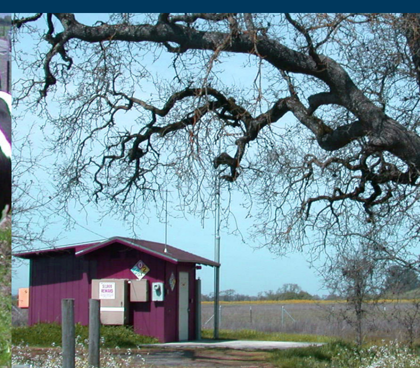
Sonoma Valley Salt and Nutrient Management Plan

Prepared for the Sonoma Valley County Sanitation District

SONOMA COUNTY WATER AGENCY



September 2013

Sonoma Valley Salt and Nutrient Management Plan
Final Report

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Prepared for the Sonoma Valley County Sanitation District

September 2013

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List of Acronyms

AF	Acre-Feet
AFY	Acre-Feet per Year
BAP	Basin Advisory Panel
BMPs	Best Management Practices
BOD	Biological Oxygen Demand
BPO	Basin Plan Objective
CDPH	California Department of Public Health
CEC	Constituents of Emerging Concern
DWR	Department of Water Resources
EC	Electrical Conductivity
GMP	Groundwater Management Plan
IRWM	Integrated Regional Water Management
LID	Low Impact Development

MCL	Maximum Contaminant Level
OWTS	Onsite Wastewater Treatment System
SCWA	Sonoma County Water Agency
SMCL	Secondary Maximum Contaminant Level
SNMP	Salt and Nutrient Management Plan
SVCSD	Sonoma Valley County Sanitation District
SVGMP	Sonoma Valley Groundwater Management Program
SWRCB	State Water Resources Control Board
TAC	Technical Advisory Committee
TDS	Total Dissolved Solids
USGS	United States Geological Survey
UWMPs	Urban Water Management Plans
VOMWD	Valley of the Moon Water District

Executive Summary

ES-1 Recycled Water Policy Background and Salt and Nutrient Plan Requirement

In February 2009, the State Water Resources Control Board established a statewide Recycled Water Policy to encourage the use of recycled water and local stormwater capture. The Recycled Water Policy also required local water and wastewater entities, together with local salt and nutrient contributing stakeholders to develop a Salt and Nutrient Management Plan (SNMP) for each groundwater basin or subbasin in California. In addition to promoting reliance on local, sustainable water sources such as recycled water and stormwater, the SNMP's purpose is to manage salts and nutrients from all sources to ensure water quality objectives are met and sustained, and beneficial uses of the groundwater basin are protected. The information in this SNMP is limited to the available data for the subbasin.

ES-2 Conceptual Model of the Sonoma Valley Subbasin

This SNMP was developed for the Sonoma Valley Subbasin, defined as basin number 2-2.02 in the California Department of Water Resources (DWR) Bulletin 118-4 (DWR, 2003). The Sonoma Valley Subbasin encompasses an area of approximately 70 square miles and is located within the larger 166 square mile Sonoma Creek Watershed. Due to an area of historical brackish groundwater located adjacent to and northwest of San Pablo Bay, the Sonoma Valley Subbasin was divided into a Baylands Area (containing the historical brackish groundwater) and an Inland Area for the analyses within this SNMP.

There are distinct shallow and deeper groundwater zones with the subbasin, and two groundwater pumping depressions are apparent in the deep zone southeast of the City of Sonoma (City) and in the El Verano area. Groundwater serves approximately 25% of the Sonoma Valley population and is the primary source of drinking water supply for rural domestic and other unincorporated areas not being served by urban suppliers. More than half of the water demand in 2000 was met with groundwater and the remaining demand was met with imported water (36%), recycled water (7%), and local surface water (<1%).

The Sonoma County Water Agency (SCWA) manages and operates the wastewater treatment facility owned by the Sonoma Valley County Sanitation District (SVCSD). During dry weather months from May through October, the SVCSD provides 1,000 to 1,200 acre-feet per year (AFY) of recycled water for vineyards, dairies, and pasturelands in the southern part of Sonoma Valley.

In 2006, a collaborative group of over twenty stakeholders began development of a non-regulatory Groundwater Management Plan (GMP). The Sonoma Valley Groundwater Management Program (SVGMP) arising from the GMP locally manages groundwater resources for all beneficial uses.

ES-3 Developing a Plan Collaboratively

The SNMP was coordinated through the efforts of the SVGMP's existing stakeholder groups, the Basin Advisory Panel (BAP) and the Technical Advisory Committee (TAC). Development of the SNMP was a collaborative effort that utilized a series of six workshops at key milestones in the plan development and technical analysis. The San Francisco Bay Regional Water Quality Control Board (Regional Water Board), has also been heavily involved in the Plan development and progress through two inter-regional regulatory meetings, and three Sonoma Valley SNMP-specific meetings. These meetings were held to share findings and obtain concurrence on critical elements of the technical analysis and the development approach for the SNMP.

The Sonoma Valley SNMP received partial funding through the Proposition 84 Planning Grant for the SNMP preparation and development of a guidance document to assist other Bay Area agencies wanting to undergo a similar process in developing their SNMPs. The *Guidance Document for Salt and Nutrient Management Plans for the San Francisco Bay Region* was developed as a result, and is included as Appendix B.

ES-4 Recycled Water and Stormwater Goals

The goals for use of recycled water and stormwater recharge in the subasin were developed based on stakeholder input and on the information contained in UWMPs and other planning documents. Currently, approximately 1,100 AFY of recycled water is utilized within the subbasin for agricultural irrigation. Future planned use, and hence the recycled water goal for the subbasin is 4,100 AFY for irrigation of urban areas and agricultural, and environmental enhancement.

Agencies and stakeholders in the Sonoma Valley Subbasin are actively working to increase the ability to put stormwater to beneficial use. However, the benefit of recharging stormwater (which is likely to be low in TDS) is not included in the groundwater quality analyses in this Plan due to uncertainties in the projected quantity and volumes of stormwater recharge at this time.

ES-5 Existing Groundwater Quality

TDS and nitrate were utilized as indicator parameters within this SNMP. A period of 2000-2012 was utilized to establish baseline groundwater quality conditions. Generally, relatively low TDS concentrations (less than 500 mg/L) are observed throughout most of the subbasin. A few wells with elevated concentrations (above 750 mg/L) are seen in the southeastern portion of the subbasin in an area of historical brackish groundwater (Baylands Area).

This Baylands Area has been recognized for decades as an area of historical brackish groundwater (Kunkel and Upson, 1960; USGS, 2006). Due to the elevated salt in this area and land cover which is primarily tidal marshlands, groundwater pumping is limited, and the area is unlikely to be developed for groundwater supply in the future. Accordingly, this area is considered separately from the remainder of the subbasin referred to as the Inland Area to assess average groundwater quality. Average groundwater quality in the subbasin is characterized for the Inland Area, the Baylands Area, and the combined Inland and Baylands areas as one aquifer.

The average TDS concentration in the Inland Area, Baylands Area, and combined Sonoma Valley Subbasin area are shown in Table ES-1. The average Inland Area TDS concentration is 372 mg/L, well below the BPO of 500 mg/L, resulting in available assimilative capacity of 128 mg/L.

Table ES-1: Average TDS Concentrations and Available Assimilative Capacity

Concentrations in mg/L	Sonoma Valley Subbasin	Inland Area	Baylands Area
Average	635	372	1,220
BPO	500	500	500
Available Assimilative Capacity	**-135**	**128**	**-720**

TDS – total dissolved solids
mg/L – milligrams per liter

Generally low nitrate concentrations are observed throughout most of the subbasin. The average nitrate concentration in the Inland Area, Baylands Area, and combined Sonoma Valley Subbasin area are shown in Table ES-2.

Table ES-2: Average Nitrate-N Concentrations and Available Assimilative Capacity

Concentrations in mg/L	Sonoma Valley Subbasin	Inland Area	Baylands Area
Average	0.06	0.06	0.07
BPO	10.00	10.00	10.00
Available Assimilative Capacity	**9.94**	**9.94**	**9.93**

TDS – total dissolved solids
mg/L – milligrams per liter

ES-6 Source Identification and Loading

Salt and nutrient loading from surface activities to the Sonoma Valley Subbasin are due to various sources, including:

- Irrigation water (potable water, surface water, groundwater, and recycled water)
- Agricultural inputs (fertilizer, soil amendments, and applied water)
- Residential inputs (septic systems, fertilizer, soil amendments, and applied water)
- Animal waste (dairy manure land application)

To better understand the significance of various loading factors for the SNMP analysis, a GIS-based loading model was developed. Data inputs to the model include the spatial distribution of land uses (with associated loading factors), irrigation water sources (with associated water quality), septic inputs, wastewater infrastructure loads, and soil textures. The loading analysis found somewhat higher loading of TDS in the rural and agricultural areas of the subbasin, while nitrate loading was higher in the urban areas largely due to the low nitrogen application rates on vineyards. Loading model outputs were utilized to determine future water quality conditions.

ES-7 Future Groundwater Quality

A mixing model was used to predict future water quality, water quality trends, and the percentage of the existing available assimilative capacity used by recycled water projects in the subbasin during the future planning period (through 2035).

Three future scenarios were simulated:

- Future Scenario 0 (No-Project): Assumes average baseline water balance conditions and no additional enhanced stormwater capture and recharge is applied.
- Future Scenario 1: Assumes 2035 planned recycled water use of 4,100 AFY (applied consistently from WY 2013-14 through WY 2034-35)
- Future Scenario 2: Assumes 2035 planned recycled water use plus an additional 5,000 AFY of recycled water (applied consistently from WY 2013-14 through WY 2034-35).

For all three scenarios, recycled water projects use less than 10% of the available assimilative capacity for both TDS and nitrate, and projected concentrations remain well below the BPO of 500 mg/L for TDS and 10 mg/L for nitrate.

ES-8 Implementation Measures

The findings from the technical analysis completed for the SNMP indicate that overall groundwater quality in the basin is stable with low salinity and nutrient values, well below the Regional Water Board's BPOs. Analysis of future water quality (through 2035) indicates good water quality and stable trends. Therefore, no new implementation measures or BMPs as part of the SNMP process are recommended at this time; however, it is recommended that existing measures or practices to manage groundwater quality in the basin continue.

ES-9 Groundwater Monitoring Program

A Groundwater Monitoring Plan is a required element of all SNMPs. For the SNMP Groundwater Monitoring Program, 47 wells that are currently monitored by DWR, CDPH, and SVGMP will be included in the monitoring program. Wells will be monitored on the same schedule as their current monitoring, and results will be reported through the Geotracker database system to the Regional Water Board every three years in an SNMP Groundwater Monitoring Report. Parameters to be monitored include EC, TDS and nitrate.

ES-10 Antidegradation Analysis

Recycled water project(s) in the Sonoma Valley include existing (agricultural irrigation) and projected increased use of recycled water for irrigation and environmental enhancement through the end of the future planning period in 2035. Irrigation with recycled water contributes only very minor salt and nutrient loading to the subbasin and recycled water projects do not use more that 10 % of the available assimilative capacity.

In addition to the minimal negative water quality impacts associated with recycled water irrigation project(s) in the Subbasin, the Recycled Water Policy and other state-wide planning documents recognize the tremendous need for and benefits of increased recycled water use in California. The SNMP analysis finds that recycled water use can be increased while still protecting and improving groundwater quality for beneficial uses.

ES-11 Plan Finalization Process

Following the presentation of the Draft SNMP at the July 18, 2013 public workshop, public comments on the Draft SNMP Report were considered and incorporated into this Final SNMP Report. This SNMP is being submitted to the Regional Water Board (in September 2013) for their review and incorporation to their Basin Planning process and subsequent environmental documentation process. The Final SNMP Report has been posted online at the following web address: www.scwa.ca.gov/svgroundwater/

ES-12 Conclusion

The findings from the technical analysis completed for the SNMP indicate that overall groundwater quality in the basin is stable with low salinity and nutrient values (well below the Regional Water Board's BPOs), resulting from a combination of factors including the high percentage of mountain front recharge with very low TDS and nitrate concentrations, the low amount of loading from the few sources identified, and the low volume and high quality of recycled water used. Analysis of future water quality (through 2035) also indicates good water quality and stable trends.

In conclusion, no new implementation measures or BMPs as part of the SNMP process are recommended at this time.

Chapter 1 Introduction and Background

In February 2009, the State Water Resources Control Board (SWRCB) adopted Resolution No. 2009-0011, which established a statewide Recycled Water Policy. The policy encourages increased use of recycled water and local stormwater capture. It also requires local water and wastewater entities, together with local salt and nutrient contributing stakeholders to develop a Salt and Nutrient Management Plan (SNMP) for each groundwater basin or subbasin in California. The Sonoma Valley SNMP was developed through a collaborative process over an 18-month period starting in January 2012.

This SNMP was prepared for the Sonoma Valley Groundwater Subbasin in Sonoma County, California. The community overlying the groundwater subbasin includes urban areas as well as a significant amount of rural and agricultural land. Groundwater is an important resource to the area. Recycled water is currently used for agricultural irrigation and there are plans for expanded use of recycled water to augment or offset existing water supplies. As the primary local distributor of recycled water, the Sonoma Valley County Sanitation District (SVCSD) is leading the development of this SNMP.

1.1 Plan Purpose

The purpose of this SNMP is to:

- Promote reliance on local sustainable water sources such as recycled water and stormwater
- Manage salts and nutrients from all sources on a sustainable basis to ensure attainment of water quality objectives and protection of beneficial uses

1.2 Plan Organization

This SNMP is a comprehensive summary document of both the technical and planning work that went into development of the SNMP. The body of the report provides a high-level overview of the work completed in developing of the SNMP. The detailed technical analysis and assumptions for the groundwater quality trend and assimilative capacity analysis, loading and antidegradation analysis, and groundwater monitoring plan are contained within a series of technical memoranda attached as appendices to this SNMP.

This document first describes the groundwater basin characteristics and existing conditions, the collaborative process undertaken to develop this SNMP, existing groundwater quality, salt and nutrient loading analysis, future groundwater quality, goals, implementation measures, groundwater monitoring plan, and how this plan will be used.

Table 1-1: Document Organization and Chapter Summary

Chapter No.	Chapter Title	Chapter Overview
1	Introduction and Background	Plan purpose, recycled water policy requirement overview, and summary of document organization
2	Conceptual Model of the Sonoma Valley Subbasin	Groundwater subbasin characterization, water uses, groundwater levels, and water budget
3	Collaborative Plan Development Approach	Description of the collaborative process undertaken to develop the SNMP including stakeholders, meetings, and regulatory coordination
4	Goals	Documentation of recycled water and stormwater recharge goals within the Sonoma Valley Subbasin
5	Existing Groundwater Quality Analysis	Approach, methodology, and existing groundwater quality
6	Source Identification and Loading Analysis	Characterization of salt and nutrient sources, methodology for loading analysis, and findings
7	Future Groundwater Quality Analysis	Approach, methodology, and future groundwater quality
8	Implementation Measures	Documentation of groundwater management measures and volunteer efforts underway within the groundwater subbasin
9	Groundwater Monitoring Plan	Overview of SNMP groundwater monitoring plan and reporting
10	Antidegradation Assessment	Description of the antidegradation assessment
11	Plan Approval Process	Plan approval process and future updating criteria
12	Conclusion	A summary of findings from the SNMP process

1.3 Plan Limitations

Limitations and uncertainties associated with the development of this SNMP are mainly data related. Spatially, while historical information from the Baylands brackish area was available, no known wells currently exist in the Baylands and therefore no current groundwater quality information was available. Vertically within the aquifer, many well locations were lacking well construction detail information rendering the depth of the well unknown. Without depth-specific well screen information, water quality for shallow and deep zones was unable to be distinguished. Therefore the simplicity of the mixing model is a limitation because it simulates two big “buckets” (Inland and Baylands with movement between) and mixing is instantaneous. Additionally, verification of assumptions/estimates for individual anthropogenic loading sources during the calibration process was limited by the sensitivity of groundwater quality to and dominance of natural inflows (precipitation and stream recharge) in Sonoma Valley. Data collected as part of the SNMP Groundwater Monitoring Program will help in determining if flat trends predicted by the SNMP are verified.

Information used to derive future conditions was obtained from planning documents such as Urban Water Management Plans (UWMPs); however this information is projected on a 20-year planning horizon and can change. For instance recycled water expansion is planned to serve additional agricultural irrigation customers and the urban area of the City of Sonoma however exact sites and demands may shift as projects are implemented in the future. To address this, the SNMP Groundwater Monitoring Plan will assess changes in recycled water use on a triennial basis.

Chapter 2 Conceptual Model of the Sonoma Valley Subbasin

This chapter provides an overview of the hydrogeologic conceptual model of the Sonoma Valley Groundwater Subbasin located in Sonoma County, the subbasin for which this SNMP was developed.

2.1 Study Area

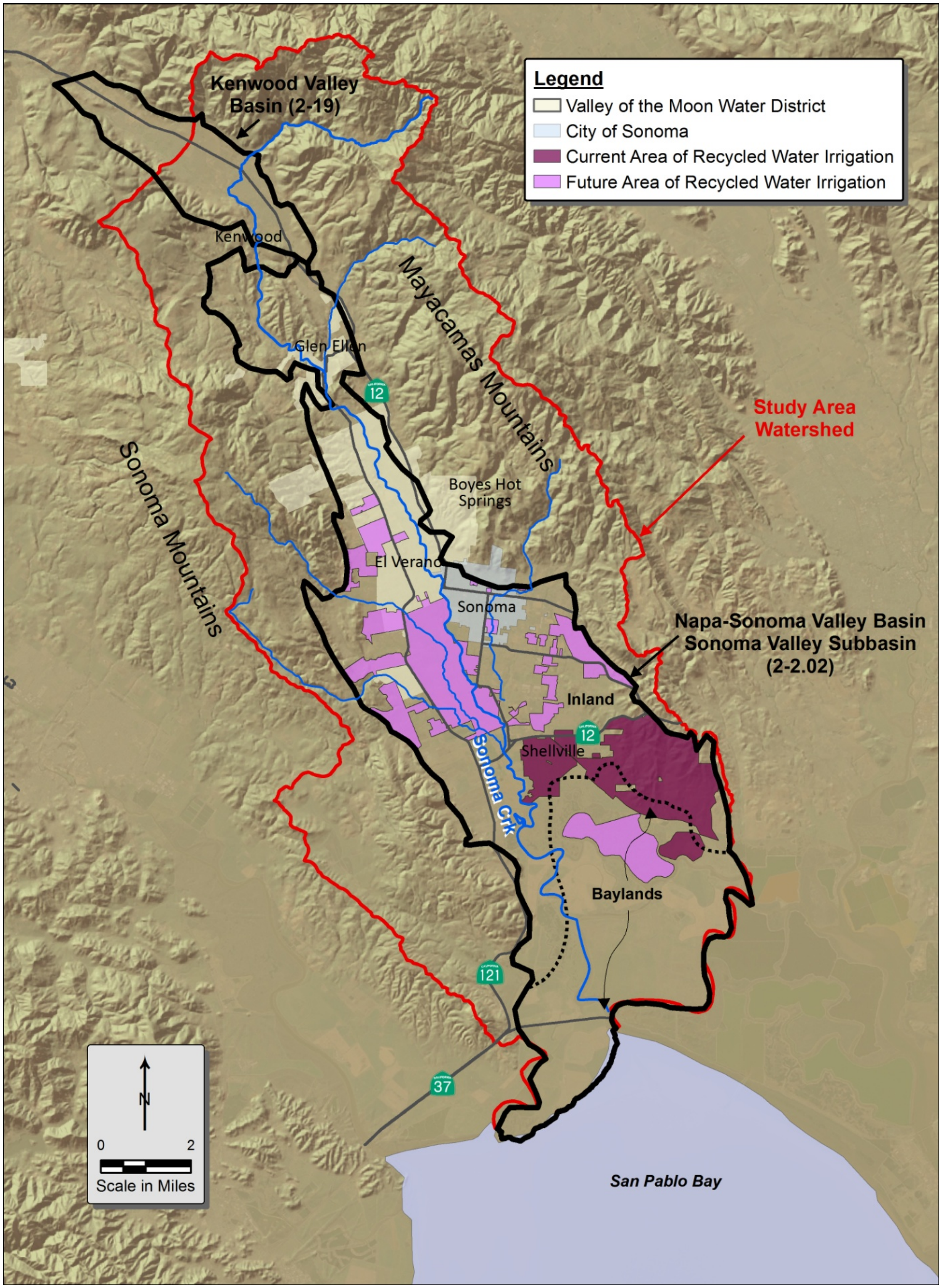
Per the Policy, SNMPs are to be developed for all groundwater basins in California. This SNMP was developed for the Sonoma Valley Subbasin, defined as basin number 2-2.02 in the California Department of Water Resources (DWR) Bulletin 118-4 (DWR, 2003). The Sonoma Valley Subbasin encompasses an area of approximately 70 square miles and is located within the larger 166 square mile Sonoma Creek Watershed, which also includes part of the Kenwood Valley Groundwater Basin, located northwest of the Sonoma Valley Subbasin. Due to an area of historical brackish groundwater located adjacent to and northwest of San Pablo Bay, the Sonoma Valley Subbasin was divided into a Baylands Area (containing the historical brackish groundwater) and an Inland Area as shown in Figure 2-1 for this SNMP. The Baylands Area is defined for this study as the area beneath the tidal sloughs adjacent to San Pablo Bay generally containing groundwater with greater than 750 milligrams per liter (mg/L) total dissolved solids (TDS).

