SANTA ROSA PLAIN WATERSHED GROUNDWATER MANAGEMENT PLAN

Table of Contents

Tables and Figures

Appendices

ABBREVIATIONS AND ACRONYMS

AB	Assembly Bill
AF	Acre-feet
Water Agency	Sonoma County Water Agency
BMO	Basin Management Objective
BMP	Best Management Practice
CCR	California Code of Regulations
Center	Center for Collaborative Policy, California State University, Sacramento
Cotati	City of Cotati
CPUC	California Public Utilities Commission
CUWCC	California Urban Water Conservation Council
DPH	California Department of Public Health
DWR	California Department of Water Resources
DWSAP	Drinking Water Source Assessment and Protection
EIR	Environmental Impact Report
ESA	Endangered Species Act
GAMA	California Groundwater Ambient Monitoring and Assessment
GIS	Geographic information system
gpm	Gallons per minute
GPS	Global positioning system
HET	High-Efficiency Toilet
INFIL	Preliminary Net Infiltration
InSAR	Interferometric Synthetic Aperture Radar
LUST	Leaking Underground Storage Tank
MCL	Maximum Contaminant Level
mg/L	Milligrams per liter
mgd	Million gallons per day
MOU	Memorandum of Understanding
µg/L	Micrograms per liter
µS/cm	microSiemens per centimeter
NAVSTAR	Navigation Signal Timing and Ranging Global Positioning System
NMFS	National Marine Fisheries Services
NHD	National Hydrography Dataset
Panel	Basin Advisory Panel
PBE	Physical Barrier Effectiveness
PBO	Plate Boundary Observatory
PCA	Potential contaminating activities
pH	Measure of hydrogen ion activity

Plan	Santa Rosa Plain Groundwater Management Plan
Plan Area	Area of the Santa Rosa Plain Groundwater Management Plan
PPCP	Pharmaceuticals and personal care products
PRMD	Sonoma County Permit & Resource Management Department
Program	Groundwater management program
PS-INSAR	Permanent Scattering Interferometric Synthetic Aperture Radar
RCD	Southern Sonoma County Resource Conservation District
Rohnert Park	City of Rohnert Park
RWQCB	Regional Water Quality Control Board
Santa Rosa	City of Santa Rosa
SB	Senate Bill
Sebastopol	City of Sebastopol
SIR	Scientific Investigations Report
SOP	Standard Operating Procedure
SRP	Santa Rosa Plain
SRPW	Santa Rosa Plain Watershed
SSURGO	Soil Survey Geographic
Subregional System	Santa Rosa Subregional Water Reuse System
SWRCB	State Water Resources Control Board
TAC	Technical Advisory Committee
TDS	Total dissolved solids
TMDL	Total maximum daily load
TOT	Time-of-travel
ULFT	Ultra-low-flow toilet
UNAVCO	University NAVSTAR Consortium
USGS	United States Geological Survey
UWMP	Urban Water Management Plan
VOC	Volatile organic compound
Water Code	California Water Code
Windsor	Town of Windsor

1.0 INTRODUCTION AND PURPOSE

The Santa Rosa Plain Watershed (also recognized locally as the Laguna de Santa Rosa Watershed) is a distinctive, ecologically and economically important hydrologic area of northern California (Figure 1-1). The watershed encompasses the largest urban area in the north coast region of California, world-class agricultural lands, internationally recognized wetlands, ecosystems, and other natural and recreational resources. Many of its finest attributes and assets are directly related to its water resources, which includes strong reliance on groundwater to meet rural domestic, agricultural and urban demands. Trends in water use, land use, population growth, and climate change indicate that the region's water resources will come under increasing stress in the future, requiring careful and thoughtful monitoring and management.

The Santa Rosa Plain Groundwater Management Plan (Plan) was developed by a broadly based, 28-member *Basin Advisory Panel* through a collaborative and cooperative effort (Section 1.7). The Panel includes diverse stakeholders who live or work in the Santa Rosa Plain Watershed. The Plan is intended to inform and guide local decisions about groundwater management in the Santa Rosa Plain Watershed (Figure 1). Its purpose is to proactively coordinate public and private groundwater management efforts and leverage funding opportunities to maintain a sustainable, locally-managed, high-quality groundwater resource for current and future users, while sustaining natural groundwater and surface water functions.

What Is Groundwater Management?
A groundwater management plan provides the overarching strategy for managing groundwater resources within a groundwater basin. To accomplish this, the plan integrates activities that affect the balance between groundwater inflows and outflows within a basin. Groundwater monitoring and management can prevent or mitigate common problems such as declining or dry wells, salt-water intrusion into fresh water, falling ground surface elevations (land subsidence), reduced water flows in creeks and streams, and a loss of water supply flexibility. In the absence of groundwater management, these problems are more likely to lead to legal conflict or regulatory solutions. An effective groundwater management plan integrates groundwater and surface water protection and management with conservation, reuse and enhanced recharge strategies to increase water supply reliability and sustainability.

1.1 PLAN VISION

The vision of this plan is to preserve high abundance and quality of SRPW groundwater resources for generations to come. This Plan identifies a series of actions our community can collectively implement to protect and enhance the

Figure 1-1 Location of Santa Rosa Plain Watershed and Groundwater Basins and Subbasins.

Figure 1-2 Plan Area and Jurisdictional Boundaries.

reliability of our groundwater resources based on the best science and technology currently available. The Plan recommends adaptive management of the resource, such that the Plan itself will be periodically updated as implementation proceeds and new information is developed regarding resource status and trends and the effectiveness of specific management actions.

1.2 AUTHORITY TO PREPARE AND IMPLEMENT A PLAN

The Plan has been prepared under the authority of the Groundwater Management Act, California Water Code (§ 10750 – 10756) originally enacted as Assembly Bill (AB) 3030 in 1992 to encourage voluntary groundwater management at the local level (Appendix A). The legislation also provides encouragement for local public agencies to work cooperatively towards groundwater management and to adopt formal plans to manage groundwater resources. AB 3030 applies to all groundwater basins identified in California Department of Water Resources (DWR) Bulletin 118-2003, except for those already subject to groundwater management, for example, by a watermaster, pursuant to judgment, decree or adjudication. The 2002 passage of Senate Bill (SB) 1938 mandated that all water agencies adopt or participate in a groundwater management plan to be eligible for state funds for groundwater supply and groundwater quality projects. To continue to be eligible for state funds for groundwater supply and groundwater quality projects, the 2011 passage of Assembly Bill 359 mandated that groundwater management plans include recharge area maps and that these maps be provided to local planning agencies, and that a resolution to prepare a plan be provided to DWR.

To initiate developing the Plan, the Sonoma County Water Agency (Water Agency) Board of Directors held a public hearing and adopted a Resolution of Intention on October 23, 2012 (Appendix B). In accordance with the provisions of Water Code § 10753.4(a), the Plan must be adopted within two years of the Resolution of Intention adoption. If it is not adopted within that time period, a new Resolution of Intention must be adopted before the Plan may be considered.

1.3 LEAD AGENCY

The Sonoma County Water Agency was selected by a Basin Advisory Panel (Panel – Section 1.7.1) as the lead agency for the Plan and is responsible for its implementation. The Water Agency is a special district that provides wholesale water supply within Sonoma and Marin Counties. In the Plan Area, it provides wholesale water to the City of Cotati, City of Rohnert Park, City of Santa Rosa, California American Water Company, and the Town of Windsor.

As described in detail in Section 5.1, the Water Agency will implement the Plan in a partnership with a broadly representative group of Santa Rosa Plain local stakeholders. A Basin Advisory Panel (Panel), consisting of 28 stakeholders (Section 1.7), has been formed to provide input to the Water Agency on development and implementation of the Plan. In addition, a Technical Advisory Committee (TAC) was formed to develop technical content of the Plan for consideration by the Panel. Once the plan is adopted, the TAC will support the Panel and the Water Agency (see Section 5.1). The Plan has been prepared through a cooperative effort between stakeholders of the Santa Rosa Plain, people who live and work there and those who are interested in Santa Rosa Plain groundwater resources.

1.4 PLAN AREA

The area subject to this Plan (Plan Area) is the Santa Rosa Plain Watershed (SRPW) as shown in Figure 1-1, and lies within the North Coast Hydrologic Region. The Plan Area encompasses the entire 262 square mile (167,680 acres) SRPW. The Plan Area includes a surface area of 160 square miles (102,400 acres) of groundwater basins, subbasins or portions thereof, as designated by DWR:

- Santa Rosa Plain groundwater subbasin 1-55.01 (123 square miles – 78,720 acres).
- Southern portion of the Alexander Valley groundwater basin 1-54 (5 square miles – 3,200 acres).
- Rincon Valley groundwater subbasin 1-55.03 located on the eastern side of the City of Santa Rosa (9 square miles – 5,760 acres).
- Northern half of the Kenwood Valley groundwater basin 2-19 located along the eastern boundary of the Plan Area (3 square miles – 1,920 acres).
- Eastern parts of the Wilson Grove Formation Highlands groundwater basin 1-59 located on the western side of the Plan Area (19 square miles – 12,160 acres).
- Eastern portion of the Lower Russian River Valley groundwater basin 1-60 (1 square mile – 640 acres).

The Plan Area also includes 102 square miles (65,280 acres) of upland areas within the SRPW that are outside of DWR-designated groundwater basins. The upland areas in the watershed provide concentrated precipitation for the watershed.

1.5 PURPOSE OF THE PLAN

The Panel's stated goal of the groundwater management program presented in the Plan is:

> *To locally manage and protect groundwater resources by a balanced group of stakeholders through non-regulatory measures to support all beneficial uses, including human, agriculture, and ecosystems, in an environmentally sound, economical, and equitable manner for present and future generations.*

The purpose of the Plan is to serve as the initial framework for integrating and developing the many independent management activities required for meeting this goal. An additional purpose of the Plan is compliance with Water Code § 10750 *et seq.*, which provides additional incentives and opportunities for program implementation, including funding.

The Plan satisfies multiple objectives, including:

- Bringing together SRPW area stakeholders and initiating a forum to collaboratively develop and implement a series of actions that will enhance groundwater resources.
- Summarizing the understanding of the hydrogeology and water balance based on recent studies by the United States Geological Survey (Nishikawa 2013; Woolfenden and Nishikawa 2014).
- Identifying a specific set of programs and projects for near-term and long-term implementation to achieve management goals and objectives.
- Providing the framework for implementing future groundwater management activities.

The Plan consists of the following sections:

<u>Section 1: Introduction and Purpose</u> - This section contains general information about the Plan, the Lead Agency, and the purposes and processes for developing the Plan.

<u>Section 2: Water Resources Setting</u> - This section provides the current understanding of surface water supplies, groundwater supplies, recycled water supplies, water conservation, water facilities, water use and water budget for the Santa Rosa Plain Watershed area.

<u>Section 3: Current Management Efforts</u> - This section presents the water resources and groundwater management efforts currently being implemented in the Plan Area.

<u>Section 4: Groundwater Management Plan Goals and Objectives</u> - This section presents the strategies identified by the Panel for groundwater management with specific goals and objectives. The goal is a broad principle. The Basin Management Objectives (BMOs) are the measurable or verifiable accomplishments that are required to meet the goal.

<u>Section 5: Groundwater Management Plan Components</u> - This section includes details on the specific actions, projects, and programs that will be implemented.

<u>Section 6: Groundwater Management Plan Implementation</u> - This section presents a schedule of actions for implementation and future evaluation of this Plan.

1.6 PLAN COMPONENTS

The Plan includes all of the following Water Code required and recommended components (Table 1-1):

Table 1-1 Location of Santa Rosa Plain Groundwater Management Plan Components by Section.

A. Water Code § 10750 *et seq.*, Mandatory Components	**Plan Section**
1. Documentation of public involvement, hearings and notices	1.7.2, Appendices
2. Basin Management Objectives (BMOs)	4.0, 5.0
3. Monitoring and management of groundwater elevations, groundwater quality, inelastic land surface subsidence, and changes in surface water flows and quality that directly affect groundwater levels or quality or are caused by pumping	5.0
4. Plan to involve other agencies located within groundwater basin	5.1
5. Adoption of monitoring protocols by basin stakeholders	5.2.1.6
6. Map of groundwater basin showing the Agency area subject to the Plan, other local agency boundaries, and groundwater basin boundary as defined in DWR Bulletin 118	1.0, 1.1
7. Map of current recharge areas substantially contributing groundwater replenishment, and submittal of recharge map to local planning agencies	5.3.4, Figure 2-17
8. For agencies not overlying groundwater basins, prepare Plan using appropriate geologic and hydrogeologic principles	2.0
9. Adoption of rules and regulations to implement the Plan	
B. DWR Recommended Components	**Plan Section**
1. Manage with guidance of advisory committee.	1.7.1, 6.2
2. Describe area to be managed under Plan	1.4
3. Create link between BMOs and goals and actions of Plan.	5.0, Table 5-1
4. Describe Plan monitoring program	5.2.1
5. Describe integrated water management planning efforts	5.7
6. Report on implementation of Plan	6.4
7. Evaluate Plan periodically	6.5
C. Water Code § 10750 *et seq.*, Voluntary Components	**Plan Section**
1. Control of saline water intrusion	NA
2. Identification and management of wellhead protection areas and recharge areas	5.3.3, 5.3.6
3. Regulation of the migration of contaminated groundwater	5.3.5
4. Administration of well abandonment and well destruction program	5.3.3
5. Mitigation of conditions of overdraft	5.3.1, 5.4, 5.5, 5.6, 5.7
6. Replenishment of groundwater extracted by water producers	5.5
7. Monitoring of groundwater levels and storage	5.2.1.1
8. Facilitating conjunctive use operations	5.5.2, 5.5.3
9. Identification of well construction policies	5.3.3
10. Construction and operation by local agency of groundwater contamination cleanup, recharge, storage, conservation, water recycling, and extraction projects	5.4, 5.5, 5.6
11. Development of relationships with state and federal regulatory agencies	5.7.3
12. Review of land use plans and coordination with land use planning agencies to assess activities that create reasonable risk of groundwater contamination	5.7.1

1.6.1 Formation of Advisory Group

- Nine mandatory components identified in Water Code § 10750 *et seq.* Plans must include these components to be eligible for funds awarded and administered by DWR for the construction of groundwater projects or groundwater quality projects.
- Seven recommended components identified in DWR Bulletin 118-2003.

The Plan also addresses as appropriate the twelve voluntary components to address technical issues in plans to manage the basin optimally and protect against adverse conditions, as identified in Water Code § 10750 *et seq*. (Appendix A).

1.7 PROCESS TO PREPARE AND ADOPT THIS PLAN

The Plan was developed through a collaborative process, incorporating the ideas and efforts of many groups and individuals. The process was sponsored by the Water Agency and facilitated by the Center for Collaborative Policy and included formation of the Panel. The Plan process received input from local agencies and organizations, consultants, members of the public, and the Panel.

In 2009, local stakeholders were interviewed through an area-wide assessment performed by the Center for Collaborative Policy, California State University, Sacramento (Center) to identify concerns and develop a process for stakeholders to work together. The Center interviewed 55 individuals representing 37 organizations with an interest in groundwater. Stakeholders included representatives from agriculture and ranching, economic interests, residential groundwater users, environmental, local governments/public agencies, and water purveyors. Based on the outcome of the stakeholder assessment, a Steering Committee was formed in 2010 to guide preliminary planning, conduct outreach to solicit input on groundwater management planning, and develop recommendations based on these stakeholder activities on whether groundwater planning should proceed. The Steering Committee met six times in 2010, held three public workshops, and conducted briefings with over 20 organizations. Based on these efforts, the Steering Committee unanimously recommended the development of an AB3030 groundwater management plan.

As part of initiating a groundwater management planning process in the Santa Rosa Plain Watershed area, a Basin Advisory Panel (Panel) was formed and has been meeting since December 2011 to lead development of a groundwater management plan through a collaborative, facilitated process. The Panel includes stakeholders representing broad interests from throughout the Plan Area including (also see Appendix C):

- Agriculture
  - Community Alliance of Family Farmers
  - EJ Gallo, Representing the Sonoma County Winegrape Commission
  - Sonoma County Farm Bureau

  - Western United Dairymen's Association

- Business / Developers
  - Building Industry Association of the Bay Area
  - Construction Coalition
  - North Bay Association of Realtors
  - Sonoma County Alliance

- Environmental
  - O.W.L. Foundation (OWL)
  - Sebastopol Water Information Group (SWIG)
  - Sierra Club
  - Sonoma County Water Coalition (representing OWL, SWIG, and 28 other organizations concerned about water supply and quality)

- General Public
  - Local Well Owner
  - Resident Rohnert Park
  - Resident Santa Rosa
  - Well Owner and Rancher

- Governmental
  - City of Cotati
  - City of Rohnert Park
  - City of Santa Rosa
  - City of Sebastopol
  - Sonoma County Agricultural Preservation & Open Space District
  - Sonoma County Permit and Resource Management Department
  - Town of Windsor

- Groundwater Users, including Rural Residential Well Owners
  - Foothills of Windsor Homeowners Association
  - Sweet Lane Wholesale Nursery

- Natural Resource Management
  - Laguna de Santa Rosa Foundation
  - Sonoma Resource Conservation District

- Tribal
  - Federated Indians of Graton Rancheria

- Water Supply & Groundwater Technical Issues
  - California Groundwater Association
  - Cal American Water Company

- Fircrest Mutual Water Company
- Sonoma County Water Agency

The Panel developed the Plan through monthly meetings and sub-committee discussions of topics including groundwater management goals and objectives, a monitoring framework, and groundwater management implementation actions. The Panel also developed a Charter outlining Panel member roles, responsibilities' and functions, and a Governance Proposal that describes the governance structure for Plan implementation (Appendix C). The Panel formed a TAC to review and present plan elements to the Panel for discussion and approval during the monthly meetings.

