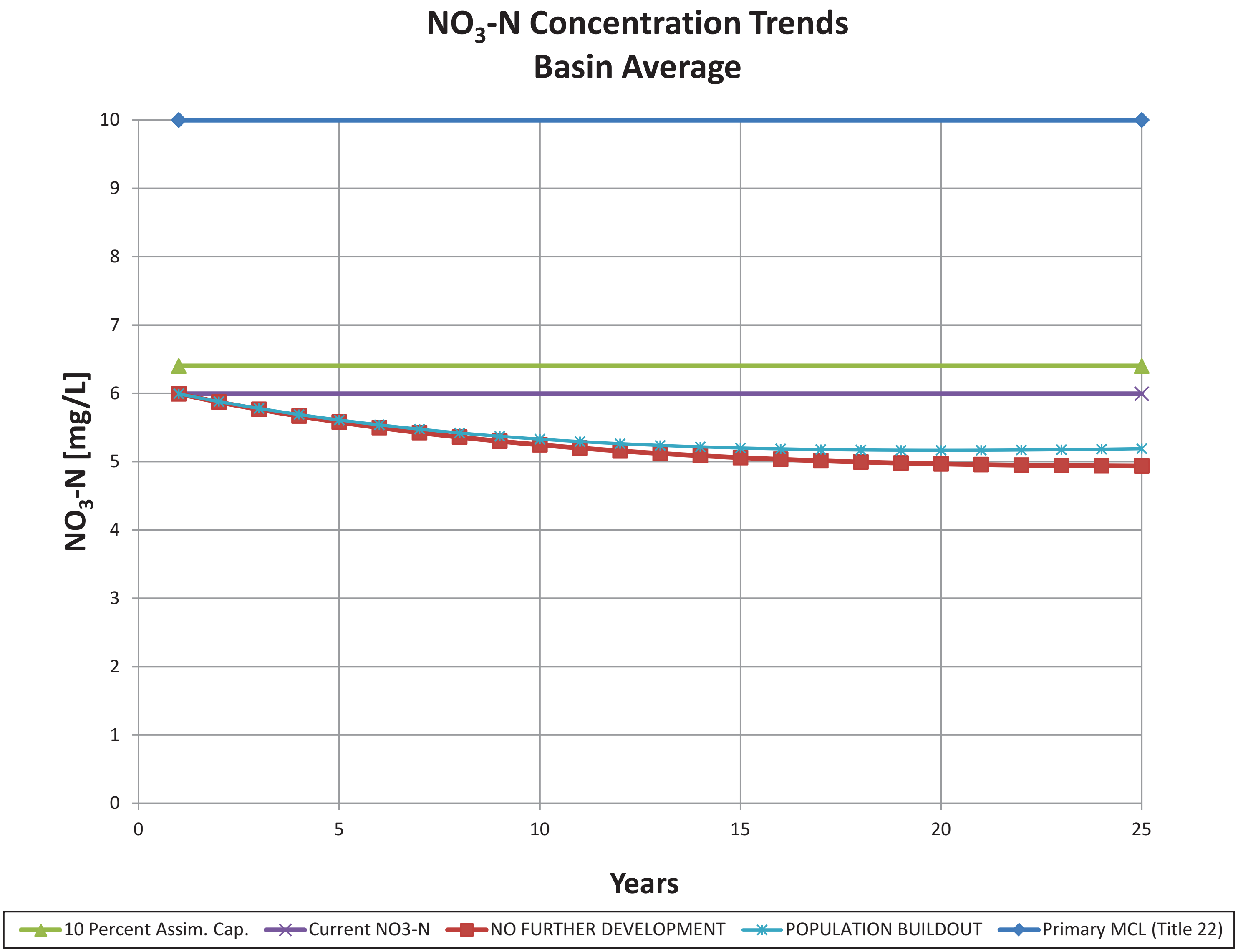

Figure 13

Basin Average NO_3-N Concentration Trends

Los Osos Groundwater Basin Assimilation Capacity and Antidegradation Analysis
County of San Luis Obispo

Cleath-Harris Geologists

Table 14. Basin Antidegradation Analysis - Los Osos Valley Groundwater Basin									
Constiuent	Assimilative Capacity [mg/L]	Assimilative Capacity Used (+lost -gained)							
		No Further Development (E+AC+U)				Population Buildout (E+ABC+UG)			
		10 Years		25 Years		10 Years		25 Years	
		mg/L	%	mg/L	%	mg/L	%	mg/L	%
TDS	560	1.7	0.3	7.0	1.3	7.8	1.4	20.7	3.7
Chloride	169	0.1	0.1	0.6	0.4	2.1	1.2	5.2	3.1
NO_3-N	4	-0.7	-18.7	-1.1	-26.5	-0.6	-15.4	-0.8	-20.1

Results for assimilative capacity use within mixing cells vary, and can exceeding 20 percent for NO_3-N in the Eastern Area and Lower Aquifer (Table 13). As previously mentioned, however, continued septic tank discharges would result in a much greater level of water quality degradation with respect to NO_3-N under the 2012 baseline (pre-LOWRF) conditions than under the sustainable LOBP scenarios.

6. IMPLEMENTATION MEASURES

Potential implementation measures for the management of salt and nutrient loading on a basin-wide scale are presented in Tables 15, 16, and 17. Table 15 include measures associated with the community water supply, Table 16 includes measures associated with basin recharge, and Table 17 includes measures associated with wastewater and reclaimed water quality. The status of implementation measures are classified as in progress or potential future measures.

Table 15: IMPLEMENTATION MEASURES - WATER SUPPLY			
Status	Specific Measure	Description	Effect
In progress[1]	Improve Community Water Use Efficiency	Continued measures to improve community water efficiency as technology and money are available	Reduces pumping induced seawater intrusion
Potential future measure	Softening of Groundwater Supplies	Advanced treatment to soften community water supplies	Reduces need for self-regenerating water softeners. Fewer self-regenerating water softeners will reduce the salt load in residential wastewater stream

[1] LOBP Urban Water Use Efficiency Program

Table 16: IMPLEMENTATION MEASURES - RECHARGE/RETURN FLOW			
Status	**Specific Measure**	**Description**	**Effect**
Potential future measure	Expand LOWRF Collection Area	Expand LOWRF connections to septic systems within Basin but outside current collection area	Reduces nitrate loading From septic discharge
In progress[1]	Evaluate/Adopt Recharge Projects using Recycled Water	Evaluate/optimize discharge to improve efficiency at reducing/reversing seawater intrusion	Increases freshwater head to limit seawater intrusion
In progress[2]	Improve Stormwater Capture	Identify and consider new projects For additional capture/infiltration of stormwater	Increases recharge of low salt/nutrient concentration water
In progress[3]	Agricultural Grower Education and Outreach	Optimize fertilization/irrigation techniques to minimize nitrate loading and improve irrigation efficiency	Reduce fertilizer use (Nitrate Loading), Reduce water use and associated concentration of salts in soil
In progress[4]	Improve Domestic Irrigation Efficiency	Outreach/incentives to use native plants and/or xeroscapes in landscaping	Reduces salt and nutrient loading and salt concentration in domestic irrigation return

[1] Broderson disposal site completed, discharge to Los Osos Creek being evaluated
[2] Septic tank repurposing program in progress
[3] Regional Board Irrigated Lands Regulatory Program
[4] LOBP Urban Water Use Efficiency Program

Table 17: IMPLEMENTATION MEASURES - WASTEWATER			
Status	**Specific Measure**	**Description**	**Effect**
Potential future measure	Source Control-Chloride	Education/outreach/regulation to reduce the number of self-regenerating water softeners	Fewer self-regenerating water softeners will reduce the salt load in residential wastewater
Potential future measure	Regulatory	Ordinance limiting or banning self-regenerating water softeners from discharging to the sanitary sewer	Reduces salt loading in wastewater stream
Potential future measure	Regulatory	Ordinance limiting or banning discharge of saltwater or brine from commercial or industrial activities	Reduces salt loading in wastewater stream

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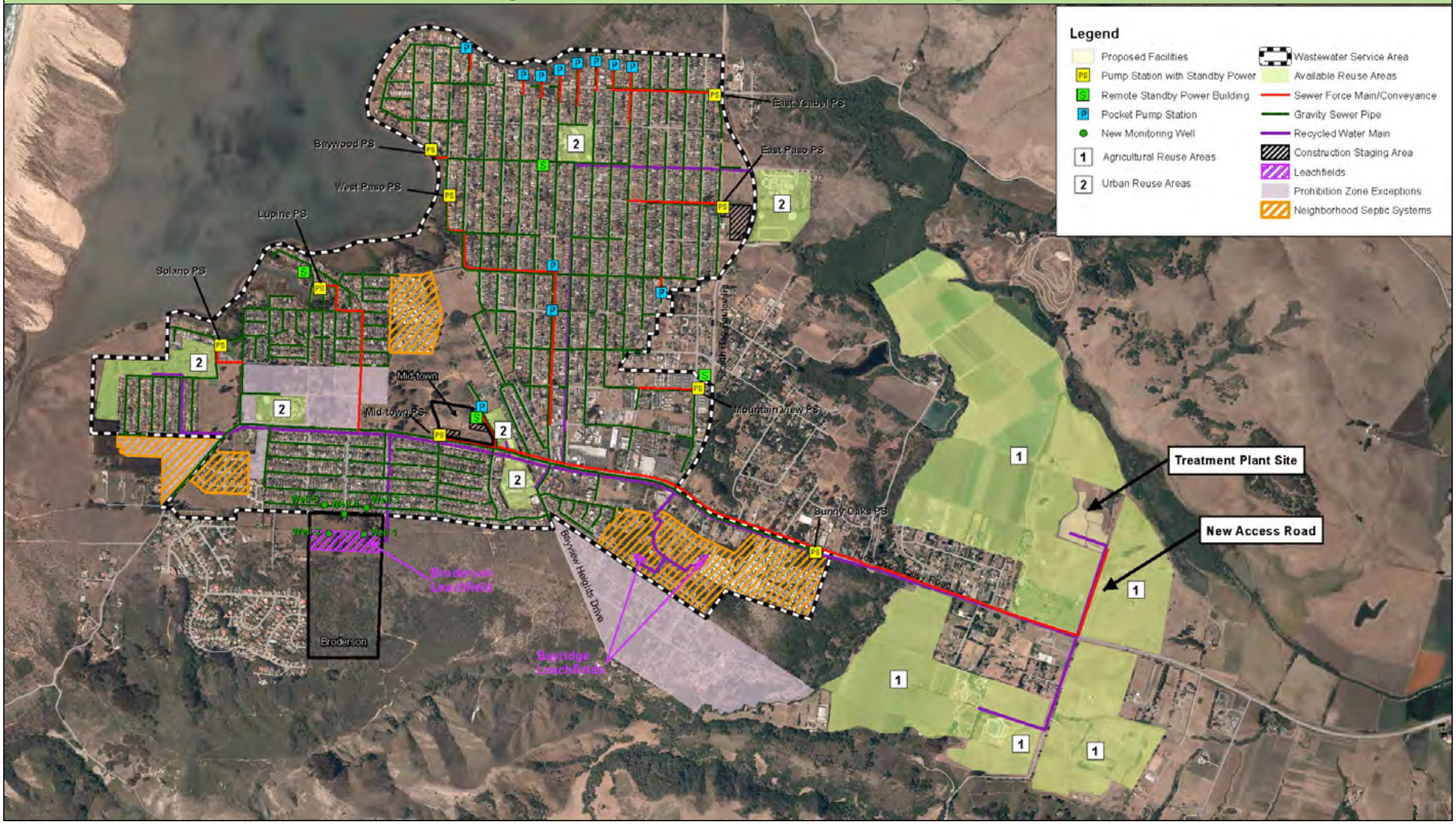
APPENDIX A

Los Osos Basin Plan Figure 54:

Los Osos Wastewater Project Map

Figure 54. Los Osos Wastewater Project Map



SOURCE: Los Osos Basin Plan (ISJ, 2015)

APPENDIX B

Water Quality Data

TABLE B1
PERCHED AQUIFER WATER QUALITY- COUNTY BASELINE

Well ID	SAMPLE DATE						
	Aug-12	Jun-13	Jan-14	May-14	Oct-14	May-15	Nov-15
	NO3-N (mg/L)						
30S/11E-8Ma	2.5	2.8	2.5	2.3			
30S/11E-8Mb	32.5	77.6	57				
30S/11E-8N2	2.1	2.8	2.8	3.5	4.5	8.3	9.2
30S/11E-17F4	0.6	0.3	0.92	1	1.1	0.9	1
30S/11E-17N4			7.4	7.4	8.2	7.7	7.1
30S/11E-18B1	7.1	11.7	20	18.3	22	14.5	22
30S/11E-18J6	3.5	3.6	12	10.8	9.3	10.4	11.3
30S/11E-18L4	18.2	27.4	18	19.6	29	29.6	32.6
30S/11E-18N1	25.9	27.9	28	27.8	23	25.4	24.8
30S/11E-18R1	21.1	20	18	18	18	17.2	
AVERAGE NO3-N	**15**	**mg/L**					

Well ID	SAMPLE DATE						
	Aug-12	Jun-13	Jan-14	May-14	Oct-14	May-15	Nov-15
	TDS (mg/L)						
30S/11E-8Ma	180	190	205	190			
30S/11E-8Mb	790	970	775				
30S/11E-8N2	100	70	95	90	120	150	150
30S/11E-17F4	440	390	350	380	530	440	420
30S/11E-17N4			225	200	190	220	190
30S/11E-18B1	400	460	580	570	640	380	410
30S/11E-18J6	370	380	340	320	350	360	360
30S/11E-18L4	490	490	430	520	620	520	510
30S/11E-18N1	440	440	475	420	420	410	410
30S/11E-18R1	370	360	365	360	450	330	
AVERAGE TDS	**380**	**mg/L**					

Well ID	SAMPLE DATE						
	Aug-12	Jun-13	Jan-14	May-14	Oct-14	May-15	Nov-15
	CHLORIDE (mg/L)						
30S/11E-8Ma	42	51	170		53		
30S/11E-8Mb	214	249	150		46		
30S/11E-8N2	14	16	63	16	51	29	32
30S/11E-17F4	122	136	120	132	70	140	145
30S/11E-17N4			96	48		46	46
30S/11E-18B1	89	133	130	175	160	70	73
30S/11E-18J6	52	63	33	51	140	62	65
30S/11E-18L4	124	133	160	106		117	104
30S/11E-18N1	108	105	220	108		80	86
30S/11E-18R1	87	89	13	83	22	74	
AVERAGE CHLORIDE	**93**	**mg/L**					

DATA SOURCE: **County Baseline Groundwater Monitoring Program (2012-2015)**

TABLE B2
UPPER AQUIFER WATER QUALITY - COUNTY BASELINE

Well ID	SAMPLE DATE						
	Aug-12	Jun-13	Jan-14	May-14	Oct-14	May-15	Nov-15
	NO3-N (mg/L)						
30S/10E-13G	11.7	9.7	13	15.3	12	13.1	10
30S/10E-13H	2.3	2.2	3.6	4	3.7	3.4	5.1
30S/10E-13L5	17.5	16	10	17.2	22	26	27.8
30S/10E-13Q1	30.4	25.7	19	29.9	29	28.8	28.8
30S/10E-24A	17	15.9	15	17.4		13.4	18.6
30S/11E-7K3	14.4	17.3	15	19.2	20	24	21.9
30S/11E-7L3	19	18.7	21	22	21	19.4	21.6
30S/11E-7N1	3.8	5.2	5.5	6.3	6	6.4	7.2
30S/11E-7Q1	15.7	18.4	18	10.8	25	26.5	23.4
30S/11E-7R1	13.1	16.3	18	21.9	18	17.6	19.5
30S/11E-17D	19.1	19.8	19	19.6	18	24.2	22.7
30S/11E-17E9	16.6	15.5	14	17.1	13	14.4	16.1
30S/11E-18A	10.9	13.1	16				
30S/11E-18C1	16.1	17.3	18	18.7	17	16.8	17.5
30S/11E-18E1	8.7	9.9	8.9	10.9	8.3	10.6	11.1
30S/11E-18L3	4.2	5	9.4	5.6	8.4	10.8	7.9
AVERAGE NO3-N	**15**	**mg/L**					

Well ID	SAMPLE DATE						
	Aug-12	Jun-13	Jan-14	May-14	Oct-14	May-15	Nov-15
	TDS (mg/L)						
30S/10E-13G	330	290	440	420	580	660	600
30S/10E-13H	140	110	140	180	200	230	220
30S/10E-13L5	510	540	435	430	470	510	520
30S/10E-13Q1	700	650	795	580	670	600	610
30S/10E-24A	330	310	410	500		490	430
30S/11E-7K3	520	600	560	550	810	590	570
30S/11E-7L3	430	430	520	470	490	410	440
30S/11E-7N1	200	190	200	200	320	360	390
30S/11E-7Q1	580	500	525	560	550	540	490
30S/11E-7R1	450	480	530	500	660	470	430
30S/11E-17D	350	400	405	340	470	460	450
30S/11E-17E9	390	370	375	390	280	340	350
30S/11E-18A	360	380	400				
30S/11E-18C1	540	520	545	490	690	510	540
30S/11E-18E1	260	290	270	310	250	290	270
30S/11E-18L3	200	200	215	170	210	210	280
AVERAGE TDS	**424**	**mg/L**					

Well ID	SAMPLE DATE						
	Aug-12	Jun-13	Jan-14	May-14	Oct-14	May-15	Nov-15
	CHLORIDE (mg/L)						
30S/10E-13G	70	74	140	129	160	254	234
30S/10E-13H	21	14	12	99	26	44	37
30S/10E-13L5	138	130	99	176	200	107	107
30S/10E-13Q1	195	183	160	173	150	157	152
30S/10E-24A	74	78		153	87	194	140
30S/11E-7K3	165	177	94	132	52	158	145
30S/11E-7L3	91	89	64	37	110	97	93
30S/11E-7N1	31	34	130	171	52	103	119
30S/11E-7Q1	173	148	46	151	100	138	119
30S/11E-7R1	107	149	97	48	130	116	108
30S/11E-17D	81	97	55	85	140	116	109
30S/11E-17E9	65	65	54	61	81	59	66
30S/11E-18A	77	100	89				
30S/11E-18C1	137	148	160	163	82	143	154
30S/11E-18E1	60	66	150	71	71	66	68
30S/11E-18L3	37	55	160	32	130	65	77
AVERAGE CHLORIDE	**107**	**mg/L**					