The Sonoma Valley is a northwest trending, elongated depression. Geologic units generally dipping toward the center of the valley are bound on the southwest by the Sonoma Mountains and on the northeast by the Mayacamas Mountains (Figure 2-1). The uppermost part of the valley is relatively flat and stretches from Kenwood to near Glen Ellen. The middle part of the valley is narrower than the upper part and has a hilly topography. This portion is sometimes referred to as the Valley of the Moon and extends southward to near Boyes Hot Springs and includes the Glen Ellen area. The remainder of the valley slopes gently southward to San Pablo Bay, has flat topography, and extends to a maximum width of about 5 miles.

Sonoma Creek is the main surface water feature draining the valley. The creek originates in the Mayacamas Mountains in the northeastern area of the watershed. The creek flows into the Kenwood Valley Basin before flowing south into the Sonoma Valley Subbasin and ultimately discharging into San Pablo Bay. Other smaller tributary creeks flow into Sonoma Creek from the east and west.

The watershed area comprises large tracks of native vegetation, as well as lands used for agriculture, primarily vineyards. Urban, residential, commercial, and industrial development constitutes a relatively small percentage of the watershed area and is primarily located in the valley areas. Sonoma is the largest city in the Study Area. Other cities and unincorporated areas in the Sonoma Valley Subbasin include Glen Ellen, Boyes Hot Springs, El Verano, and Schellville (Figure 2-1).

Figure 2-1: Study Area



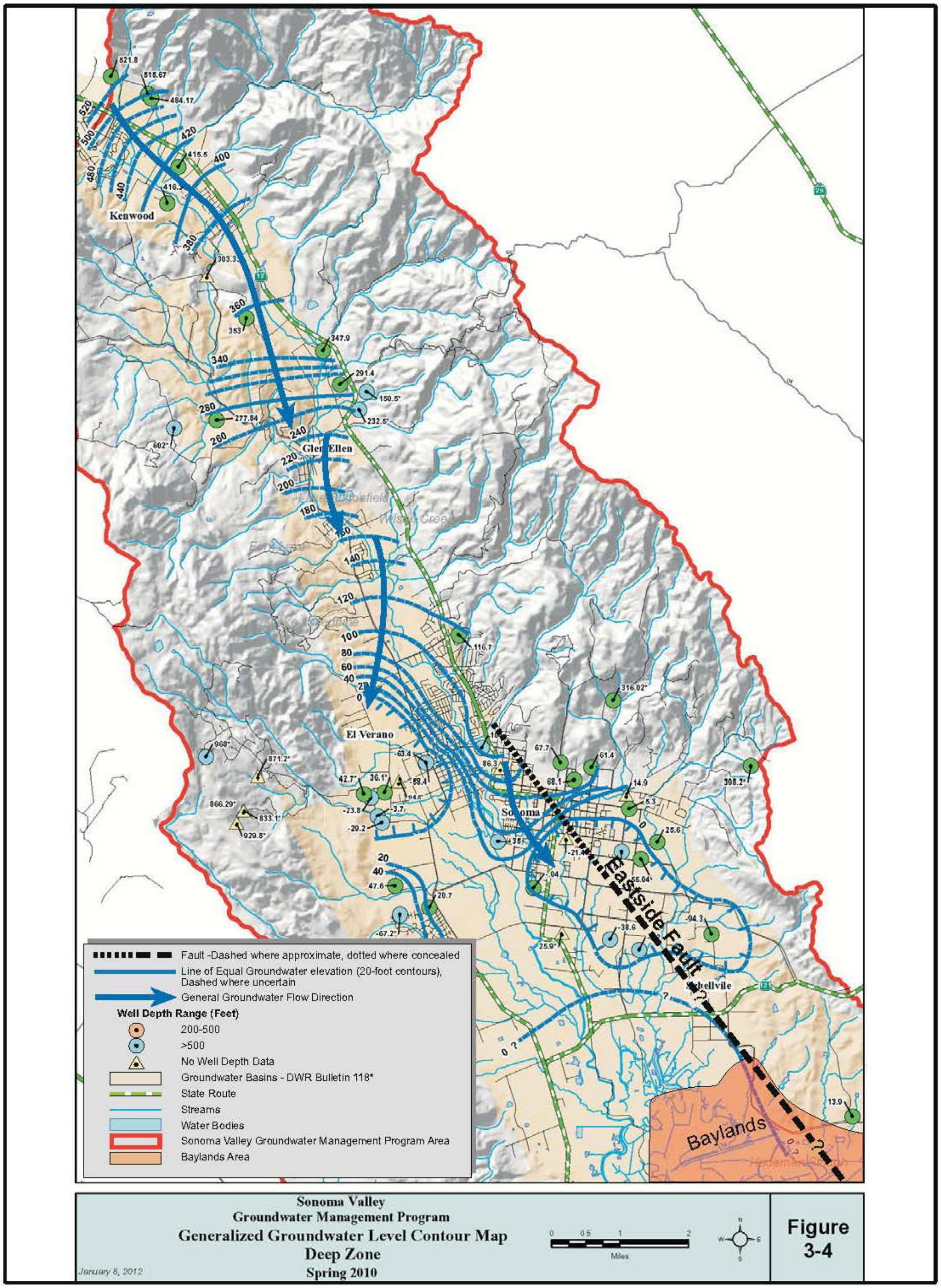
2.2 Groundwater Levels and Flow

Groundwater levels in the Sonoma Valley are monitored and reported as part of the Sonoma Valley Groundwater Management Plan (GMP) (SCWA, 2011). There is a groundwater divide within the Kenwood Valley Basin, with groundwater in the northern half of the Kenwood Basin flowing in a northwestward direction toward Santa Rosa and groundwater in the southern half of the Kenwood Basin flowing in a southeasterly direction toward the Sonoma Valley Subbasin in both the shallow and deep zones

Comparison of the shallow and deeper groundwater elevation contour maps (see Appendix A) indicates that groundwater elevations in the deep zone 1) are similar to groundwater elevations in the shallow zone in northern Sonoma Valley, and 2) are up to 100 feet lower than groundwater elevations in the shallow zone in southern Sonoma Valley, indicating a downward vertical gradient in southern Sonoma Valley.

As shown in Figure 2-2, two groundwater pumping depressions are apparent in the deep zone groundwater elevation contour map southeast of the City of Sonoma (City) and in the El Verano area. The pumping depression southeast of the City of Sonoma has the potential to induce intrusion of brackish water from the Baylands Area. This potential brackish water intrusion is being addressed through replacement of pumped groundwater with recycled water for irrigation in and north of the Baylands Area. Continued monitoring and assessment of groundwater levels and groundwater quality will be conducted to assess inland movement of the brackish water. This monitoring and assessment will be included in the triennial SNMP Groundwater Monitoring Report.

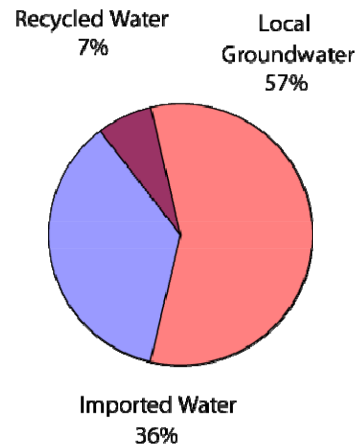
Figure 2-2: Generalized Groundwater Elevation Contour Map, Deep Zone, Spring 2010



2.2.1 Surface Water – Groundwater Interaction

Sonoma Valley is drained by Sonoma Creek, which discharges to San Pablo Bay. Seepage testing conducted by the United States Geological Survey (USGS) in 2003 showed Sonoma Creek to be a gaining (groundwater discharging to the creek) creek through most of the valley with the exception of a short reach in the northern part of the watershed where the creek enters the Kenwood Valley Basin from the Mayacamas Mountains crossing the alluvial fan between the mountain front and Highway 12 (USGS, 2006).

2.3 Water Use



The Sonoma Valley relies on groundwater, imported surface water, and recycled water to meet domestic, agricultural and urban demands. Based on the USGS study (2006), more than half of the water demand in 2000 was met with groundwater and the remaining demand was met with imported water (36%), recycled water (7%), and local surface water (<1%).

The largest use of groundwater in the Sonoma Valley in 2000 was irrigation (72%), followed by rural domestic use (19%), and urban demand (9%). In 2000, total water use in the Sonoma Valley (including groundwater and imported surface water) was estimated at 14,018 acre-feet (AF), of which 48% was used for irrigation, 41% for urban use, and the remaining 11% for rural domestic use.

2.3.1 Groundwater

Groundwater serves approximately 25% of the Sonoma Valley population and is the primary source of drinking water supply for rural domestic and other unincorporated areas not being served by urban suppliers. Rural domestic demand is predominantly met by groundwater through privately owned and operated water wells. There are also mutual water companies in the Sonoma Valley that supply multiple households predominantly with groundwater although some companies also provide imported water. Agricultural water demands are largely met by groundwater supplies. It was estimated that as of 2000 the Sonoma Creek Watershed contained approximately 2,000 domestic, agricultural, and public supply wells (USGS, 2006).

2.3.2 Imported Surface Water

Imported surface water represents the primary source of drinking water to meet urban demands, which serves approximately 75% of the Sonoma Valley population. These imported water supplies are sourced from the Russian River and are provided via aqueduct by the Sonoma County Water Agency (SCWA) to the Valley of the Moon Water District (VOMWD) and the City who, in turn, provide water directly to their urban customers. The imported water is supplemented with local groundwater from the City and VOMWD public supply wells. The City and VOMWD boundaries are shown in Figure 2-1.

2.3.3 Recycled Water

SCWA manages and operates the wastewater treatment facility owned by the SVCSD. During dry weather months from May through October, the SVCSD provides 1,000 to 1,200 acre-feet per year (AFY) of recycled water for vineyards, dairies, and pasturelands in the southern part of Sonoma Valley. As of 2007, recycled water accounted for approximately 7% of the total estimated water use in Sonoma Valley (SCWA, December 2007). The current and future areas of recycled water use for irrigation exist in both the Inland and Baylands Areas and are shown in Figure 2-1.

2.4 Groundwater Management Program

In recognition of the increasing demands and challenges facing the Sonoma Valley groundwater subbasin, a collaborative group of over twenty stakeholders began development of a non-regulatory Groundwater Management Plan in 2006. This group, called the Basin Advisory Panel (BAP) represents varied groundwater interests including local agriculture, dairies, government, local water purveyors, business, and environmental interests. The BAP, assisted by a Technical Advisory Committee (TAC), developed the non-regulatory Groundwater Management Plan, which was adopted by SCWA, the City, VOMWD, and SVCSD in late 2007.

The Sonoma Valley Groundwater Management Program (SVGMP) identifies a range of voluntary management actions to maintain the health of the groundwater basin including increasing recycled water use and enhancing groundwater recharge. The SVGMP goal is to locally manage, protect, and enhance groundwater resources for all beneficial uses, in a sustainable, environmentally sound, economical, and equitable manner for generations to come.

Chapter 3 Collaborative Plan Development Approach

The SNMP was developed in a collaborative setting with input from a wide array of stakeholders and interested parties. The SNMP was able to utilize the existing stakeholder infrastructure set up by the SVGMP to hold meetings and obtain input on technical analysis and direction of the Plan. The stakeholder group make-up, workshop process and regulatory coordination elements of the process are outlined below.

3.1 Stakeholder Group

The SNMP was coordinated through the efforts of the SVGMP's existing stakeholder groups, the BAP and the TAC. Stakeholders that also participated in the SNMP process include:

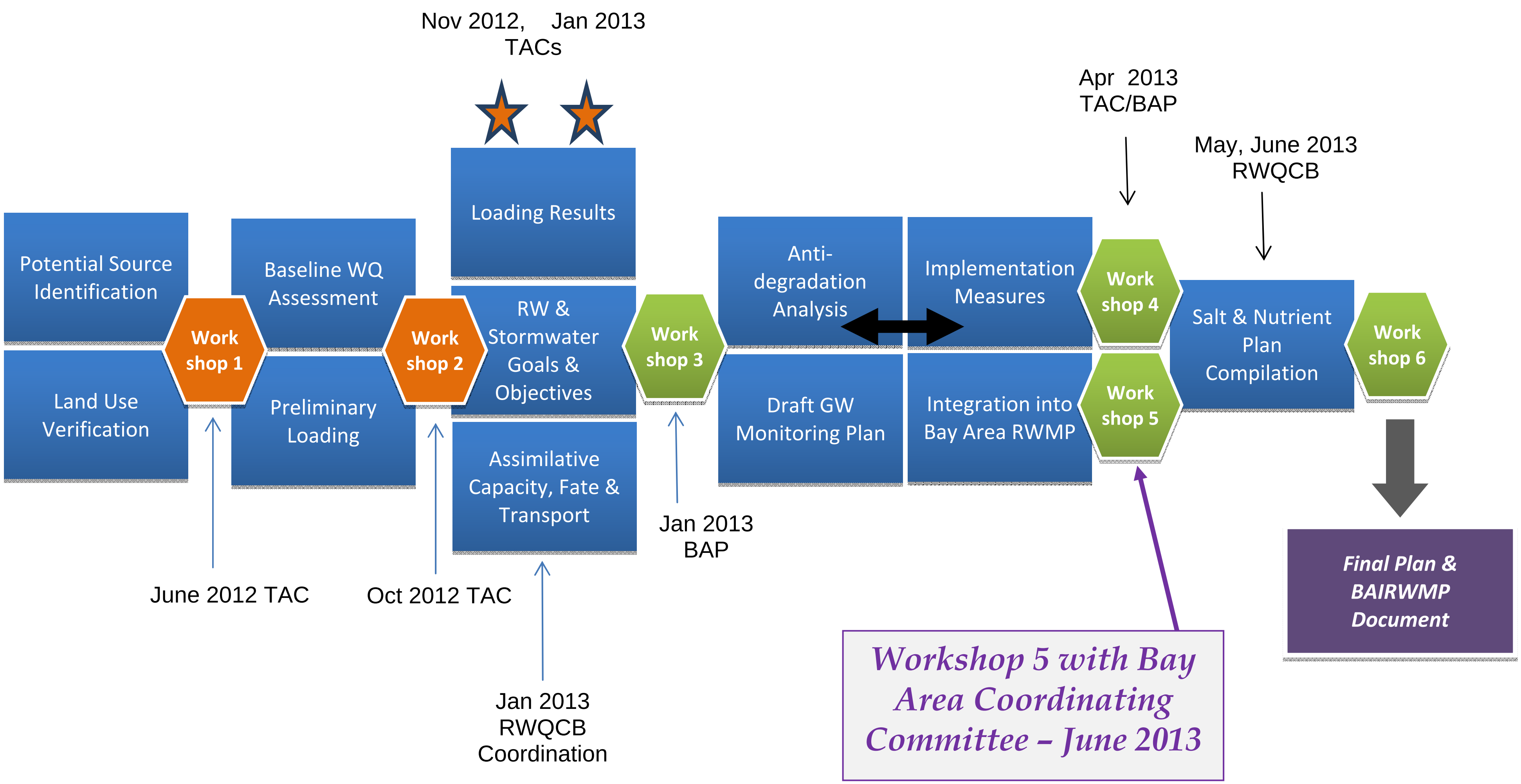
- Municipal agencies: SCWA, SVCSD, VOMWD, the City
- Resource groups: Sonoma Resource Conservation District
- Agricultural interests: members of the North Bay Agricultural Alliance and Sonoma Valley Vintners & Growers Alliance, Sonoma County Winegrape Commission, Mulas Dairy, and individual vineyard owners
- Others: Sonoma Ecology Center, private well owners
- Regulatory/Government Agencies: San Francisco Bay Regional Water Quality (Regional Water Board), California Department of Public Health (CDPH), DWR, USGS

3.2 Workshop Process

Development of the SNMP was a collaborative effort that utilized workshops at key milestones. As the technical analysis progressed, additional meetings were held with the TAC and other specific stakeholders to help develop and refine land use practices, water use information and loading parameter input. A total of six workshops were held through-out the 18-month SNMP development process. In addition to the six workshops, as part of data collection and regional coordination, the following meetings were held:

- Four meetings were held with the TAC (2012: November; 2013: January, April, July)
- Two conference calls were held with the Sonoma County Winegrape Commission (November 2013, January 2013)
- Four meetings were held with the Regional Water Board (2012: January; 2013: January, May, June)
- One meeting was held with the Bay Area Integrated Regional Water Management (IRWM) Coordinating Committee (April 22, 2013)

Figure 3-1: Collaborative Plan Development Process



Workshops were structured to present the technical analysis methodology and findings, and to obtain input and direction on assumptions and key elements of the plan moving forward. Each of the six workshops along with the major topics of discussion and outcomes are shown below.