During Plan preparation, the stakeholders discussed the uncertainties and data gaps related to the current knowledge of groundwater conditions in the Santa Rosa Plain Watershed area. This plan identifies those uncertainties and prioritizes the efforts that will be required to develop needed information. Stakeholders also recognize that funding sources must be identified for supporting studies and monitoring programs that will enhance the understanding of groundwater conditions in the Santa Rosa Plain Watershed area.

The adoption of the Santa Rosa Groundwater Management Plan (Plan) is categorically exempt from the California Environmental Quality Act (CEQA) under the State CEQA Guidelines Sections 15306, 15307and 15308.

Guideline 15306, Information Collection, provides, generally, that basic data collection, research, and resource evaluation activities which do not result in serious or major disturbance to an environmental resource are categorically exempt from CEQA. The implementation of the Plan would not result in a serious or major disturbance to an environmental resource and are for information gathering purposes which will help meet the Basin Management Objectives of the Plan

Guidelines Sections 15307 and 15308, Actions by Regulatory Agencies for Protection of Natural Resources and the Environment, provide that actions taken by regulatory agencies to assure the maintenance, restoration or enhancement of a natural resource and the environment are categorically exempt. The Plan provides a framework to support coordination of public and private groundwater management efforts and protect groundwater resources and to support all beneficial uses, in an environmentally sound, economical, and equitable manner.

While the adoption of Plan is categorically exempt from CEQA, any specific recommendations included in the Plan that promote the undertaking of future projects such as but not limited to construction activities identified in Section 5, would be subject to future evaluation under CEQA.

1.7.1 Public Involvement, Hearings and Notices

The Plan was completed as an open and public process, including public participation consistent with Water Code § 10753 *et seq.* To ensure ample opportunity for public input on the development of this Plan, the following actions were taken:

Resolution of Intention: In accordance with Water Code § 10753.2, the Water Agency Board of Directors held a public hearing and adopted a Resolution of Intent to prepare a groundwater management plan for the Santa Rosa Plain Watershed on October 23, 2012. Upon adoption, the text of the resolution was published in the local newspaper, The Press Democrat, which is published daily in the City of Santa Rosa in the County of Sonoma, on November 6 and 12, 2012 (Appendix B). The Resolution of Intention and agenda item for the resolution are also included in Appendix B.

Public Outreach and Notifications: During the development of the Plan, the public received information on the Plan progress through:

- Email List - A list of individuals and organizations with interest in the Plan has been maintained, and those individuals and organizations received regular meeting agendas and meeting minutes.
- Web Page - A dedicated section of the Water Agency Website provides a means to disseminate Plan information via the Internet:
  www.scwa.ca.gov/srgroundwater/
- Periodic Briefings – Panel members conducted briefings with constituent organizations and other interested organizations at key milestones throughout plan development.

Public Meetings during Plan Preparation: All Panel and TAC meetings have been open to the public. Draft materials have also been made available to the public and provided opportunities for public comment.

Public Forums during Plan Preparation:
Four evening public forums were held in May 2014 in the Plan Area to orient the public to the plan and offer members of the public an opportunity to ask questions and suggest enhancements:

- May 12 - Sebastopol Community Center
- May 14 – Windsor Library Forum Hall
- May 21 – Rohnert Park City Council Chambers
- May 28 – City of Santa Rosa Utilities Field Office

Notice of the public forums was provided in local newspapers, as well as notices in newsletters, at meetings and via email by a wide range of organizations recruited by Panel members, as well as Panel members organizations and through constituent briefings.

The Sacramento State University Center for Collaborative Policy provided facilitation support services for the public forums, with participation by staff of the Sonoma County Water Agency, and cities of Cotati, Rohnert Park, Santa Rosa, Sebastopol, and Town of Windsor. Many members of the Panel were also in attendance to assist in providing information and answering questions of meeting attendees. A total of approximately 250 members of the public attended the public forums.

The public forums covered the following main topics in a presentation:

- Introduction to the Groundwater Management Plan Process
- Groundwater Basics
- Santa Rosa Plain Groundwater Study
- Santa Rosa Plain Groundwater Management Planning Next Steps

Each public forum ended with a question and answer period followed by discussions at tables where local agency staff and Panel members were available. More information on the public forums is available on the Plan website at: http://www.scwa.ca.gov/srgroundwater/

Resolution Adopting a Groundwater Management Plan for the Santa Rosa Plain Watershed: In accordance with Water Code § 10753.2, the Water Agency Board of Directors held a public hearing and approved a Resolution adopting a groundwater management plan for the Santa Rosa Plain Watershed area on __________. The Resolution adopting the Plan is included in the front pages of the Plan. Prior to and upon adoption, the text of the resolution and notices of the public hearing were published in local newspapers listed below, with copies of the public notices provided in C:

- *To be added at end of Plan preparation: List of newspaper notices with copies provided in Appendix B*

Support for the Final Plan: The Plan has broad support from the stakeholders in the Santa Rosa Plain Watershed area and such support has been expressed with the following:

- Resolution Supporting the Plan - City of Cotati.
- Resolution Supporting the Plan - City of Rohnert Park.
- Resolution Supporting the Plan – City of Sebastopol.
- Resolution Supporting the Plan - City of Santa Rosa.
- Resolution Supporting the Plan – Town of Windsor.
- Letter(s) of Support – Panel member organizations?

Copies of the resolutions and letters of support are provided in Appendix D.

2.0 WATER RESOURCES

2.1 INTRODUCTION

This section provides information on the groundwater, surface water and recycled water resources of the Plan Area, including an overview of the physical setting and background studies, population, climate, land use, water demands and uses. It also summarizes details of the hydrogeology, groundwater supplies and surface water system and facilities. The latter part of the section provides projections of future water supplies and demands, data needs, and key issues in the Plan Area.

2.1.1 Location

The Plan Area is located approximately 50 miles north of San Francisco Bay, California (Figure 1-1). The Plan Area contains the low-lying Santa Rosa Plain groundwater subbasin, and portions of other groundwater subbasins, surrounded by upland areas that drain into the Santa Rosa Plain groundwater subbasin, as described in Section 1. Population centers within the Plan Area are the cities of Santa Rosa, Rohnert Park, Cotati, Sebastopol, and the Town of Windsor.

2.1.2 Population

As of 2010, the population of the Plan Area was approximately 373,000, comprising approximately 249,000 people within five main urban areas and approximately 124,000 in unincorporated (primarily rural) areas (Table 2-1). Historically, the Plan Area and surrounding mountains contained a mostly rural population, and agriculture was the main developed land use. In 1950, the City of Santa Rosa's population was 17,902. At that time, the only other incorporated city was Sebastopol (founded circ. 1902) with a population of 2,601 (Cardwell, 1958). The cities of Rohnert Park and Cotati incorporated in the early 1960s, and the Town of Windsor incorporated in 1992. All these main urban and residential areas, and their populations and economies grew rapidly between 1974 and 1999. The most rapid population growth began in the early 1980's with an expansion of housing developments.

The overall Santa Rosa Plain population, including unincorporated areas, grew by 29 percent between 1990 and 2000 and by just over 5 percent between 2000 and 2010.

Table 2-1 Population for 1990-2010, Cities and Township, Santa Rosa Plain Watershed.

2.1.3 Previous Studies

This section identifies significant regional hydrogeologic studies in the Plan Area. These key studies, and especially the recent USGS SRP study, provide most of the information reported in this Section.

- Cardwell (1958). Geology and ground water in the Santa Rosa and Petaluma areas, Sonoma County, California: U.S. Geological Survey Water Supply Paper 1427, 273 p.

- Ford, R.S., 1975, Evaluation of ground water resources: Sonoma County, volume 1: geologic and hydrologic data: California Department of Water Resources, Bulletin 118-4, 177 p.
- Herbst, C.M., Jacinto, D.M., and McGuire, R.A., 1982, Evaluation of ground water resources, Sonoma County, volume 2: Santa Rosa Plain: California Department of Water Resources, Bulletin 118-4, 107 p.
- Kadir, T.N. and McGuire, R.A., 1987, Santa Rosa Plain ground water model: California Department of Water Resources Central District, 318 p.
- Kulongoski, J.T., Belitz, Kenneth, Landon, M.K., and Farrar, Christopher, 2010, Status and understanding of groundwater quality in the North San Francisco Bay groundwater basins, 2004: California GAMA Priority Basin Project: U.S. Geological Survey Scientific Investigations Report 2010-5089, 88 p.
- Nishikawa, Tracy, ed., (2013), Hydrogeologic and geochemical characterization of the Santa Rosa Plain Watershed, Sonoma County, California: U.S. Geological Survey Scientific Investigations Report 2013-5118, 199 p.
- Woolfenden, L.R., and Nishikawa, Tracy, eds., (2014), Simulation of groundwater and surface-water resources of the Santa Rosa Plain Watershed, Sonoma County, California: U.S. Geological Survey Scientific Investigations Report 2014-5052, 258 p.

2.2 BACKGROUND AND PHYSICAL SETTING

2.2.1 Physical Setting and Description

The SRPW lies within the Coast Ranges geomorphic province (Figure 1-1), consisting of many small mountain ranges and ridges along the Pacific coast line, which trend generally northwest-southeast (Jenkins, 1938; California Geological Survey, 2002). The Northern Coast Ranges extend northward from San Francisco Bay to the California-Oregon border.

The geographic term ‘Santa Rosa Plain’ is used to describe the lowland valley area of about 90 square miles in a northwest trending structural depression between the Mendocino Range to the west and the Sonoma Mountains and Mayacamas Mountains to the east (Figure 1-1). The Santa Rosa Plain in large part coincides with Santa Rosa Plain groundwater subbasin, and lies mostly between altitudes of about 50 and 150 feet above sea level (ft asl). The north-northwest trending axis of the valley extends for about 20 mi, from Meacham Hill on the south to near the Russian River on the north; the valley width ranges mostly from 4 to 7 miles. The valley floor consists of a low uneven topography, developed on alluvial flood plains, terraces, and fans eroded by west-flowing intermittent streams (Sowers and others, 1998). Rincon and Bennett valleys also occur within the Plan Area and occupy an approximately 7-mile long northwest-trending fault-bounded trough, 1 to 2 miles east of, and parallel to, Santa Rosa Plain. The Sonoma Mountains and a narrow Mayacamas Mountains ridge mostly separate the two valleys, connecting to it only through a narrow gap in eastern Santa Rosa (Figure 1-2).

All the highlands within the SRPW have modest relief, with peaks generally lower than 2,500 ft asl, and most ridge lines between 500 and 1,500 ft asl. The Mendocino Range in this area is made up of mostly low, rounded hills that generally range from 200 to 300 ft asl in the SRPW. The Sonoma Mountains rise from near sea level to altitudes of 1,000-2,500 ft asl southeast of Santa Rosa. Along the southeastern study area boundary, the Sonoma Mountains' maximum altitude is 2,452 ft asl. The Mayacamas Mountains are less steep and altitudes mostly vary between 500 and 2,500 ft asl. The maximum altitude within the SRPW is 2,730 ft asl, at the summit of Mt. Hood in the Mayacamas Mountains.

2.2.2 Climate

Regional climate patterns in the Northern California region encompassing the SRPW are characterized by Mediterranean conditions. Distributions of temperature and rainfall display high spatial and temporal variability due to the combination of coastal and inland weather systems. The intersection of these variable weather patterns with the rugged topography of the Coast Ranges results in a broad variety of microclimates. These diverse microclimates create both the natural biodiversity and agricultural diversity that characterize the region.

The Mediterranean climate in the Plan Area also influences water demands, primarily outdoor water use, because the year is divided into wet and dry seasons. Approximately 93 percent of the annual precipitation normally falls during the wet season, October to May, with a large percentage of the rainfall typically occurring during three or four major winter storms. Precipitation is highly affected by atmospheric rivers, which concentrate rainfall and runoff along narrow bands. Nearly 50% of precipitation in the Sonoma County area is due to atmospheric rivers (personal communication, M. Ralph, NOAA). The quantity of rainfall over the watershed increases with elevation, with the greatest precipitation over the highest ridges, reaching more than 50 inches per year in the Mayacamas and Sonoma Mountains (Figure 2-1). The mean annual precipitation for the period from 1906 through 2010 is approximately 30 inches, measured within the lowlands of the study area at the California Data Exchange Center station (Figure 2-2). The mean annual rainfall over the entire 167,400 acre Plan Area is approximately 40 inches (Nishikawa, 2013).

Winters are cool, and below-freezing temperatures seldom occur. A significant part of the region is subject to marine influence and fog intrusion. Summers are warm and the frost-free season is fairly long. Daily minimum and maximum temperatures, averaged monthly, varied from 34ºF to 90ºF for a 12 to 22 year period based on data from several weather stations in the Plan Area and the Russian River watershed (Santa Rosa, Windsor, Petaluma East, Bennett Valley, Hopland, and Sanel Valley). Average annual evapotranspiration (ETo) ranged from 43 to 51 inches for the six weather stations. Prevailing winds are from the west and southwest.

Figure 2-1 Precipitation Map.

Figure 2-2 Total Water Year Precipitation 1906-2010.

Climate Change

The San Francisco Bay Area climates have warmed over the 20th century, as monthly maximum temperatures increased approximately 1°C between 1900 and 2000 (Flint and Flint, 2012). A long-term variability in precipitation is demonstrated by droughts in the 1920s, the 1970s, and the late 1990s. The US Geological Survey conducted a regional study of how climate change affects water resources and habitats in the San Francisco Bay area. The study relied on historical climate data and future climate projections, which were downscaled to fine spatial scales for application to a regional water-balance model (Flint and Flint, 2012). Changes in climate, potential evapotranspiration, recharge, runoff, and climatic water deficit modeled for the San Francisco Bay area included detailed studies in the Russian River Valley.

Results indicated large spatial variability in climate change and the hydrologic response across the region. Although the model results indicate warming under all projections, the potential precipitation changes by the end of the 21st century differed depending on the model details. Hydrologic models predicted reduced amounts of early and late wet season runoff at the end of the century under both wetter and drier future climate projections, suggesting extended dry seasons. Summers are projected to be longer and drier in the future than in the past regardless of precipitation trends. The greater variations in precipitation could directly affect water supplies and result in reduced reliability. The study also found that water demands are likely to steadily increase because of increased evapotranspiration rates and climatic water deficit during the extended summers. The study concluded that extended dry season conditions and greater potential for drought, combined with increases in precipitation, could serve as additional stressors on water quality and habitat. The USGS study is available at: http://pubs.usgs.gov/sir/2012/5132/

2.2.3 Soils

Soil characteristics are one of the primary factors that influence the location and amount of recharge that enters the groundwater system. Maps of soil types, properties, and thickness within the Plan Area are based on the U.S. Department of Agriculture spatial database of soils for the entire United States [US Department of Agriculture (SSURGO)] (2007). The SSURGO database defines 2,165 separate soil map units and their distribution within the SRPW. According to the SSURGO database, the thickness of soils varies within the SRP, with thinner soils in the highlands and thicker soils in the basins and valleys (Figure 2-5). The average soil thickness throughout the SRP lowlands is approximately 5 feet, while average soil thickness in the Mayacamas and Sonoma Mountains is approximately 1.8 feet. The thickest soils, approximately 6 feet and greater, are in the Laguna de Santa Rosa floodplain. Soil is absent at a few isolated locations in the more rugged terrain of the Mayacamas Mountains, which are dominated by rock outcrops.

Figure 2-3 SSURGO Soil Maps for the Plan Area.

The SSURGO database also defines basic soil properties, such as soil texture (the proportion of sand, silt, and clay), porosity, and permeability, which indicate whether water is likely to run off or infiltrate to groundwater. Higher clay content is generally associated with higher potential for runoff, and high sand content associated with a higher potential for infiltration. In general, soil texture is highly variable throughout the SRPW.

The map of soil hydrologic group distribution in the SRPW (Figure 2-3) shows soils with relatively lower runoff potential and higher infiltration potential (types A and B) covering the western uplands, portions of the northeastern uplands, and along many of the major streams, such as Mark West Creek and Santa Rosa Creek. Soils with high to moderately high runoff potential and lower infiltration potential (types C and D) occur in the southern portions of the Santa Rosa Plain groundwater subbasin, along the Laguna de Santa Rosa floodplain, and throughout Sonoma and Mayacamas Mountains upland areas.