DATA SOURCE: **County Baseline Groundwater Monitoring Program (2012-2015)**

TABLE B3

UPPER AQUIFER WATER QUALITY - LOCSD TASK 3

Well ID	Sample date	NO3-N	TDS	Cl
		mg/L		
30S/10E-13F1	5/6/2006	19	354	92
30S/10E-13Q1	4/7/2006	18	454	60
30S/11E-7Q1	5/6/2006	18	432	76
30S/11E-17E9	4/6/2006	12	302	88
30S/11E-18F1	5/8/2006	5	146	28
AVERAGE		**14**	**338**	**69**

DATA SOURCE: **Cleath & Associates (2006)**

TABLE B4

UPPER AQUIFER WATER QUALITY BASELINE SCENARIO MIX

Source	NO3-N	TDS	Cl
	mg/L		
COUNTY BASELINE	15	424	107
LOCDS TASK 3	14	338	69
AVERAGE	**15**	**381**	**88**

DATA SOURCES: **County Baseline Groundwater Monitoring Program (2012-2015)**
Cleath & Associates (2006)

TABLE B5

WESTERN AREA LOWER AQUIFER WATER QUALITY (NON-INTRUDED ZONE D)

Well ID	Sample Date	TDS	Cl	NO3-N
		mg/L		
30S/10E-13J1	1/14/2010	435	200	1.6
	7/24/2014	910	303	1.7
	4/22/2015	750	331	1.9
	10/5/2015	950	329	1.7
30S/10E-24C1	11/20/2009	347	130	4.1
	7/24/2014	240	46	8.4
	4/22/2015	320	95	5.5
	10/5/2015	270	50	7.6
30S/11E-18L2	11/19/2009	890	360	0.4
	7/23/2014	390	90	0.4
	10/28/2015	420	104	0.6
30S/10E-13N	11/19/2009	267	73	6.1
	7/24/2014	270	76	7
	4/21/2015	280	77	7.7
	10/6/2015	310	75	6.8
AVERAGE WESTERN ZONE D		**470**	**156**	**4.1**

DATA SOURCE: LOCSD Lower Aquifer Groundwater Monitoring Program (2009-2015)

TABLE B6

CENTRAL AREA LOWER AQUIFER WATER QUALITY

Well ID	Sample Date	TDS	Cl	NO3-N*
		mg/L		
30S/11E-7Q3	11/19/2009	465	92	0
	7/23/2014	460	91	0
	4/21/2015	500	101	0
	10/6/2015	490	91	0
30S/11E-17N10	11/20/2009	357	41	0.5
	7/24/2014	370	37	0.5
	4/22/2015	360	43	0.6
	10/5/2015	370	38	0.5
30S/11E-17K9	11/20/2009	307	36	1
	7/23/2014	300	32	1
	4/21/2015	270	38	1.6
20S/10E-12J1	11/20/2009	732	83	0
	7/24/2014	780	105	0
	4/22/2015	810	112	0
	10/1/2015	840	117	0
30S/11E-17E8	11/20/2009	255	42	4.3
	7/23/2014	270	43	6.3
	4/21/2015	270	49	7.1
	10/1/2015	290	44	6.6
30S/11E-18K8	11/20/2009	378	32	0
	7/24/2014	380	28	0
	4/21/2015	400	33	0
	10/19/2015	370	29	0
AVERAGE CENTRAL		**436**	**59**	**1**

*0 = not detected at laboratory practical quantitation limit

DATA SOURCE: LOCSD Lower Aquifer Groundwater Monitoring Program (2009-2015)

TABLE B7

WESTERN AND CENTRAL AREA LOWER AQUIFER WATER QUALITY MIX

AREA	VOLUME	TDS	Cl	NO3-N
	ACRE-FEET	mg/L		
WESTERN	14300	470	156	4.1
CENTRAL	56100	436	59	1
WEIGHTED AVERAGE		**443**	**79**	**2**

DATA SOURCE: LOCSD Lower Aquifer Groundwater Monitoring Program (2009-2015)

TABLE B8

EASTERN AREA - ALLUVIAL / LOWER AQUIFER WATER QUALITY

Well ID	Sample Date	NO3-N	TDS	Cl
		mg/L		
30S/11E-17R1	3/10/1982	3.4	450	76.2
30S/11E-20A2	3/3/1982	0.1	328.5	64.6
30S/11E-20E1	3/10/1982	13.4	230	47.8
30S/11E-21M5	3/3/1982	0	546	70.5
30S/11E-21D9	3/1/1995	0.2	854	101
30S/11E-21E3	3/3/1982	0	606	121
30S/11E-20Aa	2/1/2005	0.7	380	55
30S/11E-21D13	1/6/2005	31.7	880	98
30S/11E-20La	1/12/2005	0	510	40
AVERAGE		**6**	**532**	**75**

DATA SOURCES: **Cleath & Associates (2005)**
Baywood Groundwater Study (County, 1998)

TABLE B9

BEDROCK INFLOW QUALITY

Well ID	Sample Date	NO3-N	TDS	Cl
		mg/L		
30S/11E-20G2	8/7/1985	0	446	43
30S/11E-21P	2/14/2005	0	540	57
AVERAGE		**0**	**493**	**50**

DATA SOURCES: **Cleath & Associates (2005)**
Baywood Groundwater Study (County, 1998)

TABLE B10

LOS OSOS CREEK INFLOW QUALITY

Location	Sample Date	NO3-N	TDS	Cl
		mg/L		
Los Osos Creek upstream	Oct-83	0.79	495	47
	Jan-84	0	418	33
	May-84	0	477	43
	Aug-84	0.29	573	65
	Feb-87	0		48
	Jun-87	0	494	56
	Dec-87	0	519	54
	Dec-88	0	556	53.3
	Mar-89	0	583	57
	Jun-89	0	590	57
	Mar-90	0.79	700	54
	Mar-92	0	538	41
	Jun-92	0	652	55
	Dec-92	0.94	726	72
	Mar-93	0.18	434	51
	Jun-93	0	474	49
	Sep-93	0	646	74
	Dec-93	0.22	658	82
	Mar-94	0	476	46
	Jun-94	0	556	58
	Sep-94	0.76	606	54.8
	Mar-95	0	446	26.7
	Jun-95	0	540	47.6
	Sep-95	0	536	67.3
	Dec-95	0.56	620	74.6
	Mar-96	0	445	30.6
	Jun-96	0	502	48.7
	Sep-96	0.13	622	60
	Mar-97	0.09	397	35
	Jun-97	0.36	552	50.7
	Sep-97	0	680	67.7
	Dec-97	0.74	614	63
	Mar-98	0.25	386	30
	Jun-98	0	430	36
	Sep-98	0	510	50
	Dec-98	0	540	55
	Dec-04	0	540	62
AVERAGE		**0.17**	**543**	**53**

DATA SOURCES: **Cleath & Associates (2005)**
Baywood Groundwater Study (County, 1998)

TABLE B11
PERCHED AND UPPER AQUIFER
PRE-DEVELOPMENT WATER QUALITY

Well ID	Sample Date	NO3-N	TDS	Cl
		mg/L		
30S/10E-13P1	10/2/1954	4.9	171	34
30S/11E-07J1	3/5/1957	2.9	122	30
30S/11E-7N1	10/2/1954	1	201	41
	8/30/1957	2.9	130	28
	9/30/1958	0	204	36
	7/28/1959	0.4	197	35
30S/11E-7Q1	12/30/1959	0.3	109	30
30S/11E-17H1	6/16/1955	0.7	332	51
30S/11E-18H1	12/30/1959	0.4	125	32
30S/11E-18Q1	6/11/1954	2	125	39
	8/30/1957	2.5	141	37
	9/30/1958	5.8	109	47
	7/28/1959	0.9	165	46
WEIGHTED AVERAGE		**1.9**	**165**	**37**

DATA SOURCE: **DWR (1973)**

TABLE B12
WESTERN AND CENTRAL AREA LOWER AQUIFER PRE-DEVELOPMENT WATER QUALITY

Well ID	Sample Date	NO3-N	TDS	Cl
		mg/L		
30S/10E-12J1	11/19/1970	0	679	87
30S/10E-13J1	5/16/1980	1.3	110	28
30S/10E-13L4	3/25/1977	1	269	41.5
30S/11E-18L2	8/9/1982	0	316	51
30S/11E-19H2	8/6/1985	0	315	35
30S/11E-20G2	8/7/1985	0	446	43
AVERAGE		**0.4**	**356**	**48**

DATA SOURCE: **DWR (1972)**
Brown & Caldwell (1983)
USGS (1987)

TABLE B13
EASTERN AREA ALLUVIUM / LOWER AQUIFER PRE-DEVELOPMENT WATER QUALITY

Source	Description	Sample Date	NO3-N	TDS	Cl
			mg/L		
30S/11E-17H1	Pre-1960 lower creek valley	6/16/1955	0.7	332	51
30S/11E-20Aa	Lower Aquifer (low N)	2/1/2005	0	380	55
30S/11E-20G2	Bedrock influence	8/7/1985	0	446	43
30S/11E-20L1	Alluvial aquifer	3/26/1970	0.9	517	57
Upper/perched aquifer	Upper/perched influence	1954-1959	1.9	165	37
Los Osos Creek	Creek influence	1983-2004	0.17	543	53
AVERAGE			**0.6**	**397**	**49**

DATA SOURCE: **DWR (1972)**
DWR (1973)
USGS (1987)
Cleath & Associates (2005)

TABLE B14
SEPTIC DISCHARGE / LOWRF INFLOW WATER QUALITY

Agency/Project	Sample Site	Collected Date/Time	NH3-N, mg/L	Nitrite as N, mg/L	Nitrate as N, mg/L	TDS, mg/L	Alkalinity as CaCO3, mg/L	Chloride, mg/L
LOS OSOS WATER RECYCLING FACILITY	Influent	8/1/2016 10:20	57.2			750	397	196
		8/5/2016 10:53						
		8/8/2016 10:25	49.8				310	
		8/15/2016 10:25	74.8				442	
		8/22/2016 8:57	56				453	
		8/29/2016 10:00	51.2				390	
		9/6/2016 9:35	52.1			820	414	223
		9/7/2016						
		9/9/2016 11:20	53.5				420	
		9/12/2016 9:30	50.8	0.159	0.6	800	415	182
AVERAGE			**55.7**	**0.2**	**0.6**	**790**	**405**	**200**

DATA SOURCE: **LOWRF Monitoring Data**

TABLE B15
SEPTIC DISCHARGE / LOWRF OUTFLOW WATER QUALITY

Agency/Project	Sample Site	Collected Date/Time	NH3-N, mg/L	Nitrite as N, mg/L	Nitrate as N, mg/L	TDS, mg/L	Alkalinity as CaCO3, mg/L	Chloride, mg/L
LOS OSOS WATER RECYCLING FACILITY	Effluent	8/1/2016 10:30	0.072		6.47		197	
		8/2/2016 9:42	0.101		6.17			
		8/3/2016 9:03	0.092		5.45			
		8/4/2016 9:51	0.039		5.27			
		8/5/2016 9:06	0.052		5.49			
		8/6/2016 11:35			5.51			
		8/7/2016 9:43			5.66			
		8/8/2016 10:00	0.07		5.64		180	
		8/9/2016 11:16	0.057		4.89			
		8/10/2016 9:16	0.044		5.34			
		8/11/2016 10:50	0.026		5.71			
		8/12/2016 10:05	0.038		6.41			
		8/15/2016 10:00	0.05		7.05		169	
		8/16/2016 9:43	0.051		7.43			
		8/17/2016 9:04	0.073	< 0.013	7.04			
		8/18/2016 10:36	0.059		9.83			
		8/19/2016 9:23	0.059		11.3			
		8/22/2016 8:50	0.051		9.47		191	
		8/23/2016 10:28	0.126		8.64	720		
		8/24/2016 8:35	0.06		8.32			
		8/25/2016 11:10	0.104		8.25			
		8/27/2016 7:55			7.3			
		8/29/2016 9:00	0.046		6.55		199	
		8/30/2016 9:51	0.046		5.15			
		8/31/2016 9:45	0.09		4.59			
		9/1/2016 9:45	0.047		5.36			
		9/2/2016 10:09	0.056		5.47			
		9/6/2016 8:55			5.53		205	
		9/7/2016 8:35				700		197
		9/9/2016 10:30	0.041		5.31	690		160
		9/12/2016 9:15	0.037	0.028	6.4	740	199	191
		9/14/2016 11:32	0.039		6			
		9/16/2016 10:18	0.039		6.27		193	
		9/20/2016 9:40						
AVERAGE			**0.06**	**0**	**7**	**713**	**191**	**183**

DATA SOURCE: **LOWRF Monitoring Data**

APPENDIX C

Natural Loading and Evaporative Enrichment Calibration

TABLE C1

MASS BALANCE SPREADSHEET RESULTS - NATURAL LOADING CALIBRATION

Perched Aquifer				Eastern Area Alluvial / Lower Aquifer				Upper Aquifer				Western and Central Area Lower Aquifer				Basin Average			
Year	TDS [mg/L]	Chloride [mg/L]	Nitrate as N [mg/L]	Year	TDS [mg/L]	Chloride [mg/L]	Nitrate as N [mg/L]	Year	TDS [mg/L]	Chloride [mg/L]	Nitrate as N [mg/L]	Year	TDS [mg/L]	Chloride [mg/L]	Nitrate as N [mg/L]	Year	TDS [mg/L]	Chloride [mg/L]	Nitrate as N [mg/L]
1	165.00	37.00	1.90	1	397.00	49.00	0.60	1	165.00	37.00	1.90	1	356.00	48.00	0.40	1	246.06	41.36	1.38
2	165.00	37.00	1.90	2	396.98	48.70	0.61	2	165.02	36.99	1.90	2	355.99	47.99	0.42	2	246.07	41.29	1.39
3	164.99	37.00	1.90	3	396.95	48.73	0.61	3	165.04	36.98	1.90	3	355.99	47.98	0.44	3	246.07	41.28	1.39
4	164.99	37.00	1.89	4	396.93	48.74	0.62	4	165.05	36.96	1.90	4	355.99	47.97	0.46	4	246.07	41.28	1.40
5	164.99	37.00	1.89	5	396.91	48.76	0.63	5	165.07	36.95	1.91	5	355.98	47.96	0.48	5	246.08	41.27	1.40
6	164.99	37.00	1.89	6	396.89	48.78	0.63	6	165.08	36.94	1.91	6	355.98	47.95	0.49	6	246.08	41.27	1.41
7	164.98	37.00	1.89	7	396.88	48.79	0.64	7	165.09	36.93	1.91	7	355.97	47.94	0.51	7	246.08	41.27	1.41
8	164.98	37.00	1.89	8	396.86	48.81	0.64	8	165.10	36.93	1.91	8	355.97	47.93	0.53	8	246.08	41.26	1.42
9	164.98	37.00	1.89	9	396.84	48.82	0.65	9	165.11	36.92	1.91	9	355.97	47.92	0.55	9	246.08	41.26	1.42
10	164.98	37.00	1.89	10	396.83	48.83	0.65	10	165.12	36.91	1.92	10	355.96	47.91	0.57	10	246.09	41.26	1.43
11	164.98	37.00	1.89	11	396.82	48.85	0.66	11	165.13	36.91	1.92	11	355.96	47.90	0.58	11	246.09	41.26	1.43
12	164.98	37.00	1.89	12	396.81	48.86	0.66	12	165.13	36.90	1.92	12	355.95	47.89	0.60	12	246.09	41.25	1.43
13	164.98	37.00	1.89	13	396.80	48.87	0.66	13	165.14	36.90	1.92	13	355.95	47.88	0.62	13	246.09	41.25	1.44
14	164.98	37.00	1.89	14	396.79	48.88	0.67	14	165.14	36.89	1.92	14	355.95	47.87	0.63	14	246.09	41.25	1.44
15	164.98	37.00	1.89	15	396.78	48.88	0.67	15	165.15	36.89	1.92	15	355.94	47.86	0.65	15	246.09	41.25	1.45
16	164.98	37.00	1.89	16	396.77	48.89	0.67	16	165.15	36.88	1.92	16	355.94	47.86	0.67	16	246.09	41.25	1.45
17	164.98	36.99	1.89	17	396.76	48.90	0.67	17	165.16	36.88	1.92	17	355.94	47.85	0.68	17	246.09	41.24	1.45
18	164.98	36.99	1.89	18	396.75	48.91	0.68	18	165.16	36.88	1.92	18	355.94	47.84	0.70	18	246.09	41.24	1.46
19	164.98	36.99	1.89	19	396.74	48.91	0.68	19	165.16	36.88	1.93	19	355.93	47.83	0.71	19	246.09	41.24	1.46
20	164.98	36.99	1.89	20	396.74	48.92	0.68	20	165.17	36.87	1.93	20	355.93	47.82	0.73	20	246.09	41.24	1.46
21	164.98	36.99	1.89	21	396.73	48.92	0.68	21	165.17	36.87	1.93	21	355.93	47.81	0.74	21	246.09	41.24	1.47
22	164.98	36.99	1.89	22	396.73	48.93	0.68	22	165.17	36.87	1.93	22	355.92	47.80	0.76	22	246.09	41.24	1.47
23	164.98	36.99	1.89	23	396.72	48.93	0.69	23	165.17	36.87	1.93	23	355.92	47.80	0.77	23	246.09	41.24	1.47
24	164.98	36.99	1.89	24	396.72	48.94	0.69	24	165.18	36.87	1.93	24	355.92	47.79	0.79	24	246.09	41.24	1.48
25	164.98	36.99	1.89	25	396.71	48.94	0.69	25	165.18	36.86	1.93	25	355.92	47.78	0.80	25	246.09	41.24	1.48

NOTE: Results in Table C1 are for concentrations of natural loading that match pre-development water quality from Appendix B (Tables B11, B12, and B13