Workshop 1 - June 13, 2012 (held with TAC)

- **Discussion Topics**
  - Recycled Water Policy Requirements
  - Sonoma Valley Planned Approach
  - Input on Land Cover Changes
  - Constituents to Address in the Plan
  - Schedule
- **Meeting Outcomes**
  - Stakeholder agreement on SNMP Plan development process
  - Refinements to land use and land cover (updated dairy areas, future recycled water areas)
  - Agreement on constituents to address in SNMP

Workshop 2 - October 10, 2012 (held with TAC)

- **Discussion Topics**
  - Existing Groundwater Water Quality Analysis and Findings
  - Salt and Nutrient Loading Model and Mixing Model Approach
  - Recycled Water and Stormwater Goals
- **Meeting Outcomes**
  - Stakeholder understanding of existing water quality
  - Confirmation of recycled water and stormwater recharge goals for the basin

Workshop 3 - January 17, 2013 (held as a public workshop following the BAP meeting)

- **Discussion Topics**
  - Background Recycled Water Policy and SNMP Requirements
  - Existing Groundwater Water Quality and Assimilative Capacity
  - Salt and Nutrient Loading Analysis and Findings
  - Recycled Water and Stormwater Goals
  - Mixing Model Approach
  - Bay Area IRWM Guidance Document Development
- **Meeting Outcomes**
  - Stakeholder understanding of existing water quality and assimilative capacity

- Confirmation of technical approach
- Input on land management practices for dairy operations

<u>Workshop 4</u> - April 18, 2013 (held with BAP)

- **Discussion Topics**
  - Future Water Quality and Assimilative Capacity
  - Existing Implementation Measures
  - SNMP Groundwater Monitoring Program
  - Next Steps for SNMP Finalization
- **Meeting Outcomes**
  - Stakeholder understanding of technical analysis
  - Agreement with approach of utilizing existing implementation measures
  - Confirmation of plan for Groundwater Monitoring

<u>Workshop 5</u> - June 3, 2013 (held with Bay Area IRWM Coordinating Committee)

- **Discussion Topics**
  - Proposition 84 Planning Grant SNMP Element
  - Key Steps in Preparing an SNMP
  - Review of Draft Guidance Document for SNMPs for the Bay Area Region and Off-Ramp Language within Document
  - Incorporation of Guidance Document into IRWM Plan Update
- **Meeting Outcomes**
  - Confirmation of approach
  - Modification of title wording and revisions to introductory text

<u>Workshop 6</u> - July 18, 2013 (held as a public workshop following the BAP meeting)

- **Discussion Topics**
  - Background on Recycled Water Policy and SNMP Requirements
  - Review SNMP Process and Findings
  - Process for Providing Input on Draft SNMP Report
  - Regulatory Coordination and SNMP Finalization
- **Meeting Outcomes**
  - Informed public of SNMP Process
  - Received clarifying questions

3.3 Regulatory Coordination

Sonoma Valley is one of three groundwater basins in the Bay Area Region that is nearing completion of its SNMP. The Regional Water Board has been part of the SNMP development processes over the last 18-months through a series of meetings and region-wide workshops. Two Bay Area Region-wide SNMP coordination meetings have been held with the Regional Water Board, SVCSD, Zone 7 Water Agency and the Santa Clara Valley Water District, the first in January 2012, and the second in June 2013. The inter-regional coordination meetings provided a forum to share SNMP develop approaches and progress; and to understand and provide feedback on the Regional Water Board's planning process.

In addition to the two inter-regional regulatory meetings, three Sonoma Valley SNMP-specific meetings have been held with the Regional Water Board to share findings and obtain concurrence on critical elements of the technical analysis and the development approach for the SNMP. These coordination meetings were held at critical points in the technical analysis to obtain feedback on preliminary findings so that modifications and new approaches could be accounted for. Meeting minutes from the January and May meetings which pertained directly to the Sonoma Valley SNMP are included as Appendix B.

The first meeting was held in January 2013, in which the SNMP plan development process, collaboration and stakeholder make-up, existing water quality and assimilative capacity findings, goal setting, and the approach for the loading analysis and future water quality analysis was shared. The Regional Water Board staff agreed with the SNMP's approach for using the 2000-2012 period for establishing current basin averages, and agreed with the goal setting (utilizing recycled water use goals from the 2010 UWMPs, and not including numeric goals for stormwater recharge until recharge projects in Sonoma Valley are further developed). Additionally, Regional Water Board staff agreed that it made sense to continue to distinguish between the Inland and Baylands area for the assimilative capacity assessment. There was significant discussion regarding the proposed approach for establishing average TDS and nitrate and assimilative capacity, which was to average across the basin and across all depth intervals to estimate one TDS and one nitrate concentration for the entire subbasin. While Regional Water Board staff preferred a depth discrete analysis of the assimilative capacity, this was not possible given the limited data set. Moving forward, a reasonable mixing depth was assumed for the basin in the mixing analysis (approximately 400 feet), and the shallow and deep zones are accounted for in the monitoring plan.

The second meeting held in May 2013 shared the methodology and findings from the loading and future water quality analysis, future assimilative capacity, existing implementation measures, and planned SNMP groundwater monitoring program. The results of the technical analysis showing good water quality with relatively flat trends through 2035 were shared. A third meeting with the Regional Water Board was held on June, 24 2013 to present and discuss the Draft Guidance Document for SNMP for the Bay Area Region (Appendix C).

3.4 Coordination with the Bay Area Integrated Regional Water Management Plan

The *Guidance Document for Salt and Nutrient Management Plans for the San Francisco Bay Region* was developed as a result of the Sonoma Valley SNMP preparation effort. The SVCSD, along with the Zone 7 Water Agency and the Santa Clara Valley Water District are leading SNMP development efforts in three groundwater basins for the San Francisco Bay Region. The Sonoma Valley SNMP received partial funding through the Proposition 84 Planning Grant for the SNMP preparation and development of a guidance document to assist other Bay Area agencies wanting to undergo a similar process in developing their SNMPs.

The purpose of the *Guidance Document* (included as Appendix C) is to describe the common steps that may be undertaken by Bay Area groups in preparing an SNMP. The Regional Water Board is expected to consider the size, complexity, level of activity, and site-specific factors within a basin in reviewing the level of detail and the specific tasks required for each SNMP.

Chapter 4 Goals

This chapter presents the goals for using recycled water and stormwater in the Sonoma Valley Subbasin. The goals were developed based on stakeholder input and on the information contained in UWMPs and other planning documents. The UWMPs are developed by the individual water purveyors (SCWA, VOMWD, and the City), so the information contained in those UWMPs was summarized and merged together to meet the needs of this Plan. Additionally, water conservation programs provide a useful basis for understanding and assessing recycling activities. The agencies within the basin implement extensive water conservation programs, ranging from residential, commercial, industrial and municipal to agricultural programs. More information on individual agency conservation programs can be found in each individual agency's UWMP.

4.1 Recycled Water Goals

Recycled water goals are based on information provided in 2010 UWMPs and 2012 recycled water usage data. Recycled water goals were set based on 2010 UWMP recycled water use projections.

Existing recycled water use is presented in Table 4-1, and is based on 2012 recycled water usage data provided by SVCSD. These values represent recycled water use within the Subbasin, which is currently used for agricultural irrigation. Future expansion of the recycled water system is planned to provide recycled water to urban areas in the City, environmental enhancement, and more water for agricultural customers.

Table 4-1 also presents the projected 2035 recycled water use in the basin. These future estimates represent the recycled water goals for the Sonoma Valley Subbasin.

Table 4-1: Current Use and Future Goals for Recycled Water

Provider	2012 Use (AFY)	2035 Use (AFY)
SVCSD	1,100	4,100
Increase over 2012 usage	n/a	2,750

4.2 Stormwater Recharge Goals

Agencies and stakeholders in the Sonoma Valley Subbasin are actively working to increase the ability to put stormwater to beneficial use. For example in 2012, SCWA completed a watershed scoping study for a stormwater management/groundwater recharge project in the Sonoma Valley and performed similar studies for other area watersheds. The goal of the study was to evaluate the feasibility of implementing multi-benefit projects that will provide stormwater detention and groundwater recharge, while maximizing opportunities for flood control, water quality enhancement, and potential open space benefits.

Additionally, there is a trend towards requiring implementation of Low Impact Development (LID) features in development and redevelopment that increase recharge of stormwater. The Southern Sonoma County Resource Conservation District recently published the "Slow It, Spread It, Sink It" LID Guidance Document for Sonoma Valley. Water management planning efforts related to stormwater and their corresponding implementation schedules are shown in Table 4-2.

Table 4-2: Basin Water Management Studies and Timeline

Study/Project	General Scope	Implementing and Cooperating Agencies	Schedule
Stormwater LID Technical Design Manual	Provide design guidance to mitigate water quality impacts due to development and encourage infiltration of storm water.[a]	City of Santa Rosa, Sonoma County Water Agency, County of Sonoma	Completed in 2011
Groundwater Banking Feasibility Study	Evaluate feasibility of using excess wintertime water from Russian River drinking water facilities for storage and subsequent recovery in the Santa Rosa Plain and/or Sonoma Valley groundwater basins during dry weather conditions or emergency situations.	Sonoma County Water Agency, Cities of Cotati, Rohnert Park and Sonoma, Town of Windsor, Valley of the Moon Water District	Complete by Winter 2013
Sonoma Valley Stormwater Management and Groundwater Recharge Scoping Study	Assess potential projects in the watershed that can provide both flood control and groundwater recharge.	Sonoma County Water Agency	Scoping Study Completed Spring 2012

a. SCWA is also developing a "WaterSmart Manual" to promote water smart practices including conservation, recycling and low impact development. The WaterSmart Manual is scheduled to be completed in Winter 2013.

While these efforts and others are continuing in the subbasin, the benefit of recharging stormwater (which is likely to be low in TDS) is not included in the groundwater quality analyses in this Plan due to uncertainties in the projected quantity and volumes of stormwater recharge at this time. Not including stormwater in the future water quality analysis at this point is a conservative approach as stormwater would likely decrease TDS and nitrate concentrations in the subbasin. Future updates to the Plan will consider these efforts as they continue to be developed and implemented. Future updates to the Plan could also include quantitative goals for stormwater recharge as they are established through these planned efforts.

Chapter 5 Existing Groundwater Quality Analysis

Determining the existing groundwater quality is a critical step in SNMP technical analysis. A summary of the existing groundwater quality is presented below with additional detail contained in the *Existing and Future Groundwater Quality TM (Todd, 2013)* attached as Appendix A.

5.1 Existing Groundwater Quality

5.1.1 Indicator Parameters of Salts and Nutrients

TDS and nitrate are the indicator salts and nutrients selected for the Sonoma Valley SNMP. Total salinity is commonly expressed in terms of TDS in mg/L. TDS (and electrical conductivity data that can be converted to TDS) are available for source waters (both inflows and outflows) in the valley. While 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 generally associated with agricultural activities, septic systems, confined animal facilities, landscape fertilization, and wastewater treatment facility discharges. Nitrate is the primary form of nitrogen detected in groundwater. Natural nitrate levels in groundwater are generally very low, with concentrations typically less than 10 mg/L for nitrate as nitrate (nitrate-NO_3) or 2 to 3 mg/L for nitrate as nitrogen (nitrate-N). Nitrate is commonly reported as either nitrate-NO_3 or nitrate-N; and one can be converted to the other. Nitrate-N is selected for the assessment in this SNMP.

5.1.2 Water Quality Objectives

Water quality objectives provide a reference for assessing groundwater quality in the Sonoma Valley Subbasin. The CDPH has adopted a Secondary Maximum Contaminant Level (SMCL) for TDS. SMCLs 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 recommended SMCL for TDS is 500 mg/L with an upper limit of 1,000 mg/L. It has a short-term limit of 1,500 mg/L. The Regional Water Board has established a basin plan objective (BPO) of 500 mg/L for TDS for municipal and domestic supply in their Basin Plan (December 2010).

The MCL for nitrate plus nitrite as nitrogen (as N) is 10 mg/L. The Regional Water Board has established the BPOs at the maximum contaminant levels (MCLs) for these constituents. Table 5-1 lists numeric BPOs for groundwater with municipal and domestic water supply and agricultural water supply beneficial uses in the San Francisco Bay Region.

Table 5-1: Basin Plan Objectives

Constituent	Units	BPOs
TDS	mg/L	500
Nitrate-N	mg/L	10

5.1.3 TDS and Nitrate Fate and Transport

Salt and nutrient fate and transport describes the way salts and nutrients move and change through an environment or media. In groundwater, it is determined by groundwater flow directions and rate, the characteristics of individual salts and nutrients, and the characteristics of the aquifer media.

Water has the ability to naturally dissolve salts and nutrients along its journey in the hydrologic cycle. The types and quantity of salts and nutrients present determine whether the water is of suitable quality for its intended uses. Salts and nutrients present in natural water result from many different sources including atmospheric gases and aerosols, weathering and erosion of soil and rocks, and from dissolution of existing minerals below the ground surface. Additional changes in concentrations can result due to ion exchange, precipitation of minerals previously dissolved, and reactions resulting in conversion of some solutes from one form to another such as the conversion of nitrate to gaseous nitrogen. In addition to naturally occurring salts and nutrients, anthropogenic activities can add salts and nutrients.

TDS and nitrate are contained in the source water that recharges the Sonoma Valley. Addition of new water supply sources, either through intentional or unintentional recharge, can change the groundwater quality either for the worse by introducing contamination or for the better by diluting some existing contaminants in the aquifer. Another important influence on salts and nutrients in groundwater is unintentional recharge, which can occur, for example, when irrigation water exceeds evaporation and plant needs and infiltrates into the aquifer (i.e., irrigation return flow). Irrigation return flows can carry fertilizers high in nitrogen and soil amendments high in salts from the yard or field into the aquifer. Similarly, recycled water used for irrigation also introduces salts and nutrients.

TDS is considered conservative in that it does not readily attenuate in the environment. In contrast, processes that affect the fate and transport of nitrogen compounds are complex, with transformation, attenuation, uptake, and leaching in various environments. Nitrogen is relatively stable once in the saturated groundwater zone and 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.

5.1.4 Analysis Methodologies

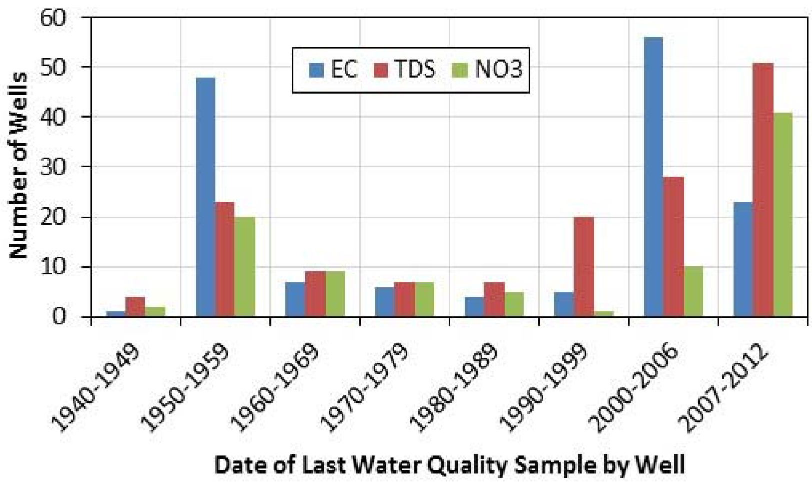
Lateral and Vertical Segmentation

Initially, the available groundwater quality data and well completion information were assessed to determine if the subbasin groundwater quality characterization could be divided into subareas (north and south) and layers (shallow and deep) to assess differences in groundwater quality laterally and vertically. Unfortunately, well completion information for many of the monitored wells is unavailable, and the available data are considered insufficient to reliably differentiate groundwater quality in the shallow and deep zones. The Baylands Area shown in Figure 2-1 is defined as the area with median TDS concentrations greater than 750 mg/L. This general area has been recognized for decades as an area of historical brackish groundwater (Kunkel and Upson, 1960; USGS, 2006). Due to the elevated salt in this area and land cover which is primarily tidal marshlands, groundwater pumping is limited, and the area is unlikely to be developed for groundwater supply in the future. There are a limited number of wells in the Baylands Area based on DWR well logs acquired for the USGS study (2006). Many of the wells in the Baylands Area have been destroyed and agricultural land use in the area is primarily limited to non-irrigated crops such as hay. Accordingly, this area is considered separately from the remainder of the subbasin referred to as the Inland Area. Available monitoring data do not indicate clear differences between groundwater quality in the northern and southern portion of the Inland Area. Therefore average groundwater quality in the subbasin is characterized for the Inland Area, the Baylands Area, and the combined Inland and Baylands areas as one aquifer. This approach was shared with the Regional Water Board in January 2013.

Groundwater Quality Averaging Period

In accordance with the Policy, the available assimilative capacity shall be calculated by comparing the BPOs with the average ambient salt and nutrient concentrations in the subbasin over the most recent five years of available data (2007 to 2012) or a time period approved by the Regional Water Board. Figure 5-1 shows the number of wells sampled over the history of sampling in the subbasin. As shown in the figure, a significant number of wells were sampled in the 2000 to 2006 time period, predominantly as part of the work conducted by the USGS (2006). In order to provide a more robust dataset, data collected during the 12 year period from 2000 to 2012 are used to assess the average groundwater quality in the subbasin. The Regional Water Board approved this baseline period duration in the January 2013 regulatory coordination meeting. Evaluation of concentration trends finds overall relatively stable or flat trends for TDS and nitrate in most wells in the subbasin, which also supports use of a longer averaging period.

Figure 5-1: Summary of Available Water Quality Data



Calculation of Existing Ambient Groundwater Quality and Assimilative Capacity

The median groundwater concentration for samples collected from individual wells over the 12-year averaging period for TDS and nitrate are plotted on maps with different size and color circles representing median concentrations (dots maps). The TDS and nitrate dots maps are then used to develop concentration contour maps for TDS and nitrate.

The average TDS and nitrate concentrations for each area (Inland and Baylands) and for the entire subbasin are compared to the BPOs to determine the current available assimilative capacity.

Time-Concentration Plots and Trends

Time-concentration plots are prepared and evaluated to assess whether TDS and nitrate groundwater concentrations across the subbasin have been historically increasing, decreasing, or showing no significant change. The trend analysis facilitates the comparison of observed concentration trends in individual wells with simulated average groundwater concentration trends from the mixing model over the baseline period, from 1996-97 (water year 1997) through 2005-06 (WY 2006), for calibration purposes. A water year is from October 1 to September 30 of the following year and is commonly used for hydrogeologic analysis.

5.1.5 TDS in Groundwater

Figure 5-2 shows TDS concentration contours in the subbasin. Generally, relatively low TDS concentrations (less than 500 mg/L) are observed throughout most of the subbasin. A few wells with elevated concentrations (above 750 mg/L) are seen in the southeastern portion of the subbasin. The southeastern portion of the subbasin is an area of historical brackish groundwater.

The area of very high TDS near San Pablo Bay with TDS greater than 1,500 mg/L is based on older well sampling conducted between 1954 and 1973 by DWR. Use of these older data is conservative in that their use results in higher average concentrations in the Baylands Area and there are no more recent data available for this area.

The average TDS concentration in the Inland Area, Baylands Area, and combined Sonoma Valley Subbasin area are shown in Table 5-2. The average Inland Area TDS concentration is 372 mg/L, well below the BPO of 500 mg/L, resulting in available assimilative capacity of 128 mg/L. As expected the average TDS concentration in the Baylands Area is high, with an average concentration of 1,220 mg/L, resulting in no available assimilative capacity. The average TDS concentration for the combined subbasin including both the Inland and Baylands Areas is 635 mg/L, also resulting in no available assimilative capacity.