2.2.4 Land Use History

Significant anthropogenic land use changes have occurred in the Plan Area since the first non-native settlers in the area began to modify the landscape. Recent studies of historical Laguna de Santa Rosa land uses, and re-routing of water courses (Sloop and others, 2009; Dawson and Sloop, 2010) documented large alterations to surface hydrological patterns of the Laguna's southern headwaters and tributaries over the last 170 years, and are further discussed in Section 2.5.2.2.

Sloop (2009) also identified significant impacts on the SRPW hydrologic system as a result of long-term land use trends. Sloop's key conclusions included four important anthropogenic changes to SRPW hydrologic conditions:

1) In 1837, initiation of intensive ranching with large-scale wetland drainage.
2) In 1853, conversion of land from grazing on native grasslands to wheat farming.
3) Beginning in the 1940's, rapid urbanization starting with subsequent growth of irrigated agricultural.
4) Current trends of urbanizing crop and pasture land, and increased grassland conversion to vineyards.

Converting land covers from native grasslands to agriculture and urban areas has generally caused a loss of "water-interception storage capacity" (the amount of precipitation stored on plant leaves and branches), a decrease in the overall root density, an increase in soil compaction, and a decrease in soil surface roughness (Sloop 2009). The combined effect of these anthropogenic changes is higher runoff compared to unaltered landscapes, with an increase in the total amount of runoff. This tends to increase the "flashiness" of streamflow, characterized by a steepening of the streamflow hydrograph, and decreases the potential for groundwater recharge.

Land use mapping over the past several decades provides a measure of the significant growth and land use changes in the SRP, most notably an increase in urban and residential land use, and also an increase in irrigated agriculture (Table 2-2 and Figures 2-4 and 2-5). Accompanying those increases in land use is a loss in native vegetation in the SRPW.

Table 2-2 Land Use Survey Data Summary 1974-2008.

Figure 2-4 a&b Land Use Maps for 1974, 1979, 1986, 1999, and 2012 - California Department of Water Resources.

Figure 2-5 Agricultural Land Use Map for 2008.

According to a 1999 California Department of Water Resources (DWR, 1999) land use type survey, the dominant land use type in the SRP groundwater basin is native vegetation (93,909 acres), followed by total urban and residential (single and mixed use, 43,615 acres) and agriculture (24,644 acres). Comparison of DWR land use surveys in 1974, 1979, 1986 and 1999, indicates native vegetation loss of 18,728 acres (-17 percent), and a 51 percent increase in total single and mixed use urban and residential (14,713 acres). DWR is in the process of updating the land use type survey and the results should be available in 2014. Additionally, the Sonoma County Vegetation & Lidar Mapping Program is developing high resolution base imagery for the Sonoma County, which is projected to be available in 2015.

A 2008 Sonoma County undifferentiated agricultural land use survey found that total agricultural land use was 24,861 acres in 1974, peaked in the 1980s at 28,080 acres, and fell to 25,782 acres in 2008. This is an increase of 921 acres (+3.7 percent) over the past 34 years. Irrigated agriculture was 7,298 acres in 1974 and 19,040 acres in 1999, an increase of 11,742 acres or +160 percent.

2.3 WATER USE

Communities within the Plan Area rely on a combination of surface water from the Russian River imported from outside the Plan Area and local groundwater from the SRPW to meet water supply demands. Municipal water users within the Plan Area primarily rely on imported surface water from the Russian River that is supplemented with local groundwater. Smaller public supply systems and rural domestic and agricultural water users primarily rely on local groundwater within the Plan Area. Figure 2-6 shows the approximate distribution of domestic, agricultural irrigation and public-supply wells in the Plan Area. The following sections summarize water use characteristics for urban, rural and agricultural users.

Figure 2-6 Location of Water Wells in the Plan Area.

2.3.1 Urban Water Providers and Facilities

2.3.1.1 Sonoma County Water Agency (Water Agency)

The Sonoma County Water Agency (Water Agency) is the primary urban water supplier within the Plan Area. The Water Agency is a Special District providing wholesale water supply to contracting cities and water districts in Sonoma and Marin counties. A special district is a local government entity that focuses on a limited set of activities, with powers and duties defined by its enabling statutes. The 1949 State law creating the Water Agency gives it the authority to: produce and furnish surface water and groundwater for beneficial uses, control floodwater, generate electricity, and provide recreation in connection with its facilities. Legislation enacted in 1994 added the treatment, disposal, and reuse of wastewater to the Water Agency's powers and duties.

The primary source of the Water Agency's water supply is naturally filtered Russian River water conveyed to retail customers via a transmission system (Figure 2-9). The Water Agency supplements Russian River supplies with three groundwater supply wells in the SRPW. Retail customers deliver Water Agency-provided drinking water to more than 600,000 residents in parts of Sonoma and Marin counties.

Figure 2-7 Russian River Watershed and Water Agency Facilities.

The Water Agency provides urban potable water supplies in the Plan Area to the Cities of Cotati, Rohnert Park, Santa Rosa, Town of Windsor, California American Water Company and the Penngrove Water Company (Figure 1-2, and Brown & Caldwell, 2011). Table 2-3 provides a summary of water provided by the Water Agency to these customers between 2003 and 2012. Within the Plan Area, the Water Agency's transmission system provides potable water via the Santa Rosa aqueduct, West Transmission main, Russian River-Cotati intertie, and Kawana Springs pipeline.

Table 2-3 Water Supplied to Contractors in the Plan Area, 2003 - 2012.

Most potable water (generally over 95%) provided by the Water Agency is produced at its Russian River facilities. Groundwater from the SRPW is utilized as a supplemental supply source (see below). As described in the following sections, the Water Agency's customers located within the Plan Area also use local groundwater, recycled water, and other water supplies.

The Russian River watershed drains an area of 1,485 square miles that includes much of Sonoma and Mendocino counties (Figure 2-7). The headwaters of the Russian River are located in central Mendocino County, approximately 15 miles north of Ukiah. The Russian River receives water imported from the Eel River through Pacific Gas and Electric Company's Potter Valley Project. The Russian River is approximately 110 miles in length and flows generally southward to Mirabel Park, where it changes course and flows westward to the discharge point at the Pacific Ocean near Jenner, approximately 20 miles west of Santa Rosa.

Two federal projects impound water in the Russian River watershed:
1) Coyote Valley Dam on the Russian River east of the City of Ukiah in Mendocino County (forming Lake Mendocino).
2) Warm Springs Dam on Dry Creek (a tributary of the Russian River) northwest of the City of Healdsburg in Sonoma County (forming Lake Sonoma).

The Water Agency diverts water from the Russian River near Forestville (outside the Plan Area) and conveys the water via its transmission system (including diversion facilities, treatment facilities, aqueducts, pipelines, water storage tanks, and booster pump stations) to its customers. The Water Agency's diversion facilities extract Russian River underflow, which is reported under the Water Agency's surface water rights.

The Water Agency's three groundwater supply wells are located along the Water Agency's aqueduct in the Santa Rosa Plain at Occidental Road, Sebastopol Road, and Todd Road. The wells were initially constructed in 1977 as emergency supply wells in response to the 1976-1977 drought. Two of the wells (Occidental and Sebastopol) were replaced in 1998. The three wells range in depth from 794 to 1,060 feet. Relatively continuous operations of the Todd, Sebastopol, and Occidental Road water supply wells began in April 1999, June 2001, and July 2003, respectively, and continued through 2008. Beginning in 2009, the use of the wells was shifted to a seasonal and as-needed basis to better balance the conjunctive management of Russian River and groundwater supplies (during years when sufficient supplies are available from the Russian River, use of the groundwater wells are limited). The groundwater quantities pumped by the Water Agency between 2006 and 2010 range from a high of 3,922 acre-feet (af) in 2008 to a low of 52 af in 2010, and averaged 2514 acre-feet per year (afy).

2.3.1.2 City of Cotati

The City of Cotati is located within the southern Plan Area, west of Rohnert Park and north of Petaluma (Figure 1-2). With a 2010 population of 7,265, (Table 2-1), Cotati provides water service to residents, businesses, and other institutions within its service area, of approximately 1.9 square miles.

Cotati relies on a mixture of approximately 72 percent imported Russian River water purchased from the Water Agency and approximately 28 percent local groundwater to meet customer demands. The water supply system consists of two turnouts from the Water Agency, as well as three municipal groundwater wells. The three wells were constructed between 1975 and 1979, and each has undergone recent renovations. The wells range from approximately 500 to 685 feet deep, with pumping capacities ranging between approximately 310 to 670 gallons per minute (gpm). Cotati's annual groundwater production within the Plan area between 2006 and 2010 varied from 80 to 312 afy, and averaged 268 afy.

Cotati plans to continue to rely on the current mix of Water Agency water and local groundwater to meet future demands. Cotati has proposed to install one additional water supply well, based on projected population growth to 2035. Cotati is also working with the Water Agency to further evaluate the potential for a groundwater banking program, using imported Russian River water from the Water Agency's supply (Section 3.1.5).

2.3.1.3 City of Santa Rosa

The City of Santa Rosa is located within the central Plan Area between Rohnert Park and Windsor (Figure 1-2). With a population of 163,436 in 2010 (Table 2-1), Santa Rosa provides water service to residents, businesses, and other institutions within its service area of approximately 41.5 square miles. Santa Rosa's annual water demand was 22,897 af in 2005 and 19,620 af in 2010. Since the early 1960s, the majority of Santa Rosa's water demands have been met through the Water Agency as imported Russian River water, accounting for 100 percent in 2005. In 2010, groundwater accounted for 902 af and recycled water 204 af of the City's supply. Santa Rosa receives Water Agency water through a series of turnouts, check valves, and direct connections serving City pump stations along the Water Agency's Santa Rosa and Sonoma Aqueducts. Santa Rosa's major water distribution facilities consist of 25 treated water reservoirs, 20 water pump stations, and 1 well treatment facility. Santa Rosa also provides recycled water to some Santa Rosa irrigators from the Santa Rosa Subregional Water Reuse System (Subregional System).

Santa Rosa maintains a total of six municipal groundwater wells within its service area. Several of the wells provide only landscape irrigation to City parks and school grounds but others also are standby/emergency wells. The wells range in depth from approximately 160 to 1,200 feet with pumping capacities from approximately 250 to 1,500 gpm. Since 2005, the City has used Farmers Lane Wells No. 1 and 2 to supplement the Water Agency potable water supplies, particularly during high demand, peak summer periods. Between 2006 and 2010, Santa Rosa's annual groundwater production within the Plan Area varied from 0 to 1,052 afy, and averaged 866 afy.

Santa Rosa has prepared a Groundwater Master Plan (West Yost, 2013) that provides information on future plans and groundwater projects. Under an agreement with the Water Agency, water contractors are encouraged to develop and maintain local water production capacity capable of meeting approximately 40 percent of their average day maximum month demand. Santa Rosa is in the process of installing additional water supply wells to meet this emergency demand. Santa Rosa is also considering aquifer storage and recovery to assist in seasonal storage/peak demand offset, to help stabilize water quality, and add to sustainable yield in the basin.

Santa Rosa also is the owner and operator of the Subregional System, which produces recycled water (see Section 2.6). The City has historically used approximately 350 afy of Title 22 treated recycled water for landscape irrigation and has recently expanded the recycled water system within the City limits to provide an additional approximately 60 afy of recycled water for landscape irrigation purposes.

2.3.1.4 City of Sebastopol

The City of Sebastopol (Sebastopol) is a semi-urban community located along the western portions of the Plan Area, approximately 7 miles west of Santa Rosa (Figure 1-2). With a 2010 population of 7,397 (Table 2-1), Sebastopol's water service area is approximately 1.9 square miles, bounded by the Laguna de Santa Rosa to the east and Atascadero Creek on the west. Land use in the service area is predominantly residential, with a number of parks and institutional use for schools. Commercial areas concentrate along the Highway 116 corridor, and in the City's northeast quadrant.

Sebastopol's sole source of drinking water has been groundwater since the late 1920's. Sebastopol owns, operates, and maintains Sebastopol Municipal Water System, including the water distribution system network. Between 2006 and 2011, Sebastopol's annual groundwater production varied from 1,037 to 1,264 afy, and averaged 1,145 afy.

Sebastopol currently maintains a total of five active municipal supply wells that pump groundwater in the Plan Area from 530 to 690 feet below ground surface. Since 2008, only three wells are in active service. The combined capacity of the three wells is 2,200 gpm. Two wells are currently out of service due to contamination, and three older wells have been abandoned due to contamination, casing and/or structural failures and age. Sebastopol intends to continue to rely on groundwater as its primary source of water supply into the future, as the Water Agency does not have capacity to provide imported water, and conveyance cost would be high with about one mile of pipeline required.

2.3.1.5 City of Rohnert Park

The City of Rohnert Park is located between the Cities of Cotati and Santa Rosa in the southern Plan Area (Figure 1-2). The 2010 population of Rohnert Park is 43,398 (Table 2-1), and the water service area is approximately 6.4 square miles.

Rohnert Park primarily uses imported Russian River water purchased from the Water Agency and local groundwater supply. Rohnert Park also uses recycled water delivered to large landscape accounts by the Subregional System.

Rohnert Park's groundwater supply is from 29 active groundwater supply wells located within Rohnert Park's service area. Rohnert Park manages its Water Agency and groundwater supplies in a conjunctive use manner: it relies primarily on Water Agency supplies, when those supplies are unconstrained. During periods when the Water Agency supply is restricted, primarily for legal and institutional reasons, Rohnert Park increases groundwater pumping. Rohnert Park has developed 42 groundwater wells, 29 of which are currently active, and has one standby well that can be used in emergencies. The active wells have individual production capacities of 95 to 450 gpm and a total rated production capacity of 5,735 gpm (8.3 million gallons per day - mgd).

In 2000, Rohnert Park pumping had lowered groundwater levels significantly in the southern Santa Rosa Plain. In 2003, the City began an operational shift toward greater use of Water Agency imported water and reduced groundwater pumping, Rohnert Park also passed a Water Policy Resolution in 2004 specifying that it would not pump more groundwater than 2.3 mgd (total of 2,577 afy) from groundwater. Rohnert Park's annual production of groundwater within the Plan area ranged from 348 to 2,327 afy between 2006 and 2010 and averaged 1,168 afy. Rohnert Park plans to continue this strategy of pumping less groundwater and maximizing use of imported water supplies from the Water Agency, if feasible. Rohnert Park is also working with the Water Agency to further evaluate the potential for a groundwater banking program using imported Russian River water from the Water Agency (Section 3.1.5).

Rohnert Park also delivers recycled water to customers from Title 22 treated wastewater from the Subregional System. Approximately 1,000 acre-feet per year of recycled water are delivered for landscape irrigation.

Rohnert Park's annual water demand was 7,391 af in 2005 and 5,266 af in 2010. From 2005 to 2010, an average of 70 percent of Rohnert Park's total water supply (i.e., Water Agency water, recycled water and groundwater) was purchased from the Water Agency; in 2010 groundwater accounted for 1,582 af and recycled water 710 af.

2.3.1.6 Town of Windsor

The Town of Windsor (Windsor) is located within the northern portions of the Plan Area between Santa Rosa and Healdsburg (Figure 2-2). The 2010 population was 26,158 (Table 2-1). Windsor supplies water to approximately 9,000 service connections, including residential, commercial, construction, and landscape irrigation customers. Windsor also provides wastewater collection and treatment services for the local community. Windsor owns and operates a wastewater treatment plant on Windsor Road that has a capacity of 2.25 million gallons per day, with an average dry weather flow capacity of 1.9 million gallons per day. Windsor's recycled water program provides reclaimed wastewater for: irrigation of Town parks and landscape, non-potable uses at the High School, domestic irrigation of two neighborhoods near the treatment plant, irrigation of the nearby golf course, and various agricultural users.

Windsor has two potable water supply sources: 1) The Town's Russian River Well Field, which diverts Russian River water under the Water Agency's water right, and 2) the Water Agency's water transmission system. Agency water is delivered through a connection to the 36-inch diameter Santa Rosa Aqueduct.

The Town's Russian River Well Field is located along the middle reach of the Russian River west of Windsor, outside of the Plan Area. Well field production is limited by terms of an agreement with the Water Agency that allow Windsor to divert water under the Water Agency's surface water rights permit issued by the State Water Resources Control Board. Pursuant to its contract with the Water Agency, Windsor may divert up to 4,725 afy at a maximum rate of 7.2 MGD over 30 days from the well field under the existing agreement.

Windsor also has five off-river groundwater wells in three locations, Bluebird Court, Keiser Park and Esposti Park, with capacities ranging from 150 to 450 gpm. The wells are not currently used for potable water production. In recent years, the off-river wells have been used primarily for park irrigation. The original Bluebird Well was constructed in 1972 at the end of Bluebird Court in Windsor and had been used intermittently until 2006 when it was taken off-line due to elevated concentrations of arsenic. The Keiser Park well was taken off-line in 2013 when the park irrigation system was converted to use recycled water. The only off-river well currently being used by the Town is the original Esposti Park well, which provides irrigation water to the park. Replacement wells for both Bluebird and Esposti Park were constructed in 2010 but they have not been used for production, have not been permitted for public water supply, and are not connected to the Town's distribution system.