TABLE C2
CALIBRATED NATURAL LOADING CONCENTRATIONS

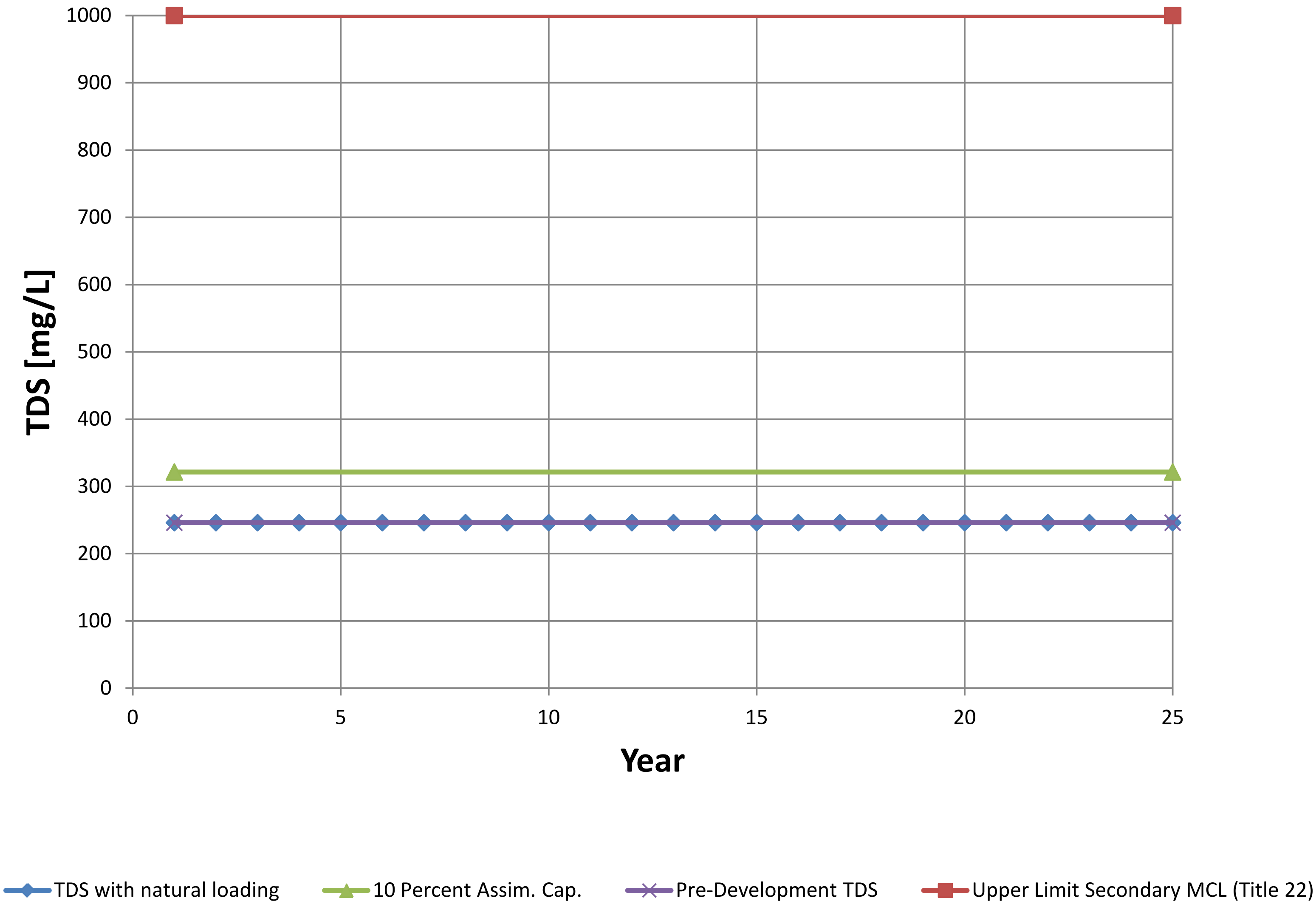
Aquifer	Perc. of Precip. and Leakage[1]	Loading Concentration to match pre-development quality[2]		
		TDS	Cl	NO3-N
	AFY	mg/L		
Perched	685	165	37	1.9
Eastern Area Alluvium / Lower Aquifer	490	240	35	1.3
Upper Aquifer	1155	85	33	2.3
Western and Central Lower Aquifer (leakage)*	890	180	10	--
Basin Average perc. of precip load (weighted)		141	35	2

*salt load from Leakage through regional aquitard

[1] From Baseline Water Balance

[2] Results of using these natural loads are listed in Table C1 and shown in Figures C1-C3

Figure C1
TDS Concentration Trends
Basin Average
Natural Loading Calibration



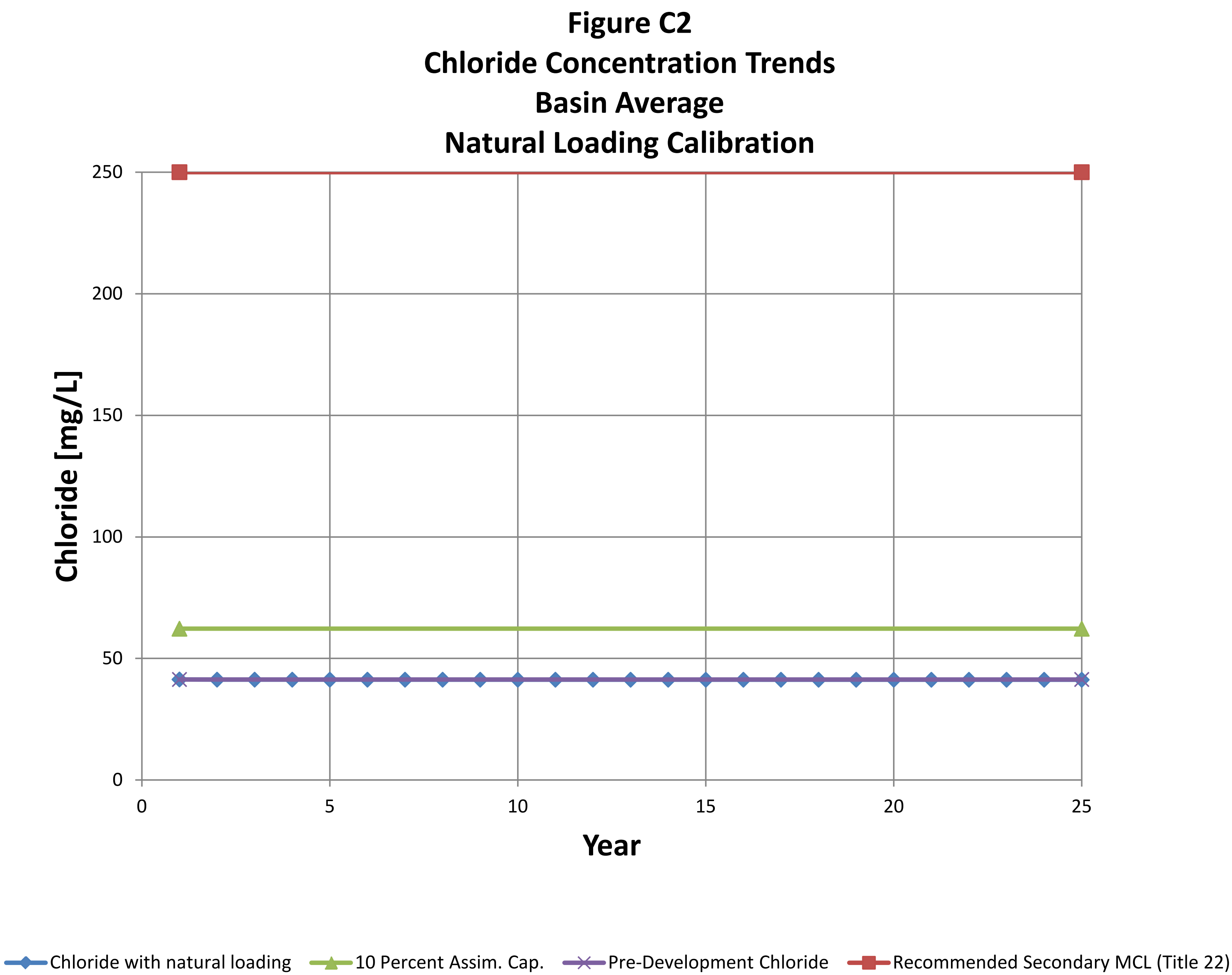


Figure C2
Chloride Concentration Trends
Basin Average
Natural Loading Calibration
Chloride [mg/L]
250
200
150
100
50
0
0
5
10
15
20
25
Year
Chloride with natural loading
10 Percent Assim. Cap.
Pre-Development Chloride
Recommended Secondary MCL (Title 22)

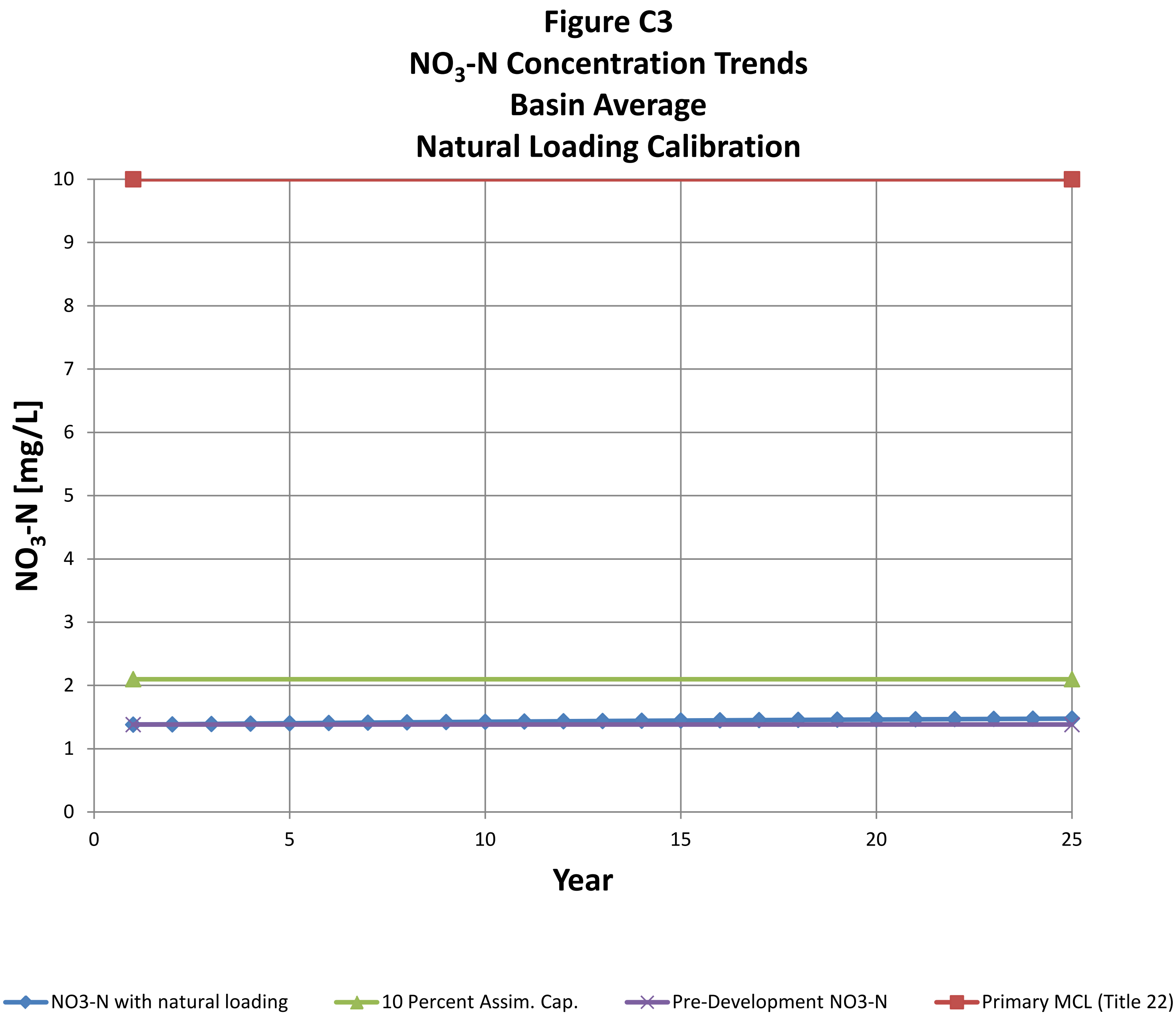


Figure C3
NO3-N Concentration Trends
Basin Average
Natural Loading Calibration
NO3-N [mg/L]
10
9
8
7
6
5
4
3
2
1
0
0
5
10
15
20
25
Year
NO3-N with natural loading
10 Percent Assim. Cap.
Pre-Development NO3-N
Primary MCL (Title 22)

TABLE C3

Evaporative Enrichment Calibration

Eastern Area Alluvial / Lower Aquifer			
Year	TDS [mg/L]	Chloride [mg/L]	Nitrate as N [mg/L]
1	532.00	75.00	6.00
2	532.00	74.78	6.09
3	532.00	74.87	6.21
4	532.00	74.96	6.25
5	532.00	75.04	6.28
6	532.00	75.11	6.32
7	532.00	75.18	6.35
8	532.00	75.25	6.37
9	532.00	75.31	6.40
10	532.00	75.37	6.42
11	532.00	75.43	6.44
12	532.00	75.48	6.47
13	532.00	75.53	6.48
14	532.00	75.58	6.50
15	532.01	75.62	6.52
16	532.01	75.66	6.53
17	532.01	75.70	6.55
18	532.01	75.74	6.56
19	532.01	75.77	6.57
20	532.01	75.81	6.58
21	532.01	75.84	6.59
22	532.01	75.87	6.60
23	532.01	75.89	6.61
24	532.01	75.92	6.62
25	532.01	75.94	6.63

NOTE: Results for 3.4 multiplier on irrigation return flow water quality (calibrated to Baseline water quality shown in Table B8)

Figure C4
TDS Concentration Trends
Eastern Area Alluvial Aquifer / Lower Aquifer
Evaporative Enrichment Calibration

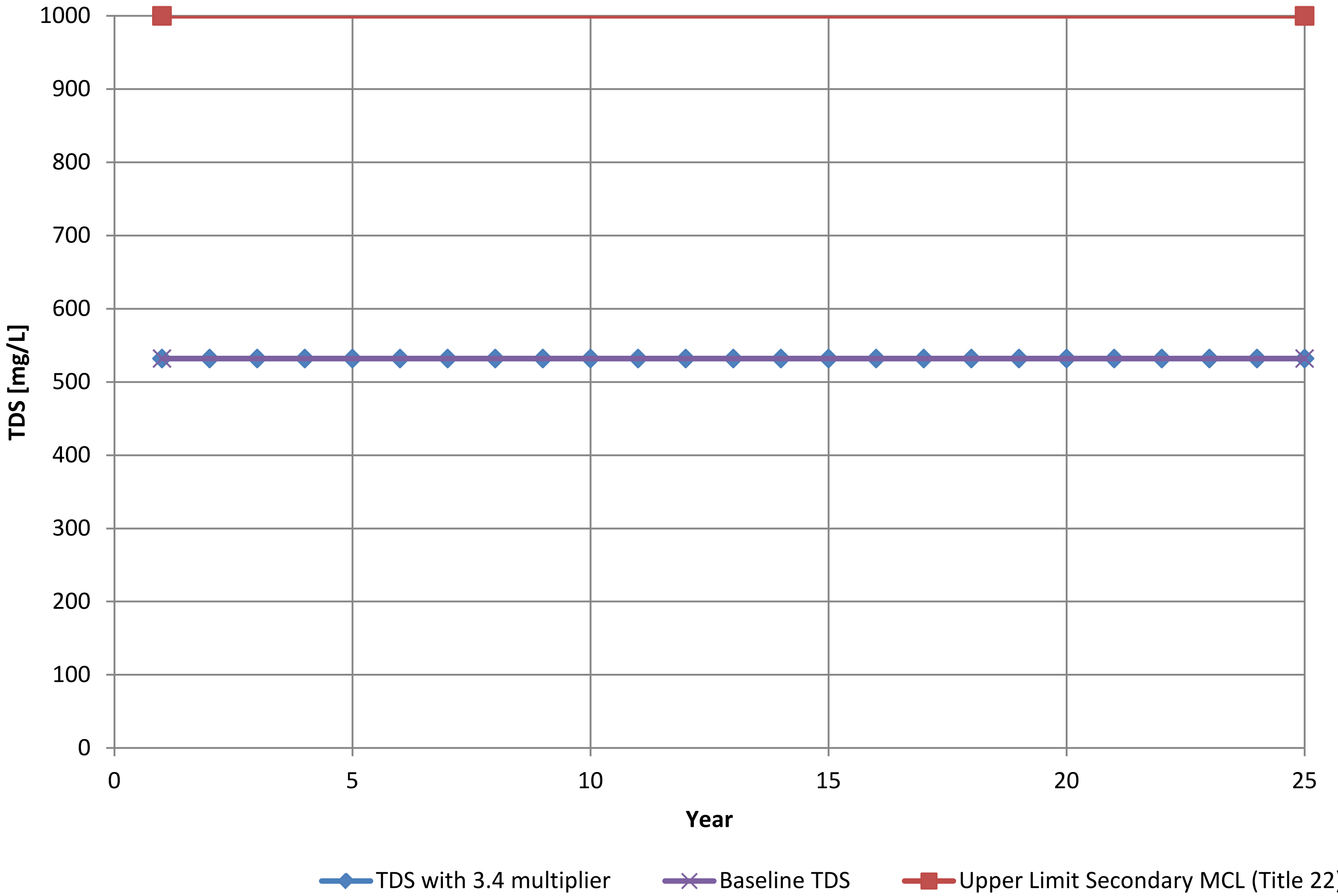


Figure C5
Chloride Concentrations
Eastern Area Alluvial Aquifer / Lower Aquifer
Evaporative Enrichment Calibration