Table 5-2: Average TDS Concentrations and Available Assimilative Capacity

Concentrations in mg/L	Sonoma Valley Subbasin	Inland Area	Baylands Area
Average	635	372	1,220
BPO	500	500	500
Available Assimilative Capacity	**-135**	**128**	**-720**

TDS – total dissolved solids
mg/L – milligrams per liter

TDS Trends

Figure 5-3 shows time-concentration plots for TDS, along with the applicable BPO. The well dots and charts are shaded to indicate the wells depths with red wells and charts indicating wells less than 200 feet deep, yellow wells and charts indicating wells between 200 and 500 feet deep and green wells and charts indicating wells greater than 500 feet deep. Wells and charts shaded gray indicated wells with unknown completion depths. The figure shows relatively flat TDS trends in the subbasin indicating generally stable conditions. However, Wells 5N/5W-28R1 and 5N/5W-28N1 located in the southern portion of the subbasin near the Baylands Area show modest increasing concentration trends, which could be attributed increasing saline intrusion as well as other sources. One well is an intermediate zone well (200 to 500 feet deep) and the other is a shallow zone well (less than 200 feet deep). The shallow well (5N/5W-28N1) is owned by a dairy, and this well also shows increasing nitrate concentrations as discussed in the next section. Therefore, it is possible that the increasing TDS concentrations could be associated with local surface sources rather than saline intrusion. The other intermediate well with increasing TDS does not have a similar increasing nitrate trend.

The analysis indicates the importance of preventing additional saline intrusion into the Inland Area. The Baylands brackish groundwater area is a concern in the Sonoma Valley. One of the objectives of developing and increasing the use of recycled water for irrigation is to reduce groundwater pumping in the southern Sonoma Valley, prevent additional saline intrusion, and potentially reduce the existing inland extent of brackish groundwater. Irrigation with recycled water began in 1992 and is projected to increase in the future. To date, the data are insufficient to determine if the replacement of groundwater with recycled water has reduced the areal extent of brackish groundwater. However, continued monitoring of this area is a key component of the ongoing SVGMP and SNMP.

Figure 5-2: Total Dissolved Solids Concentration Contours (2000 to 2012)

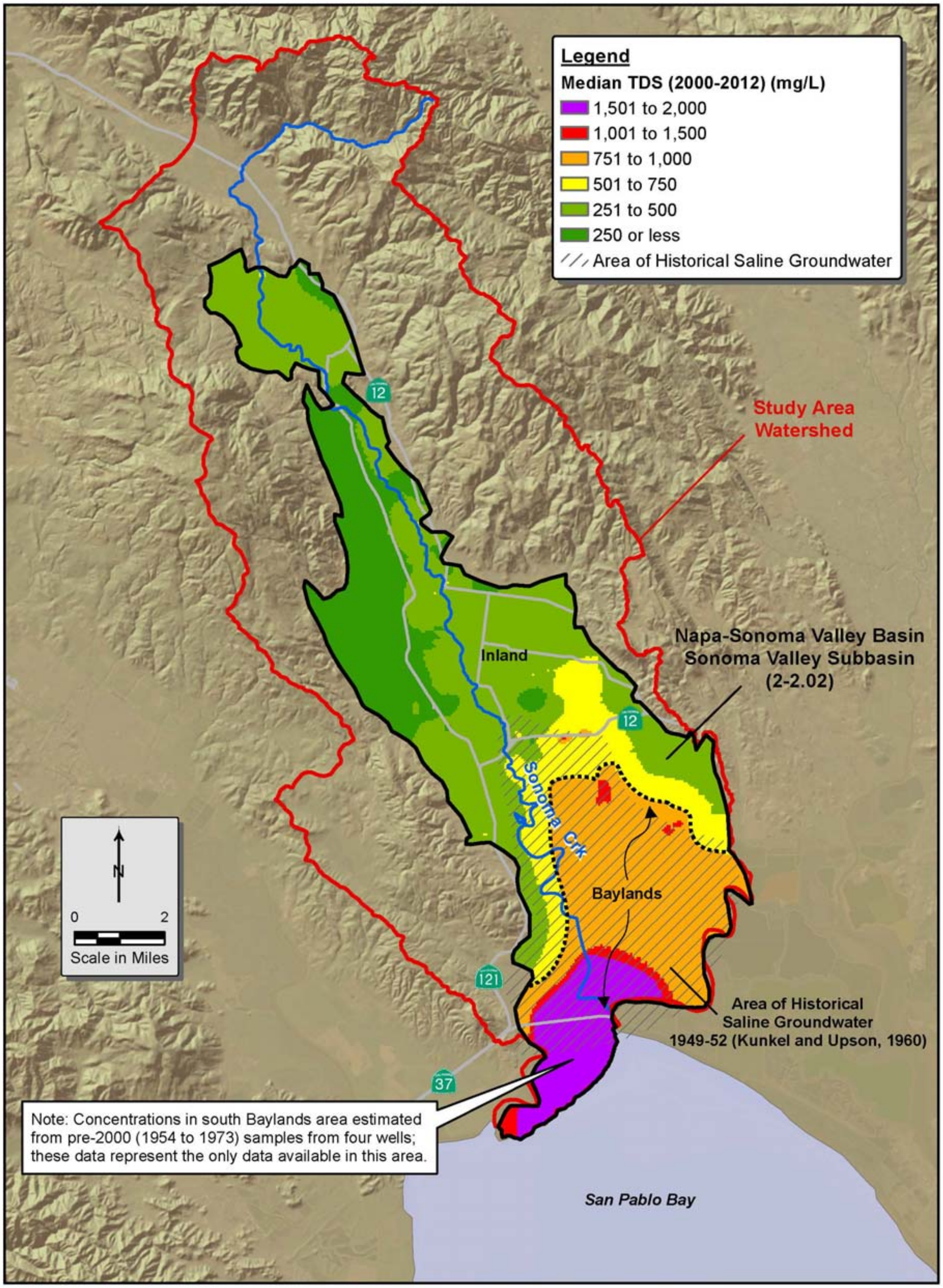
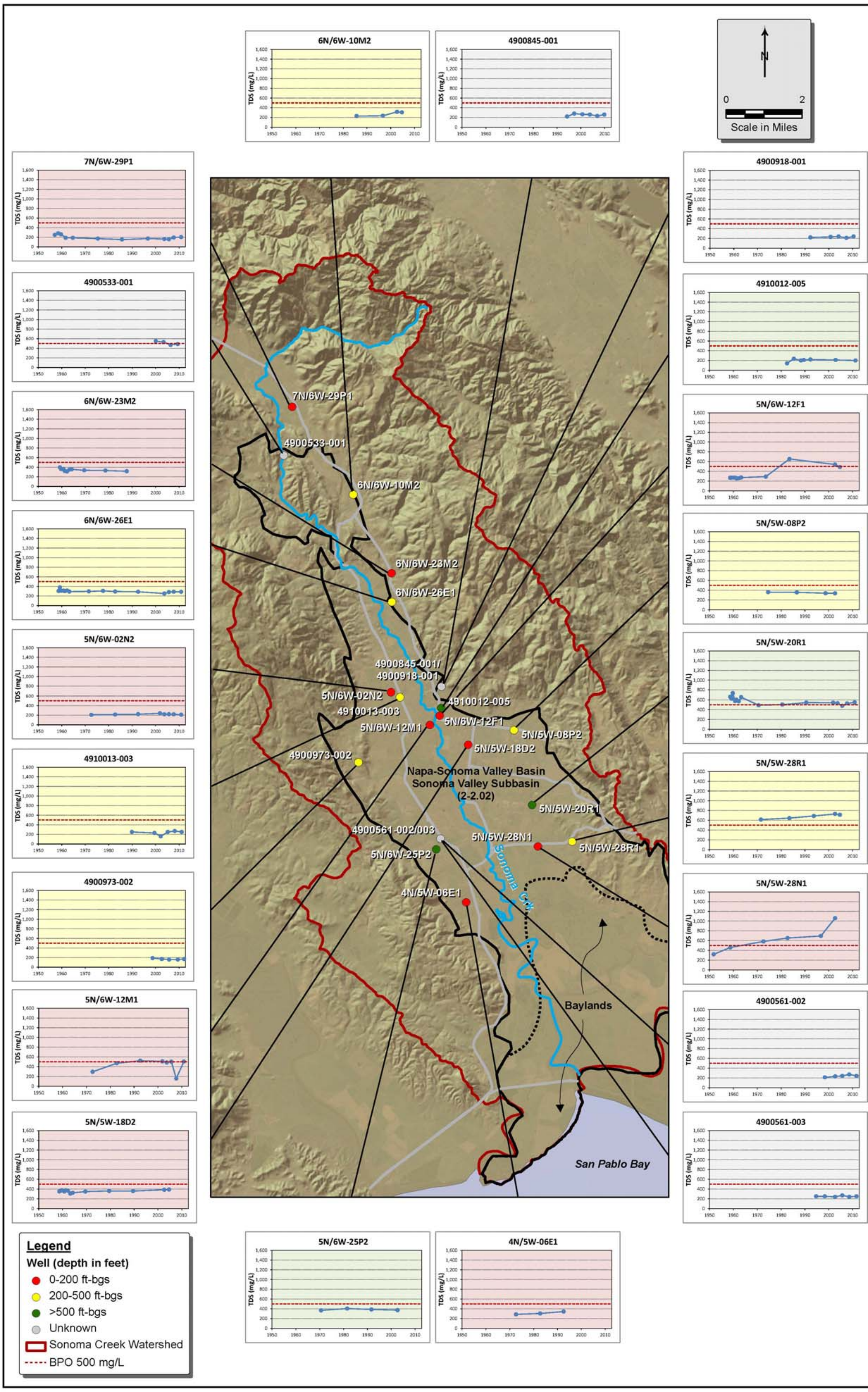


Figure 5-3: Time-Concentration Plots Total Dissolved Solids



5.1.6 Nitrate in Groundwater

A nitrate concentration contour map is shown in Figure 5-4. Generally low nitrate concentrations are observed throughout most of the subbasin. The nitrate-N BPO is 10 mg/L. The area of nitrate between 2.6 and 5.0 mg/L near the San Pablo Bay is based on older well sampling conducted by the DWR between 1954 and 1973. The average nitrate concentration in the Inland Area, Baylands Area, and combined Sonoma Valley Subbasin area are shown in Table 5-3.

Table 5-3: Average Nitrate-N Concentrations and Available Assimilative Capacity

Concentrations in mg/L	Sonoma Valley Subbasin	Inland Area	Baylands Area
Average	0.06	0.06	0.07
BPO	10.00	10.00	10.00
Available Assimilative Capacity	**9.94**	**9.94**	**9.93**

TDS – total dissolved solids
mg/L – milligrams per liter

Nitrate Trends

Figure 5-5 shows time-concentration plots for nitrate-N along with the applicable BPO. As discussed above, the wells and charts are shaded to indicate relative well depth. Generally flat concentrations are observed in most wells in the subbasin, typically well below the BPO of 10 mg/L.

Figure 5-4: Nitrate as N Concentration Contours (2000 to 2012)

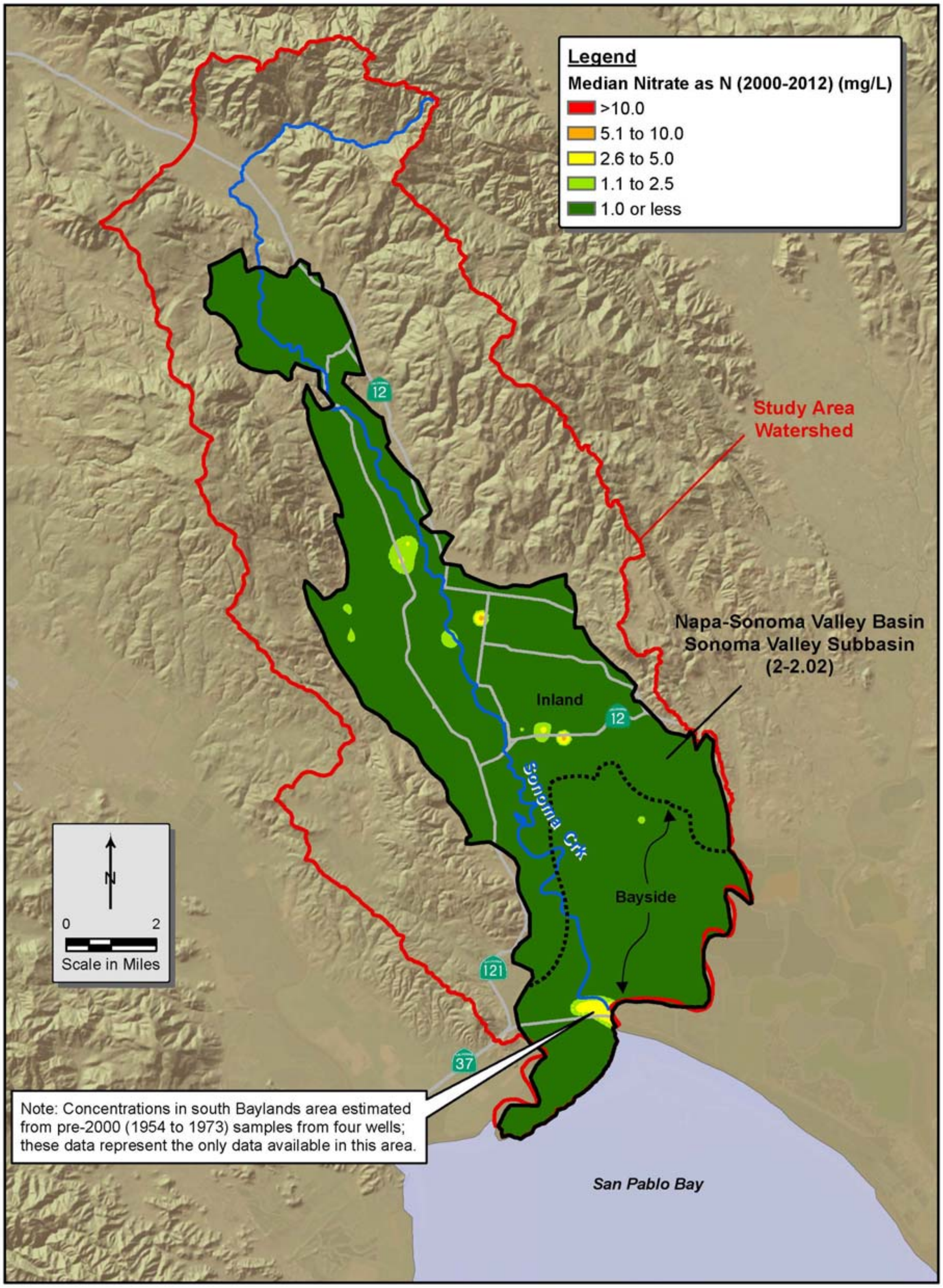
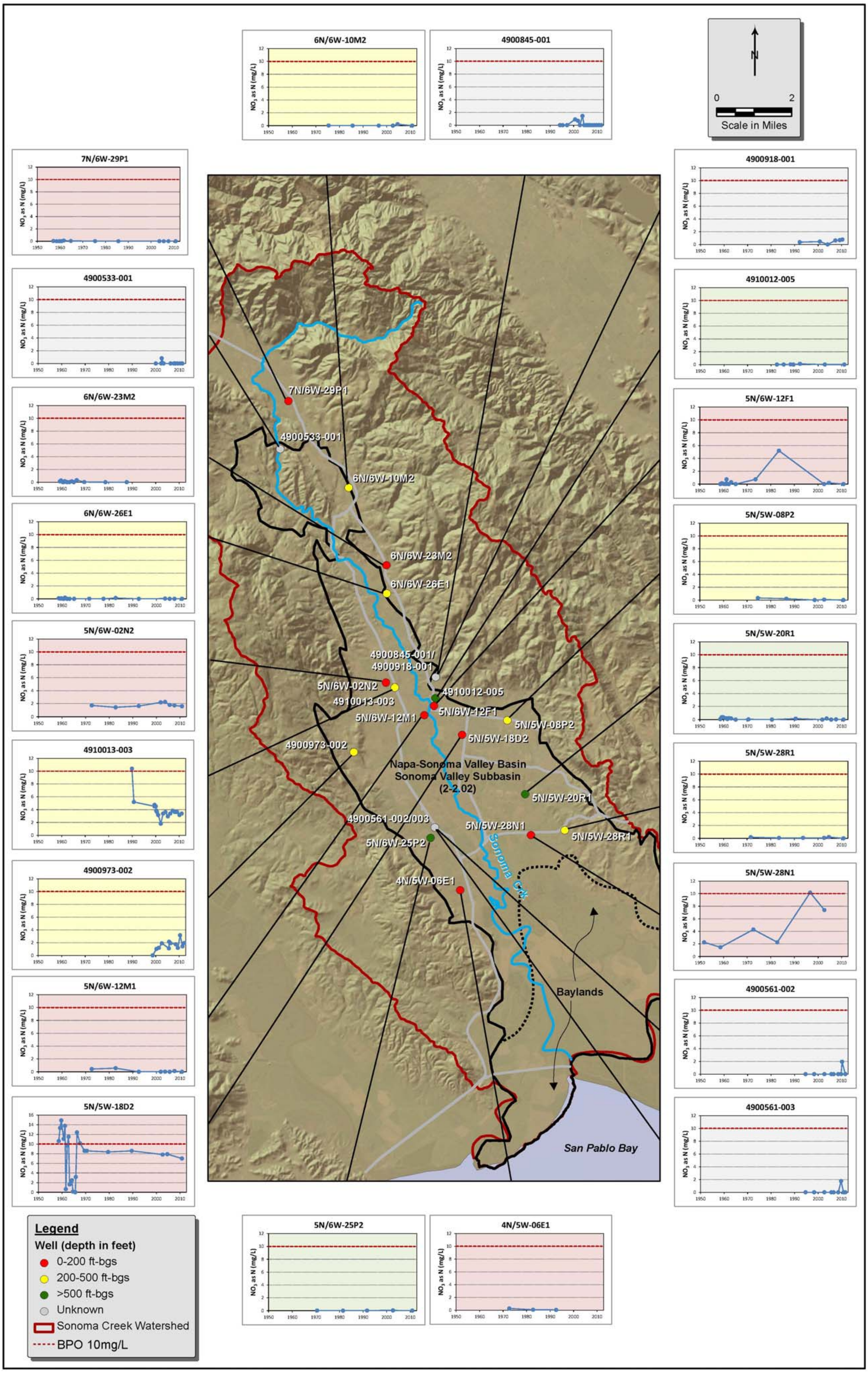


Figure 5-5: Time-Concentration Plots Nitrate as N



Chapter 6 Source Identification and Loading Analysis

An analysis of salt and nutrient loading occurring due to surface activities is presented to identify sources of salt and nutrients, evaluate their linkage with the groundwater system, and estimate the mass of salts and nutrients loaded to the Sonoma Valley groundwater subbasin associated with those sources.