Windsor's total annual potable water production was 4,167 af in 2005 and 3,471 af in 2010. Recycled water use was 942 af in 2005 and 844 af in 2010. From 2005 to 2010, the Town's primary water supply sources came under the Water Agency's Russian River water rights, either as extraction from the Town's Russian River Well Field or by direct purchase through the Water Agency Aqueduct.

The Town intends to construct groundwater supply wells over the next several years and bring the Esposti Park replacement well online to provide additional summer, dry year, and emergency water supply, thereby increasing the supply reliability. The Town has also worked with the Water Agency to further evaluate the potential for a groundwater banking program using imported Russian River water from the Water Agency (Section 3.1.5).

2.3.1.7 California American Water – Larkfield District

California American Water's (CAW) Larkfield District is located within the northern portions of the Plan area between Santa Rosa and Windsor (Figure 1-2) in an unincorporated section of Sonoma County. The Larkfield District serves a population of approximately 7,890 within its approximately 3 square mile service area. As of January 2011, CAW provides water to 2027 residential, 139 multi-family residential, 138 business, and 45 landscape irrigation connections.

CAW's Larkfield District supplies customers with a mix of 60 percent locally produced and treated groundwater and 40 percent imported Russian River water purchased from the Water Agency. The water supply system consists of four groundwater wells that draw water from multiple aquifers located between elevations of about 20 to 400 feet below sea level and one Water Agency turnout in the Town of Fulton. The wells were constructed between 1989 and 2003 and have a sustainable capacity of 0.72 MGD. CAW's annual groundwater production within the Plan area between 2006 and 2010 varied from a low of 502 afy to a high of 749 afy.

2.3.1.8 Small Water Systems

Small water systems supply water to a wide variety of uses such as rural businesses, residences and schools, mobile home parks and small unincorporated communities. Most are owned by mutual companies or other private entities, and a few are operated by special districts. There are approximately 26 mutual water companies providing water through small public water supply systems in the Plan Area to an estimated 2010 population of 3,900. The majority of the mutual water companies rely solely on groundwater to meet demands. A number of other small water supply systems throughout the Plan Area rely on groundwater for supply and include apartments and mobile homes, wineries and vineyards, wine tasting rooms, hotels, restaurants, schools, churches, camps, parks and recreational facilities, warehouses and factories.

2.3.2 Rural Users

Rural groundwater users include agriculture and private domestic wells. Pumping from private domestic and agricultural wells is not reported and therefore must be estimated.

2.3.2.1 Agriculture

Water for agricultural irrigation within the Plan Area is sourced from a combination of local groundwater, recycled water and local surface water. Agricultural crops that are irrigated within the Plan Area include vineyards, pastures, orchards and row crops, which totaled approximately 18,800 acres in 1999. The USGS estimated agricultural pumping for water years 1975-2010 using a calibrated watershed model of the Plan Area, using land use data and monthly crop coefficients, and incorporating changes in crop type over the 35-year interval (Woolfenden and Nishikawa 2014). The estimated daily irrigation demand was used to approximate an average of monthly agricultural pumping for 1,072 agricultural wells over the same time period. Total estimated agricultural water demand varied from 9,200 af in water year 1975 21,400 af in water year 2008, reflecting a change from dominantly dry-farming agriculture in 1974 (17,100 non-irrigated acres to 6,700 irrigated acres) to predominantly irrigated agriculture in 1999 (18,780 acres irrigated to 4,746 acres non-irrigated) (Hevesi and others 2011). For the model simulation time period 1975 to 2010, agricultural groundwater pumping is estimated to represent approximately 32 percent of the total pumping from the SRPW, or an average of approximately 12,500 acre feet per year.

2.3.2.2 Rural Domestic

Rural domestic pumpage was estimated for 1976-2010 by using population density and census tracts for rural areas, and an assumed per capita consumptive use factor of 0.19 AF per person per year (170 gallons per capita per day - GPCD). For the time period of 1976 to 2010 simulated by the model, rural domestic groundwater pumping is estimated domestic water demand varied from 4,000 af in water year 1975 to 22,900 af in water year 2010, and represents approximately 50 percent of the total pumping from the SRPW, or an average of 19,300 af per year.

2.4 GROUNDWATER

As a preface to discussing the characteristics and occurrence of groundwater in the Plan Area, it is first necessary to provide an overview of the underlying geology and hydrogeology, as the geology controls groundwater flow and hydrogeology describes the water-bearing characteristics of the geology.

2.4.1 Regional Geology

The complex geology of the SRPW is due to the multifaceted geologic history of the California Coast Ranges, and particularly to the presence of region-wide fault zones (Figure 2-8). The SRPW is located in the northern Coast Ranges, which are characterized by northwest trending, elongate ridges and valleys, formed from interaction between the North American and Pacific tectonic plates.

Figure 2-8 Geology of the Santa Rosa Plain Watershed.

The Coast Ranges structure is dominated by the San Andreas right-lateral transform fault system, which includes the San Andreas zone of faults to the west, the Rodgers Creek, the Maacama, and the Bennett Valley fault zones -- all right lateral strike slip faults (Figure 2-8). The Rodgers Creek fault zone is approximately 0.6 mile wide and consists of a northern Healdsburg fault segment and a southern Rodgers Creek fault segment, separated by the Santa Rosa Creek floodplain. The Bennett Valley fault zone is a narrow, steeply dipping right lateral fault. On the west side of the SRP, the Sebastopol fault is a curved zone of east-side-down normal faults at the break in slope between the west side hills and valley floor. The Sebastopol fault generally coincides with the lowest SRPW elevations, forming the contact between Quaternary sediments and the underlying Wilson Grove formation. An unnamed fault east of the Sebastopol Fault may be a branch from the Sebastopol, and is important for deep groundwater flow and quality. All of these faults have sufficient offset to juxtapose different geologic units against one other and serve as the main boundaries for the sedimentary basins beneath the SRPW.

Analysis of gravity data reveals two steep-sided sedimentary structural basins beneath the SRP: the Windsor basin beneath the northern portion of the SRP and the Cotati basin beneath the southern part. These two structural basins are separated by northwest to west-northwest trending, northeast dipping Trenton Ridge thrust fault, which forms a bedrock high between the basins possibly as shallow as 1,000 feet bgs.

The SRPW sits on a bedrock basement of deformed and faulted Mesozoic age rocks of the Franciscan Complex, Great Valley Sequence, and Coast Range ophiolite (Table 2-4). Overlying the basement rocks are five geologic units of Cenozoic age that form the SRP's primary aquifers. These are: (1) Quaternary Alluvium, (2) Glen Ellen Formation, (3) Wilson Grove Formation, (4) Petaluma Formation, and (5) Sonoma Volcanics.

Table 2-4 Hydrogeologic Units in the Plan Area.

The Glen Ellen Formation interfingers with uppermost strata of the Wilson Grove and Petaluma formations (gradually transitioning from one type to another). The Wilson Grove and Petaluma formations are generally contemporary deposits, which interfinger with each other, and with the Sonoma Volcanics, forming a complex aquifer system. All SRPW geologic formations outcrop to some degree in the hills flanking the basin. Estimates of their subsurface extent comes from interpretation of geologic cross sections, well log data, and geophysical surveys. Generalized southwest-northeast geologic cross sections are shown in Figure 2-9.

Figure 2-9 Schematic West-East Geologic Cross Sections.

The figures show a thick section of Sonoma Volcanics at the east side of the basin, interfingering westward with Petaluma Formation in the subsurface. The rocks are cut by the Rogers Creek fault and other faults along the eastern edge of the basin. On the west side of the basin, Wilson Grove formation overlies bedrock, but to the east has been lowered by movement along the Sebastopol fault. The Wilson Grove Formation interfingers eastward with Petaluma Formation in the subsurface. In the central portions of the SRPW, the Petaluma Formation is the main unit at depth, overlain by a relatively thin veneer of Glen Ellen Formation and Quaternary alluvium sediments.

2.4.2 Hydrogeology

The Mesozoic age basement which makes up a large portion of the underlying SRP area yields relatively little groundwater (Herbst et al., 1982). However, the thick sedimentary layers and some of the volcanic rocks that overlie this bedrock in the SRPW are capable of storing and yielding large quantities of groundwater. The water-bearing properties of the geologic units vary considerably as a result of changes in rock type within units and interfingering between units. This variability determines how much water can be obtained from wells in different parts of the watershed.

Aquifer properties are estimated through the analysis of well and aquifer pumping tests, which consist of pumping a well at a controlled rate and observing the amount of water level lowering at or near the well. The specific yield of an aquifer generally represents how much water will come out of storage during pumping, reported as a ratio of the volume of water produced to the total volume of the sediments or rocks. The specific yield estimates also provide insight as to which geologic formations are likely to yield higher volumes of water to wells. The following sections provide information on hydraulic properties and characteristics of each of the geologic units that form the primary aquifers in the SRP (summarized in Table 2-4).

2.4.2.1 Quaternary Alluvium

Quaternary Alluvium consists of sedimentary deposits that are widespread throughout the SRPW, generally in close proximity to and comprising minor aquifers of limited extent along modern streams and beneath alluvial fans. These deposits are dominated by alluvial fan sediment deposits, which are materials eroded from rock exposed in the flanking hills. The deposits generally consist of mixed poorly- to well-sorted sand, silt, clay, gravel, cobbles, and boulders, as interfingering, variably thin or thick beds of limited lateral extent (tens to hundreds of feet). Layers in the older alluvium add up to a thickness of about 500 feet and younger alluvium layers are generally less than 150 feet thick. These deposits provide some water to shallow wells and contribute part of the water to deeper wells that also draw from underlying formations. Within the SRP groundwater subbasin, production from wells that only tap water from alluvial deposits produce as little as 1 gpm to as much as 650 gpm. The highest well yields are in the northern SRPW near Mark West Creek. The generally poorly sorted character of the alluvial deposits and large fractions of clay they contain result in a range of specific yields between 8 and 17 percent.

2.4.2.2 Glen Ellen Formation

The Glen Ellen Formation consists of clay-rich stratified stream deposits of poorly sorted sand, silt, and gravel (Table 2-4). Beds of these sediments vary from coarse- to fine-grained, commonly over distances of a few tens to a few hundreds of feet, both laterally and vertically. The relatively high content of clay-sized material, degree of compaction, and cementation tend to limit the permeability of the Glen Ellen. Where sufficiently thick, the Glen Ellen Formation includes some beds of moderately- to well-sorted, coarse-grained materials that have high permeability and yield large amounts of water to wells. Glen Ellen Formation wells typically produce a few tens to hundreds of gpm, but some optimally constructed wells produce greater than 500 gpm. The specific yield range for the Glen Ellen is between 3 and 7 percent.

2.4.2.3 Wilson Grove Formation

The sandstone-dominated Wilson Grove Formation is exposed in the low hills west of SRP groundwater subbasin and is also continuous to the east for some distance, where it interfingers with the Petaluma Formation beneath alluvial fan materials. It generally underlies Glen Ellen Formation in the northern SRPW. The Wilson Grove Formation is relatively thick (300 ft to greater than 1000 ft thick), and mostly composed of weakly cemented marine-deposited sandstone, with volcanic ash intervals. The predominance of relatively clean sand and the low degree of cementation in the Wilson Grove Formation result in moderate to high permeability. Well production in the Wilson Grove Formation is high: from 200 to 1,000 gpm or more. Wells drawing from the upper part of the Wilson Grove Formation have estimated specific yields in the range of 10 to 20 percent, higher than any of the other rocks or sediments in the SRPW.

2.4.2.4 Sonoma Volcanics

Rocks of the Sonoma Volcanics, an important aquifer in the SRP groundwater subbasin and surrounding areas, are predominant only in the eastern SRP groundwater subbasin. These rocks comprise a highly variable assemblage of andesitic and basaltic tuffs with interbedded lava flows and explosive volcaniclastic rocks, having a broad range of water-bearing properties. Many of the volcanic units have limited extent and appear to have erupted from local centers. Estimated specific-yield values for the Sonoma Volcanics vary from 0 to 15 percent. Water production from wells drilled into thick air-fall pumice units may exceed a few hundred gpm, but wells drawing from unfractured lavas or welded tuffs may produce less than 10 gpm and dry holes are encountered occasionally.

2.4.2.5 Petaluma Formation

The Petaluma Formation is dominated by more or less consolidated silt or clay-rich mudstone, with local beds and lenses of poorly-sorted sandstone and minor conglomerate beds. Due to the large amount of silt- and clay-sized particles, the specific yields of wells are low, varying from 3 to 7 percent. Domestic wells drilled into the Petaluma Formation yield on average about 20 gpm and vary from 10 to 50 gpm. However, the Petaluma Formation is at least 3,000 ft thick in places within the study area, and at favorable places can contain enough better-sorted thin sand and gravel beds to make possible well production of hundreds of gpm from deeper wells. For example, in the Rohnert Park area, municipal wells drawing predominantly from the Petaluma Formation have produced as much as 500 gpm.

2.4.2.6 Basement Rocks

Basement rocks that underlie the SRP aquifers are exposed in the hillsides of the SRPW. These units include the Great Valley sequence, Franciscan Complex, and Coast Range Ophiolite. Wells completed in the basement rocks generally produce relatively small amounts of water suitable for domestic supply. The most productive targets for drilling in basement rocks are highly fractured zones in well-cemented Great Valley or Franciscan sedimentary rocks. Many successful domestic wells produce 5 gpm or less from basement rocks in the hills and mountains within the study area. While the basement rocks provide a viable, sole source supply for many households, they are not considered a major water supply source in the SRP groundwater subbasin.

2.4.2.7 Hydrogeologic Subareas

The recent studies conducted by the USGS revealed that the basin is divided by northwest trending faults, some of which serve as groundwater barriers, offsetting the geologic units and forming five hydrogeologic subareas (Figure 2-10 referred to as 'groundwater storage units' in Nishikawa, 2013). These subareas are not hydrologically distinct, as groundwater and surface water flows occur between subareas. However, the subareas exhibit unique hydrogeologic characteristics that allow for subdividing the Plan Area.

Figure 2-10 Hydrogeologic Subareas.

1) **Uplands** – The Uplands hydrogeologic subarea consists dominantly of undifferentiated older basement rocks with overlying to adjacent deposits of the Sonoma Volcanics in the Mayacamas and Sonoma Mountains east of the Rogers Creek fault zone, excluding the Valley Subarea. The basement rocks have low permeabilities except were fractured and weathered, with generally small well yields that are small. The Sonoma Volcanics is a diverse assemblage of volcanic and debris flows, air fall ashes and tuffs and lacustrine deposits which can produce moderate amounts of water to wells, although dry wells are not uncommon as well.
2) **Valley** – The Valley hydrogeologic subarea, which includes the alluvial fill of the Rincon Valley, Bennett Valley and northern half of the Kenwood Valley, is mostly composed of Glen Ellen Formation (including the surficial Quaternary alluvial deposits) and the Sonoma Volcanics. The Glen Ellen Formation consists of diverse mixtures of tuffaceous clay, mud, gravel, and silt deposits with interbedded conglomerates, and is approximately 100-150 feet thick throughout the SRPW.
3) **Windsor** – The Windsor hydrogeologic subarea is located north of the Trenton Ridge Fault, west of the Mayacamas Mountain foothills, and east of the Sebastopol fault. The Windsor subarea consists of 100-150 feet of Glen Ellen Formation underlain by the Petaluma Formation, at depths greater than 2000 feet by the Sonoma Volcanics, and by the Wilson Grove Formation along their western edge. The Pliocene and Miocene age Petaluma Formation is composed primarily of moderately to weakly consolidated silt and clayey mudstone with local beds and lenses of poorly sorted sandstone. The clay-rich Petaluma Formation is generally much finer grained than the overlying Glen Ellen Formation, yields less water to wells, and interfingers with the Sonoma Volcanics to the east and the Wilson Grove Formation to the west.
4) **Cotati** – The Cotati hydrogeologic subarea is located south of the Trenton Ridge fault, west of the Sonoma Mountain foothills, and east of the Sebastopol fault. Very similar in geology to the Windsor, the Cotati subarea consists of 100-150 feet of Glen Ellen Formation underlain by the Petaluma Formation, at depths greater than 2000 feet by the Sonoma Volcanics, and by the Wilson Grove Formation along their western edge.

5) **Wilson Grove** – Located between the Mendocino Range and Sebastopol fault, the Wilson Grove hydrogeologic subarea consists almost completely of the weakly to well consolidated, massive to thick-bedded, fine-to very fine-grained fossiliferous sand and sandstone deposits of the Wilson Grove Formation. In contrast to the Petaluma Formation, the coarser-grained and permeable Wilson Grove Formation yields moderate to abundant water to wells.

The two primary hydrogeologic subareas that are separated by the Trenton fault, Windsor in the north and Cotati in the south, represent the deepest parts of the basin and range from 6,000 to 10,000 feet deep. The study does not conclude whether aquifers at these great depths are productive enough or contain suitably usable water quality.