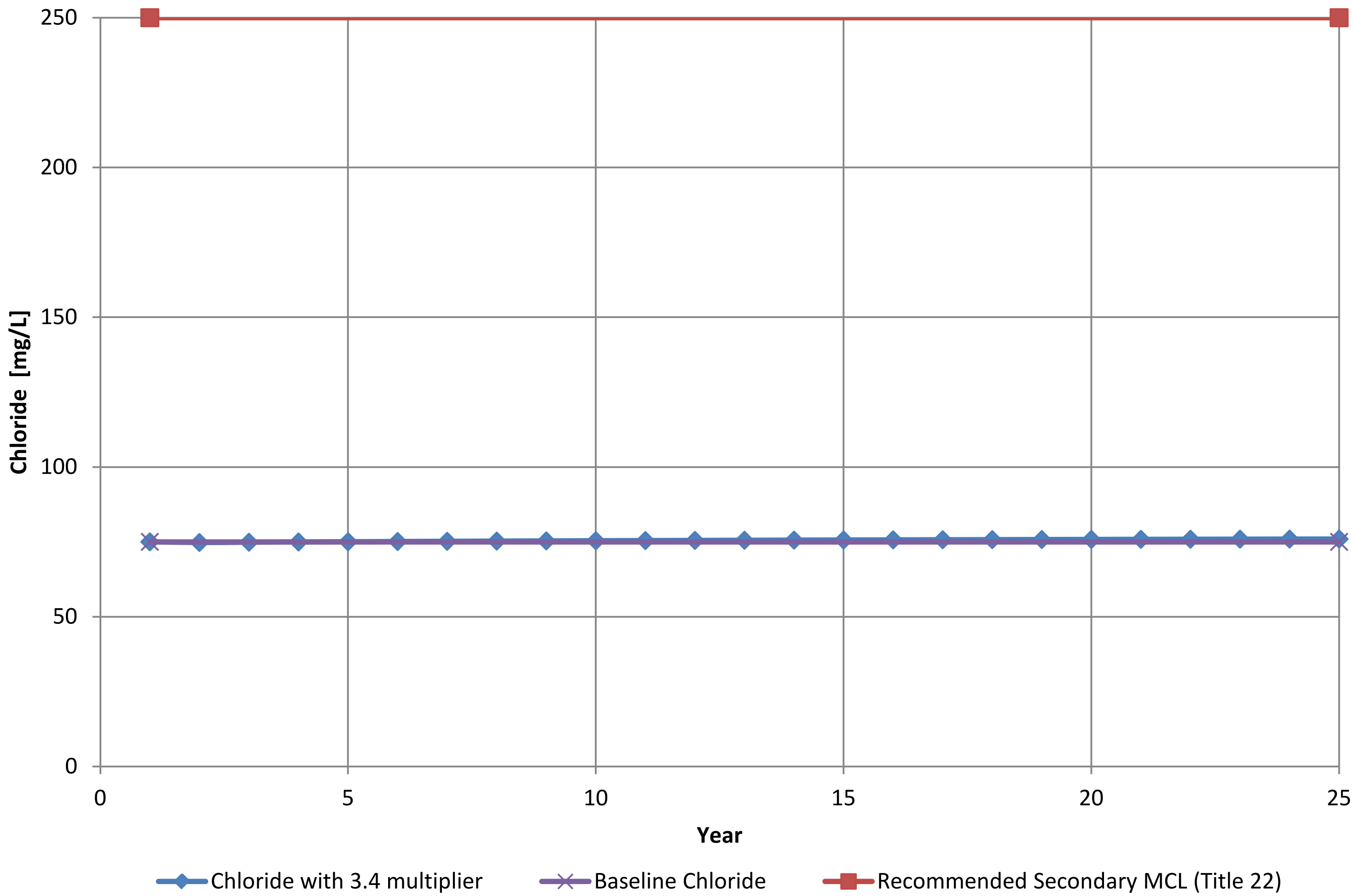
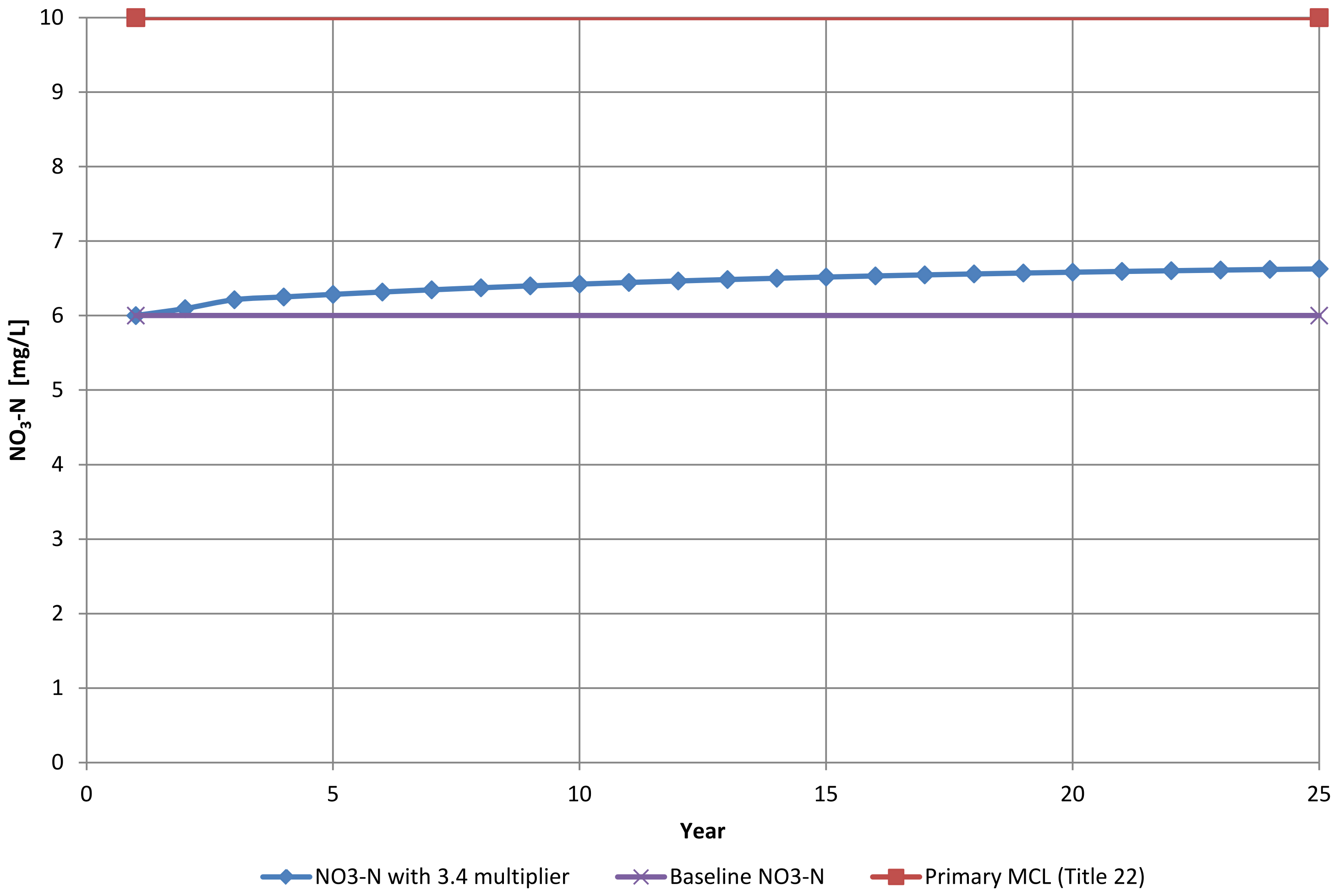


Figure C6
NO_3-N Concentrations
Eastern Area Alluvial Aquifer / Lower Aquifer
Evaporative Enrichment Calibration



APPENDIX D

Mass Loading Spreadsheet Model Results - Tables with Sample Calculations

TABLE D1

MASS BALANCE SPREADSHEET MODEL RESULTS - BASELINE (NO PROJECT)

Perched Aquifer				Eastern Area Alluvial/Lower Aquifer				Upper Aquifer				Western and Central Area Lower Aquifer				Basin Average (weighted by volume)			
Year	TDS [mg/L]	Chloride [mg/L]	Nitrate as N [mg/L]	Year	TDS [mg/L]	Chloride [mg/L]	Nitrate as N [mg/L]	Year	TDS [mg/L]	Chloride [mg/L]	Nitrate as N [mg/L]	Year	TDS [mg/L]	Chloride [mg/L]	Nitrate as N [mg/L]	Year	TDS [mg/L]	Chloride [mg/L]	Nitrate as N [mg/L]
1	380.00	92.00	15.00	1	532.00	75.00	6.00	1	381.00	88.00	15.00	1	443.00	79.00	2.00	1	440.12	80.89	5.99
2	399.87	96.25	14.85	2	533.15	74.52	6.12	2	379.00	87.58	14.65	2	480.12	97.45	2.17	2	462.40	91.74	6.03
3	417.88	101.05	14.73	3	534.48	74.37	6.26	3	378.24	87.59	14.32	3	516.60	115.59	2.34	3	484.55	102.57	6.07
4	434.49	106.18	14.64	4	535.84	74.25	6.39	4	378.57	87.97	14.03	4	552.46	133.42	2.50	4	506.53	113.32	6.12
5	450.05	111.56	14.58	5	537.22	74.17	6.51	5	379.84	88.71	13.77	5	587.73	150.96	2.66	5	528.34	123.99	6.16
6	464.82	117.12	14.53	6	538.60	74.12	6.63	6	381.92	89.77	13.53	6	622.43	168.21	2.81	6	549.98	134.58	6.21
7	479.00	122.83	14.49	7	539.98	74.10	6.73	7	384.73	91.14	13.31	7	656.57	185.18	2.95	7	571.43	145.08	6.26
8	492.73	128.65	14.46	8	541.36	74.11	6.82	8	388.16	92.77	13.11	8	690.19	201.89	3.09	8	592.69	155.50	6.31
9	506.11	134.55	14.43	9	542.74	74.16	6.91	9	392.16	94.66	12.93	9	723.28	218.34	3.22	9	613.76	165.83	6.36
10	519.24	140.42	14.42	10	544.11	74.23	6.99	10	396.64	96.77	12.77	10	755.88	234.54	3.35	10	634.64	176.06	6.42
11	532.09	146.35	14.40	11	545.48	74.33	7.06	11	401.56	99.08	12.63	11	787.99	250.49	3.48	11	655.32	186.20	6.47
12	544.80	152.25	14.39	12	546.84	74.46	7.13	12	406.86	101.57	12.50	12	819.63	266.20	3.60	12	675.80	196.25	6.52
13	557.33	158.20	14.39	13	548.19	74.61	7.19	13	412.49	104.23	12.38	13	850.82	281.69	3.72	13	696.08	206.20	6.57
14	569.70	164.10	14.38	14	549.53	74.79	7.25	14	418.42	107.03	12.27	14	881.55	296.94	3.84	14	716.16	216.05	6.63
15	581.88	170.05	14.38	15	550.86	74.98	7.30	15	424.59	109.97	12.18	15	911.84	311.98	3.95	15	736.02	225.81	6.68
16	593.98	175.95	14.37	16	552.19	75.20	7.35	16	430.99	113.02	12.09	16	941.71	326.80	4.06	16	755.69	235.47	6.73
17	605.93	181.80	14.37	17	553.50	75.44	7.39	17	437.59	116.17	12.02	17	971.17	341.41	4.17	17	775.14	245.03	6.78
18	617.85	187.62	14.37	18	554.81	75.69	7.44	18	444.36	119.41	11.95	18	1000.22	355.82	4.27	18	794.39	254.49	6.84
19	629.65	193.41	14.37	19	556.11	75.97	7.47	19	451.28	122.73	11.88	19	1028.87	370.03	4.38	19	813.44	263.85	6.89
20	641.28	199.09	14.37	20	557.40	76.25	7.51	20	458.31	126.11	11.83	20	1057.13	384.04	4.48	20	832.27	273.11	6.94
21	652.84	204.76	14.37	21	558.67	76.56	7.54	21	465.46	129.55	11.78	21	1085.01	397.86	4.57	21	850.91	282.27	6.99
22	664.27	210.35	14.37	22	559.94	76.87	7.57	22	472.68	133.02	11.73	22	1112.51	411.49	4.67	22	869.33	291.33	7.04
23	675.58	215.94	14.37	23	561.20	77.20	7.60	23	479.98	136.55	11.69	23	1139.65	424.94	4.76	23	887.55	300.29	7.09
24	686.80	221.46	14.37	24	562.45	77.54	7.62	24	487.33	140.10	11.66	24	1166.43	438.21	4.85	24	905.56	309.15	7.14
25	697.94	226.91	14.37	25	563.69	77.89	7.65	25	494.73	143.68	11.62	25	1192.86	451.30	4.94	25	923.38	317.92	7.19

TABLE D2

MASS BALANCE SPREADSHEET MODEL RESULTS - NO FURTHER DEVELOPMENT (LOWRF PROJECT)

Perched Aquifer				Eastern Area Alluvial/Lower Aquifer				Upper Aquifer				Western and Central Area Lower Aquifer				Basin Average (weighted by volume)			
Year	TDS [mg/L]	Chloride [mg/L]	Nitrate as N [mg/L]	Year	TDS [mg/L]	Chloride [mg/L]	Nitrate as N [mg/L]	Year	TDS [mg/L]	Chloride [mg/L]	Nitrate as N [mg/L]	Year	TDS [mg/L]	Chloride [mg/L]	Nitrate as N [mg/L]	Year	TDS [mg/L]	Chloride [mg/L]	Nitrate as N [mg/L]
1	380.00	92.00	15.00	1	532.00	75.00	6.00	1	381.00	88.00	15.00	1	443.00	79.00	2.00	1	440.12	80.89	5.99
2	366.82	87.83	13.32	2	533.44	75.08	6.09	2	379.24	88.10	14.30	2	444.43	79.17	2.14	2	440.32	80.88	5.87
3	355.26	84.41	11.93	3	534.73	75.37	6.20	3	377.06	88.04	13.64	3	445.84	79.34	2.27	3	440.44	80.89	5.77
4	345.68	81.59	10.78	4	535.89	75.63	6.30	4	374.83	87.91	13.00	4	447.21	79.50	2.39	4	440.58	80.90	5.67
5	337.76	79.27	9.84	5	536.93	75.86	6.38	5	372.60	87.75	12.40	5	448.54	79.67	2.51	5	440.74	80.91	5.58
6	331.19	77.35	9.05	6	537.87	76.06	6.45	6	370.41	87.56	11.84	6	449.84	79.83	2.61	6	440.92	80.92	5.50
7	325.74	75.77	8.41	7	538.71	76.25	6.51	7	368.29	87.34	11.31	7	451.10	79.98	2.72	7	441.12	80.94	5.43
8	321.21	74.47	7.87	8	539.48	76.42	6.57	8	366.25	87.11	10.82	8	452.33	80.14	2.81	8	441.34	80.96	5.36
9	317.45	73.40	7.43	9	540.18	76.57	6.61	9	364.31	86.87	10.36	9	453.53	80.29	2.90	9	441.58	80.97	5.30
10	314.31	72.51	7.06	10	540.81	76.71	6.65	10	362.47	86.63	9.93	10	454.69	80.43	2.98	10	441.83	81.00	5.25
11	311.70	71.76	6.76	11	541.39	76.83	6.69	11	360.74	86.39	9.54	11	455.82	80.58	3.06	11	442.11	81.02	5.20
12	309.53	71.15	6.51	12	541.93	76.95	6.72	12	359.13	86.16	9.18	12	456.93	80.72	3.14	12	442.40	81.05	5.16
13	307.71	70.64	6.30	13	542.43	77.05	6.75	13	357.64	85.94	8.85	13	458.01	80.85	3.21	13	442.70	81.07	5.12
14	306.20	70.21	6.13	14	542.88	77.15	6.77	14	356.24	85.73	8.54	14	459.06	80.98	3.27	14	443.02	81.10	5.09
15	304.94	69.87	5.99	15	543.30	77.24	6.80	15	354.96	85.53	8.26	15	460.08	81.11	3.34	15	443.35	81.13	5.06
16	303.88	69.58	5.87	16	543.69	77.32	6.82	16	353.76	85.34	8.00	16	461.08	81.24	3.40	16	443.69	81.17	5.04
17	302.99	69.34	5.77	17	544.04	77.40	6.83	17	352.67	85.17	7.76	17	462.06	81.36	3.45	17	444.04	81.20	5.01
18	302.25	69.13	5.69	18	544.38	77.47	6.85	18	351.68	85.00	7.55	18	463.01	81.48	3.50	18	444.41	81.24	5.00
19	301.64	68.95	5.62	19	544.69	77.53	6.86	19	350.76	84.85	7.35	19	463.95	81.60	3.55	19	444.78	81.28	4.98
20	301.12	68.81	5.56	20	544.98	77.59	6.88	20	349.93	84.71	7.17	20	464.86	81.71	3.60	20	445.15	81.32	4.97
21	300.70	68.69	5.51	21	545.25	77.65	6.89	21	349.17	84.58	7.01	21	465.76	81.82	3.65	21	445.53	81.36	4.96
22	300.35	68.59	5.48	22	545.51	77.70	6.90	22	348.49	84.46	6.86	22	466.64	81.93	3.69	22	445.92	81.40	4.95
23	300.06	68.51	5.44	23	545.74	77.75	6.91	23	347.87	84.35	6.72	23	467.50	82.03	3.73	23	446.32	81.44	4.94
24	299.84	68.44	5.42	24	545.96	77.80	6.92	24	347.31	84.25	6.60	24	468.34	82.14	3.77	24	446.71	81.48	4.94
25	299.64	68.39	5.39	25	546.18	77.84	6.92	25	346.82	84.15	6.49	25	469.17	82.24	3.81	25	447.12	81.53	4.94

TABLE D3

SAMPLE ANTIDEGRADATION CALCULATIONS FOR NO FURTHER DEVELOPMENT SCENARIO USING MASS BALANCE RESULTS TABLE D2

SAMPLE CALCULATIONS FOR TABLE 11 (TDS ANTIDEGRADATION ANALYSIS)

PERCHED AQUIFER No Further Development at 10 Years:
Change in TDS: 314.31 mg/L (TDS at Year 10) - 380 mg/L (TDS at Year 1) = -65.7 mg/L (lower TDS)
Percent TDS Assimilative Capacity Used: -65.7 mg/L (change in TDS) ÷ 620 mg/L (TDS assimilative capacity) = -10.6 % (TDS assimilative capacity used)

UPPER AQUIFER - No Further Development at 25 Years:
Change in TDS: 346.82 mg/L (TDS at Year 25) - 381 mg/L (TDS at Year 1) = -34.2 mg/L (lower TDS)
Percent TDS Assimilative Capacity Used: -34.2 mg/L (change in TDS) ÷ 620 mg/L (TDS assimilative capacity) = -5.5 % (TDS assimilative capacity used)