Salt and nutrient loading from surface activities to the Sonoma Valley groundwater basin are due to various sources, including:

- Irrigation water (potable water, surface water, groundwater, and recycled water)
- Agricultural inputs (fertilizer, soil amendments, and applied water)
- Residential, commercial, and industrial inputs (septic systems, fertilizer, soil amendments, and applied water)
- Animal waste (dairy manure land application)

Most of these sources, or "inputs", are associated with rural and agricultural areas except for turf irrigation in commercial and industrial areas. Urban area salt and nutrient loads (e.g. due to indoor water use) are assumed to be primarily routed to the municipal wastewater system for recycling or discharge rather than to groundwater, except for landscape irrigation. Other surface inputs of salts and nutrients, such as atmospheric loading, are not considered a significant net contributing source of salts and nutrients and are not captured in the loading analysis. In addition to surface salinity inputs, potential subsurface inputs of high salinity waters from San Pablo Bay, thermal water upwelling and connate groundwater exists within the basin.

6.1 Methodology for Loading Model

To support the Sonoma Valley SNMP and to better understand the significance of various loading factors, a GIS-based loading model was developed. The loading model is a simple, spatially based mass balance tool that represents TDS and nitrogen loading on an annual-average basis. Calibration of the model was limited to focusing on comparing recent historical trends to changes in concentrations estimated through incorporating the loading model results into the mixing model. In addition to the limited calibration activities, extensive stakeholder coordination was performed to refine the parameters in the loading model, including land use, applied water, TDS and nitrogen application (in applied water, as fertilizers and amendments, and in land applied manure), irrigation water source quality, and sewer service areas (to determine septic loads). Given these activities, the model is considered suitable for this analysis of basin conditions.

Primary inputs to the model are land use, irrigation water source and quality, recycled water storage pond locations and percolation, septic system areas and loading, and soil characteristics. These datasets are described in the following sections. The general process used to arrive at the salt and nutrient loads was:

- Identify the analysis units to be used in the model. In the case of Sonoma Valley, parcels from the Sonoma County Assessor's Office are the analysis units.
- Categorize land use into discrete groups. These land use groups represent land uses that have similar water demand as well as salt and nutrient loading and uptake characteristics.
- Apply the land use group characteristics to the analysis units.
- Apply the irrigation water source to the analysis units. Each water source is assigned concentrations of TDS and nitrogen.
- Apply the septic system assumption to the analysis units.
- Apply the soil texture characteristics to the analysis units.
- Estimate the water demand for the parcel based on the irrigated area of the parcel and the land use group.

- Estimate the TDS load applied to each parcel based on the land use practices, irrigation water source and quantity, septic load, and infrastructure load. The loading model makes the conservative assumption that no salt is removed from the system once it enters the system. Other transport mechanisms (such as runoff draining to creeks exiting the basin) likely reduce the total quantity of salt in the subbasin.
- Estimate the nitrogen load applied to each parcel based on the land use practices, irrigation water source and quantity, septic load, and infrastructure (e.g. wastewater ponds) load. The loading model assumes that a portion of the applied nitrogen is taken up by plants and (in some cases) removed from the system (through harvest of plant material). Additional nitrogen is converted to gaseous forms and lost to the atmosphere. Remaining nitrogen is assumed to convert to nitrate and to be subject to leaching. Soil texture is used to estimate and account for mobility of leaching water and the efficiency of nitrate transport through the root zone.

6.2 Data Inputs

Data inputs to the model include the spatial distribution of land uses (with associated loading factors), irrigation water sources (with associated water quality), septic inputs, wastewater infrastructure loads, and soil textures. These inputs are summarized below, and are further described in the *Salt and Nutrient Source Identification and Loading* TM (RMC, 2013).

6.2.1 Land Use

Land use data were obtained from the 2012 Sonoma County Assessor's Office parcel dataset. This dataset contains several hundred discrete land use categories. These categories are consolidated into the following land use groups for the Sonoma Valley subbasin area:

- Flowers and nursery
- Pasture
- Vines
- Other row crops
- Dairy production areas
- Other livestock operations
- Non-irrigated vines
- Non-irrigated field crops
- Non-irrigated orchard
- Shrub/Scrub
- Grassland/ Herbaceous
- Barren land
- Farmsteads
- Urban commercial and industrial
- Urban commercial and industrial, low impervious surface (e.g. maintenance yards, schools)
- Urban landscape/golf course
- Urban residential
- Paved areas (roads and parking lots)

Local stakeholders and SNMP partners confirmed that the land use is substantially unchanged since the 2012 dataset, within the accuracy requirements of this type of analysis. The spatial distribution of land uses is shown in Figure 6-1. Upon review of the land use dataset, stakeholders provided updates to the dairies and grassland/herbaceous categories in the October 10, 2012 SNMP Workshop with the SVGMP's TAC. Because there are so many distinct categories, a discrete color for each type could not be assigned. Therefore, land use categories with similar characteristics (i.e. urban, non- irrigated agriculture, irrigated agriculture) are shown combined into a color category.

Each land use group is assigned characteristics including:

- Applied water
- Percent irrigated
- Applied nitrogen

- Used nitrogen
- Leachable nitrogen
- Applied TDS

Leachable nitrogen is assumed to be the applied nitrogen less 10 percent of the applied nitrogen for gaseous loss, less nitrogen removal in harvested plant material. Table 6-1 consists of a matrix of values for the land use categories and characteristics. These values were also presented to the stakeholder group and refined based on their input. Refinements included adjustments to vineyards, farmsteads/rural residential, and non-irrigated field crops. For vineyards, coordination with stakeholders included modification to applied TDS and irrigation volume to reflect practices in the area. For farmsteads/rural residential, modifications were made to applied TDS, applied N, and irrigation volume based on improved understanding of land uses on these diverse parcels. Finally, non-irrigated field crops were given the non-irrigated designation based on stakeholder input on the farming practices of what are generally small-grain hay crops in the southern portion of the basin.

Figure 6-1: Land Use

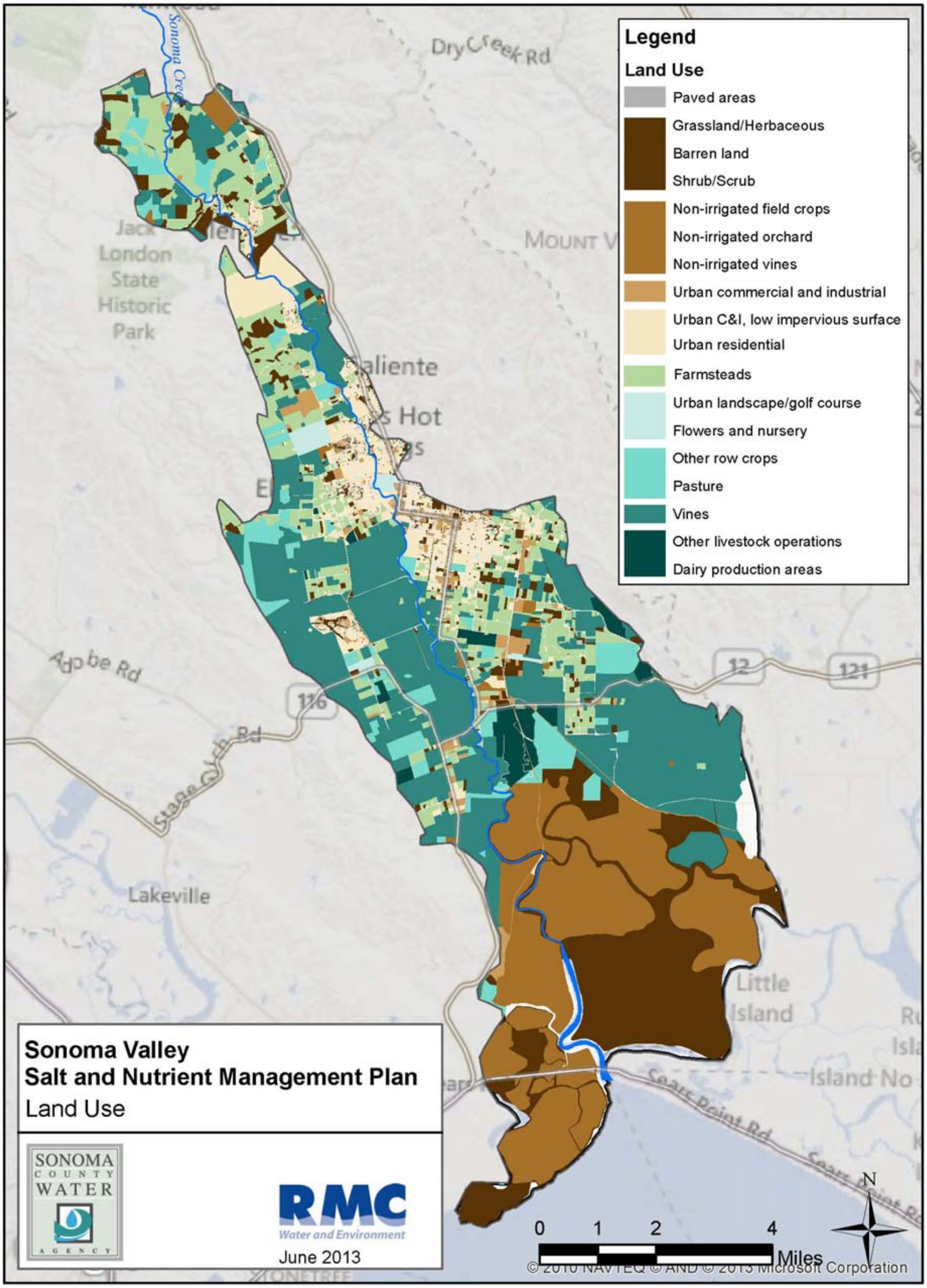


Table 6-1: Land Use Related Loading Factors

Land Use Group	Total Area **(acres)**	Percent Cultivated[1]	Applied Water[2] **(in/yr)**	Applied Nitrogen[3] **(lbs/acre-year)**	Nitrogen Uptake[4] **(lbs/acre-year)**	Leachable Nitrogen[5] **(lbs/acre-year)**	Applied TDS[6] **(lbs/acre-year)**
Paved Areas (roads and parking lots)	28	0%	0	0	0	0	0
Grasslands/Barren/ Herbaceous	7,212	0%	0	0	0	0	0
Non-irrigated vines	284	80%	0	18	16	0	84
Non-irrigated Orchard	41	80%	0	75	60	8	292
Non-irrigated field crops (hay)	8,489	80%	0	34	22	8	170
Urban Commercial and Industrial	1,018	5%	48.5	92	60	23	657
Urban C&I, Low Impervious Surface	807	30%	48.5	92	60	23	438
Farmsteads/Rural-Residential[7]	5,608	10%	28.7	60	42	13	303
Urban Residential	2,238	15%	51.1	92	60	23	438
Urban Landscape/Golf Course	327	75%	48.5	92	60	23	584
Pasture	2,266	40%	51.1	110	90	14	584
Vines[8]	13,075	100%	6.3	29	23	3	168
Other Livestock Operations	102	10%	0.0	84	-	75	730
Dairy[9]	769	N/A	N/A	N/A	N/A	N/A	N/A

Notes:

1 Percent of land area assumed to be cultivated within each class is estimated is based review of aerial photography and agricultural scientist professional judgment of a reasonable, broad average for each class.

2 Applied water values and other climatic data are taken from Department of Water Resources (DWR) land and water use data (http://www.water.ca.gov/landwateruse/anlwuest.cfm). On this website, four years of data are available. Climatic data averages, based on these four years of data, was compared to the 21-year average of available CIMIS climatic data for the Sonoma Valley area. As the two data sets correspond well, the average DWR applied water values were used, with some adjustment using crop coefficients for the Sonoma Valley area to fit the study land use classes.

3 Applied nitrogen estimates are based on literature review for individual land cover classes and professional judgment. Applied nitrogen was then calculated for total acreage and checked against fertilizer sales records for Sonoma County (available from the California Department of Food and Agriculture). Application rates were then scaled to match sales records, and adjusted if appropriate based on discussions with growers in the region.

4 Uptake of nitrogen was estimated from available literature by multiplying reported yield figures by reported nitrogen concentrations for harvested plant parts. Balances between uptake and application were checked to ensure that nitrogen use efficiencies were in the reported ranges, adjusted for professional knowledge of irrigation and fertilization practice in each land cover class.

5 Maximum nitrogen leaching calculations for each land cover unit were calculated based on the balance between application, gaseous loss (volatilization and denitrification), and uptake. The maximum was then reduced based on soil conditions mapped for the area.

6 Applied TDS estimates are based on literature review for individual land cover classes and professional judgment. Applied TDS was then calculated for total acreage and checked against amendment sales records for Sonoma County (available from the California Department of Food and Agriculture). Application rates were then scaled to match sales records. Amendment application rates were adjusted if appropriate based on discussions with growers in the region.

7 Farmstead irrigated areas are assumed to be a mix of turf grasses and vineyards.

8 Assumes that irrigated vines have a larger percent cultivation due to increased production efficiency from irrigation and a conservative value of 100% cultivation was used. An additional assumption for vines is that vines irrigated with recycled water utilize the same fertilizer and amendment application rates as those irrigated with groundwater (conservative estimate).

9 See discussion on dairy parcels below.

Due to the importance of dairies, some additional consideration is applied to dairy parcels. To better reflect land use practices, the applied, used, and leachable nitrogen characteristics and the applied TDS characteristic are further subdivided into production areas, ponds, and land application areas. Leachable nitrogen is calculated the same way as for the other land use groups except that gaseous loss is assumed to be 20 percent, as opposed to the 10 percent assumed loss for other land use groups, mainly due to the regular timing and highly organic nature of applied nitrogen.

Table 6-2: Assumed Characteristic Dairy Values for the Loading Model

Dairy Subdivision Designation	Percent of Total Parcel Area Used Per Designation	Applied Nitrogen **(lbs/acre-year)**	Used Nitrogen **(lbs/acre-year)**	Leachable Nitrogen **(lbs/acre-year)**	Applied TDS **(lbs/acre-year)**
Production Area	6%	20	0	8	82
Ponds	1%	141	0	113	933
Land Application Area	93%	367	352	30	1,280

6.2.2 Irrigation Water Source

The irrigation water source forms the basis to determine the TDS and nitrate loads that result from irrigation of the land uses described above. Source water quality for any given parcel was identified based on the location of the parcel relative the water retailers in the area. Parcels not supplied by potable municipal water sources or recycled water are assumed to obtain irrigation water from local groundwater wells. Table 6-3 summarizes the water quality inputs used for each irrigation water source.

Table 6-3: Water Quality Parameters for Loading Model Water Sources

Source	TDS (mg/L)	Nitrate (as N) (mg/L)
Valley of the Moon Water District	162	0.2
City of Sonoma	172	0.4
Groundwater	372	0.1
Recycled Water	440	5.2

6.2.3 Septic Systems

Salt and nutrient loads due to septic systems were estimated based on typical wastewater production and TDS and nitrate concentrations. It has been assumed that parcels outside of the SVCSD Service Area use a septic system or multiple systems. Of those parcels, septic systems are assumed where a residence is identified in the land use dataset. Each parcel with a septic system is assumed to produce 263 gallons per day (gpd), based on 75 gpd/person with 3.5 people per system. The 75 gpd/person estimate is based domestic use quantity estimates per California Code of Regulations, Title 23, Section 697. An estimate of 3.5 persons per household is a conservative estimate which assumes that household size for homes with septic is larger than that that of homes within the City (per the census bureau, persons per household for

2007-2011 is 2.54 in Sonoma County, with the City at only 2.07 people per household, therefore the outlying areas must be greater than 2.54 persons per household).The septic waste is assumed to have TDS concentrations of 572 mg/L, based on typical groundwater concentrations plus an assumed household contribution of 200 mg/L (Metcalf & Eddy, 2003 Table 3-7). Nitrate-N concentrations were assumed to be 30 mg/L, based on typical wastewater concentrations for medium strength wastewater (Metcalf & Eddy, 2003) of 40 mg/L minus an assumed volatization rate of 25% within the septic system.

6.2.4 Wastewater/Recycled Water Infrastructure

SVCSD operates five recycled water ponds within the groundwater basin; these are indicated in Attachment 1 of Appendix D. Two of the ponds use clay liners, while the other three ponds use plastic liners. Due to the liners, it is assumed that no significant loading occurs at pond locations. It is also assumed that leakage from wastewater (sanitary sewer) and recycled water pipelines is not likely to be a significant source of salt and nutrient loading.

An effort was also undertaken to quantify potential salt and nutrient loading from winery wastewater ponds. These ponds are often lined with plastic or clay and contain rinsewater with salt and TDS concentrations similar to the source water (likely groundwater), because no additional salts and nutrients are added in the winemaking process. This effort showed that salt and nutrient loading from these ponds were likely negligible, with biological oxygen demand (BOD) the primary concern. These loads were not included in the model, beyond the loads already included through irrigation of the vineyards.

6.2.5 Soil Textures

Soil textures (NRCS, 2013) were obtained from the Soil Survey of Sonoma County (SCS, 1972). Soil textures were assigned a hydraulic conductivity (NRCS, 1993). Hydraulic conductivity was used to develop an adjustment factor through linearly scaling the estimated conductivities from 0.1 (lowest) to 1.00 (highest). The adjustment factor is used to represent the proportion of nitrate that will migrate to the aquifer, relative to the other textural classes. Where conductivity is lower, it is reasoned (and observed) that nitrogen resides longer in the soil, increasing the proportion that is either taken up or lost through conversion to gaseous species. Similar logic is not applied to TDS as salts are mostly not subject to conversion to gaseous forms, and rapidly saturate soil capacity to absorb and retain them.

6.3 Loading Model Results

Based on the loading parameters and methodology described above, the loading model is used to develop TDS and nitrogen loading rates across the subbasin. Table 6-4 summarizes the overall contribution of each land use group to total TDS and nitrogen loading. The spatial distribution of TDS and nitrogen loading rates are shown in Figure 6-2 and Figure 6-3, respectively. The loading analysis estimates somewhat higher loading of TDS in the rural and agricultural areas of the subbasin, while nitrate loading is higher in the urban areas largely due to the low nitrogen application rates on vineyards.