Cross Section B-B' intersects multiple faults including, from east to west, the Bennett Valley fault zone, the Rodgers Creek fault zone, Trenton Ridge fault, an unnamed fault and the Sebastopol fault. The Bennett Valley fault is a northwest trending right-lateral fault, a characteristic branch of the San Andreas fault zone to the west, which cuts across the Uplands and Valley subareas. The Rodgers Creek fault zone is another right-lateral fault branch of the San Andreas that forms the eastern boundary of the Windsor and Cotati hydrogeologic subareas. The Trenton Ridge fault is a northwest trending thrust fault that dips to the northeast and forms the boundary between the Windsor and Cotati hydrogeologic subareas. An unnamed northwest trending fault appears to truncate the eastern extent of the Wilson Grove Formation. The Sebastopol fault forms the boundary between the Wilson Grove and Cotati hydrogeologic subareas and the western boundary of the Windsor hydrogeologic subarea.

2.4.3 Groundwater Level Movement and Trends

Changing patterns of land use, surface water and groundwater use, as well as climate changes, can cause changes in groundwater levels and movement directions. This section discusses changes in groundwater level and movement over time by comparing past and current groundwater level contour maps and hydrographs.

With a few exceptions, between 1951 and 2007 the pattern of groundwater level movement has remained generally constant, and groundwater levels have been relatively stable. The main exception is a groundwater depression beneath the Rohnert Park-Cotati area, which developed during the 1970s but was significantly reduced after 2005. That groundwater depression accompanied 1980s population growth, which increased local water supply demand with associated increased groundwater pumping, prior to urban water use metering and conservation incentives. As discussed in Section 2.3.2.3, the urban water demand in the area currently is met with a combination of surface water and groundwater supply, and by metering urban water use with incentives to increase conservation and water use efficiency.

Contour maps of groundwater-levels in the SRPW (Figure 2-11) show groundwater flow directions and trends for selected seasons between 1951 through 2007. Figure 2-11shows that the dominant direction of groundwater flow in the spring of 1951 was from the east toward the west side in the northern part of the SRP groundwater subbasin, and from the east towards the Laguna Santa Rosa in the southern portion of the basin. The influence of Mark West and Santa Rosa Creeks also appear as upstream deflections in the contours, indicating the watercourses were being fed from groundwater discharge. Precipitation in 1951 was just above average.

Figure 2-11 Groundwater Level Contours 1951, 1990, & 2007, Plan Area.

Groundwater-level contours for 1990(Figure 2-11) show the two most significant changes in groundwater levels included:

- Continued decline of groundwater levels in the Rohnert Park-Cotati area, yielding a more complex outline for the expanded groundwater pumping depression
- Approximately 20 feet of groundwater level decline west of the City of Santa Rosa area

Groundwater-level contours for 2007 (Figure 2-11) show higher water levels in the Rohnert Park-Cotati area and a reduced pumping depression. These changes coincided with a significant pumping reduction at City of Rohnert Park wells (Figure 2-12), primarily due to increased imports of Russian River water provided by the Water Agency. The reduction of the 1990s groundwater depression suggests that reduced pumping in the Rohnert Park-Cotati area allowed groundwater levels to recover to elevations typical of the early 1970s. This also suggests the aquifer is relatively resilient and has an ability to recover quickly under reduced pumping conditions.

Figure 2-12 Total Annual Pumping, Southern SRP, Surface Water Deliveries, and Groundwater Levels, 1968-2008.

Groundwater level trends are generally evaluated by collecting and graphing long-term groundwater levels in wells. These ‘hydrographs’ are individual well plots of groundwater level elevation versus time. They typically have undulating shapes, which exhibit seasonal groundwater level fluctuations as demand and pumping changes over the wet and dry seasons. It is also typical to see long-term trends that correlate with land use and demand changes, and with varying hydrologic cycles of wet years and dry years (droughts). Figure 2-13 provides a number of well hydrographs across the SRPW.

Figure 2-13 Well Hydrographs - (A) Cotati, (B) Sebastopol, (C) Santa Rosa-Bennett Valley-Rincon Valley, and (D) Windsor Basin.

Many hydrographs of Cotati basin wells (6N/8W-23H1, -25C1, -26A1, -15J3, -26L1, -27H1 – Figure 2-13A) show seasonal fluctuations and a decline in groundwater levels for the late 1970's and 1980's. The declines reached a maximum in the early 1990's, followed by recovery in the early 2000's. These declines may be due to increasing groundwater demands, coupled with droughts in 1976-77 and 1987-92. The recovered groundwater levels coincided with reduced pumping and increased deliveries of Russian River supplies from the Water Agency to the City of Rohnert Park. Current data show relatively stable groundwater levels.

2.4.4 Faults and Groundwater Movement

Faults, several of which serve as SRPW boundaries played a significant role in the development of inland California Coast Range valleys, including the SRPW, and are probably responsible for the greater depth of some sediment filled basins within them. Faults also can affect water flow and well production, because groundwater movement may be inhibited or preferentially increased across or within faults and fault zones.

Faulting can break even very strong rocks, producing fracture zones that tend to increase permeability, and may provide preferential paths for groundwater flow. Conversely, some faults can form groundwater barriers, if the faulting grinds the broken rock into fine-grained fault gouge with low permeability, or where chemical weathering and cementation over time have reduced permeability. The hydraulic characteristics of materials in a fault zone, and the width of the zone, can vary considerably so that a fault may be a barrier along part of its length but elsewhere allow or even enhance groundwater flow across it. Faults also may displace rocks or sediments so that geologic units with very different hydraulic properties are moved next to each other.

The alignments of thermal springs and wells (affected by waning volcanic heat sources), along and near SRPW valley-bounding faults, indicate that some SRPW faults enable deep waters to move upward to the surface or into shallow formations. West of the Rogers Creek Fault (Figure 2-8), and directly downgradient (in the groundwater flow direction), groundwater compositions change from characteristics typical of recent rainfall replenishment to those of hydrothermal or connate water (water included during accumulation of the rock or sediment materials). These changes suggest that the fault orientation and activity may be directing groundwater downward and causing deep mixing of older and more recently replenished waters. The Sebastopol Fault may be acting as a barrier to shallow flow, but does not appear to impede flow at greater depths.

2.4.5 Groundwater-Surface Water Interaction

The relationship between surface water and groundwater depends upon the amount of water available in the surface water body or stream and in the subsurface, as well as the subsurface geology and streambed conductivity (measure of the ability of the streambed to transmit water into the underlying subsurface). Under natural conditions, some streams gain water from the subsurface and other streams lose water to the subsurface. Streams can shift between gaining and losing streams along their courses when the hydrology, underlying geology, local climate or storm flow conditions occur. Surface water-groundwater interactions are important to understand for hydrologic balance, water quality and ecosystem health.

Streambed conductivity was estimated in the groundwater model (Section 2.8) and is displayed in Figure 2-14. The highest values are predominantly in streams in the uplands, in Mark West Creek and Santa Rosa Creek, in a segment of the Laguna De Santa Rosa, and in some of the smaller creeks at the eastern margins of the SRP. The lowest streambed conductivity values are generally in the Windsor, Santa Rosa, and Cotati areas. The areas of higher streambed conductivity have the highest potential for groundwater-surface water interaction.

Figure 2-14 Streambed Conductivity (feet per day).

In the Plan Area, the Santa Rosa Creek is largely a gaining stream just east of the Rodgers Creek fault zone, and becomes a losing stream just west of the Rodgers Creek fault zone, and then several miles to the west once again becomes a gaining stream.

2.4.6 Groundwater Recharge and Discharge

Sources of groundwater recharge within the Plan Area are infiltrated rainfall, streams, septic-tank effluent, and irrigation return flow. Groundwater discharge appears as stream baseflow (gaining streams) and as the source of Laguna de Santa Rosa wetlands, discharge from springs, evapotranspiration (ET) from phreatophytes, and groundwater pumpage. Groundwater inflow and outflow can also occur as subsurface underflow across SRPW boundaries, with flows crossing either into or coming from adjacent groundwater basins. The amount of groundwater recharge and discharge in the Plan Area is estimated a number of ways through direct measurement, approximation incorporating some literature-based variables, and with the use of the groundwater model.

The principal sources of recharge to groundwater systems within the Plan Area are direct infiltration of precipitation and infiltration from streams. Minor sources of recharge include infiltration from septic tanks, leaking water-supply pipes, leaking storm drain pipes, irrigation water in excess of crop requirements, and crop frost-protection applications. Previous estimates of the average annual recharge for the SRP groundwater sub-basin (representing approximately half the Plan Area) between 1960 and 1975 equaled 29,300 acre-feet. Those estimates included infiltration of precipitation and streamflow. An integrated hydrologic model of the study area estimated average annual precipitation falling on the Plan Area between 1976 and 2010 at 531,000 afy (Woolfenden and Nishikawa, 2014). This value is not equal to groundwater recharge, because it does not include losses such as ET and runoff. More recent recharge estimates using the fully-coupled USGS surface water-groundwater flow model (Section 2.8) indicate a 1976-2010 average annual recharge of approximately 80,600 afy, with recharge through streambeds comprising 32,400 afy, recharge through surface percolation comprising 41,000 afy, and inflow from adjacent groundwater basins 7,200 afy.

Recent natural recharge potential mapping of the SRPW was conducted that incorporates soil permeability, slope, and shallow geologic unit permeability (0 to 50 feet below ground surface (ft bgs)) (Winzler & Kelly GHD, 2012). The weighting of each parameter – slope (20%), soil (30%), and geology (50%) is generally based on other similar studies and guidance (Sesser et al., 2011; DWR, 1982; and Muir and Johnson, 1979) and sensitivity analysis. The natural recharge potential map (Figure 2-15) ranks the very high to very low relative potential for natural groundwater recharge from rainfall infiltration.

Figure 2-15 Natural Relative Recharge Potential Map, Plan Area.

Potential sources of groundwater recharge from adjacent basins include underflow from the adjacent Petaluma, Russian River, and Wilson Grove Formation Highlands groundwater basins. Total estimated average annual groundwater underflow into the SRP watershed has been estimated at approximately 7,200 afy using the integrated hydrologic model of the study area (Woolfenden and Nishikawa, 2014).

Groundwater discharge occurs as natural baseflow in streams; discharge from springs; evapotranspiration (ET), and as underflow that leaves the groundwater basin. Groundwater pumping is another form of groundwater discharge.

Natural groundwater discharges occur where the potentiometric head (highest groundwater level) is higher than the land surface, such as at springs or in the Laguna de Santa Rosa. The groundwater-level contour map for 1951 (Figure 2-11) shows that groundwater moved toward, and discharged into, the stream channels, likely sustaining baseflow. On a larger scale, groundwater also moved away from the margins of the valley toward the Laguna de Santa Rosa, which is the main location of natural SRP groundwater discharge.

Based on USGS topographic maps and CDWR records, there are 28 mapped springs and seeps in the SRPW. On the west side of the SRPW groundwater discharges from the Wilson Grove Formation through springs and seeps, and on the east side discharge is from the Sonoma Volcanics and Glen Ellen formation.

Groundwater evapotranspiration (plant groundwater uptake) is estimated at 7,200 afy by the groundwater model (Section 2.8). Groundwater discharge in excess of that used by plants in the Laguna de Santa Rosa is lost to the atmosphere by evaporation or discharge to the lower reach of Mark West Creek, which flows out of the study area.

Groundwater pumping is the most significant basin discharge from the study area with the largest significant proportions being domestic and agricultural pumpage, followed by public supply pumpage. The majority of pumping is not measured or reported and was estimated by the USGS using land use data and the groundwater flow model. Pumping from municipal public supply wells is the only component that is required to be measured and reported; it comprises up to approximately 16% of the total pumping. An estimate of agricultural irrigation pumpage was reconstructed from areas of irrigated crop types identified in California Department of Water Resources land use surveys for 1974, 1979, 1986 and 1999. Watershed component simulations were used in conjunction with a daily crop-water demand model to estimate pumpage. Because agricultural well information is incomplete and locations not precise, amount and location of irrigation was estimated in the model. For domestic pumpage, it was assumed that population identified outside the urban areas were supplied by domestic supply wells and the census data for 1970, 1980, 1990, 2000, and 2010 were used to approximate per capita water demand assumed to equal 0.19 af per capita. Census tracts were multiplied by the population density of each census tract to estimate the total census tract population. Because domestic well information is also incomplete and locations not precise, amount and location of domestic pumpage was also estimated in the model.

Figure 2-16 summarizes the total estimated average annual groundwater pumping between 1976 and 2010, based on the groundwater flow model. The 1976-2010 average annual total pumping was approximately 35,600 afy, with an overall increasing trend over time as indicated by the 2004-2010 average annual estimate of 42,000 afy. The largest demand on groundwater estimated by the model is for rural domestic and agricultural pumping estimated at 82 percent on average (50 percent domestic and 32 percent agricultural). See Appendix E for information on how the pumping estimates were derived.

Figure 2-16 Total Estimated Average Annual Pumping in the Plan Area.

2.4.7 Land Subsidence

Land subsidence is the lowering of the land surface due to changes that occur underground. Common causes of land subsidence from human activities include pumping of groundwater, oil, and (or) gas from subsurface reservoirs; dissolution of limestone, causing sinkholes; collapse of underground mines; drainage of organic soils; and hydro-compaction. Aquifer overdrafting is a major cause of land subsidence in many parts of the southwestern United States.

Land subsidence can also be caused by tectonic forces related to movement of the Earth's tectonic plates, which may include movements along fault planes. Existing data related to the potential for land subsidence in the Santa Rosa Plain is limited to Global position system (GPS) data collected as part of a plate boundary study and a focused study of the Rodgers Creek fault zone.

GPS data is being collected as part of a Plate Boundary Observatory (PBO) network to monitor tectonic Earth movements in North America. The project is led and managed by University NAVSTAR (Navigation Signal Timing and Ranging Global Positioning System) Consortium (UNAVCO), a university-governed consortium. PBO's network of 1100 permanent continually-operating GPS stations spans the Pacific/North-American plate boundary in the western United States and Alaska, with additional stations on the stable continental interior. Three PBO GPS stations are located within the SRP watershed (Figure 2-17). These three stations (P196, P197 and P201) have been actively monitored since 2005, 2006 and 2008, and results are shown in Figures 2-17. Station P196 located in the hills southwest of Cotati indicates a gradual and continuous lowering of the land surface of about 5 millimeters (1/5 of an inch) over the past 6 years; in contrast neither P197 nor P201 illustrate trends of changes in land surface. Whether the land surface changes observed southwest of Cotati are related to tectonic movements, groundwater extraction or other factors has not been examined.

Figure 2-17 Santa Rosa Plain Watershed Ground Surface Monitoring Stations.

Data collected as a part of a study of the Rodgers Creek fault for evidence of creep revealed evidence of potential land subsidence in the SRP (Funning et. al., 2007). The study used Permanent Scattering Interferometric Synthetic Aperture Radar (PS-InSAR) technique from satellite data from 1992-2001 to analyze the area for land surface deformation related to fault movements (Figure 2-18). PS-InSAR is an advanced processing technique for satellite radar data, which uses the radar returns from stable targets on the ground to generate a series of surface displacement changes over time, with atmospheric effects mitigated.

Figure 2-18 INSAR Output for Santa Rosa Plain, 1992-2001.

While not specifically designed to investigate potential land subsidence due to groundwater pumping, the fault study identified areas where ground levels declined at a rate of about 6 mm (0.2 inches) per year in areas (Figure 2-18) that coincide with the groundwater depressions seen in Figure 2-11. The decade-long study (1992-2001) included a time of relatively increased groundwater pumping in the City of Rohnert Park, before most water usage was metered.

Beginning in 2002 the City of Rohnert Park curbed groundwater pumping and began metering urban water use. It now primarily relies on surface water supplies from the Russian River. Shallow and intermediate depth groundwater levels in the Rohnert Park-Cotati area have recovered significantly, which reduces the potential for future subsidence related to groundwater extraction in that area.

2.4.8 Groundwater Quality

Groundwater quality in the SRPW was characterized by the USGS using analyses for selected wells from previous investigations, from databases maintained by the California Department of Public Health, California Department of Water Resources, and public supply purveyors from 1974-2010. Additionally, groundwater sample data collected by the USGS in 2004 (under the State Water Resources Control Board

GAMA program) and 2006-2010 was evaluated. Construction information for wells sampled is provided in Appendix E. Groundwater sample locations are provided in Figure 2-19.

Figure 2-19 Location of Water Quality Sampling Wells.

Groundwater quality information from the USGS study is used to: (1) identify some of the primary constituents of potential concern present in groundwater in the SRPW; (2) describe the general groundwater chemistry characteristics for each of the five defined hydrogeologic subareas; and (3) provide insights into how groundwater enters, moves through, and leaves the hydrogeologic system.

2.4.8.1 Water Quality Constituents of Potential Concern

Groundwater quality is highly variable throughout the study area and is generally acceptable for beneficial uses, although constituents of potential concern pose challenges on a localized basis within the study area. Specific conductance, chloride, total dissolved solids, nitrate, arsenic, boron, iron, and manganese are considered water quality constituents of potential concern in the SRPW because some samples from wells exceeded state or federal recommended or mandatory regulatory standards for drinking water. Much of the data summarized below is from public drinking water systems that provide treatment to remove these and other constituents of potential concern to levels below applicable regulatory standards. The concentrations presented for these wells are prior to such treatment, so as to allow for a characterization of native (or ambient) groundwater quality conditions. All these constituents of potential concern occur naturally in groundwater, although nitrate also tends to be strongly associated with land use practices. Other anthropogenic constituents associated with land use practices, such as releases of fuel hydrocarbons and solvents, also occur in localized areas.