BASIN TOTAL No Further Development at 25 Years (Refer to Table 11 for compartment values and Table 4 for compartment volumes):
Average Change in TDS (weighted by volume): ((-80.4 mg/L * 5.18E9 L) + (-34.2 mg/L * 3.33E10 L) + (26.2 mg/L * 8.68E10 L) + (14.2 mg/L* 2.21E10 L)) ÷ 1.47E11 L = 7 mg/L (greater TDS)
Percent TDS Basin Assimilative Capacity Used: 7 mg/L (change in TDS) ÷ 560 mg/L (TDS assimilative capacity) = 1.3 % (TDS assimilative capacity used)

SAMPLE CALCULATIONS FOR TABLE 12 (CHLORIDE ANTIDEGRADATION ANALYSIS)

PERCHED AQUIFER No Further Development at 10 Years:
Change in Chloride: 72.51 mg/L (Cl at Year 10) - 92 mg/L (Cl at Year 1) = -19.5 mg/L (lower Cl)
Percent Chloride Assimilative Capacity Used: -19.5 mg/L (change in Cl) ÷ 157 mg/L (Cl assimilative capacity) = -12.4 % (Cl assimilative capacity used)

UPPER AQUIFER -No Further Development at 25 Years:
Change in Chloride: 84.15 mg/L (Cl at Year 25) - 88 mg/L (Cl at Year 1) = -3.85 mg/L (lower Cl)
Percent Chloride Assimilative Capacity Used: -3.85 mg/L (change in Cl) ÷ 162 mg/L (Cl assimilative capacity) = -2.4 % (Cl assimilative capacity used)

BASIN TOTAL No Further Development at 25 Years (Refer to Table 12 for compartment values and Table 4 for compartment volumes):
Average Change in Chloride (weighted by volume): ((-12.8 mg/L * 5.18E9 L) + (0.4 mg/L * 3.33E10 L) + (1.4 mg/L * 8.68E10 L) + (10.8 mg/L* 2.21E10 L)) ÷ 1.47E11 L = 2.1 mg/L (greater Cl)
Percent Chloride Basin Assimilative Capacity Used: 2.1 mg/L (change in Cl) ÷ 169 mg/L (TDS assimilative capacity) = 1.2 % (Cl assimilative capacity used)

SAMPLE CALCULATIONS FOR TABLE 13 (NO_3-N ANTIDEGRADATION ANALYSIS)

PERCHED AQUIFER No Further Development at 10 Years:
Change in NO3-N: 7.06 mg/L (NO3-N at Year 10) - 15 mg/L (NO3-N at Year 1) = -7.94 mg/L (lower NO3-N)
Percent NO3-N Assimilative Capacity Used: -7.94 mg/L (change in NO3-N) ÷ -5 mg/L (NO3-N assimilative capacity) = 159 % (NO3-N assimilative capacity used)
NOTE: The 159% is a use of negative NO_3-N capacity, or effectively a gain of assimilative capacity, and is expressed as -159% in Table 12 to be consistent with TDS and Cl analyses

UPPER AQUIFER No Further Development at 10 Years:
Change in NO3-N: 6.49 mg/L (NO3-N at Year 10) - 15 mg/L (NO3-N at Year 1) = -8.51 mg/L (lower NO3-N)
Percent NO3-N Assimilative Capacity Used: -8.51 mg/L (change in NO3-N) ÷ -5 mg/L (NO3-N assimilative capacity) = 170 % (NO3-N assimilative capacity used)
NOTE: The 170 % is a use of negative NO_3-N capacity, or effectively a gain of assimilative capacity, and is expressed as -170 % in Table 12 to be consistent with TDS and Cl analyses

BASIN TOTAL No Further Development at 25 Years (Refer to Table 13 for compartment values and Table 4 for compartment volumes):
Average Change in NO3-N (weighted by volume): ((-7.5 mg/L * 5.18E9 L) + (-5 mg/L * 3.33E10 L) + (1 mg/L * 8.68E10 L) + (1.1 mg/L* 2.21E10 L)) ÷ 1.47E11 L = -0.64 mg/L (lower NO3-N)
Percent NO3-N Basin Assimilative Capacity Used: -0.64 mg/L (change in NO3-N) ÷ 4 mg/L (NO3-N assimilative capacity) = -15.4 % (NO3-N assimilative capacity used)

TABLE D4

MASS BALANCE SPREADSHEET MODEL RESULTS - POPULATION BUILDOUT (CUMULATIVE PROJECTS)

Perched Aquifer				Eastern Area Alluvial/Lower Aquifer				Upper Aquifer				Western and Central Area Lower Aquifer				Basin Average (weighted by volume)			
Year	TDS [mg/L]	Chloride [mg/L]	Nitrate as N [mg/L]	Year	TDS [mg/L]	Chloride [mg/L]	Nitrate as N [mg/L]	Year	TDS [mg/L]	Chloride [mg/L]	Nitrate as N [mg/L]	Year	TDS [mg/L]	Chloride [mg/L]	Nitrate as N [mg/L]	Year	TDS [mg/L]	Chloride [mg/L]	Nitrate as N [mg/L]
1	380.00	92.00	15.00	1	532.00	75.00	6.00	1	381.00	88.00	15.00	1	443.00	79.00	2.00	1	440.12	80.89	5.99
2	373.39	89.16	13.38	2	535.53	76.42	6.16	2	380.14	88.22	14.31	2	444.54	79.12	2.13	2	441.13	81.12	5.88
3	367.30	86.86	12.05	3	538.52	77.84	6.32	3	378.79	88.35	13.65	3	446.08	79.25	2.25	3	441.97	81.36	5.78
4	362.31	85.01	10.96	4	541.29	79.17	6.46	4	377.46	88.43	13.02	4	447.61	79.39	2.37	4	442.81	81.59	5.69
5	358.20	83.49	10.06	5	543.86	80.43	6.59	5	376.18	88.47	12.43	5	449.12	79.53	2.48	5	443.65	81.83	5.61
6	354.82	82.26	9.32	6	546.25	81.62	6.71	6	374.95	88.48	11.88	6	450.62	79.69	2.59	6	444.49	82.05	5.54
7	352.04	81.25	8.71	7	548.47	82.74	6.81	7	373.79	88.48	11.36	7	452.10	79.85	2.69	7	445.34	82.28	5.48
8	349.77	80.43	8.21	8	550.53	83.81	6.90	8	372.71	88.47	10.88	8	453.57	80.01	2.78	8	446.19	82.50	5.42
9	347.89	79.76	7.79	9	552.44	84.81	6.98	9	371.69	88.44	10.44	9	455.02	80.18	2.88	9	447.04	82.73	5.37
10	346.36	79.22	7.45	10	554.22	85.76	7.05	10	370.75	88.42	10.03	10	456.46	80.35	2.96	10	447.88	82.95	5.33
11	345.87	78.75	7.17	11	555.90	86.66	7.12	11	369.90	88.39	9.65	11	457.88	80.53	3.05	11	448.76	83.17	5.29
12	345.48	78.37	6.94	12	557.46	87.52	7.18	12	369.15	88.37	9.30	12	459.28	80.71	3.13	12	449.64	83.38	5.26
13	345.18	78.07	6.75	13	558.93	88.33	7.23	13	368.47	88.37	8.98	13	460.67	80.90	3.20	13	450.51	83.60	5.24
14	344.94	77.82	6.59	14	560.31	89.10	7.28	14	367.89	88.36	8.69	14	462.04	81.09	3.28	14	451.39	83.82	5.22
15	343.98	77.65	6.46	15	561.60	89.82	7.33	15	367.38	88.37	8.42	15	463.40	81.28	3.35	15	452.23	84.03	5.20
16	344.00	77.49	6.35	16	562.80	90.52	7.37	16	366.91	88.37	8.18	16	464.75	81.47	3.41	16	453.10	84.25	5.19
17	344.04	77.36	6.26	17	563.94	91.17	7.41	17	366.52	88.38	7.96	17	466.07	81.66	3.48	17	453.97	84.46	5.18
18	344.09	77.27	6.18	18	565.01	91.79	7.44	18	366.19	88.39	7.76	18	467.39	81.86	3.54	18	454.83	84.66	5.17
19	344.16	77.19	6.12	19	566.02	92.39	7.48	19	365.92	88.41	7.57	19	468.69	82.06	3.60	19	455.69	84.87	5.17
20	344.24	77.14	6.06	20	566.97	92.95	7.50	20	365.69	88.43	7.40	20	469.97	82.26	3.66	20	456.54	85.08	5.17
21	344.34	77.10	6.02	21	567.88	93.48	7.53	21	365.52	88.45	7.25	21	471.24	82.46	3.72	21	457.39	85.28	5.17
22	344.45	77.07	5.98	22	568.72	93.99	7.56	22	365.39	88.47	7.11	22	472.50	82.66	3.77	22	458.23	85.48	5.17
23	344.57	77.06	5.95	23	569.53	94.47	7.58	23	365.30	88.52	6.99	23	473.74	82.86	3.82	23	459.06	85.68	5.18
24	344.70	77.06	5.93	24	570.30	94.93	7.60	24	365.25	88.57	6.87	24	474.97	83.07	3.87	24	459.90	85.88	5.18
25	344.84	77.06	5.91	25	571.02	95.36	7.62	25	365.22	88.62	6.77	25	476.19	83.27	3.92	25	460.72	86.07	5.19

TABLE D5

SAMPLE ANTIDEGRADATION CALCULATIONS FOR POPULATION BUILDOUT SCENARIO USING MASS BALANCE RESULTS TABLE D4

SAMPLE CALCULATIONS FOR TABLE 11 (TDS ANTIDEGRADATION ANALYSIS)

LOWER AQUIFER - WESTERN AND CENTRAL AREA Population Buildout at 10 Years:
Change in TDS: 456.46 mg/L (TDS at Year 10) - 443 mg/L (TDS at Year 1) = 13.5 mg/L (greater TDS)
Percent TDS Assimilative Capacity Used: 13.5 mg/L (change in TDS) ÷ 560 mg/L (TDS assimilative capacity) = 2.4 % (TDS assimilative capacity used)

LOWER AQUIFER AND ALLUVIAL AQUIFER - EASTERN AREA Population Buildout at 25 Years
Change in TDS: 571.02 mg/L (TDS at Year 25) - 532 mg/L (TDS at Year 1) = 39 mg/L (greater TDS)
Percent TDS Assimilative Capacity Used: 39 mg/L (change in TDS) ÷ 470 mg/L (TDS assimilative capacity) = 8.3 % (TDS assimilative capacity used)

BASIN TOTAL Population Buildout at 25 Years (Refer to Table 11 for compartment values and Table 4 for compartment volumes):
Average Change in TDS (weighted by volume): ((-35.2 mg/L * 5.18E9 L) + (-15.8 mg/L * 3.33E10 L) + (33.2 mg/L * 8.68E10 L) + (39 mg/L* 2.21E10 L)) ÷ 1.47E11 L = 20.7 mg/L (greater TDS)
Percent TDS Basin Assimilative Capacity Used: 20.7 mg/L (change in TDS) ÷ 560 mg/L (TDS assimilative capacity) = 3.7 % (TDS assimilative capacity used)

SAMPLE CALCULATIONS FOR TABLE 12 (CHLORIDE ANTIDEGRADATION ANALYSIS)

LOWER AQUIFER - WESTERN AND CENTRAL AREA Population Buildout at 10 Years:
Change in Chloride: 80.35 mg/L (Cl at Year 10) - 79 mg/L (Cl at Year 1) = 1.4 mg/L (greater Cl)
Percent Chloride Assimilative Capacity Used: 1.4 mg/L (change in Cl) ÷ 171 mg/L (Cl assimilative capacity) = 0.8 % (Cl assimilative capacity used)

LOWER AQUIFER AND ALLUVIAL AQUIFER - EASTERN AREA Population Buildout at 25 Years
Change in Chloride: 95.36 mg/L (Cl at Year 25) - 75 mg/L (Cl at Year 1) = 20.4 mg/L (greater Cl)
Percent Chloride Assimilative Capacity Used: 20.4 mg/L (change in Cl) ÷ 175 mg/L (Cl assimilative capacity) = 11.7 % (Cl assimilative capacity used)

BASIN TOTAL Population Buildout at 25 Years (Refer to Table 12 for compartment values and Table 4 for compartment volumes):
Average Change in Chloride (weighted by volume): ((-14.9 mg/L * 5.18E9 L) + (0.6 mg/L * 3.33E10 L) + (4.3 mg/L * 8.68E10 L) + (20.4 mg/L* 2.21E10 L)) ÷ 1.47E11 L = 5.2 mg/L (greater Cl)
Percent Chloride Basin Assimilative Capacity Used: 5.2 mg/L (change in Cl) ÷ 169 mg/L (TDS assimilative capacity) = 3.1 % (Cl assimilative capacity used)

SAMPLE CALCULATIONS FOR TABLE 13 (NO_3-N ANTIDEGRADATION ANALYSIS)

LOWER AQUIFER - WESTERN AND CENTRAL AREA Population Buildout at 10 Years:
Change in NO3-N: 2.96 mg/L (NO3-N at Year 10) - 2 mg/L (NO3-N at Year 1) = 0.96 mg/L (greater NO3-N)
Percent NO3-N Assimilative Capacity Used: 0.96 mg/L (change in NO3-N) ÷ 8 mg/L (NO3-N assimilative capacity) = 12 % (NO3-N assimilative capacity used)

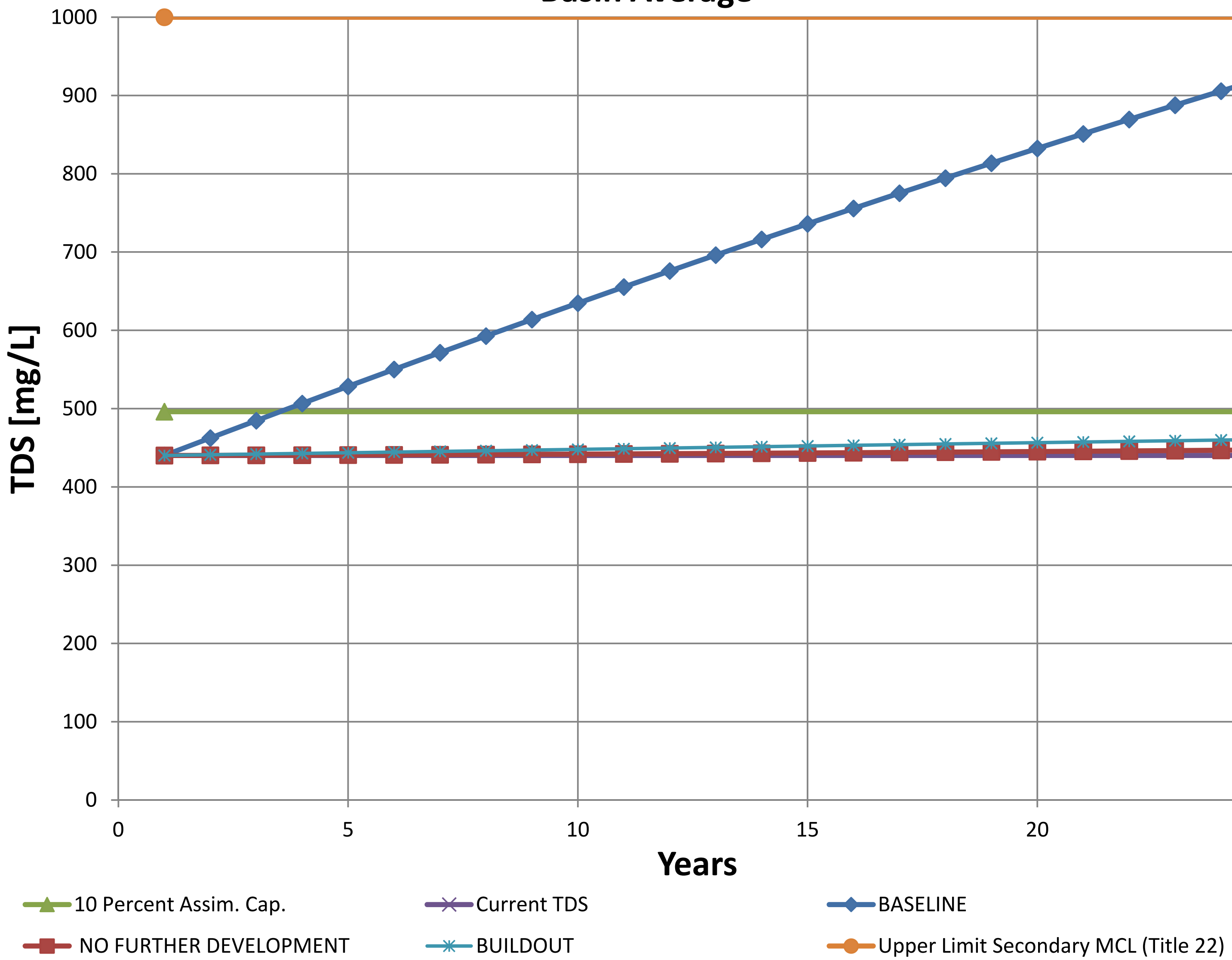
LOWER AQUIFER AND ALLUVIAL AQUIFER - EASTERN AREA Population Buildout at 25 Years
Change in NO3-N: 7.62 mg/L (NO3-N at Year 25) - 6 mg/L (NO3-N at Year 1) = 1.62 mg/L (greater NO3-N)
Percent NO3-N Assimilative Capacity Used: 1.62 mg/L (change in NO3-N) ÷ 4 mg/L (NO3-N assimilative capacity) = 40.5 % (NO3-N assimilative capacity used)

BASIN TOTAL Population Buildout at 25 Years (Refer to Table 13 for compartment values and Table 4 for compartment volumes):
Average Change in NO3-N (weighted by volume): ((-9.1 mg/L * 5.18E9 L) + (-8.2 mg/L * 3.33E10 L) + (1.9 mg/L * 8.68E10 L) + (1.6 mg/L* 2.21E10 L)) ÷ 1.47E11 L = -0.82 mg/L (lower NO3-N)
Percent NO3-N Basin Assimilative Capacity Used: -0.82 mg/L (change in NO3-N) ÷ 4 mg/L (NO3-N assimilative capacity) = -20.5 % (NO3-N assimilative capacity used)