Figure 6-2: TDS Loading in Study Area

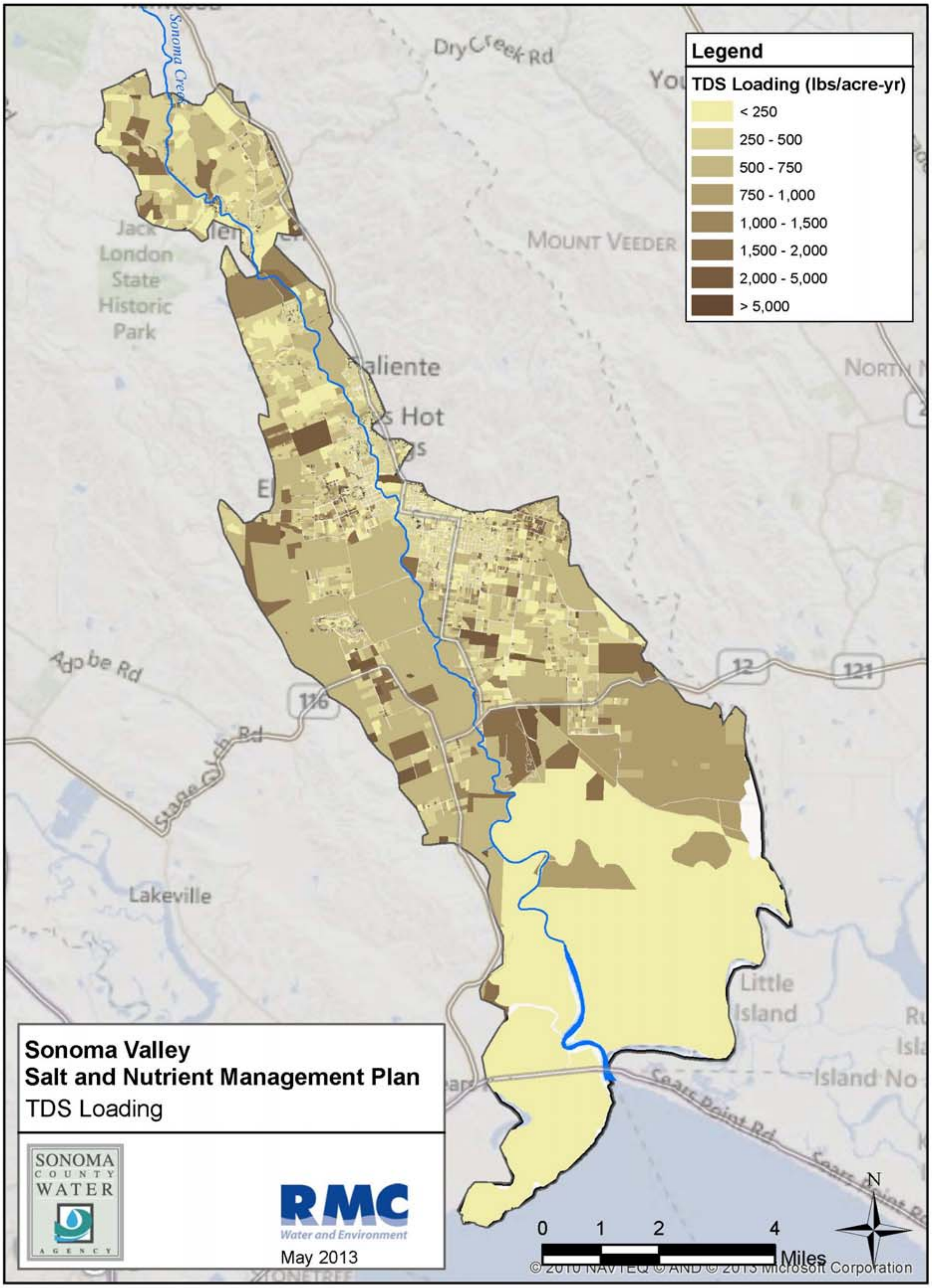


Figure 6-3: Nitrate Loading in Study Area

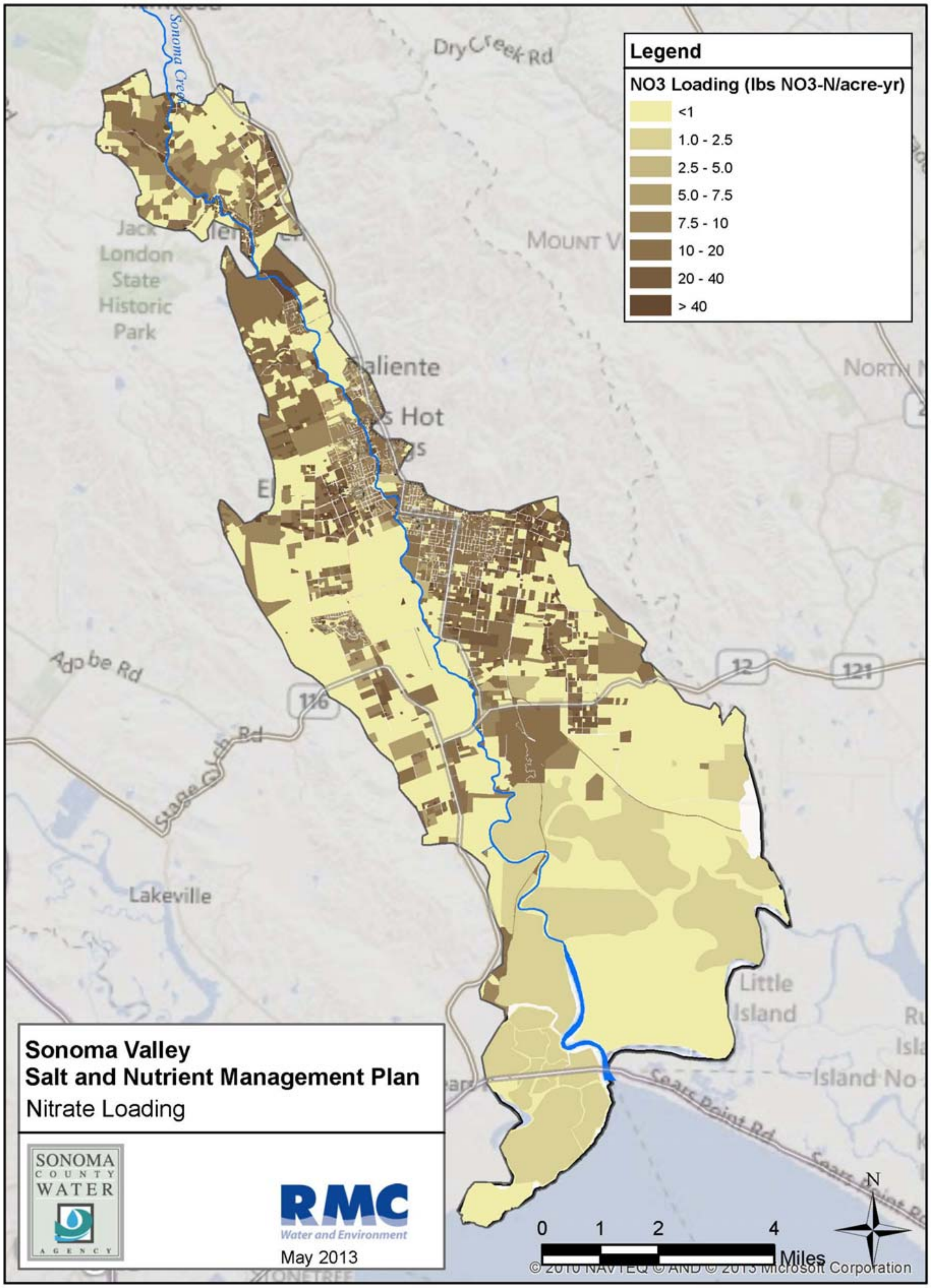
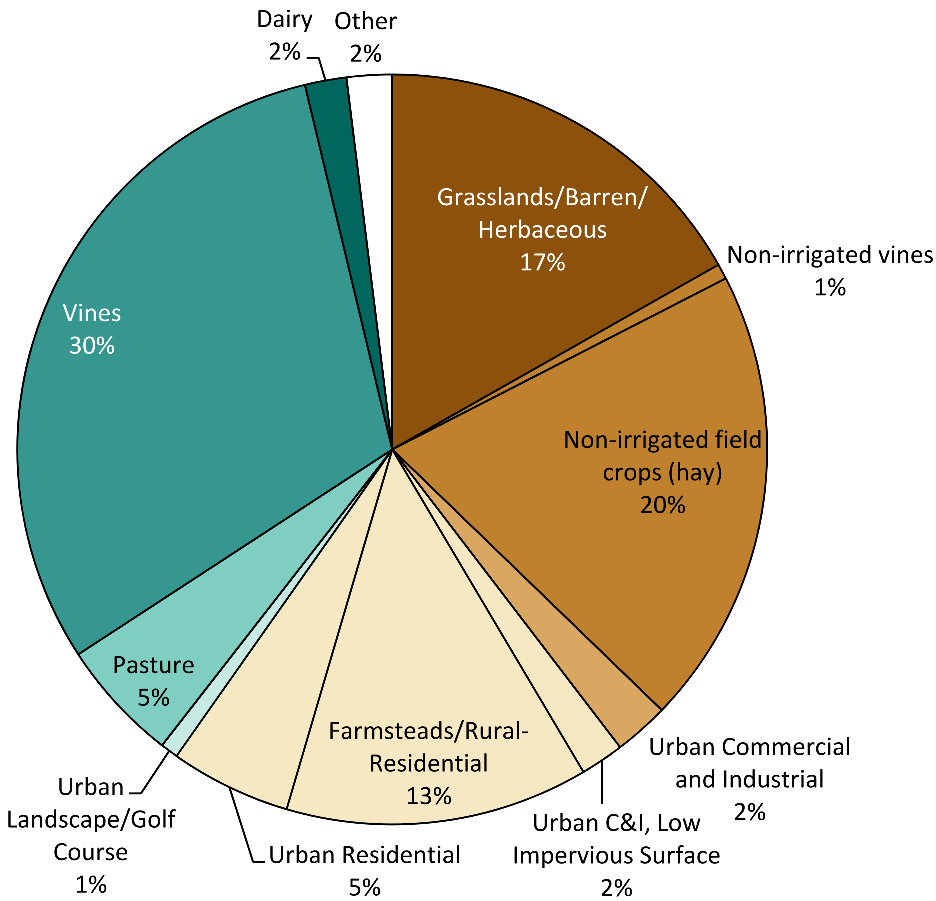


Table 6-4: TDS and Nitrate Loading Results

Land Use Group	Total Area **(acres)**	Percent of Total Area	Percentage of Total TDS Loading	Percentage of Nitrogen Loading
Paved Areas (roads and parking lots)	28	0%	0%	0%
Grasslands/Barren/ Herbaceous	7,212	17%	0%	0%
Non-irrigated vines	284	1%	0%	0%
Non-irrigated Orchard	41	0%	0%	0%
Non-irrigated field crops (hay)	8,489	20%	5%	6%
Urban Commercial and Industrial	1,018	2%	1%	8%
Urban C&I, Low Impervious Surface	807	2%	5%	7%
Farmsteads/Rural-Residential	5,608	13%	11%	37%
Urban Residential	2,238	5%	6%	22%
Urban Landscape/Golf Course	327	1%	5%	1%
Pasture	2,266	5%	17%	10%
Vines	13,075	31%	42%	3%
Other livestock operations	102	0%	0%	0%
Dairy	769	2%	7%	5%

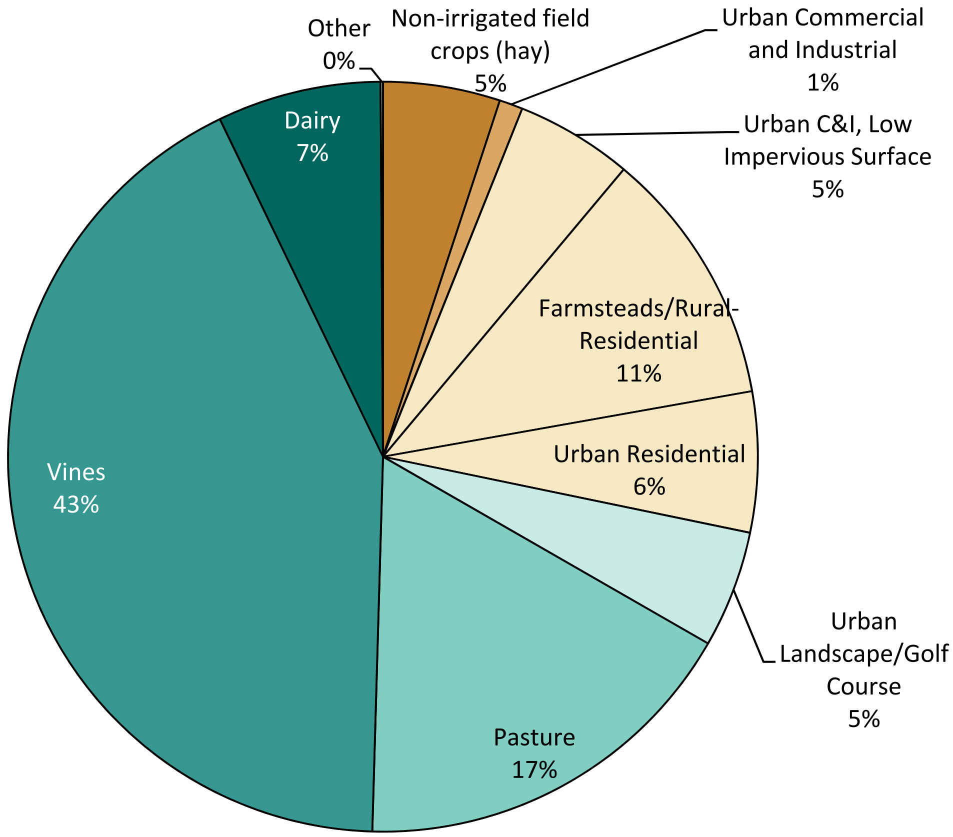
The relative proportion of the land uses by area, nitrogen loading, and TDS loading are shown in Figure 6-4, Figure 6-5, and Figure 6-6, respectively.

Figure 6-4: Percentage of Land Use in Study Area



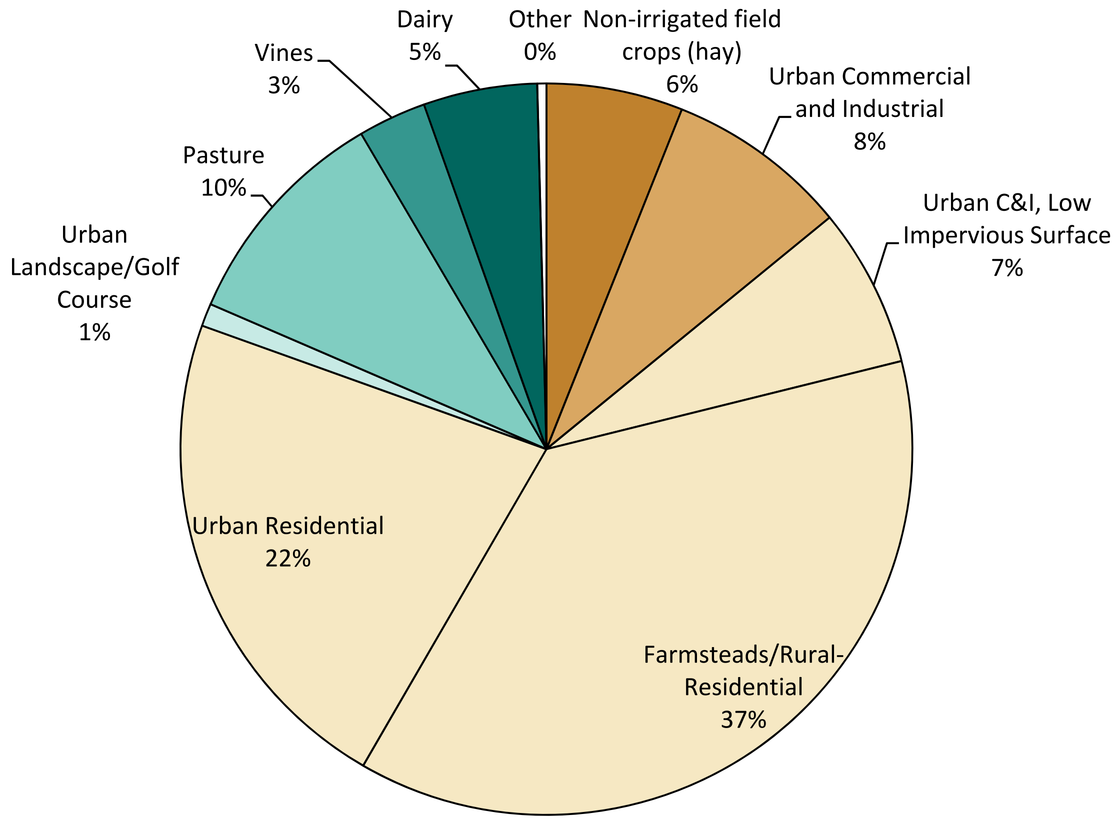
Other: Categories contributing less than 1% of land area: paved areas, non-irrigated orchards, livestock operations

Figure 6-5: Percentage of TDS Loading in Study Area, by Land Use



Other: Categories contributing less than 1% of TDS loading: paved areas, grasslands/barren/shrubs, non-irrigated vines, non-irrigated orchards, livestock operations

Figure 6-6: Percentage of Nitrogen Loading in Study Area, by Land Use



Other: Categories contributing less than 1% of nitrogen loading: paved areas, grasslands/barren/shrubs, non-irrigated vines, non-irrigated orchards, livestock operations

Chapter 7 Future Groundwater Quality Analysis

This chapter describes the development and results from the future groundwater quality analysis. The future groundwater quality analysis is described in more detail in the *Existing and Future Groundwater Quality TM* (Todd, 2013) included as Appendix A.

7.1 Simulation of Baseline and Future Groundwater Quality

Groundwater quality concentrations for TDS and nitrate are simulated for the baseline period and future planning period using a mixing model. Concentration estimates are based on water and mass inflows and outflows (balances) mixed with the volume of water in the aquifer and the average ambient groundwater quality. The baseline period is from WY 1997 to 2006. This baseline period was selected based on the period for which water balances were available from the USGS (2006) groundwater flow model and updated groundwater model (Bauer, 2008). The future planning period is from WY 2014 to WY 2035 based on the planning horizon in supporting planning documents.

The baseline period water balances estimate all groundwater inflows and outflows for the baseline period and the associated change in storage based on estimates provided in the groundwater model and updated model. Future changes simulated include increased use of recycled water for irrigation.

TDS and nitrate concentrations are associated with each water balance inflow and outflow component. In order to simulate the effect of current and future salt and nutrient loading on groundwater quality in the Sonoma Valley Subbasin, the spreadsheet mixing model mixes the volume and quality of each inflow and outflow with the existing volume of groundwater and mass of TDS and nitrate in storage and tracks the annual change in groundwater storage and salt and nutrient mass for the baseline and future planning period. The existing volume of water in the groundwater basin is calculated based on the subbasin or subarea (Inland and Baylands) surface areas, a uniform saturated thickness of 400 feet and a porosity of 0.1. The mixing model produces an average TDS and nitrate concentration for each year of the baseline and future planning period.

7.2 Use of Assimilative Capacity by Recycled Water Projects

In accordance with the Policy, a recycled water irrigation project that meets the criteria for a streamlined irrigation permit and is within a basin where a SNMP is being prepared, may be approved by the Regional Water Board by demonstrating through a salt and nutrient mass balance or similar analysis that the project uses less than 10% of the available assimilative capacity (or multiple projects use less than 20% of available assimilative capacity). Accordingly, the recycled water irrigation projects in place and planned for the Sonoma Valley Subbasin are assessed in terms of their use of available assimilative capacity.

7.3 Baseline Period Analysis

The baseline period water balance tracks groundwater inflows and outflows and storage changes from WY 1996-97 through WY 2005-06. This period represents a recent time period characterized by average climatic conditions. The primary source of information used to develop the water balance is the Sonoma Valley groundwater flow model. The flow model was originally developed by the USGS (2006) and later updated by Bauer (2008). Groundwater recharge from natural precipitation in the flow model for the baseline period represented 94% of the natural recharge over the historical flow model period.