Since much of the data comes from public supply wells that typically are completed in deeper aquifer zones, the data largely represents deeper aquifer zones. Therefore, the data may not adequately represent the water quality of the more shallow aquifers being accessed by most domestic wells.

Iron and manganese in groundwater comes from natural weathering of many common rocks. The concentrations of iron and manganese are sensitive to redox (presence or absence of oxygen) and pH conditions. High iron content can give a red tint to water and high manganese content can form a characteristic black-colored deposit that gives water an unpleasant taste and appearance at high pH in the presence of oxygen and carbonate or silicate. About 43 percent of the samples analyzed for iron had concentrations greater than or equal to the secondary maximum contaminant level (SMCL) of 300 ug/L, and about 73 percent of the samples analyzed for manganese equaled or exceeded the SMCL of 50 ug/L.

Arsenic is semimetallic element that is tasteless, odorless and its presence in groundwater is most commonly associated with sulfide and ferromanganese minerals, particularly in geothermal and highly evaporated water. Manmade sources of arsenic wood preservatives, pesticides and in the semiconductor industry. Approximately 12 percent of the samples analyzed for arsenic had concentrations greater than or equal to the MCL of 10 ug/L; about 30 percent of the samples collected from wells in the Windsor and Cotati hydrogeologic subareas exceeded the arsenic MCL.

Boron is naturally occurring in many minerals and rocks, including tourmaline, igneous rocks and evaporate minerals such as borax, and is also commonly associated with geothermal water and thermal springs. Boron can also occur in wastewater with cleaning agents containing boron. Boron concentrations were exceeded or equaled regulatory standards in 7 percent of the samples analyzed.

Nitrate, specific conductance, and chloride values were greater than or equal to regulatory standards in only about 2 percent of the samples analyzed. Nitrate (NO_3) is both derived from manmade and natural sources, and is one of the most frequently identified constituents of concern in groundwater. Natural sources of nitrate include the atmosphere and decomposition of organic material, and manmade sources include fertilizers, septic tank effluent, leaking sewers, and atmospheric deposition of nitrogen emissions. Only 2 of the 92 groundwater samples analyzed for nitrate as nitrogen exceeded or equaled the nitrate MCL of 10mg/L. On the basis of nitrate concentration in the Upland subarea, nitrate concentrations greater than 1 mg/L in the Windsor and Cotati hydrogeologic subareas are considered anthropogenic. The median concentration of nitrate in shallow Windsor and Cotati subarea wells was 0.9 and 4.4 mg/L, respectively and in deeper wells the median concentrations were 0.2 and 1.0 mg/L respectively.

While concentrations of chloride and specific conductance are predominantly well below secondary drinking water standards, concentrations of these two constituents appear to be increasing with time in the SRPW (Figure 2-20). The specific conductance or conductivity of an electrolyte solution is a measure of its ability to conduct electricity, and as the ion concentration increases so does the specific conductance. The unit of measure for specific conductance is micro-siemens per centimeter (uS/cm), and the measure of specific conductance can be used to help estimate the total dissolved solids content. Specific conductance has a maximum recommended secondary MCL of 900 uS/cm. Nearly three-quarters of the 33 wells with water quality records spanning 20 years or more had increased specific conductance over time, and about half of those wells also showed increases of more than 10 percent since first being sampled.

Figure 2-20 Specific Conductance and Chloride Trend Lines.

Chloride occurs naturally in groundwater from the weathering and dissolution of sedimentary rocks and evaporites (salt deposits), and in fossil saline groundwater buried in marine sediments. Seawater intrusion is another very common source of chloride in groundwater basins that are connected to seawater bodies. Anthropogenic sources of chloride commonly include manufacturing, power generation, landfill leachate, and wastewater. Chloride concentrations increased similarly in about two-thirds of the wells, and just more than half increased by more than 10 percent. Not all wells had increases: a more than 10 percent decrease in concentration was measured in 15 percent of the wells for specific conductance and 30 percent for chloride.

The greatest increases in concentrations of specific conductance, chloride or both were in wells located in the vicinity of the cities of Rohnert Park and Cotati (Figure 2-20B). Possible causes of the increased specific conductance and chloride include groundwater underflow of high dissolved solids concentration groundwater present along the Rodgers Creek fault zone, historic irrigation return flow, septic tank effluent or leaky sewer pipes. Depth-dependent hydrologic, chemical and isotopic data are needed to better understand the cause of the increased specific conductance and chloride concentrations.

The SRPW contains a number of currently -regulated contaminant release sites (Figure 2-21), many of which are under active cleanup order by the State Water Resources and Regional Water Quality Control Boards. These include leaking underground tanks from gasoline and solvent storage, land disposal and military facilities. These releases, include petroleum and chlorinated solvent contaminants and metals are generally are of limited areal extent, although impacts to water-supply wells from a number of sites have occurred within the study area. The SWRCB GAMA Priority Basin Project study of the North San Francisco Bay Groundwater Basins evaluated inorganic and organic constituents in groundwater. Some of the 89 public‑supply wells sampled had low-level detections of volatile organic compounds (VOCs) and pesticides, but all detections were significantly below the contaminant's respective MCLs (Kulongoski, 2010).

Figure 2-21 Contaminant Release Sites in the Plan Area.

2.4.8.2 Groundwater Quality Classification by Subarea

Groundwater characteristics in the five hydrogeologic subareas in the SRPW have been classified on the basis of groundwater quality data analyses. As groundwater flows through the subsurface, it assumes a characteristic chemical composition as a result of interaction with the aquifer matrix (solid) materials and length of time in the subsurface. Typically, the longer the groundwater flows along a pathway following the hydraulic gradient (groundwater flowpath) in contact with and flowing through the aquifer matric materials, the higher the dissolved solids concentrations and major constituent concentrations. This basic phenomenon helps explain why it is common to find higher dissolved solids concentrations in groundwater with depth. The term groundwater classification is used to describe the bodies of groundwater, or in this case to help define hydrogeologic subareas, that differ in their major chemical composition on the basis of major constituent concentrations.

Diagrams depicting the relative proportion for groundwater quality constituents are provided in Nishikawa 2013. The following summarizes the general groundwater classification of the five hydrogeologic subareas:

1. Uplands
   - Mixed cation-bicarbonate and calcium/magnesium bicarbonate type
   - Mean dissolved solids concentration of 330 mg/L
2. Valley
   - Dominantly contains mixed cation-bicarbonate type groundwater with relatively higher sodium
   - Median dissolved solids concentration of 392 mg/L
3. Windsor
   - Dominantly a mixed cation-bicarbonate and sodium-bicarbonate type groundwater
   - Median dissolved solids concentration of 321 mg/L
4. Cotati
   - Mixed cation-bicarbonate and sodium-bicarbonate type groundwater
   - Median dissolved solids concentration of 362 mg/L
5. Wilson Grove hydrogeologic
   - Calcium-bicarbonate and mixed cation-bicarbonate type groundwater
   - Dissolved solids concentrations less than 300 mg/L

2.4.8.3 Groundwater Movement Inferred from Water Quality Data

A groundwater flowpath is the route that water molecules follow from a point of infiltration into the ground, through the subsurface into an aquifer and ultimately either remaining in long-term storage or discharging to the surface at a stream, spring, wetland or well. In addition to the general groundwater type classifications described in the preceding section, other water quality constituents can be used as tracers to infer groundwater flowpaths, as well as recharge and discharge characteristics. Some of the more robust and sophisticated tracers are those that provide information on the approximate age of groundwater, including stable environmental isotopes and tritium. The USGS evaluated the general water quality constituents in conjunction with stable isotope and tritium data from groundwater samples to develop the following general summary of groundwater movement within the Plan Area.

As discussed in previous sections, groundwater flows generally from the east to west from the Uplands and Valley subareas into the Windsor and Cotati subareas, discharging into springs, streams and wells and finally into the Laguna de Santa Rosa (Figure 2-22). The Rodgers Creek fault zone, comprising the boundary between the Cotati-Windsor subareas and the Upland-Valley subareas, and an unnamed fault east of the Sebastopol fault in the Cotati subarea, appear to form at least partial if not whole barriers to flow. These faults also have the potential to impart higher dissolved solids and boron to groundwater through deep circulation. It also appears that deep groundwater flows east to west across the Cotati and perhaps Windsor subareas. The Wilson Grove subarea has relatively low dissolved solids and appears fairly separated from the other hydrogeologic units and groundwater flows west to east towards the Laguna de Santa Rosa.

Figure 2-22 Hydrogeologic Conceptual Model of the Plan Area.

2.5 SURFACE WATER

This section provides a regional description of the primary surface water features within the Plan area.

2.5.1 Surface Water System and Water Bodies

As noted in previous sections, the Plan Area is mostly within the middle Russian River drainage basin and includes three main drainage subbasins based on the National Hydrography Dataset (NHD), that collectively cover an area of 251 square miles. These three main drainage subbasin areas are named for the main streams in each area: Mark West Creek, Santa Rosa Creek, and Laguna de Santa Rosa. The drainage subbasins are shown on Figure 2-23, along with other major and minor tributary streams (Simley and Carswell, 2009). The Plan Area also contains numerous natural and man-made surface water bodies, including small lakes, ponds and wetland areas. The following sections describe these drainage subbasins, as well as other significant surface water features within the Plan Area.

Figure 2-23 Subwatersheds, Major Streams, and Stream Gages in the Plan Area.

2.5.1.1 Mark West Creek

The Mark West Creek drainage subbasin covers 86 square miles in the northern Plan Area. Mark West Creek (Figure 2-23), has a 29.9 mile-long channel originating at an altitude of 1,922 feet in the Mayacamas Mountains, close to the northeasternmost Plan Area.

The main channel of Mark West Creek is perennial throughout much of its length (Simsley and Carswell, 2009), having summer flows maintained by numerous springs near the headwaters. Most of the main channel is in its natural state and much of the riparian vegetation adjacent to the Mark West Creek channel, as well as the creek bed, is undeveloped and characteristic of natural channel conditions. Some tributaries of Mark West Creek are perennial, but most are either ephemeral or intermittent and become dry during late spring to early fall.

2.5.1.2 Santa Rosa Creek

The Santa Rosa Creek Basin is a 77 square mile drainage area in the central and eastern Plan Area (Figure 2-23). Santa Rosa Creek, the main stream in the Santa Rosa Creek Basin, is a 22 mile-long channel flowing in a westerly direction from drainage divides in the Mayacamas and Sonoma Mountains, to its confluence with the Laguna de Santa Rosa drainage channel. The source of Santa Rosa Creek at an altitude of 1,940 ft asl, is close to the 2,730 feet summit of Hood Mountain, the highest point in the Plan Area.

Santa Rosa Creek originates in steep terrain of the Mayacamas Mountains, an area of mostly natural vegetative cover. The middle Santa Rosa Creek drainage crosses the City of Santa Rosa, and adjacent agricultural lands, whereas the lower Santa Rosa Creek drainage traverses mainly agricultural land. Through the urbanized City landscape, Santa Rosa Creek flows in an engineered channel with concrete or earthen embankments. The upper Santa Rosa Creek and its tributary, Matanzas Creek, are perennial steams that carry diminished flows in late summer and fall. Other Santa Rosa Creek tributaries generally have engineered channels and flows are intermittent (Simley and Carswell, 2009).

2.5.1.3 Laguna de Santa Rosa, Peripheral Streams and Drainages

The Laguna de Santa Rosa Basin is an 88 square mile area drained by the Laguna de Santa Rosa channel, upstream of the Santa Rosa Creek tributary, (Figure 2-24). The "Laguna de Santa Rosa" also refers to the general area of wetlands, ponds, and vernal pools within the area of the 100-year floodplain surrounding the main Laguna de Santa Rosa channel (Figure 2-23). The Laguna de Santa Rosa channel and floodplain together form a natural overflow basin connecting Santa Rosa Creek, Mark West Creek, and the smaller creeks in the Plan Area with the Russian River. The overflow basin, approximately defined by the 100-year floodplain, has the distinction of being the second largest freshwater wetland area in the coastal northern California region, and is valued as an important ecological resource. The Laguna de Santa Rosa channel drains the southern and southwestern areas of the Plan Area.

The Laguna de Santa Rosa channel originates at an altitude of 260 ft asl, west of Cotati and close to the southern boundary of the Plan area (Figure 2-23). Much of the Laguna de Santa Rosa upstream of the Mark West Creek juncture is below an altitude of 50 ft asl. Santa Rosa Creek, which is not included in the Laguna de Santa Rosa drainage subbasin, is the largest tributary to the Laguna de Santa Rosa. Other important Laguna de Santa Rosa tributaries include Copeland Creek, Crane Creek, Hinebaugh Creek, Five Creek, Colgan Creek, Gossage Creek, Washoe Creek, and Roseland Creek (Figure 2-23). Copeland Creek and Crane Creek have short perennial reaches (Simley and Carswell, 2009) draining the Sonoma Mountains in the southeastern part of the Plan Area. Copeland Creek is perennial in its upper sections, becomes intermittent as it flows westward across the alluvial fan east of

Rohnert Park, and is mostly channelized as it continues flowing westward through the Rohnert Park and Cotati before joining the Laguna de Santa Rosa at an altitude of 92 feet.

The main channel of the Laguna de Santa Rosa originates west of Cotati, in close proximity to the southern boundary of the Plan Area. The Laguna de Santa Rosa and its tributaries drain the Sonoma Mountains to the east and the southern part of the Plan Area. Downstream of tributary junctions, the Laguna de Santa Rosa is a very low gradient drainage network defined by straight and engineered channels, canals, and drainage ditches through urbanized and agriculturally developed lands. The Laguna de Santa Rosa main channel is perennial, although summer flows can be quite small. Tributaries of the Laguna de Santa Rosa are primarily ephemeral.

2.5.1.4 Water Bodies

The Plan Area includes 403 permanent and semi-permanent water bodies, including intermittent lakes and ponds, perennial lakes and ponds, man-made reservoirs, and swampy or marshy wetlands, comprising a total area of 982 acres (Simley and Carswel, 2009) (Figure 2-23). Most of the water bodies, identified on 7.5-minute USGS topographic maps, are less than 10 acres each. The largest water bodies are wetlands, averaging 26 acres each, located mostly within the Laguna de Santa Rosa. The largest water body within the Plan Area is an unnamed 103-acre swamp/marsh, east of Sebastopol and directly upstream from the Santa Rosa Creek confluence, connected to the upper and lower Laguna drainage channel.

The Plan Area includes eight named water bodies identified by NHD (Simley and Carswell, 2009) (Figure 2-23). Four of them, Brush Creek reservoir, Piner Creek reservoir, Matanzas Creek reservoir, and Spring Lake (also referred to as Santa Rosa Creek reservoir) are flood-control facilities (U.S. Army Corps. of Engineers, 2002). Piner Creek and Brush Creek reservoirs are mostly empty during summer, but Santa Rosa Creek and Matanzas Creek reservoirs store water throughout the year for recreational purposes and to maintain Santa Rosa Creek's summer flows. Annadel reservoir (also referred to as Lake Ilsanjo), Fountaingrove Lake, Lake Ralphine, and Roberts Lake also store water throughout the year primarily for recreational purposes. These reservoirs vary in size from 72 acres (Spring Lake) to 5 acres (Roberts Lake).

2.5.2 Surface Water Facilities

Surface water facilities in the Plan Area include flood control structures to reduce flood risk, and historic and modern drainage modifications to improve surface water flow and for irrigation. Surface water supplies to supply urban demand come from Water Agency facilities located outside the Plan area on the Russian River (described in Section 2.3.2.1).

2.5.2.1 Flood Control

The Plan Area includes five retention basins, all impounded behind earthen dams, to mitigate Santa Rosa Creek floods within the City of Santa Rosa. The Natural

Resources Conservation Service (NRCS) and the Sonoma County Flood Control District (now 'Water Agency') constructed four of these retention basins: Spring Lake, Matanzas Creek, Piner Creek, and Middle Fork Brush Creek reservoirs during the early 1960s (U.S. Army Corps of Engineers, 2002). They are now owned and operated by the Water Agency. The California State Department of Parks and Recreation constructed the fifth retention basin, Annadel reservoir (Annadel No. 1), in 1956. California Parks and Recreation owns and operates this reservoir as part of Annadel State Park, both for recreation and flood control. Each of these facilities are briefly described below:

- Spring Lake reservoir is located in Spring Lake Regional Park, close to the main branch of Santa Rosa Creek, within the City of Santa Rosa. The reservoir was built in 1963, and is the largest local flood-control facility, having a maximum storage capacity of 3,550 acre-feet and a surface area of 0.24 square miles (154 acres).
- Matanzas Creek reservoir is located on Matanzas Creek in the upper section of the drainage. Built in 1963, the reservoir is the second largest retention structure in the SRPW, with a maximum surface area of 62 acres, 1,500 af maximum storage capacity, and catchment area of 11 square miles (7,040 acres).
- The relatively small Piner Creek reservoir was built in 1962 on Paulin Creek, with a maximum surface area of 19 acres, maximum storage capacity of 172 af, and 2.05 square miles (1,312 acres) catchment area.
- The smallest flood retention facility in the Plan area is the Middle Fork Brush Creek reservoir, built in 1961, with a maximum surface area of 20 acres, maximum 138 af storage capacity, and a catchment area of 2.24 square miles (1,434 acres).
- Annadel reservoir, constructed in 1956, is located on Spring Creek in Annadel Park. Annadel reservoir has a maximum surface area of 67 acres, 395 af maximum storage capacity, and a drainage area of 1.71 square miles (1,094 acres).