APPENDIX E

Mass Loading Spreadsheet Model Results - Graphs

Figure E1
TDS Concentration Trends
Basin Average



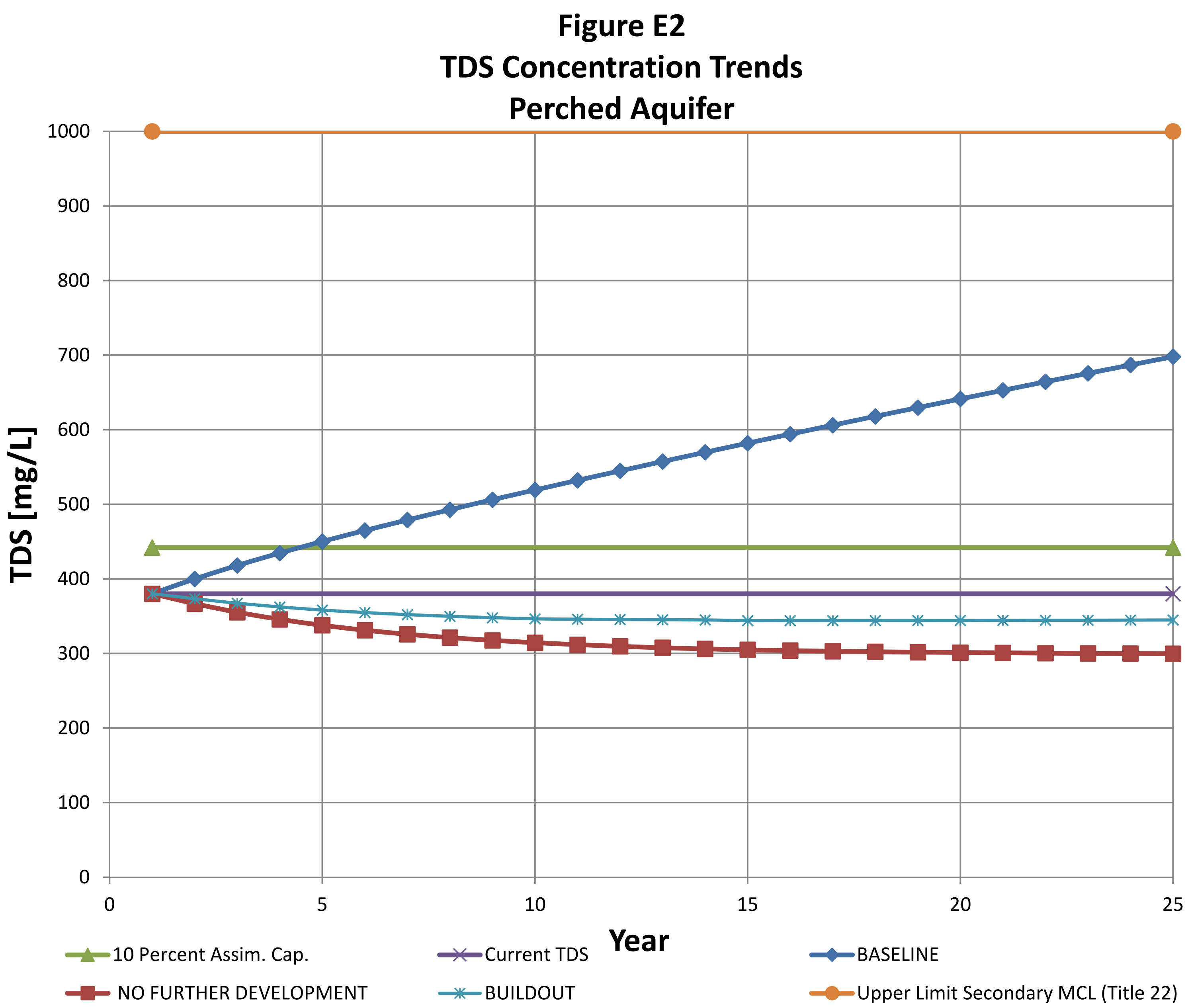


Figure E2
TDS Concentration Trends
Perched Aquifer
TDS [mg/L]
1000
900
800
700
600
500
400
300
200
100
0
0
5
10
15
20
25
Year
10 Percent Assim. Cap.
Current TDS
BASELINE
NO FURTHER DEVELOPMENT
BUILDOUT
Upper Limit Secondary MCL (Title 22)

Figure E3
TDS Concentration Trends
Upper Aquifer

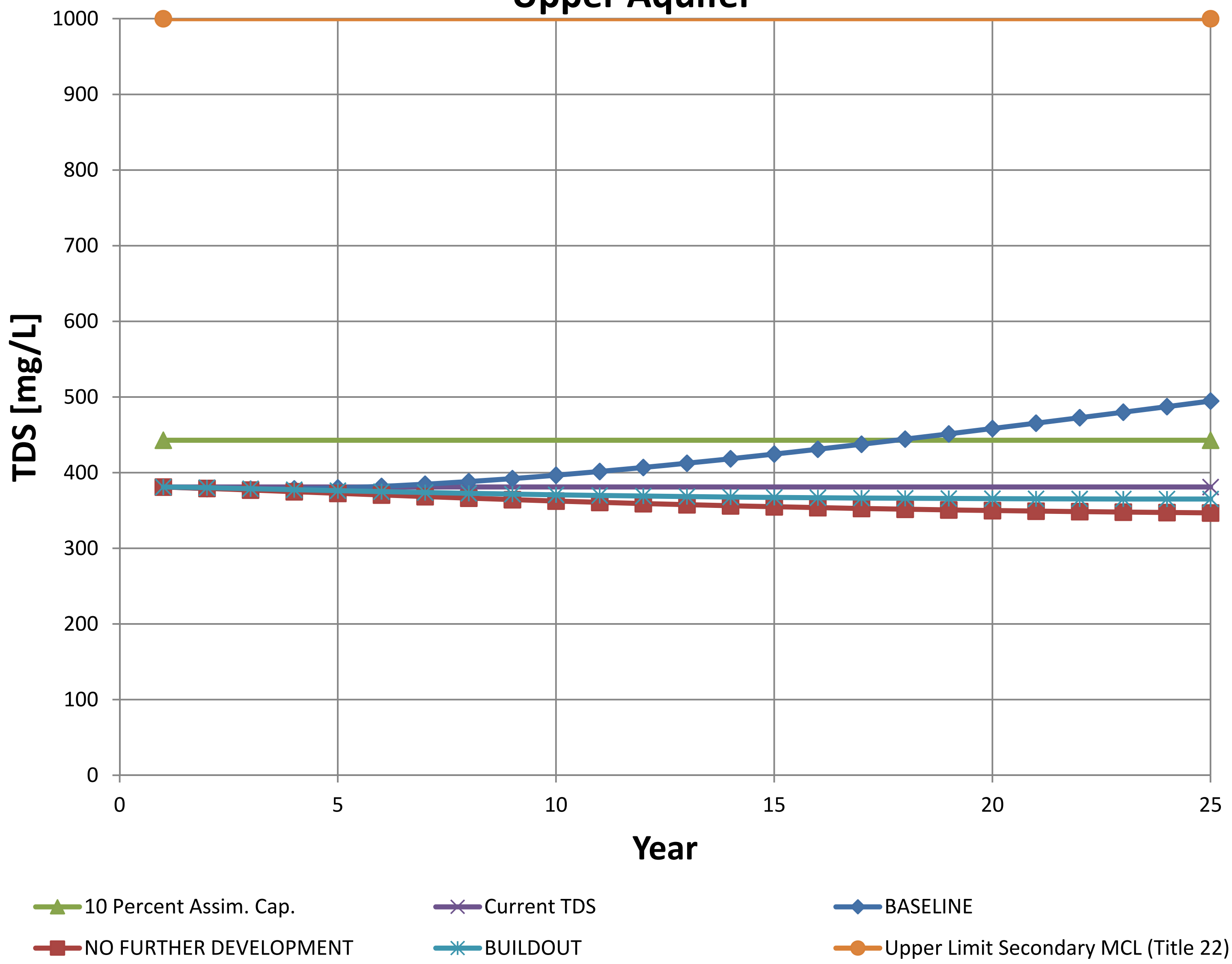
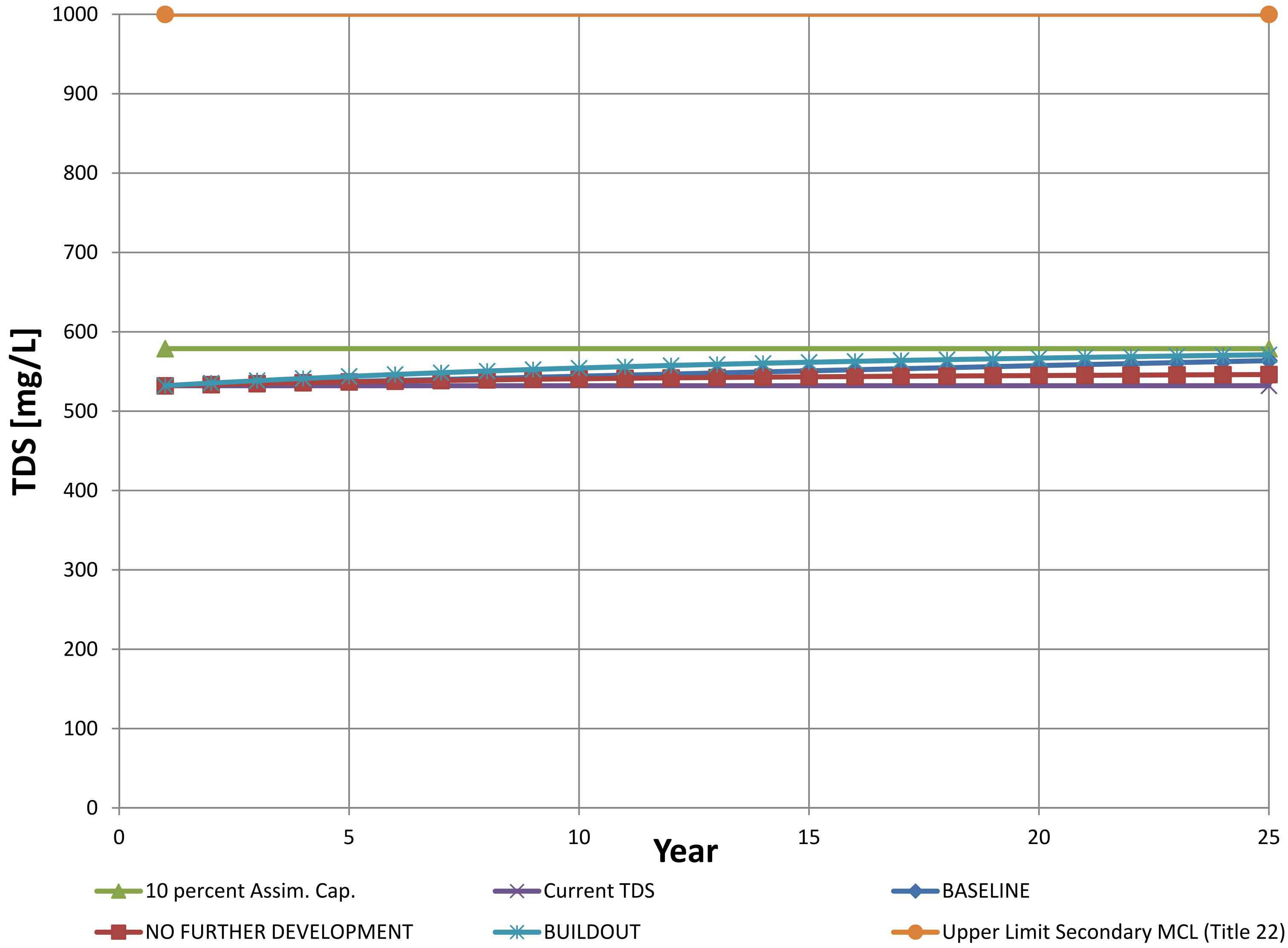


Figure E4
TDS Concentration Trends
Eastern Area Alluvial Aquifer/Lower Aquifer



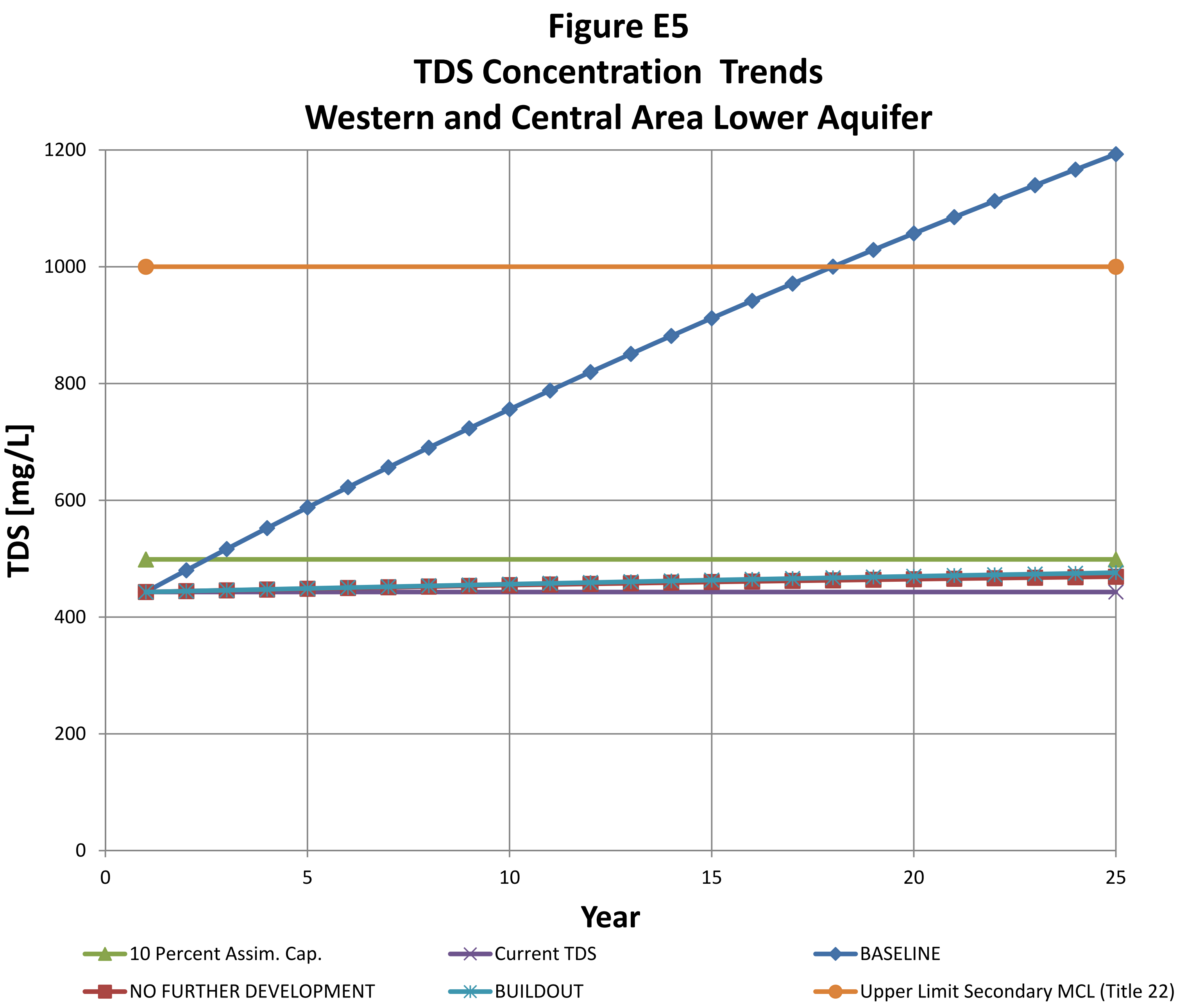


Figure E5
TDS Concentration Trends
Western and Central Area Lower Aquifer
1200
1000
800
600
400
200
0
TDS [mg/L]
0
5
10
15
20
25
Year
10 Percent Assim. Cap.
Current TDS
BASELINE
NO FURTHER DEVELOPMENT
BUILDOUT
Upper Limit Secondary MCL (Title 22)