Major inflows accounted for in the baseline water balance include:

- deep percolation of precipitation and mountain front recharge,
- natural stream recharge,
- agricultural irrigation water return flow,
- domestic/municipal irrigation water (including recycled water) return flow,

- septic system return flow, and
- subsurface groundwater inflow (from Baylands Area)

Major outflows accounted for in the water balance include:

- groundwater pumping,
- groundwater discharge to streams, and
- subsurface groundwater outflow (to Baylands Area)

Areal anthropogenic recharge sources (return flows from agricultural and municipal irrigation and septic systems) are not independently considered in the flow model but instead subsumed within the model aerial recharge rates. Model areal recharge rates were apportioned into natural sources (precipitation) and anthropogenic sources (return flows) based on the results of the salt and nutrient loading evaluation conducted for the SNMP (RMC, 2013).

7.3.1 Water Quality of Inflows and Outflows

Initial and adjusted TDS and nitrate concentration estimates for subbasin inflows and outflows in the water balance are described below followed by a discussion of the baseline mixing model calibration and results.

Sonoma Creek Leakage

TDS and nitrate data from available surface water quality monitoring stations in the watershed were assessed to characterize the water quality of stream leakage from Sonoma Creek, the second largest subbasin inflow. Based on recent water quality sampling a constant TDS concentration of 210 mg/L and constant nitrate-N concentration of 0.19 mg/L was applied to Sonoma Creek leakage for the baseline period.

Deep Percolation of Areal Precipitation and Mountain Front Recharge

Recharge from deep percolation of areal precipitation and mountain front recharge represents 65% of total subbasin inflows and is the primary controlling salt and nutrient load factor. Generally, precipitation contains minimal salts and nutrients. However, due to its low solute content, precipitation also dissolves (or leaches) salts and nutrients along its subsurface flow path from near-surface soils through the vadose zone sediments and saturated zone sediments. The degree of leaching is dependent on numerous site-specific factors and is difficult to predict reliably. Based on available groundwater quality wells located in the watershed, nitrate deposition information, and mixing model calibration, a constant concentration of 250 mg/L TDS and 0.06 mg/L nitrate-N was applied to deep percolation of areal precipitation and mountain front recharge was applied.

Return Flows – Agricultural (Groundwater and Recycled Water), Municipal, and Septic System

Salt and nutrient loads from agricultural, municipal, and septic sources are described in Chapter 6 - Source Identification and Loading Analysis. For the mixing model, the TDS and nitrogen mass load for each return flow component was mixed with its respective annual return flow volume to obtain a concentration. For the loading estimate, it was conservatively assumed that all nitrogen mass is converted to nitrate. Based on initial simulation results for the baseline period, nitrate loading from return flows was reduced by 15% to account for attenuation processes beneath the soil root zone and septic system, in order to provide a better match between simulated average concentrations and observed regional trends.

Table 7-1 shows the initial calculated and adjusted (during calibration) TDS and nitrate mass and concentrations for each return flow component. The adjusted concentrations are applied as a constant concentration over the baseline period.

Table 7-1: Return Flow TDS and Nitrate-N Mass and Concentrations for Baseline Period Analysis

Return Flows	Volumetric Rate	Iniitial and Adjusted TDS Concentration[1]	Initital Nitrate-N Concentration[1]	Adjusted Nitrate-N Concentration[1]
	AFY	mg/L	mg/L	mg/L
Agricultural (Groundwater) Irrigation Return	1,415	**4,347**	**28.0**	**23.8**
Agricultural (Recycled Water) Irrigation	91	**4,344**	**28.0**	**23.8**
Municipal Irrigation	1,074	**1,182**	**23.9**	**20.3**
Septic System	621	**572**	**30.0**	**25.5**
Total	3,201			
Weighted-average		**2,552**	**27.0**	**23.0**

[1]Initial TDS and nitrate concentrations calculated from mass loading estimates in *Salt and Nutrient Source Identification and Loading TM* (RMC, 2013). Initial TDS concentrations for return flows were not adjusted during calibration. Adjusted nitrate concentrations reflect 15% reduction to account for additional attenuation below the root zone/septic system in the mixing model.

As shown in Table 7-1, the initial and final adjusted TDS concentration of agricultural irrigation water (groundwater and recycled water source water) at about 4,300 mg/L is the highest of the return flow components. Differences between agricultural return flow concentrations/mass for groundwater and recycled water are attributable to differences in source water quality. The TDS concentration of municipal irrigation water (1,182 mg/L) is lower than for agricultural irrigation. Septic system return flows have the lowest TDS concentration (572 mg/L) compared to the irrigation return flows. Overall, the volume weighted-average TDS concentration of the irrigation and septic system return flows is 2,552 mg/L.

Subsurface Inflows from Baylands Area

While groundwater levels and the flow model-based water balance indicate that subsurface groundwater flows generally from the Inlands area to the Baylands Area, there is a small component of subsurface inflow from the Baylands Area. This is likely caused by groundwater pumping, which has created a pumping depression in the southern portion of the subbasin.

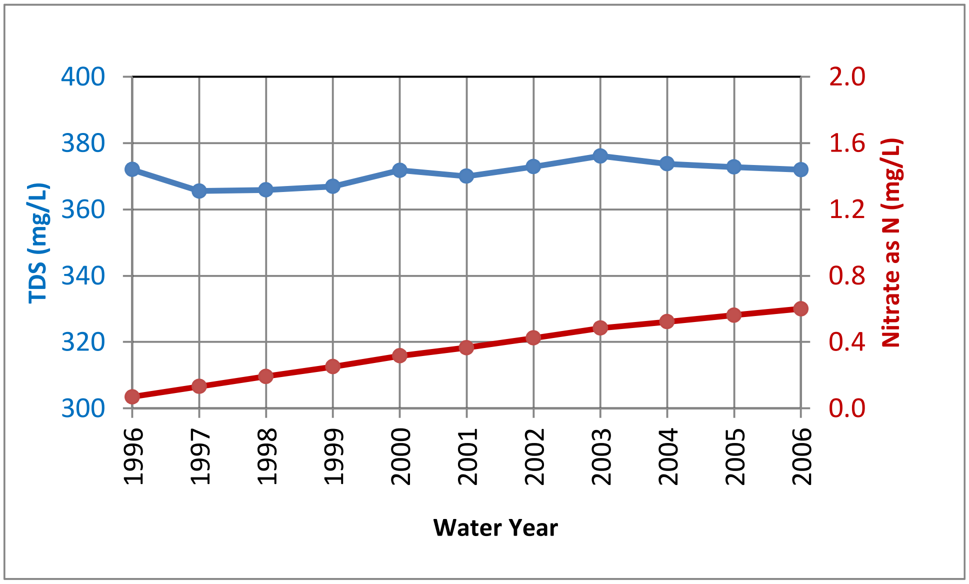
The concentrations applied to subsurface inflows from the Baylands Area were assumed to be the current average concentration in the Baylands Area (1,220 mg/L for TDS and 0.07 mg/L for nitrate-N).

7.3.2 Mixing Model Calibration and Salt and Nutrient Balance

In order to simulate the effect of current salt and nutrient loading on groundwater quality in the Inland Area of the subbasin, a spreadsheet mixing model was developed. In the mixing model, the simulated baseline period concentrations and trends were compared to the predominant pattern of observed concentrations and trends. From this comparison, loading factors were adjusted (calibrated) to achieve a better match between simulated and observed concentrations and trends.

Figure 7-1 shows the final simulated average subbasin TDS and nitrate concentrations over the 10-year baseline period (WY 1996 represents the hypothetical initial water quality condition equivalent to the current ambient condition).

Figure 7-1: Final Simulated Baseline Average Groundwater Concentrations for Inland Area of Sonoma Valley Subbasin (WYs 1997-2006)



As shown in the figure, simulated average subbasin TDS concentrations vary slightly from year to year, but exhibit no change over the 10-year baseline period. This flat trend compares well to observed flat trends in wells across the subbasin over the baseline period.

In contrast to the TDS trend, simulated average nitrate-N concentrations increase by about 0.5 mg/L over the baseline period, despite nitrate loading from return flows being reduced by 15% to account for additional attenuation below the root zone/septic system. Observed nitrate concentrations in monitoring wells across the subbasin are not increasing regionally, but instead show overall flat or stable concentrations over time. The discrepancy between simulated and observed trends may be caused by an overestimate of the nitrate load due to one or more of the following:

1. Assumption that 100% of nitrogen is converted to nitrate
2. Potential underestimation of ambient average groundwater nitrate concentrations due to limited spatial distribution of wells with recent nitrate data
3. Application of all nitrate loading associated with recycled water use within the Inland Area in the mixing model, despite portions of existing (and proposed future) recycled water use areas being located south of the Inlands area in the Baylands area (see Figure 2-1)
4. Underestimation of nitrate attenuation below the root zone/septic system in the mixing model

For the reasons mentioned above, simulated nitrate concentrations generated from the calibrated mixing model are likely conservative and overestimated for both baseline and future nitrogen loading. While application of higher nitrate attenuation rate was considered, given the limited distribution of monitoring wells with long-term nitrate trend data in the subbasin, a 15% attenuation rate was maintained.

7.4 Future Planning Period Water Quality

The spreadsheet mixing model developed for the baseline analysis was modified to evaluate the effects of planned future salt and nutrient loading on overall groundwater quality in the Sonoma Valley Subbasin for the future planning period (WY 2013-14 through WY 2034-35). Future project changes are superimposed over average water balance conditions during the 10-year baseline period (described above) to simulate future groundwater quality.

The mixing model is used to predict future water quality, water quality trends, and the percentage of the existing available assimilative capacity used by recycled water projects in the subbasin during the future planning period. The mixing model is designed to incorporate the existing volume of groundwater and mass of TDS and nitrate in storage and track the annual change in groundwater storage and salt and nutrient mass for the subbasin as a whole.

Three future scenarios were simulated:

- Future Scenario 0 (No-Project): Assumes average baseline water balance conditions and no additional enhanced stormwater capture and recharge is applied.
- Future Scenario 1: Assumes 2035 planned recycled water use of 4,100 AFY (applied consistently from WY 2013-14 through WY 2034-35)
- Future Scenario 2: Assumes 2035 planned recycled water use plus an additional 5,000 AFY of recycled water (applied consistently from WY 2013-14 through WY 2034-35).

7.4.1 Future Scenarios

The average TDS and nitrate concentrations for the baseline period were applied to all future scenarios for the following inflows:

- Deep percolation of areal precipitation and mountain front recharge
- Leakage from Sonoma Creek
- Subsurface inflow from Baylands area

Concentrations for future return flow components are described below.

Return Flows – Agricultural, Municipal Irrigation and Septic System

The same methodology used to estimate TDS and nitrogen loading from return flows over the baseline period was used to estimate future return flow loading.

Table 7-2 through Table 7-4 show the estimated TDS and nitrate mass and concentrations of each return flow for Scenario 0 (No-Project), Scenario 1, and Scenario 2, respectively. The adjusted values are applied as a constant concentration over the entire future planning period. For both TDS and nitrate, the total cumulative mass and weighted-average concentration of return flows increases slightly from Scenario 0 (No-Project) to Scenario 1 to Scenario 2.

Table 7-2: Future Scenario 0 (No-Project)

Return Flows	Volumetric Rate	Iniitial and Adjusted TDS Concentration[1]	Initital Nitrate-N Concentration[1]	Adjusted Nitrate-N Concentration[1]
	AFY	mg/L	mg/L	mg/L
Agricultural (Groundwater) Irrigation Return	1,415	**4,347**	**28.0**	**23.8**
Agricultural (Recycled Water) Irrigation	91	**4,344**	**28.0**	**23.8**
Municipal Irrigation	1,074	**1,182**	**23.9**	**20.3**
Septic System	621	**572**	**30.0**	**25.5**
Total	3,201			
Weighted-average		**2,552**	**27.0**	**23.0**

[1]Initial TDS concentrations for return flows were not adjusted for future simulations. Adjusted nitrate concentrations reflect 15% reduction to account for additional attenuation below the root zone/septic system in the mixing model.

Table 7-3: Future Scenario 1 (2035 recycled water conditions)

Return Flows	Volumetric Rate	Iniitial and Adjusted TDS Concentration[1]	Initital Nitrate-N Concentration[1]	Adjusted Nitrate-N Concentration[1]
	AFY	mg/L	mg/L	mg/L
Agricultural (Groundwater) Irrigation Return	998	**4,481**	**29.3**	**24.9**
Agricultural (Recycled Water) Irrigation	508	**4,479**	**29.3**	**24.9**
Municipal Irrigation	1,074	**1,182**	**23.9**	**20.3**
Septic System	621	**572**	**30.0**	**25.5**
Total	3,201			
Weighted-average		**2,615**	**27.6**	**23.5**

[1]Initial TDS concentrations for return flows were not adjusted for future simulations. Adjusted nitrate concentrations reflect 15% reduction to account for additional attenuation below the root zone/septic system in the mixing model.

Table 7-4: Future Scenario 2 (2035 recycled water conditions plus 5,000 AFY recycled water)

Return Flows	Volumetric Rate	Iniitial and Adjusted TDS Concentration[1]	Initital Nitrate-N Concentration[1]	Adjusted Nitrate-N Concentration[1]
	AFY	mg/L	mg/L	mg/L
Agricultural (Groundwater) Irrigation Return	374	**4,706**	**31.6**	**26.8**
Agricultural (Recycled Water) Irrigation	1,132	**4,706**	**31.6**	**26.8**
Municipal Irrigation	1,074	**1,182**	**23.9**	**20.3**
Septic System	621	**572**	**30.0**	**25.5**
Total	3,201			
Weighted-average		**2,722**	**28.7**	**24.4**

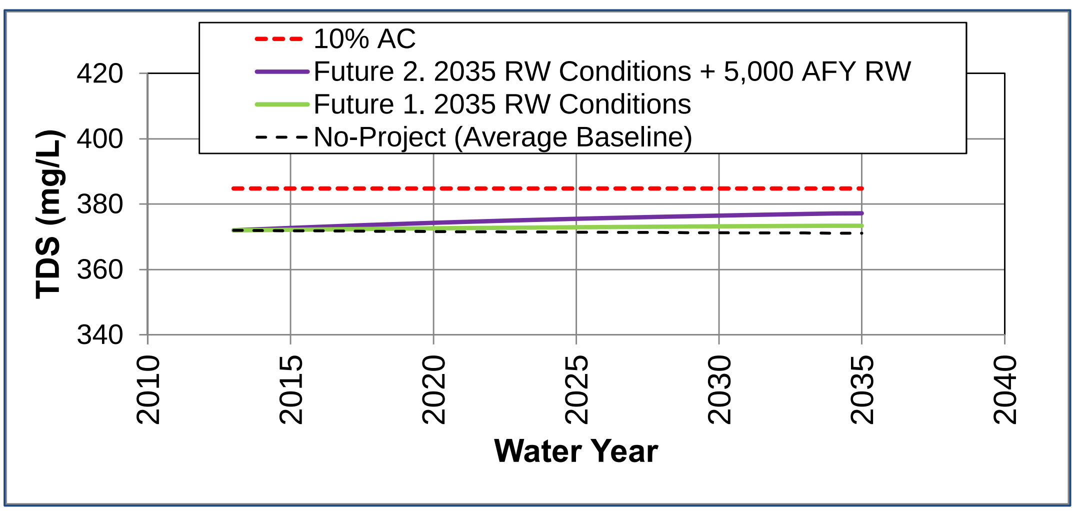
[1]Initial TDS concentrations for return flows were not adjusted for future simulations. Adjusted nitrate concentrations reflect 15% reduction to account for additional attenuation below the root zone/septic system in the mixing model.

7.4.2 Future Water Quality Results

TDS Groundwater Concentrations

Figure 7-2 shows the simulated future TDS concentrations from the calibrated mixing model for the three future scenarios from WY 2013-14 through 2034-35 for the Inland Area of the Sonoma Valley Subbasin. Also shown on the chart is the 10% assimilative capacity threshold.

Figure 7-2: Simulated Future Groundwater TDS Concentrations



The following conclusions can be made for future TDS groundwater concentrations:

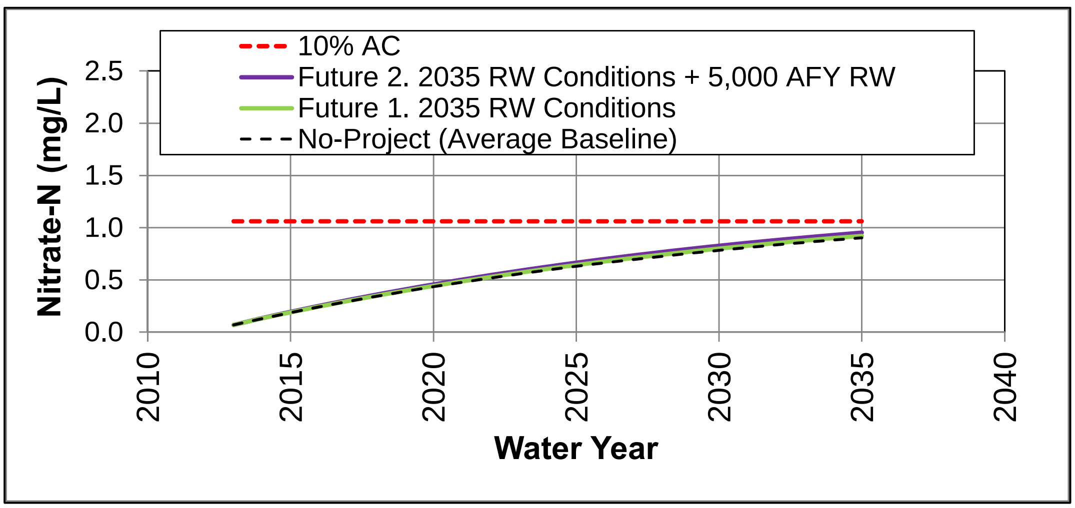
- Average TDS concentrations in the subbasin Inland Area are projected to decrease from WY 2013 through WY 2035 by 0.9 mg/L for Scenario 0 (No-Project).
- Average TDS concentrations in the subbasin Inland Area are projected to increase from WY 2013 through WY 2035 by 1.4 mg/L for Scenario 1 and by 3.5 mg/L for Scenario 2.
- For all three scenarios, recycled water projects use less than 10% of the available assimilative capacity, and projected TDS concentrations remain well below the BPO of 500 mg/L.

When considering the differences between Scenarios 1 and 2 and the No-Project Scenario (i.e., loading associated with the No Project components is removed), Scenarios 1 uses 1.8% (2.3 mg/L) of the available assimilative capacity, while Scenario 2 use 4.8% (6.1 mg/L) of the assimilative capacity.

Nitrate-N Groundwater Concentrations

Figure 7-3 shows the simulated results of the calibrated mixing model for nitrate for the three future scenarios from WY 2013-14 through 2034-35 for the Inland Area of the Sonoma Valley Subbasin. The chart shows the simulated concentration trends for each scenario and the 10% assimilative capacity threshold.

Figure 7-3: Simulated Future Groundwater Nitrate-N Concentrations



The following conclusions can be made for future nitrate-N groundwater concentrations:

- Average nitrate concentrations in the subbasin Inland Area are projected to increase similarly for all three scenarios from WY 2013 to WY 2035 (between 0.83 and 0.88 mg/L).
- For all three scenarios, recycled water projects use less than 10% of the available assimilative capacity, and projected nitrate concentrations remain well below the BPO of 10 mg/L.
- When considering the difference between Scenarios 1 and 2 and the No-Project Scenario (i.e., loading associated with the No Project components is removed), Scenarios 1 uses 0.2 % (0.02 mg/L) of the available assimilative capacity (9.93 mg/L), while Scenario 2 uses 0.5 % (0.05 mg/L) of the available assimilative capacity.