2.5.2.2 Historical and Modern Drainage Modifications

With the onset of more intensive agriculture from the early 1800s on, as described in Section 2.2.4, many stream channels were modified to promote more rapid drainage of wetlands and vernal pools that would develop on the alluvial fans during the wet winter season (Dawson and Sloop, 2010). Channels that were formerly disconnected on the alluvial fans became straightened and more connected by a network of roadside ditches and canals. In their natural state, stream channels shifted periodically across the alluvial fans during the wet season, with Copeland Creek occasionally switching watersheds between the Russian River and the Petaluma River drainage systems (Dawson and Sloop, 2010). With the conversion of land to ranching and agricultural uses, streams draining the mountains on the eastern side of the valley that normally fed seasonal wetlands and did not originally join with the Laguna de Santa Rosa, such as Copeland and Crane Creeks, were instead redirected by straight canals and drainage ditches into the main channel of the Laguna de Santa Rosa as early as the 1870s (Dawson and Sloop, 2010). The trend of increasing connectivity of the drainage network has been ongoing through present day, with storm drains installed in housing developments and drainage tile placed under vineyards (Dawson and Sloop, 2010). These drainage modifications and practices have resulted in the loss of wetlands and valuable ecosystems and reduced groundwater recharge.

Ongoing channel restoration and maintenance has included the removal of invasive vegetation, stabilization of eroding channel banks using riprap and native vegetation cover, and the conversion of riparian areas to recreational uses that includes the removal of underbrush.

2.5.3 Streamflow

Streamflow information in the Plan Area is based on data gathered from stream gages and previous studies. Streamflow records are available at 15 USGS gaging stations within the Plan Area (Figure 2-23, Table 2-5). At the time of GMP preparation, eight stream discharge gages, and one stream stage gage remained active within the Plan Area (Table 2-5).

Table 2-5 Streamflow Gaging Stations in the Plan Area.

Most streamflow records within the Plan Area are relatively recent and date to water year 1998 or more recently (Table 2-5). Many of the records are also short; the average record length is only 2 to 5 water years (Table 2-5). To help with analyses of streamflow characteristics within the Plan Area, and to estimate historical streamflow variability, records from five gages outside of the Plan Area were used to extend the MWCM gage record from water year 1930 through 2010. Results show that shorter-term records tend to inadequately represent longer-term streamflow characteristics within the Plan Area (Figure 2-23 A). In general, water years 2007 to 2010 had average to drier-than-average conditions than the longer-term records (Figure 2-23 A and B).

Figure 2-24 Average Water Year Discharge for Gages Within and Adjacent to the Plan Area.

Figure 2-25 displays the characteristic seasonal variability between high winter and low summer flows by comparing monthly mean discharges for water years 1999 to 2010, recorded at four selected gages in the Plan Area. For all gages, high winter streamflow is at least two orders of magnitude greater than the low summer flows.

Figure 2-25 Monthly Mean Discharge for Four Selected Stream Gages in the Plan Area.

The Plan Area experiences extremes, from very high flows and flooding during wetter than normal winters, to periods of no flow during drought years (Figure 2-24 (A)). Notable high winter flows occurred during an atmospheric river event on February 18, 1986 and December 31, 2005, following a series of large storms that produced high-intensity rainfall over saturated ground. In contrast, streams classified as perennial can still go dry in late summer during drier than normal periods. Unusually low flows occurred in 1977, an extremely low rain year for the northern California coastal region, more recently from October through December of 2008, following an extended period of unusually dry weather, and finally the 2012 to 2014 drought.

Winter streamflow is marked by relatively rapid response times for overland flow to reach first-order streams in upper drainages, and then continue into the main channels. The rapid response times are caused by a combination of storm and basin characteristics. Some localized flooding typically occurs in low-lying areas each winter during the largest storms. The rapid response times for most drainages within the Plan Area increases the potential for flooding in low lying areas of the basin, especially within the Laguna de Santa Rosa's 100-year floodplain (Figure 2-23).

High Russian River flows, and rapid, high-volume inflow to the Laguna de Santa Rosa from tributary drainages, can slow and even reverse streamflow in the Laguna de Santa Rosa drainage channel, and in the lower channels of Mark West Creek, and Santa Rosa Creek due to backwater effects in the Laguna de Santa Rosa floodplain. These conditions arise only from larger storms, during wetter than normal winters. The largest floods within the Plan Area are caused by the combined effects of runoff from within the Plan Area and inflows from the Russian River into the Laguna de Santa Rosa floodplain. When the Russian River rises above flood stage, the Laguna de Santa Rosa Plain acts as a natural flood retention basin for the Russian River by capturing and storing up to 80,000 acre-feet of flood water, thus dampening the peak flows in the Russian River downstream of the Mark West Creek tributary.

During summer, low-flow conditions occur throughout the Plan Area, with most of the streamflow consisting of baseflow (the component of the hydrograph that persists without precipitation, generally spring-fed or groundwater-fed), and in some cases irrigation runoff. Perennial streamflow may characterize sections of Matanzas Creek, Spring Creek, and upper Santa Rosa Creek.

2.5.4 Surface Water Diversions

Surface-water diversions in the Plan Area include internal diversions and diversions that cross the Plan Area boundary. Internal diversions for flood control are discussed above. In addition, minor flow diversions from Mark West and Santa Rosa Creeks may be diverted for irrigating as much as 6,000 acres of mostly agricultural land may occur Plan Area (U.S. Geological Survey, 2010, Water Resources Data for the U.S., Water Year 2009). In headwater areas, numerous localized diversions of runoff from small, unnamed channels likely supply water to ponds and small lakes constructed for holding irrigation water. The total magnitude of these diversions is unknown.

2.5.5 Imported and Exported Water

As described in Section 2.3, the Water Agency diverts water from the Russian River (beyond Plan Area boundaries) for import and delivery to its customers. Given these imports, the overall amount of imported water significantly exceeds the amount of water exported from the SRP. In the Plan Area, the imported water is primarily used for municipal water supply in the Town of Windsor, the cities of Santa Rosa, Rohnert Park, and Cotati, and the Larkfield-Wikiup area serviced by Cal-Am. A portion of this imported water is used for residential landscape irrigation and other purposes, which may in turn result in some runoff and recharge increases. A minor amount of Russian River water (less than about 1,000 afy) is used directly for irrigation within the Plan Area (SCWA 2010). The Water Agency's diversion facilities extract Russian River underflow, which is reported under the Water Agency's surface water rights. Deliveries of imported water from the Water Agency to its customers within the Plan area over the last five years have varied from 25,000 to 34,000 afy (Table 2-3).

Imported Russian River water not applied as landscape irrigation is ultimately processed at two wastewater treatment facilities within the Plan Area. The recycled water is either pumped from the Plan Area to the Geysers, delivered for irrigation and wetland applications, or discharged to stream channels (see Section 2.3).

Any groundwater exports from the Plan Area are not well documented and are not considered significant. Potential groundwater exports include anecdotal reports of water truck deliveries of groundwater from the Plan Area to other water scarce regions of the County. Additionally, as described in Section 2.3.2.1, groundwater from the Plan Area represents a minor component of the water delivered to urban customers by the Water Agency, ranging from less than one to approximately five percent of the total water delivered. When groundwater is produced from the Water Agency's wells, it is blended with much higher quantities of Russian River water in the Water Agency's transmission system. In addition to the Cities of Cotati, Rohnert Park, and Santa Rosa, municipalities located outside of the Plan Area (ie, the City of Petaluma, City of Sonoma, Valley of the Moon Water District, North Marin Water District, and the Marin Municipal Water District) may receive some proportion of this blended water depending upon climatic and operational conditions.

2.5.6 Surface Water Quality –

Surface water quality information is discussed based on information from the North Regional Water Quality Control Board and from Sloop et al, 2007. The Laguna de Santa Rosa and its tributaries are known to have surface water quality impairment as a result of multiple studies and analysis as part of the development of TMDLs for nitrogen, phosphorous, dissolved oxygen, temperature, and sediment. EPA first listed the Laguna de Santa Rosa for nutrients, dissolved oxygen, and coliform in 1976. Sediment was added in 1998; nitrogen, phosphorous, dissolved oxygen and temperature in 2002; mercury (fish tissue) was added in 2006, and indicator bacteria were added in 2010. The 303(d) Listed Impairments which are part of the current NCRWQCB total maximum daily load (TMDL) project include nitrogen, phosphorous, low dissolved oxygen, high temperature, and sediment. The future will include mercury and pathogens/indicator bacteria.

A summary of the nutrient concentrations that reflects the status in the Laguna (2000-2005), compared to historical levels (1989-1994, 2000-2005) is summarized in the following section (from Sloop, e. al. 2007). Spatial and temporal patterns of nutrient concentrations were also explored. Some key observations from the analysis are:

- Historically very high total ammonium (NH_3) and total nitrogen (TKN) concentrations (e.g., average of 6.8 mg/l at certain locations) were observed for the period of 1989 to 1994.
- Nutrient concentrations have shown large decreases since 1989. The largest decreases are in total NH^3 and TKN concentrations.
- Current median nutrient concentrations for the Laguna main channel are mainly 0.3-0.5 mg N/l for total NH_3, 1-3 mg N/l for NO_3 and 1-2 mg N/l for organic nitrogen. Median total phosphorous (TP) concentrations are generally between 0.5- 1 mg P/l with a few locations above 1 mg P/l.
- For the main channel of the Laguna, nutrient concentrations generally increase from upstream, and then decrease downstream. The section upstream of the Santa Rosa Creek confluence can potentially function as a nutrient sink.
- Santa Rosa Creek generally has lower nutrient concentrations. Dilution from Santa Rosa Creek decreases nutrient concentrations further downstream.
- Generally higher nutrient concentrations are observed during winter/spring months. Low NO3 concentrations are observed in summer for all the locations. However, relatively high TP concentrations (0.3-0.5 mg/l) have also been observed in summer months, suggesting contribution from other sources rather than wastewater discharge.

The data available for analysis summarized above includes: 1) City of Santa Rosa Self Monitoring Program (SMP) nutrient data for 2000 to 2005; 2) TMDL monitoring data collected by NCRWQCB during 1995 to 2000; and 3) collated data from the City of Santa Rosa and NCRWQCB for the period of 1989 to 1994.

- City of Santa Rosa SMP data for 2000 to 2005. These are weekly grab samples collected upstream and downstream of the City's wastewater discharging locations during discharging periods. Constituents monitored include total NH3-N, NO3, organic nitrogen, and TP. This set of data provides us the current status of nutrient concentrations in the watershed.
- TMDL monitoring data collected by NCRWQCB during 1995 to 2000. These are TMDL monitoring data collected by NCRWQCB at five stations (LSP - Laguna at Stony Point, LOR -Laguna at Occidental Road, LGR - Laguna at Guerneville Road, LTH - Laguna at Trenton Healdsburg Road, and SRCWS - Santa Rosa Creek at Willowside Road) for the period of 1995 to 2000. The data are bi-weekly grab

samples. During this period, the Waste Reduction Strategy (WRS) was implemented, and therefore this set of data provides us with the effect of WRS.

- Combined data from the City of Santa Rosa and the NCRWQCB for the period of 1989 to 1994. These are weekly or biweekly samples collected at a few key locations of the Laguna during 1989 to 1994 by both the City of Santa Rosa and NCRWQCB. Data in this period generally reflect status before the implementation of WRS.

2.6 RECYCLED WATER

Recycled water management is discussed in Section 3.3 Water Reuse. This section provides information on recycled water demand and application for irrigation.

Monthly records on the application of treated wastewater used for irrigation, also referred to as recycled water, was provided by the town of Windsor and the City of Santa Rosa, and the Airport Larkfield Wastewater Treatment Plant. Monthly records of recycled water used for irrigation were available for water years 1990 through 2010. The location of land parcels where recycled water is applied as irrigation is indicated in Figure 2-26. For the most part, irrigation of land with recycled water occurs within the Laguna de Santa Rosa 100-year floodplain. Total monthly recycled water used for irrigation varies from zero during winter months to a maximum of about 3,000 af during the summer months of water years 1993 and 1994 (Figure 2-27A). The annual volume of recycled water used for irrigation averages about 10,200 afy, with a maximum of 14,117 af used during water year 2001 and a minimum of only 7,398 af used during water year 2009 (Figure 2-27B).

Figure 2-26 Location of Areas of Recycled Water Application for Irrigation.

Figure 2-27 Volumes of Recycled Water Application for Irrigation by Year.

2.7 HYDROLOGIC CONCEPTUAL MODEL

A hydrologic conceptual model is a simplified depiction of how the watershed's dynamic hydrologic system may function, including its physical processes and mechanisms, boundary conditions, hydrogeologic framework, water inflows, movement and outflows. The conceptual model is the basis of the integrated surface water-groundwater numerical flow model that was developed by the USGS (Woolfenden and Nishikawa, 2014). The Santa Rosa Plain Watershed hydrologic conceptual model is used to:

- Describe the basic movement (surface and subsurface inflows and outflows) and water storage levels in the Santa Rosa Plain Watershed.
- Provide a basis for interpreting field data, including hydrologic quality and quantity information.
- Develop a surface water-groundwater numerical water-flow model based on watershed data, and evaluate future management options.

The following sections describe the primary components of the hydrologic conceptual model, including boundary conditions, hydrogeologic framework, water inflows, movement and storage and outflows (Figure 2-22).

2.7.1 Boundary Conditions

The areal extent of the model is the Santa Rosa Plain Watershed, predominantly including naturally defined topographic drainage divides with minimal surface water inflows into and out of the watershed. Surface water outflows can exit as evapotranspiration or as surface water runoff, mostly as discharges from Mark West Creek to the Russian River drainage.

The watershed overlies all of the Santa Rosa Plain, Rincon Valley, northern half of the Kenwood and eastern part of the Wilson Grove Formation Highlands groundwater basins. Much of the Plan Area boundary is considered a no-flow boundary, with communication between local groundwater and adjoining areas limited by relatively impermeable bedrock.

Portions of the Plan Area boundary considered to allow subsurface hydraulic inflow or outflow include:

- Part of the eastern boundary between Kenwood Valley and Sonoma Valley
- The southern boundary between the Cotati-Rohnert Park area and Petaluma Valley
- Parts of the western boundary within the Wilson Grove Formation Highlands
- The northwestern boundary between the Windsor Creek drainage and the Russian River Valley

Groundwater movement across these boundaries can change seasonally and over longer time periods, based on the distribution and magnitude of outflows and inflows such as groundwater pumping and recharge on either side of the boundaries.

The lower (or basal) groundwater system boundary is in contact with low permeability bedrock that provides minimal flow contributions. The upper groundwater system boundary is the land surface, including plant canopies, with precipitation, irrigation and surface water inflows as recharge. Outflows across the upper boundary include evapotranspiration and surface water discharge.

2.7.2 Geologic Structures and Aquifer System

Faults in the Plan Area serve as major structural boundaries for the basins beneath the SRP. Major faults are the active Rodgers Creek-Healdsburg Fault Zone and Maacama Fault Zone; the Sebastopol Fault, Trenton Ridge Fault, Bennett Valley Fault, Carneros Fault, Petrified Forest Fault, and Gates Canyon Fault are of unknown activity status. The Rogers Creek Fault appears to act as a barrier to groundwater flow and also creates groundwater upflow or mixing along part of its length. The Sebastopol Fault appears to limit the lateral groundwater movement to the east. To the east of the Sebastopol Fault, an unnamed fault is at least a partial barrier to groundwater flow and appears to create upflow or mixing along part of its length.

Hydrogeologic units in the Plan Area include the saturated sedimentary rocks and sediments beneath the Santa Rosa Plain and adjacent lowlands, as well as sufficiently permeable sedimentary and volcanic rocks in the flanking uplands (Figure 2-22). The Glen Ellen, Wilson Grove and Petaluma Formations and the Sonoma Volcanics are the principal water-bearing aquifer units in the study area. The aquifer system has been subdivided, from east to west, into five distinct hydrogeologic subareas on the basis of hydrogeologic properties and geologic structure: (1) Uplands, (2) Valley, (3) Windsor, (4) Cotati, and (5) Wilson Grove. In general, from east to west, the aquifer units transition from the Sonoma Volcanics interbedded with the Petaluma Formation in the Uplands subarea east of the Rodgers Creek fault zone, to the Glen Ellen Formation overlying the Sonoma Volcanics in the Valley subarea, to the Glen Ellen and Petaluma Formations in the Windsor and Cotati subareas, to the Wilson Grove Formation in the Wilson Grove subarea.