Figure E6
Chloride Concentration Trends
Basin Average

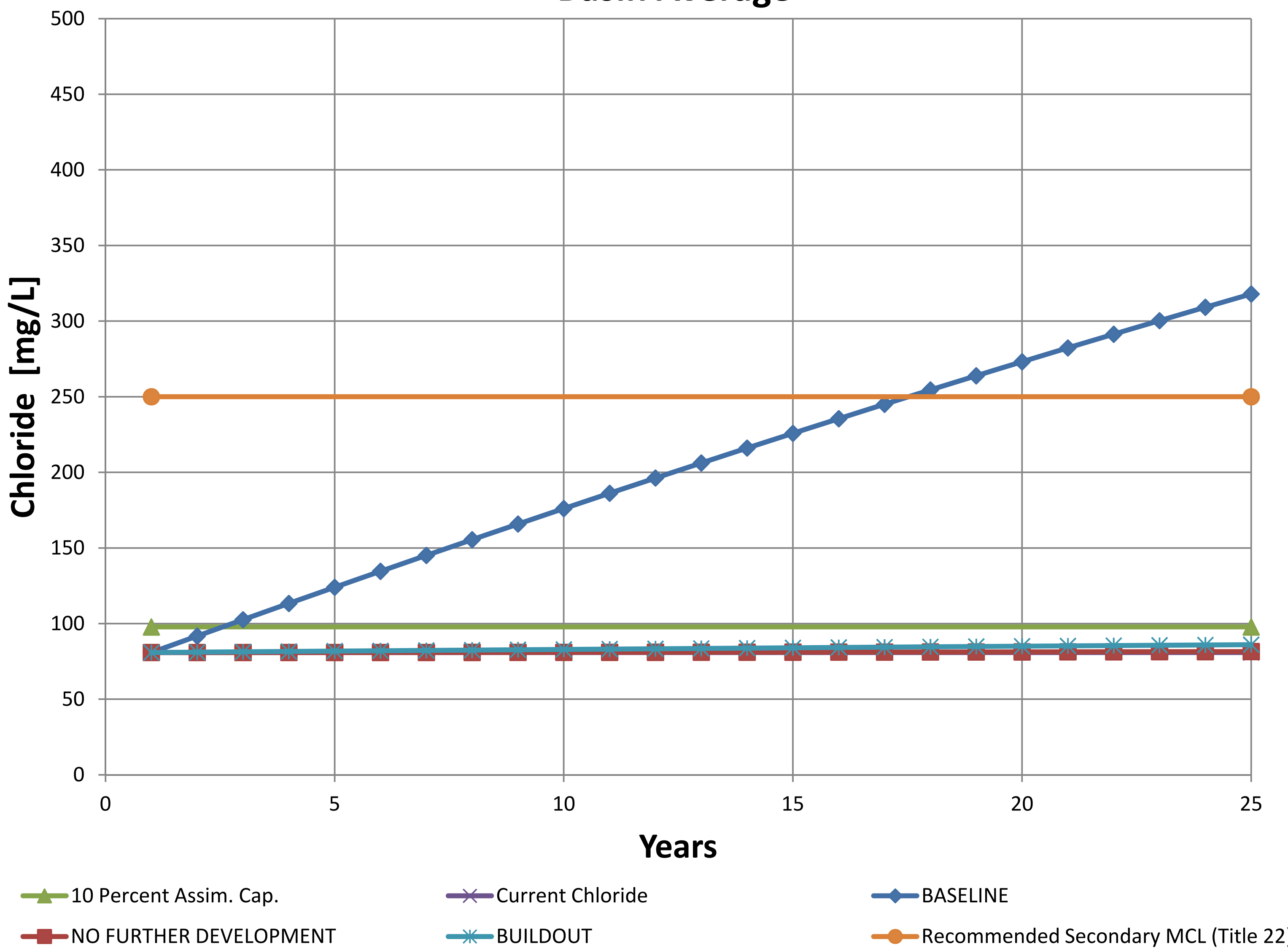


Figure E7
Chloride Concentration Trends
Perched Aquifer

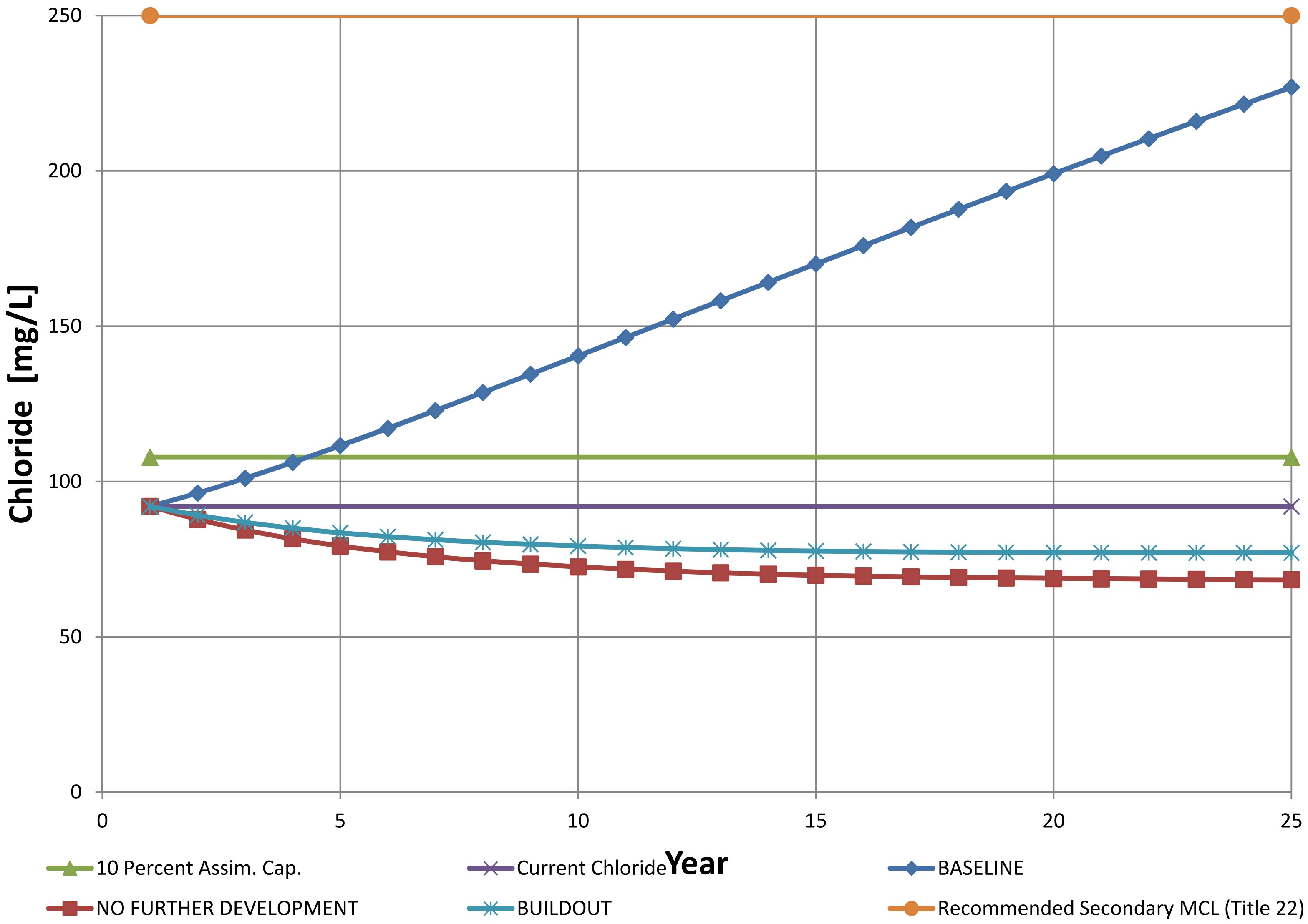


Figure E8
Chloride Concetration Trends
Upper Aquifer

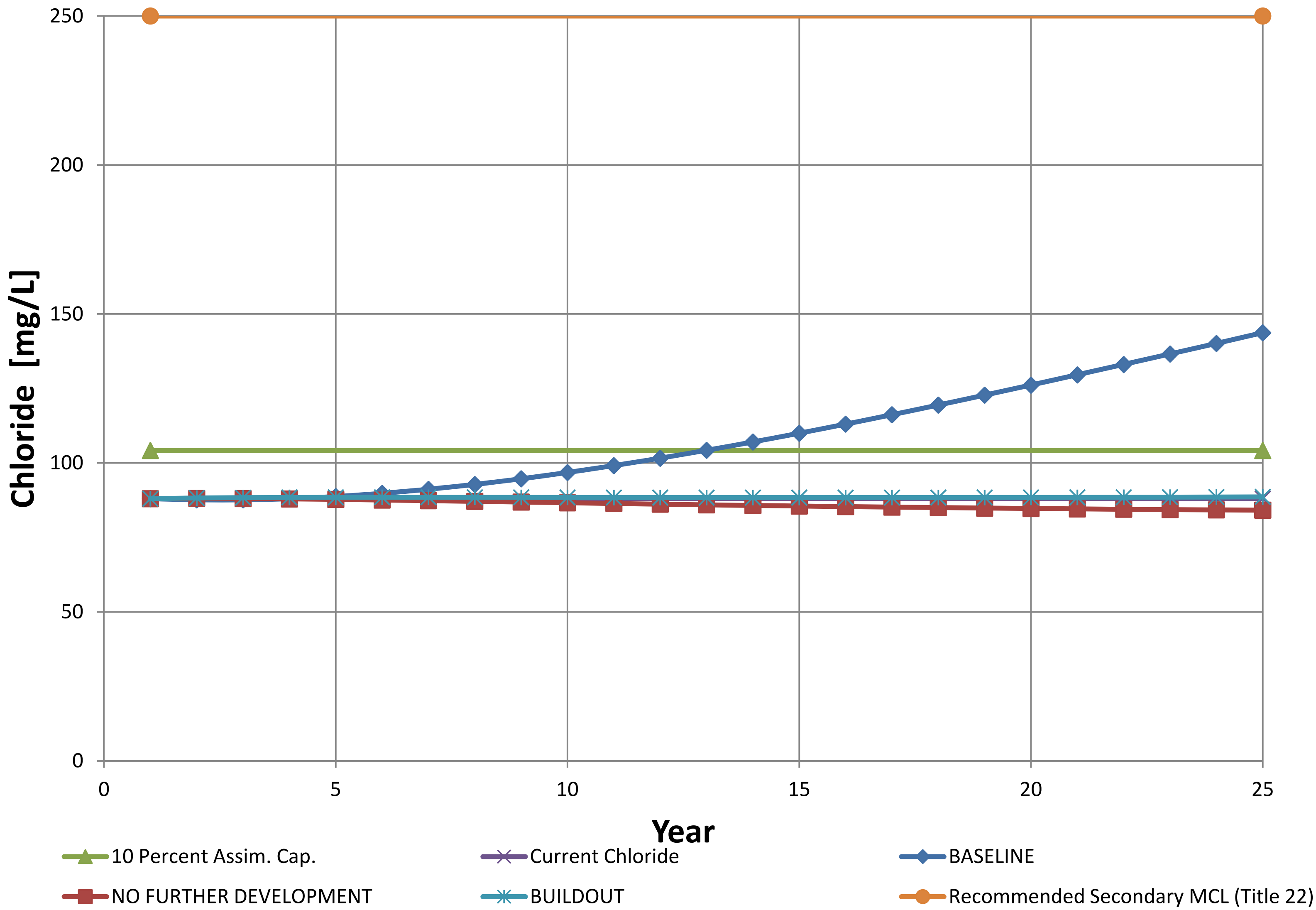
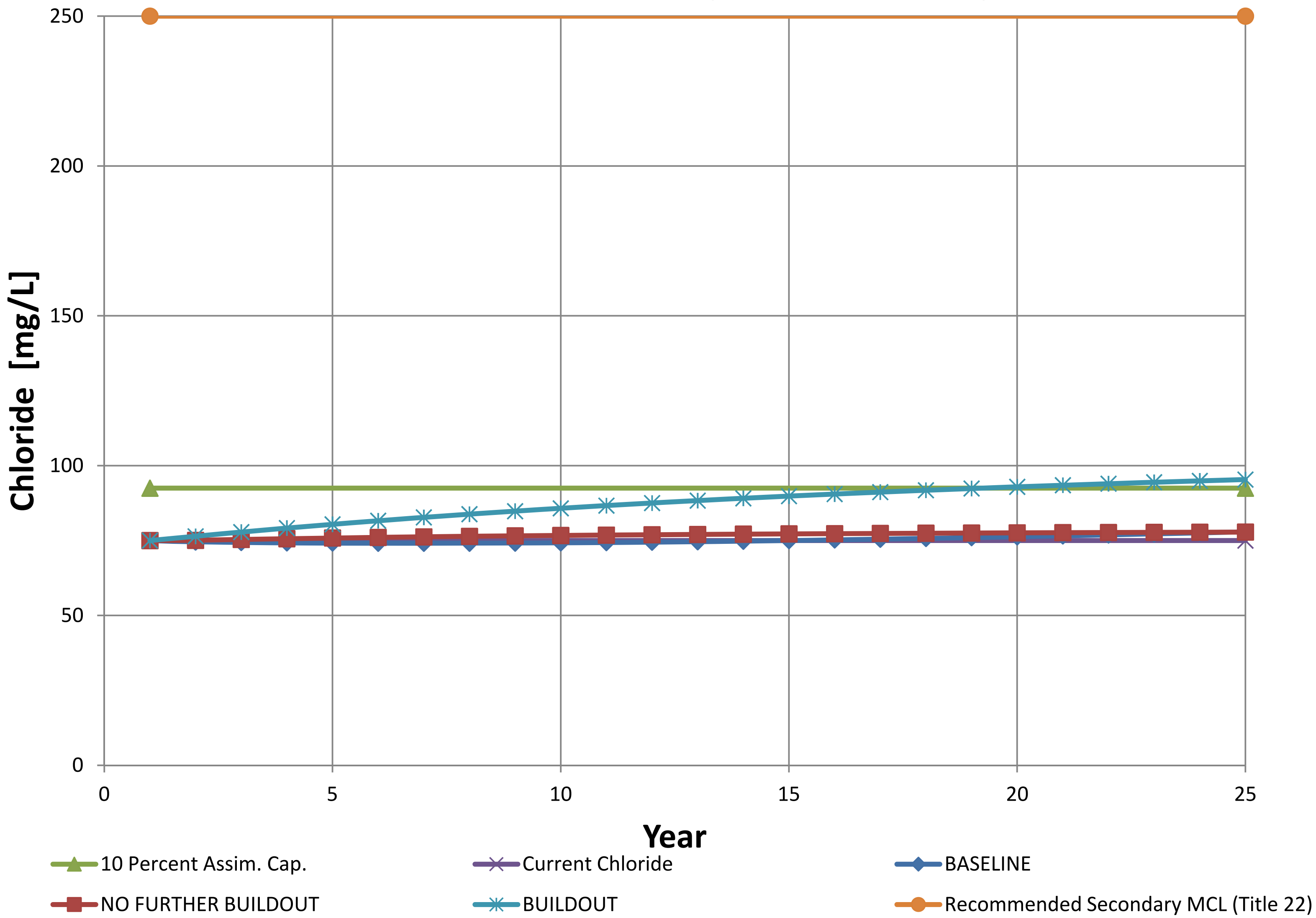


Figure E9
Chloride Concentration Trends
Eastern Area - Alluvial Aquifer / Lower Aquifer



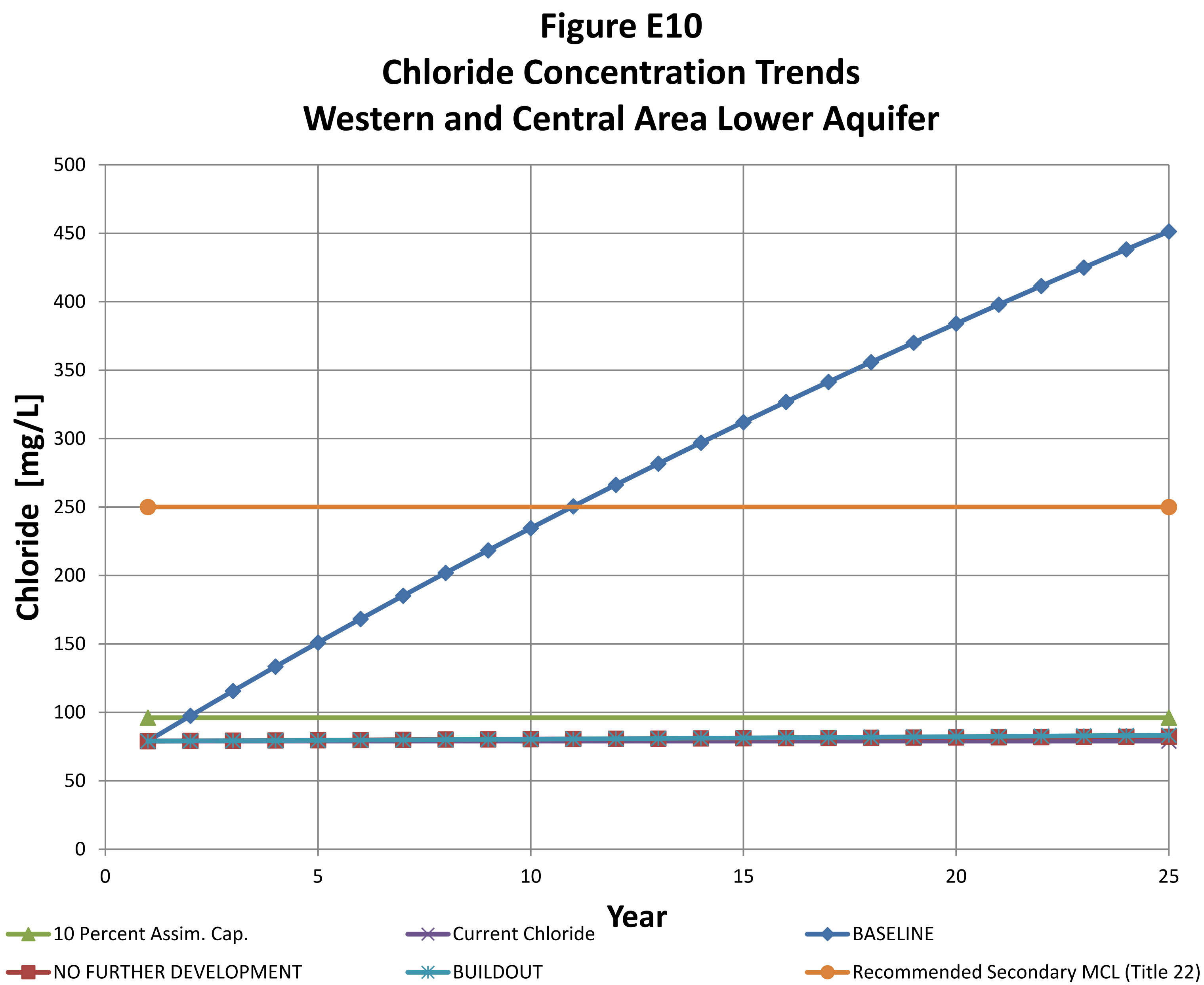


Figure E10
Chloride Concentration Trends
Western and Central Area Lower Aquifer
Chloride [mg/L]
500
450
400
350
300
250
200
150
100
50
0
0
5
10
15
20
25
Year
10 Percent Assim. Cap.
Current Chloride
BASELINE
NO FURTHER DEVELOPMENT
BUILDOUT
Recommended Secondary MCL (Title 22)