It is noted that projected increases in nitrate concentrations in the Inland area of the subbasin are considered conservative given the assumptions incorporated in the calibration of the mixing model for nitrate. Additionally, despite portions of existing and proposed future recycled water use areas being located south of the Inlands area in the Baylands area (see Figure 2-1), all TDS and nitrate loading associated with recycled water use was applied within the Inlands area in the mixing model and salt and nutrient balance. Average groundwater nitrate concentrations are predicted to increase asymptotically toward the volume-weighted average nitrate concentration of basin inflows for each scenario (1.31 mg/L for Scenario 0, 1.33 mg/L for Scenario 1, and 1.38 mg/L for Scenario 2).

Chapter 8 Implementation Measures

The findings from the technical analysis completed for the SNMP indicate that overall groundwater quality in the basin is stable with low salinity and nutrient values, well below the Regional Water Board's BPOs. Analysis of future water quality (through 2035) indicates good water quality and stable trends. Therefore, no new implementation measures or BMPs as part of the SNMP process are recommended at this time; however, the SNMP would like to endorse existing measures or practices already in place to manage groundwater quality in the basin and see that they continue.

8.1 Existing Implementation Measures and Ongoing Management Programs

Given that future groundwater quality concentration estimates are not expected to exceed BPOs for TDS and nitrate, and recycled water projects do not use more than 10% of the basin's assimilative capacity, no new implementation measures are recommended to manage salts and nutrients within the basin. Several programs are already underway in the basin, which help manage groundwater supplies and quality. These programs fall under five categories, as follows:

- Agricultural
- Recycled Water Irrigation
- Groundwater Management
- Onsite Wastewater Treatment System Management
- Municipal Wastewater Management

Implementation measures that are underway in the basin within these broad categories are described below.

8.2 Agricultural BMPs

Agricultural best management practices (BMPs) are categorized for vineyard, dairy or other agriculture below.

8.2.1 Vineyard

Land management practices within vineyards include various on-going BMPs. Several practices are listed below:

- Drip irrigation – water application is minimized by focusing the amount and area applied.
- Soil and petiole testing – it is common practice for vineyard managers to conduct annual soil testing to understand soil characteristics for grape production and flavor. Soil testing includes review of TDS and nitrate. Vineyard managers also typically test petioles to further refine vine nutrient needs.
- Focused application of fertilizer and soil amendments – application of salts and nutrients is limited to the area at the point of the irrigation drip emitter, rather than broadcast across a large area.

8.2.2 Dairy

Land management practices at dairy operations include various on-going BMPs. Several practices are listed below:

- Pavement and cover (roofing) in intensive manure areas to control runoff

- Spreading liquid manure at agronomic rates
- Manure application (solids) on vegetated fields – spreading on vegetated areas allows for greater uptake of nutrients by plants
- Organic dairies utilize larger land base for grazing area, allowing for greater uptake of nutrients.

8.2.3 Other Agriculture

In Sonoma Valley, the bulk of agriculture that is non-viticulture occurs mainly over the brackish groundwater area (referred to as "Baylands" area in the SNMP) and was not a focus for cataloging implementation measures.

8.3 Recycled Water Irrigation BMPs

The implementation of recycled water is regulated by the Title 22 California Code of Regulations (Title 22). Numerous BMPs and operating procedures are required to be followed when using recycled water for irrigation to ensure safety. The following BMPs are implemented in recycled water operations:

- Water quality monitoring at the treatment plant to ensure regulatory compliance with Title 22, and meet monitoring requirements for indicator emerging contaminants as part of the Recycled Water Policy.
- Irrigation at agronomic rates – 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.
- Site Supervisor – a site supervisor who is responsible for the system and for providing surveillance at all times to ensure compliance with regulations and Permit requirements is designated for each site. The Site Supervisor is trained to understand recycled water, and 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; and any overspray must be controlled.

8.4 Groundwater Management Plan – Ongoing Programs

The SVGMP set forth a management structure and process for conducting projects to maintain the health of the groundwater basin. The SVCSD will continue to participate with the SVGMP. Programs underway as part of the SVGMP, include the following:

- Basin-wide groundwater level monitoring
- Groundwater quality monitoring
- Installation and monitoring of two new multi-level groundwater wells
- Plans for additional monitoring well installation and development of grants to fund installation
- Groundwater banking study and pilot-project
- Stormwater management-groundwater recharge study and pilot-project
- Encouraging LID to increase stormwater recharge and limit nutrient loading to runoff. The County of Sonoma has an LID Design Manual which requires capture and treatment requirements for runoff at new construction of a certain size, and the Southern Sonoma County Resource Conservation District developed a "Slow It, Spread It, Sink It" guidance manual for stormwater management.

- Offstream infiltration study and project
- Water recycling projects to offset groundwater pumping
- Public Outreach Plan
- Seepage runs to understand basin water balance inflow and outflows
- Development of a rainfall monitoring program
- Study to develop seawater intrusion mitigation measures
- Encouraging conservation and BMPs for viticulture and non-viticulture agriculture
- Update to land cover maps, and groundwater flow model

8.5 Onsite Wastewater Treatment System Management

A large percentage of the groundwater basin is overlain by ranchettes and farmsteads with houses and structures that manage waste through individual onsite wastewater treatment system (OWTS), also known as septic systems. Individual property owners are responsible for managing their own system and employ a variety of BMPs such as monitoring and frequent pumping to manage the operation of the system. In June of 2012, the State Water Resources Control Board adopted the Water Quality Control Policy for Siting, Design, Operation, and Maintenance of Onsite Wastewater Treatment Systems. The intent of the Policy is "to allow the continued use of OWTS, while protecting water quality and public health". BMPs required in the Policy include site evaluations, setbacks, and percolation tests for new systems.

8.6 Municipal Wastewater Management

SVCSD owns and operates the only large-scale wastewater treatment plant within the groundwater basin. SVCSD implements source control programs including industrial waste management measures (i.e. educational outreach, coordination with wineries, and I/I programs) to control salinity and nutrients in influent waters, which ultimately improves the quality of recycled water.

Chapter 9 Groundwater Monitoring Plan

A Groundwater Monitoring Plan is a required element of all SNMPs. A comprehensive Groundwater Monitoring Plan has been developed for the Sonoma Valley SNMP and is included as Appendix E.

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 Regional Water Board at least every three years." With regards to constituents of emerging concern (CECs), the Recycled Water Policy Attachment A states that "Monitoring of health-based CECs or performance indicator CECs is not required for recycled water used for landscape irrigation due to the low risk for ingestion of the water."

9.1 Existing Monitoring Programs

Groundwater quality in the Sonoma Valley has been monitored since 1949. Most data represent one-time samples for short-term studies or individual well-specific assessments. The SVGMP monitoring program and the proposed SNMP monitoring program rely on three existing ongoing programs:

- DWR Monitoring
- CDPH Required Monitoring
- SVGMP Monitoring

The SNMP monitoring program will also collect and consider data from any other special studies conducted in the subbasin, such as studies conducted through the GMP to evaluate salinity sources in southern Sonoma Valley and studies conducted under the California Groundwater Ambient Monitoring and Assessment (GAMA) Program.

9.2 SNMP-Specific Groundwater Monitoring Program

For the SNMP Monitoring Program, 47 wells that are currently monitored by DWR, CDPH, and SVGMP will be included in the monitoring program (Table 9-1 and Figure 9-1). Wells will be monitored on the same schedule as their current monitoring, and results will be reported through the Geotracker database system to the Regional Water Board every three years in an SNMP Groundwater Monitoring Report. Parameters to be monitored include electrical conductivity (EC), TDS and nitrate.

The SNMP Groundwater Monitoring Report will include the following:

- Discussion of TDS and EC water quality including
    - Water quality summary tables (TDS and specific conductance)
    - Water quality concentration maps (TDS and specific conductance)
    - Time-concentration plots (specific conductance) to assess trends
    - Comparison of detections with BPOs
- Status of recycled water use and stormwater capture projects and implementation measures

- Review of future planned use of recycled water and any changes in planned use (which may trigger CEC monitoring requirements)

The SNMP Groundwater Monitoring Program will be reviewed and assessed every three years as part of the triennial SNMP groundwater monitoring reporting.

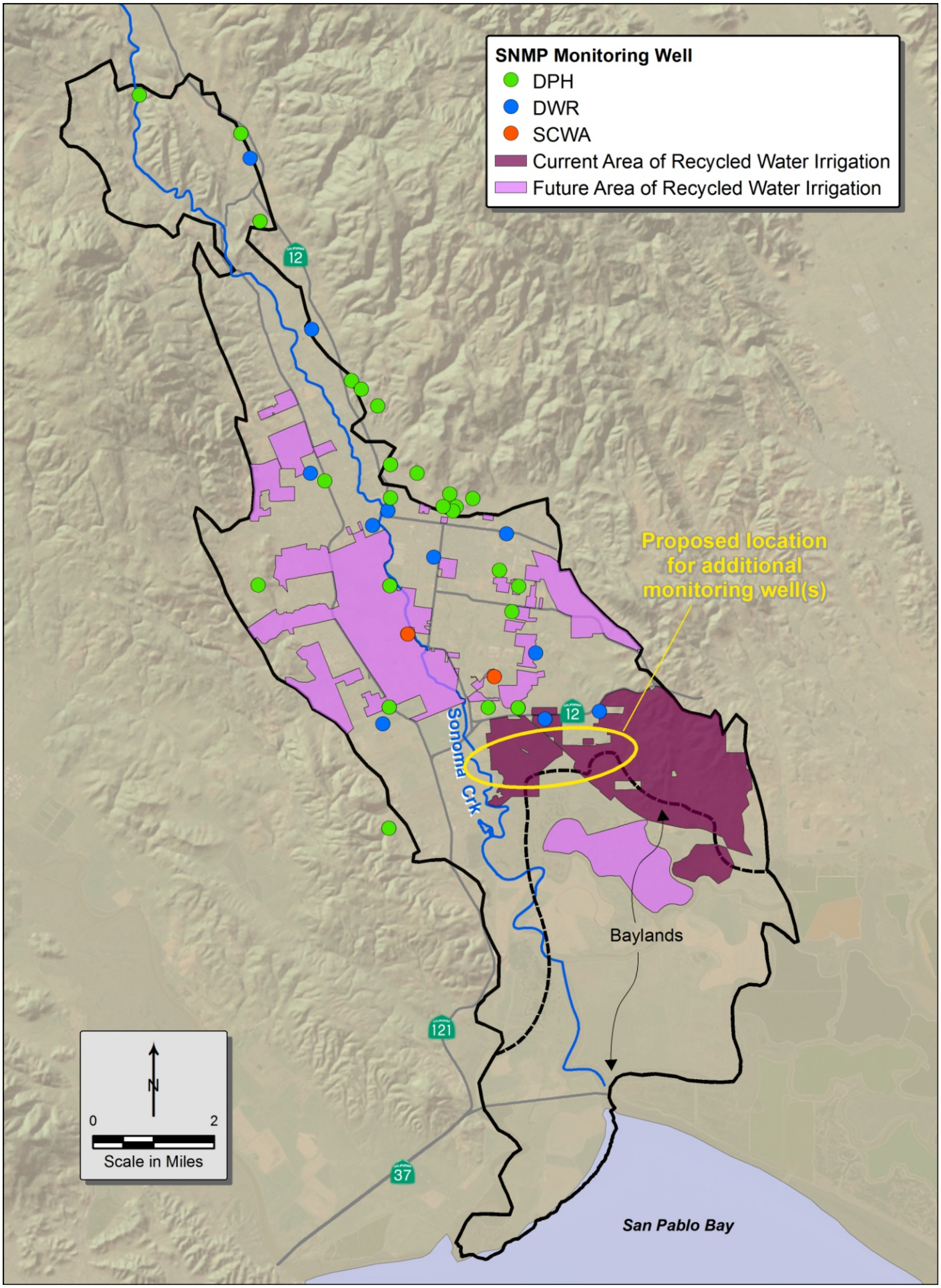
Table 9-1: SNMP Groundwater Monitoring Program

Program	No. of Wells	Monitoring Frequency	Constituents
DWR	12	Every 2 years	EC, TDS, and nitrate
CDPH	26 (varies)	Between 1-3 years	EC, TDS, or nitrate
SVGMP	9	Once per year	EC, TDS, and nitrate

9.3 Data Gaps

Additional monitoring data in the area where the Baylands zone transitions to the Inland area would be useful in the future to better understand if there is movement in the salinity intrusion area. When additional funding becomes available for the installation of additional monitoring wells, this will be the target area.

Figure 9-1: SNMP Monitoring Program



Chapter 10 Antidegradation Assessment

10.1 Recycled Water Irrigation Projects

Recycled water project(s) in the Sonoma Valley include existing and projected increased use of recycled water for irrigation through the end of the future planning period in the WY 2035.

10.2 SWRCB Recycled Water Policy Criteria

Section 9 Anti-Degradation of the SWRCB's Recycled Water Policy states, in part:

a. *The State Water Board adopted Resolution No. 68-16 as a policy statement to implement the Legislature's intent that waters of the state shall be regulated to achieve the highest water quality consistent with the maximum benefit to the people of the state.*

b. *Activities involving the disposal of waste that could impact high quality waters are required to implement best practicable treatment or control of the discharge necessary to ensure that pollution or nuisance will not occur, and the highest water quality consistent with the maximum benefit to the people of the state will be maintained…..*

d. *Landscape irrigation with recycled water in accordance with this Policy is to the benefit of the people of the State of California. Nonetheless, the State Water Board finds that the use of water for irrigation may, regardless of its source, collectively affect groundwater quality over time. The State Water Board intends to address these impacts in part through the development of salt/nutrient management plans described in paragraph 6.*

(1) *A project that meets the criteria for a streamlined irrigation permit and is within a basin where a salt/nutrient management plan satisfying the provisions of paragraph 6(b) is in place may be approved without further antidegradation analysis, provided that the project is consistent with that plan.*

(2) *A project that meets the criteria for a streamlined irrigation permit and is within a basin where a salt/nutrient management plan satisfying the provisions of paragraph 6(b) is being prepared may be approved by the Regional Water Board by demonstrating through a salt/nutrient mass balance or similar analysis that the project uses less than 10 percent of the available assimilative capacity as estimated by the project proponent in a basin/sub-basin (or multiple projects using less than 20 percent of the available assimilative capacity as estimated by the project proponent in a basin/sub-basin).*

10.3 Assessment

The average TDS and nitrate concentrations and the available assimilative capacities for baseline conditions and the future planning period with the recycled water irrigation project(s) were discussed in Section 7. Irrigation with recycled water contributes only very minor salt and nutrient loading to the subbasin and recycled water projects do not use more that 10 % of the available assimilative capacity.

In addition to the minimal negative water quality impacts associated with recycled water irrigation project(s) in the Subbasin, the Recycled Water Policy and other state-wide planning documents recognize the tremendous need for and benefits of increased recycled water use in California. As stated in the Recycled Water Policy "*The collapse of the Bay-Delta ecosystem, climate change, and continuing population growth have combined with a severe drought on the Colorado River and failing levees in the Delta to create a new reality that challenges California's ability to provide the clean water needed for a healthy environment, a healthy population and a healthy economy, both now and in the future. …….We strongly encourage local and regional water agencies to move toward clean, abundant, local water for California by emphasizing appropriate water recycling, water conservation, and maintenance of supply* *infrastructure and the use of stormwater (including dry-weather urban runoff) in these plans; these sources of supply are drought-proof, reliable, and minimize our carbon footprint and can be sustained over the long-term."* Clearly, the benefits in terms of sustainability and reliability of recycled water use cannot be overstated.

Another benefit of recycled water use for irrigation is that it reduces groundwater pumping in the southern part of the subbasin in the vicinity of a pumping depression helping to mitigate saline water intrusion from the Baylands Areas.

The SNMP analysis finds that recycled water use can be increased while still protecting and improving groundwater quality for beneficial uses. Table 10-1 provides an explanation of why proposed future recycled projects are in compliance with SWRCB Resolution No. 68-16.

Table 10-1: Antidegradation Assessment

<table>
<tr><th>SWRCB Resolution No. 68-16 Component</th><th>Anti-Degradation Assessment</th></tr>
<tr><td>Water quality changes associated with proposed recycled water project(s) are consistent with the maximum benefit of the people of the State.</td><td rowspan="3">• The irrigation projects will not use more than 10% of the available AC
• Recycled water irrigation project(s) will not cause groundwater quality to exceed applicable BPOs
• Use of recycled water for irrigation reduces groundwater pumping and helps mitigate saline water intrusion from the Baylands Area</td></tr>
<tr><td>The water quality changes associated with proposed recycled water project(s) will not unreasonably affect present and anticipated beneficial uses.</td></tr>
<tr><td>The water quality changes will not result in water quality less than prescribed in the Basin Plan.</td></tr>
<tr><td>The projects are consistent with the use of best practicable treatment or control to avoid pollution or nuisance and maintain the highest water quality consistent with maximum benefit to the people of the State.</td><td>• Concentrations of TDS and nitrate in recycled water produced by SVCSD are 440 mg/L and 5.2 mg/L, respectively. Concentrations are well below BPOs of 500 mg/L and 10 mg/L.</td></tr>
<tr><td>The proposed project(s) is necessary to accommodate important economic or social development.</td><td>• The recycled water projects are an integral part of Subbasins UWMPs</td></tr>
<tr><td>Implementation measures are being or will be implemented to help achieve BPOs in the future.</td><td>• Various measures, as described in Chapter 8 have been or will be implemented in the subbasin to address salts and nutrients</td></tr>
</table>

Chapter 11 Plan Approval Process

Following the presentation of the Draft SNMP at the July 18, 2013 public workshop, public comments on the Draft SNMP Report were considered and incorporated into this Final SNMP Report. This SNMP is being submitted to the Regional Water Board (in September 2013) for their review and incorporation to their Basin Planning process and subsequent environmental documentation process. The Regional Water Board template to be utilized for incorporating this SNMP into their Basin Planning Process has been filled in and is included as Appendix F along with environmental considerations.
The Final SNMP Report has been posted online at the following web address:
www.scwa.ca.gov/svgroundwater/

It is anticipated that this SNMP will be updated in the future. The timing of an SNMP update is not tied to a scheduled reoccurrence interval, however, an update could be triggered by the following:

- Major changes in land use or land management practices
- New information from the SNMP Groundwater Monitoring Program
- Changes in basin management (e.g. recharge projects)

Any future SNMP updates would be conducted utilizing a similar collaborative process as was utilized for development of this SNMP.

Chapter 12 Conclusion

The findings from the technical analysis completed for the SNMP indicate that overall groundwater quality in the basin is stable with low salinity and nutrient values (well below the Regional Water Board's BPOs), resulting from a combination of factors including the high percentage of mountain front recharge with very low TDS and nitrate concentrations, the low amount of loading from the few sources identified, and the low volume and high quality of recycled water used. Analysis of future water quality (through 2035) also indicates good water quality and stable trends.

In conclusion, no new implementation measures or BMPs as part of the SNMP process are recommended at this time. The SNMP would like to endorse existing measures or practices already in place to manage groundwater supplies and quality in the basin and see that they continue.

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