Figure E11
NO_3-N Concentration Trends
Basin Average

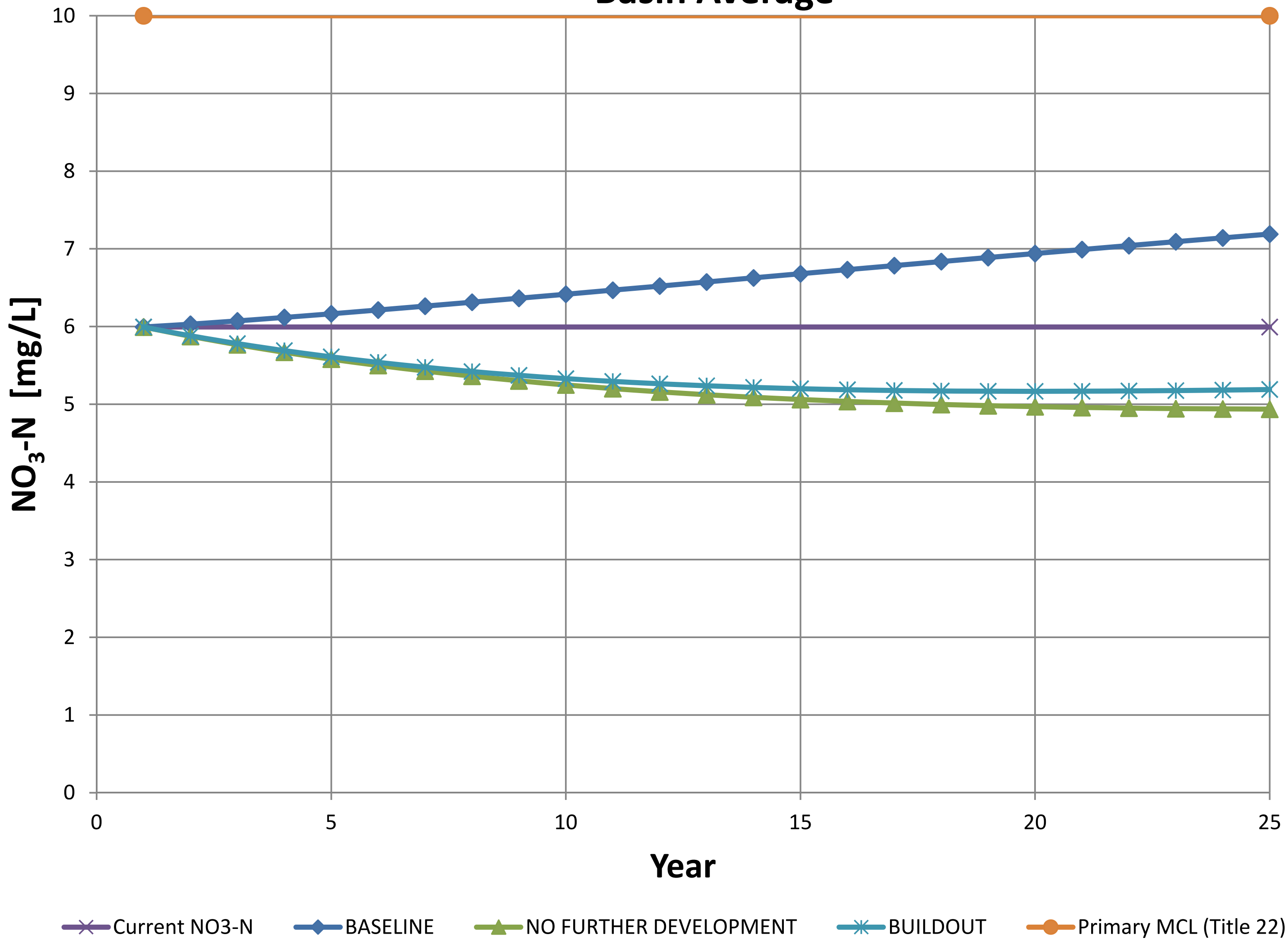


Figure E12
NO_3-N Concentration Trends
Perched Aquifer

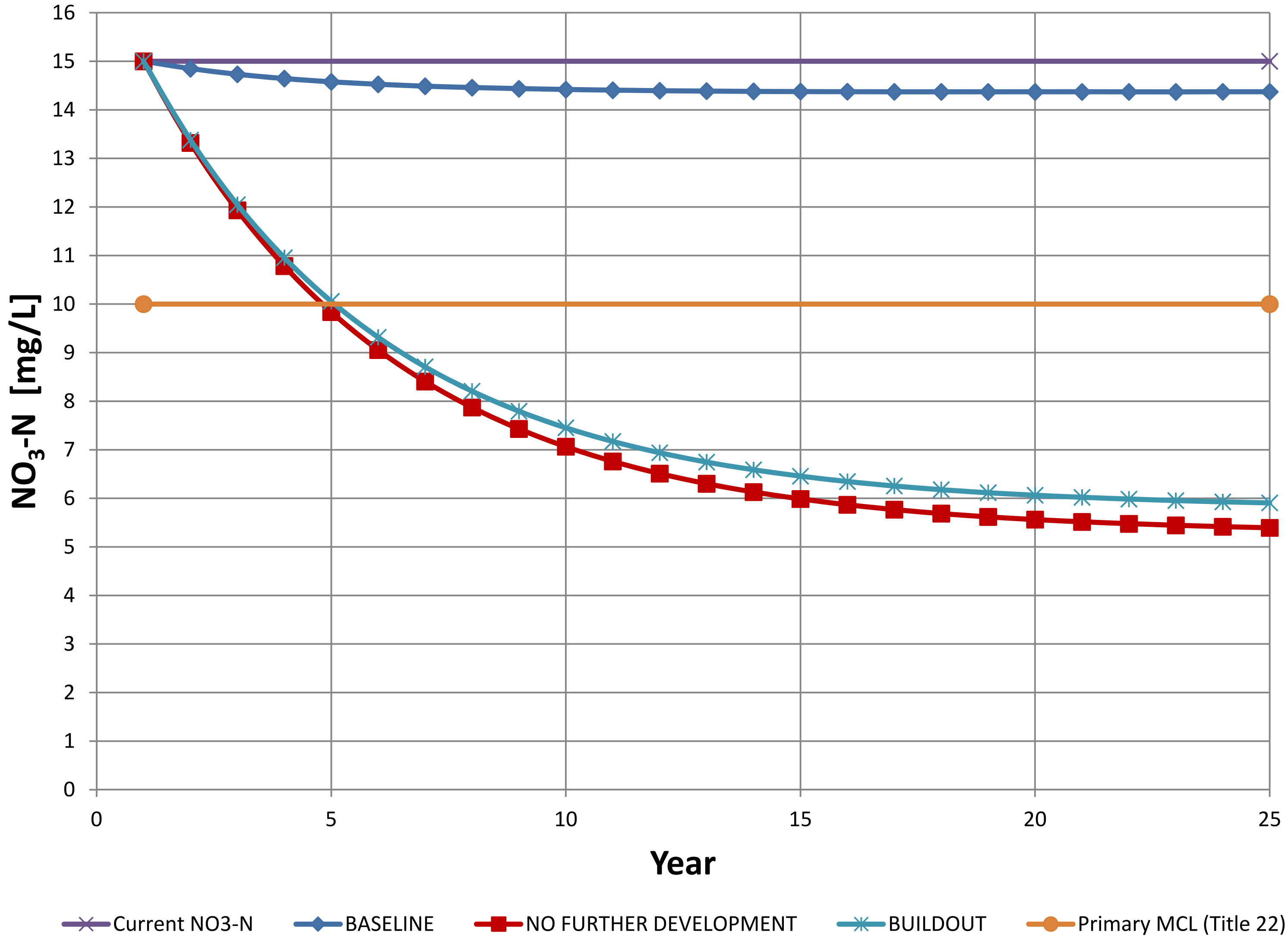


Figure E13
NO_3-N Concentration Trends
Upper Aquifer

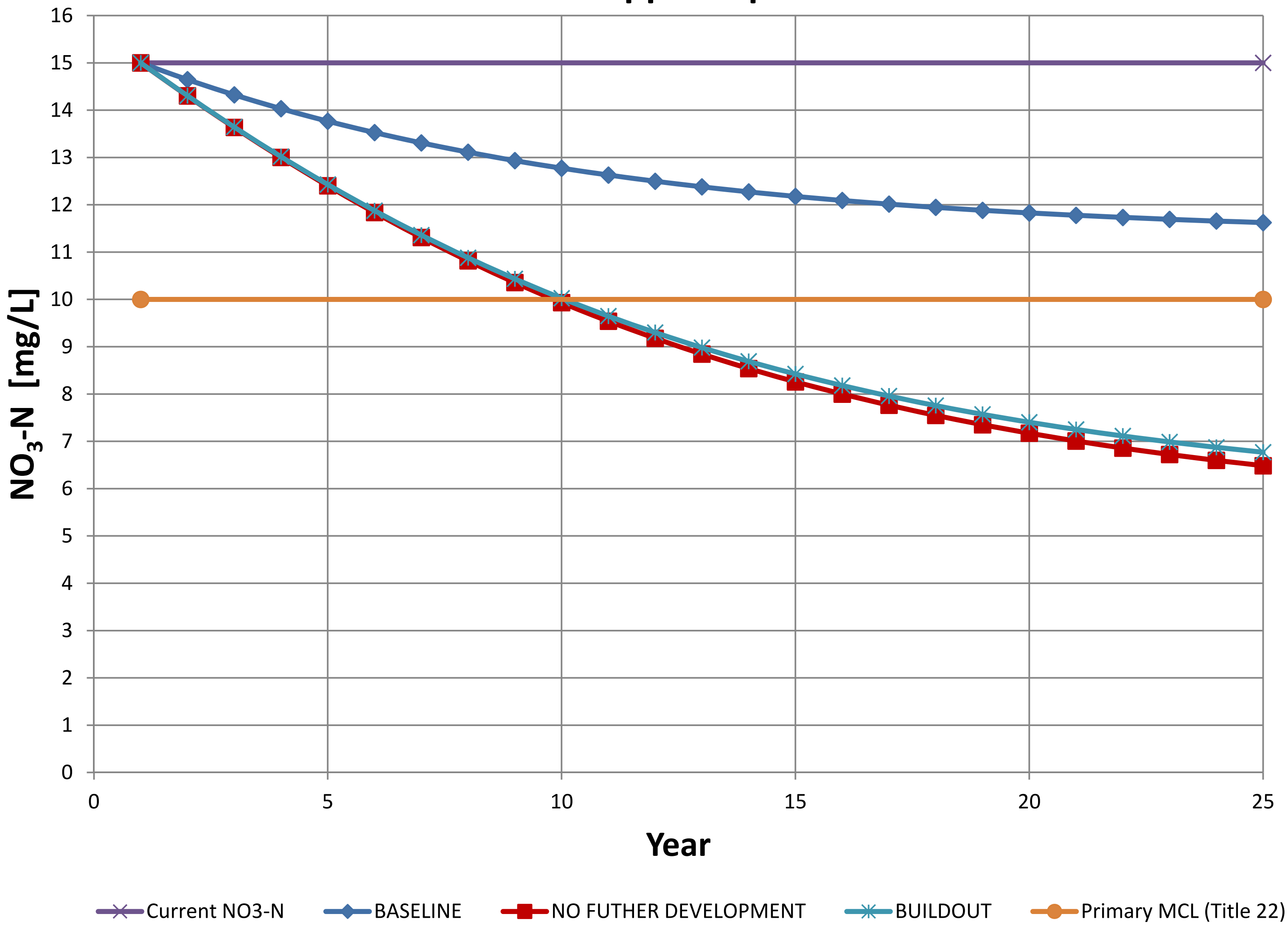
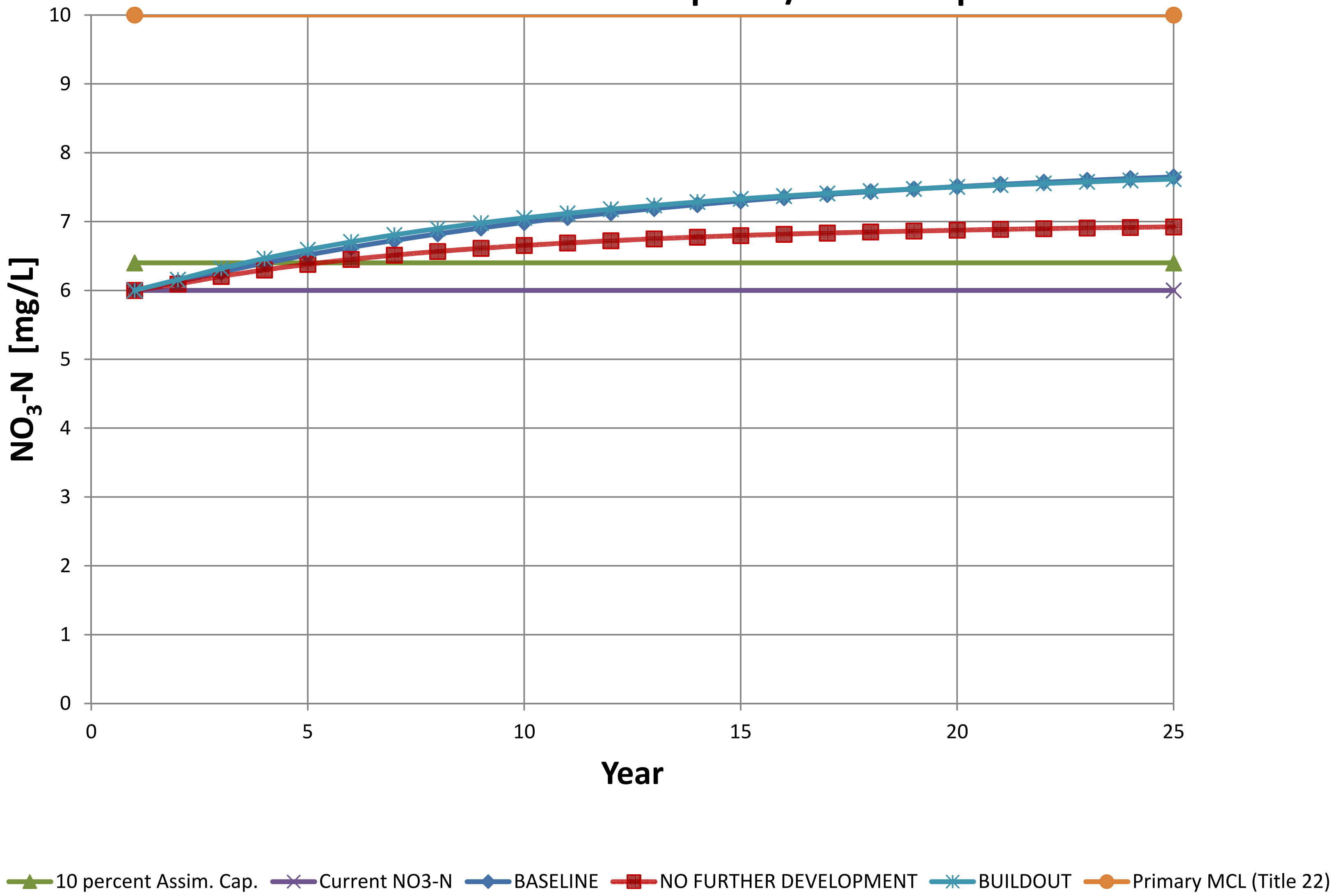


Figure E14
NO_3-N Concentration Trends
Eastern Area - Alluvial Aquifer / Lower Aquifer



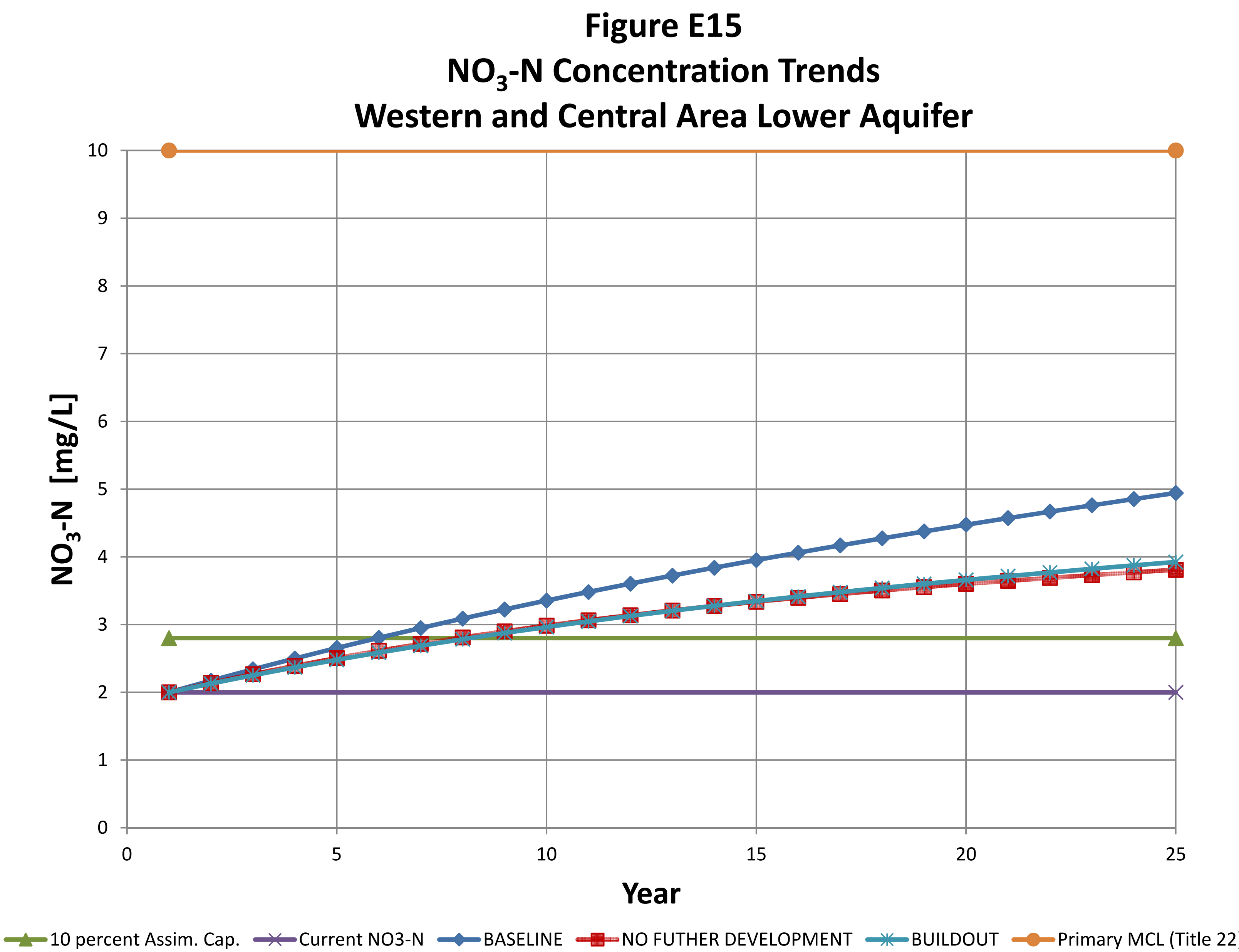


Figure E15
NO3-N Concentration Trends
Western and Central Area Lower Aquifer
NO3-N [mg/L]
Year
10 percent Assim. Cap.
Current NO3-N
BASELINE
NO FUTHER DEVELOPMENT
BUILDOUT
Primary MCL (Title 22)