2.7.3 Inflows

Precipitation, primarily as rainfall, is the main source of water inflow into the SRPW. The mean annual rainfall is approximately 40 inches, more than 560,000 acre-feet per year distributed over the entire 167,400 acre SRPW. Precipitation is greatest (42 to 57 inches per year) in the Mayacamas and Sonoma Mountains on the east side of the SRPW and lowest (averaging 30 inches per year) in the central lowlands. Due to the general low permeability of the basement rocks and Sonoma Volcanics that comprise these eastern mountains and the steep slope, most of the precipitation probably becomes runoff that contributes to streamflow and potential groundwater recharge in adjacent low lying lands to the west.

Groundwater recharge occurs also by streambed discharge, as well as variable and limited underflow from adjacent groundwater basins. Imported water, largely used for urban water supply, is also a potential source of inflow, mainly in the form of urban irrigation return flow and the discharge of septic systems and recycled water.

2.7.4 Streamflow

Mark West Creek, Santa Rosa Creek and Laguna de Santa Rosa are the major streams that drain the SRPW. Mark West Creek originates in the Mayacamas Mountains and is perennial though much of the Uplands subarea, with spring fed summer flows. Santa Rosa Creek and Matanzas Creek, one of its tributaries, also originate in the Mayacamas Mountains and are perennial in the Uplands subarea. In the Valley subarea, the Santa Rosa and Matanzas Creeks gain flow from groundwater just east of the Rodgers Creek fault zone. West of the Rodgers Creek fault zone, the Santa Rosa Creek loses to groundwater until it reaches the western end of the SRP where it once again gains water. The Laguna de Santa Rosa, which originates in the southern part of the SRPW, is perennial along most of its course.

Stream flow discharges the SRPW from Mark West Creek into the Russian River. The long-term estimated mean discharge for the extended 51-year time series is 265 cubic feet per second, or approximately 192,000 afy.

2.7.5 Groundwater Flow, Geochemistry and Outflows

As shown in Figure 2-21, groundwater generally flows from Uplands and Valley subareas to the west into the Windsor and Cotati subareas, and from the Wilson Grove subarea to the east, both towards the Laguna de Santa Rosa on the western edge of the Cotati subarea. As the groundwater moves along the flowpath from east to west, dissolved solids concentrations increase as a result of water-rock interaction and anthropogenic inputs including septic tank discharge and historic irrigation return flows.

Groundwater from the Uplands and Valley subareas into the Windsor and Cotati subareas encounters the Rodgers Creek fault zone that is a barrier, which causes groundwater to mound and discharge to streamflow. Once groundwater crosses the Rodgers Creek fault zone, streams discharge to groundwater. The Rodgers Creek fault zone structure also appears to be a source of deep circulation of groundwater flow, with significantly higher dissolved solids concentrations and much older groundwater. The older age and dissolved solids concentrations appear localized within the area of the Rodgers Creek fault zone. An unnamed fault east of the Sebastopol fault also appears to be at least a partial barrier to groundwater flow and a source of deep circulation of groundwater flow, based on significantly higher dissolved solids concentrations and much older groundwater age. The Sebastopol fault also appears to limit flow from the Wilson Grove subarea to the Cotati subarea on the basis of geochemistry.

Groundwater geochemistry of the Windsor and Cotati subareas indicate a mixture of sources of groundwater recharge. Streamflow recharge, groundwater underflow and precipitation all play an important role in recharging the Windsor and Cotati subareas. The vertical movement and recharge of groundwater in the Windsor and Cotati subareas appears to be retarded by the presence of the low permeability clay deposits of the Glen Ellen and Petaluma Formations, based on isotopic data and age dating. The low permeability clay deposits also confine the deeper aquifers, which helps to explain the rapid groundwater level recovery with pumping demand replaced largely by imported Russian River water in the early 2000's (Section 2.4.3, Figure 2-12). The oldest groundwater measured was in a well near the Laguna de Santa Rosa, and marks the end of a long groundwater flow path from the Uplands, through the Valley and across the Rodgers Creek fault zone and Cotati subareas.

Groundwater is discharged from the SRP through wells and leaves the basin as both subsurface outflow and groundwater discharge to the Laguna de Santa Rosa. Surface outflows can exit as evapotranspiration or as surface water, mostly as discharges from Mark West Creek and dominantly to the Russian River drainage, with some minor export of recycled water to the Geysers. The Plan Area primary surface water outflow is dominantly from the Mark West Creek Subbasin (about 90 percent of the Plan Area) and is estimated to be 200,000 afy based on a five-year record of streamflow data. Groundwater discharges go to springs and streams, to the soil zone, pumpage, and underflow to adjacent groundwater basins.

2.8 INTEGRATED SURFACE WATER-GROUNDWATER MODEL AND WATER BUDGET

The USGS, in cooperation with the Sonoma County Water Agency, cities of Cotati, Rohnert Park, Santa Rosa and Sebastopol, town of Windsor, Cal-American Water Company, and the County of Sonoma, developed a fully coupled surface water-groundwater flow model, utilizing the modeling code GSFLOW, to better understand and manage the hydrologic system in the Santa Rosa Plain Watershed. The model that was developed, as with all models has limitations and uncertainties associated with it (Section 2.8.5). However, comparatively it is a very sophisticated and advanced modeling tool for simulating hydrologic conditions. This section provides summary information on the GSFLOW model description, construction and calibration, model simulations and scenarios, results and model limitations. A detailed description of GSFLOW for the SRPW can be found in the report “Simulation of Groundwater and Surface-Water Resources for the Santa Rosa Plain Watershed, Sonoma County, California” (Woolfenden and Nishikawa, 2014).

2.8.1 GSFLOW Model Description

The GSFLOW model for the Santa Rosa Plain Watershed area (Figure 2-28), consists of two integrated model components:

1. A watershed component model developed using Precipitation Runoff Modeling System (PRMS – Markstrom and others, 2008) and
2. A groundwater-model component developed using the USGS Modular Groundwater Flow Model, Newton formulation (MODLFOW-NWT – Niswonger and others, 2011).

The watershed component model is used to simulate the hydrology of the land surface, vegetation, and soil zone. The groundwater component model is used to simulate the groundwater hydrology of the subsurface underlying the soil zone and the surface water hydrology of the streams represented in the model, and includes the unsaturated and saturated zones.

Figure 2-28 GSFLOW Model Boundary.

GSFLOW has the capability to simultaneously simulate both surface water and groundwater flow making it well suited for evaluating the effects of such factors as land-use change, climate variability, and groundwater withdrawals on surface and subsurface flow. The model incorporates well-documented methods for simulating runoff and infiltration from precipitation; balancing energy and mass budgets of the plant canopy, and soil zone; and simulating the interaction of surface water with ground water.

2.8.2 GSFLOW Model Construction and Calibration

The GSFLOW model was developed by initially constructing both the watershed (surface water) component and the groundwater component separately, then coupling the two components for final calibration.

The watershed component model was constructed using PRMS and consists of 16,741 hydrologic response units (HRUs) grid cells 660 feet on each side, which cover the entire SRPW. The HRUs are connected using a network of cascades and stream segments where surface-water runoff and interflow are routed by the cascades to stream segments. The stream segments route streamflow to ten points of outflow along the model boundary, with the main point of discharge for surface water at the Mark West Creek at the Russian River confluence. The watershed component model distributes the daily-climate input to all HRUs to account for variability in precipitation and air temperature. The Parameter-Regression on Independent Slopes Model (PRISM) was used to spatially distribute precipitation and temperature inputs across the watershed. Water years 1948 through 2010 were used to define the baseline historic climate period for the SRPW, which has an average precipitation rate of 38 inches per year, average maximum daily air temperature of 70.5 degrees Fahrenheit, and average minimum daily air temperature of 45.0 degrees Fahrenheit.

The groundwater component model was constructed using MODFLOW-NWT and consists of a grid of 168 rows, 157 columns, and 8 layers with uniform, square model cells 660 feet on each side (10 acres per cell). To match the watershed component model, the groundwater component model also incorporates 16,741 active cells in each of the 8 layers. All model layers are convertible between confined and unconfined aquifer conditions, and generally only the top layer is unconfined. The distribution of hydraulic conductivity was initially assigned using spatially distributed data from the stratigraphic-textural model (Sweetkind, 2010) and adjusted during calibration. Boundaries of the groundwater component model are defined using the hydrologic conceptual model as a basis (Section 2.7), with no-flow at the base and along most of the edges of the model where watershed divides occur. In areas where the model boundaries connect with other major groundwater basins, head-dependent boundaries that allow groundwater inflows and outflows are assigned and include the Wilson Grove and Russian River on the west and the Kenwood and Cotati along the east and south, respectively. Major faults and two unidentified faults are also represented in the model (Figure 2-28).

Sources of inflow that recharge groundwater include recharge by surface percolation, stream bed recharge, infiltration of treated wastewater, and subsurface inflow from adjacent basins. Groundwater outflow occurs as groundwater discharge to streams, riparian evapotranspiration (ET), groundwater discharge to the unsaturated zone or land surface, subsurface flow to adjacent groundwater basins and groundwater pumping.

The following approaches were used for pumping inputs into the model:

- Municipal pumping - input was obtained from reported monthly pumping data or estimated from average annual pumping rate data collected and reported to DPH
- Agricultural pumping - estimated using the calibrated watershed–component model in de-coupled mode, and a daily crop demand model based on land use mapping and estimates of ET
- Domestic pumping – estimated on the basis of population data for the non-urban areas and a per-capita use factor of 0.19 afy

The SRPW was subdivided into model subareas (storage units (MSUs)), also referred to as hydrogeologic subareas in Section 2.0, to aid in aquifer property and boundary condition calibration (Figure 2-29).

Figure 2-29 Model Groundwater Subareas (Storage Units).

Calibration of the Santa Rosa Plain Hydrologic Model was accomplished using coupled GSFLOW simulations and an iterative trial-and-error approach of adjusting model parameters to achieve a reasonable fit between:

1) Simulated and measured streamflow and
2) Simulated hydraulic head and measured groundwater levels

Watershed component parameters adjusted during the calibration process included PRMS-HRU parameters controlling runoff, ET, and streambed leakage. Groundwater component parameters adjusted during model calibration included hydraulic conductivity, specific leakage, specific storage, horizontal flow barrier characteristics, general head-boundary conductance, and streambed conductance.

Goodness-of-fit statistics were used to assess the model fit to streamflow data and indicate a generally good model calibration to streamflow. The model testing results are consistent with the model calibration results overall, and indicate an acceptable model calibration for simulating daily and monthly streamflow. For the groundwater component, normalized root mean squared error was within 10 percent indicating an acceptable fit of simulated hydraulic heads to measured groundwater levels. Simulated hydraulic heads in most wells generally followed the overall trends, and monthly and multi-year variation in measured groundwater levels. Since the main source of groundwater discharge, rural groundwater pumpage and associated well locations, are not known but were estimated, the model fit to groundwater levels reflects the uncertainty introduced by the estimates.

2.8.3 Model Simulated Water Budget

The Santa Rosa Plain Hydrologic Model was used to estimate the hydrologic balance (water budget) for water years 1976-2010 (see Table 2-6). Precipitation is the largest inflow to the SRPW, averaging approximately 531,000 afy for 1976-2010. The largest average outflows for the SRPW during 1976-2010 were total streamflow at 230,000 afy and total evapotranspiration at about 262,000 afy. Groundwater pumping averaged approximately 35,600 afy for water years 1976-2010. For any groundwater system developed with water wells, the groundwater pumped by wells results in some combination of reductions in baseflow to streams, reduction in ET, reduction in total storage, and/or changes in boundary flows. The water budget simulation indicated that with the exception of wet years, total groundwater pumpage generally showed an upward trend between 1976 and 2010, and was a small percentage of the overall hydrologic budget. Simulation results for the SRPW also indicate that on average pumpage reduced total streamflow by about 19,000 afy.

Table 2-6 Simulated Water Budget for 1976-2010.

The GSFLOW model was also used to estimate the groundwater budgets for specified time periods (Table 2-7). For the simulation for water years 1976-2010, recharge by surface percolation, stream recharge, and boundary flows totaled approximately 80,600 afy and accounted for 51, 40, and 9 percent, respectively, of total groundwater inflow on average. The total average net groundwater recharge for the SRPW, which subtracts groundwater ET, surface leakage and groundwater discharge to streams from the total recharge, was estimated to be approximately 33,000 afy. The total simulated average annual outflow for 1976-2010 was 83,900 afy, and pumpage and groundwater discharge to streams were the major sources of outflow on average, accounting for 42 and 31 percent, respectively, of total outflow. Groundwater ET, boundary flows, and surface leakage contributed 10, 9 and 7 percent respectively to outflow. Net stream leakage, which is the difference between the amount of water recharged through stream channels and the amount of groundwater discharged to stream channels, was approximately 6,600 afy indicating the significance of streams as a source of groundwater recharge. Finally, groundwater storage depletion was estimating at 3,300 afy on average for water years 1976-2010.

Table 2-7 Simulated Groundwater Budget for Long- and Short-Term Conditions, Dry- and Wet-Year.

The groundwater budget for average conditions for more recent water years 2004-2010 was also evaluated (Table 2-7). Results indicate that pumpage increased by about 18 percent over the long-term average and about 45 percent more groundwater was removed from storage (total -4,800 afy) than the long-term average results. In the simulated dry water year in 2009, which had an average precipitation of 25 inches, storage was reduced by an estimated 20,800 af. In a wet water year in 2006, with an average of 52 inches of precipitation, storage was increased by an estimated 19,400 AF (Table 2-7).

The average total pumping for all water-use types for 1976 through 2010 was approximately 35,600 afy and exhibited an increasing trend (simulated at approximately 42,000 afy for more recent water years 2004 through 2010). The largest demand on groundwater within the SRPW is for rural domestic and agricultural irrigation, which represent approximately 50 percent and 32 percent of the total pumping, respectively. Public supply system groundwater pumping represents approximately 18 percent of the total estimated pumping. See Appendix E for information on how the pumping estimates were derived.

In summary, groundwater budget results for water years 1976 to 2010 indicate that on the average:

- Streams are a net source of recharge (streams are losing surface water to recharge groundwater) in the Windsor, Santa Rosa and Cotati subareas
- Groundwater pumping exhibited an increase in recent years to an estimated 42,000 afy (2004 to 2010) compared with the longer-term average of 35,600 afy (1976-2010)
- Groundwater is removed from storage for all the subareas with the largest amount of groundwater removed from the Santa Rosa Plain subarea; however, the simulated storage losses represent only a small percentage of groundwater relative to the total storage and the long-term average recharge rate
- Increased pumping is causing a water budget imbalance, with an average annual groundwater storage loss of 3,300 afy
- A continued trend of groundwater storage loss can lower groundwater levels, reduce streamflows, and adversely impact riparian habitats and ecosystems

2.8.4 Climate Change Scenarios

An important objective for developing the Santa Rosa Plain Hydrologic Model is to simulate the response of the regional flow system to potential changes in stress, including the effect of projected pumping with climate change from global climate change (GCM) models. Changes in air temperature and patterns of precipitation as projected by climate change can significantly effect the SRPW hydrologic system and also cause increases in pumping. Four future climate and gas emissions scenarios (GA2, GB1, PA2, and PB1) incorporating daily precipitation and minimum and maximum air temperatures were simulated for water years 2000-2100 which incorporate the following climate change models (Table 2-8):

- G - National Oceanic and Atmospheric Administration (NOAA) Geophysical Fluid Dynamics Laboratory (GFDL) GCM
- P - Parallel Circular Model (PCM) GCM (Flint and Flint, 2012)
- A2- a medium- high greenhouse gas emissions scenario
- B1 – a low green house gas emissions scenario

Public supply pumpage was estimated based on projections in the Water Agency Urban Water Management Plan (UWMP - SCWA 2011) and input from Water Agency staff. Domestic water pumpage for water years 2011-2040 was estimated based on a projected increase in households of 12 percent in the unincorporated area for Sonoma County (Association of Bay Area Governments, 2011). This was prorated over the 30–year period to be 0.4 percent per year. The monthly pumpage for a given water year was determined by multiplying the pumpage for each month in the preceding water year by a factor of 0.4. Public and domestic supplies were assumed not to be influenced by climate and were the same for all climate scenarios. Estimates of agricultural irrigation and pumpage were developed for the four future climate scenarios using the 2008 land-use map and prescribed methods for estimated water demand based on crop type and estimates of ET and factors. The spatial distribution of irrigated crop types was held constant to the 2008 land use map throughout the 30-year future climate scenarios. Variations in irrigation estimates were in response only to the variability and trends in the future climate scenarios, and to land use changes.

Table 2-8 Simulated Groundwater Budget for Baseline and Climate Change Scenarios.

General results of the climate change simulations for all four scenarios include (Figures 2-30 to 2-32):

- An increase in the frequency of very low streamflow (100,000 AF or less) intervals relative to the historic baseline period for water years 1981-2010
- An increase in very low total recharge (30,000 AF) relative to the historic baseline period
- Sensitivity of groundwater discharge to streams (gaining streams) to trends and multi-year precipitation variations, although annual precipitation variability was less than total recharge
- Sensitivity of Groundwater ET to the trend of increasing air temperature
- Variability in the overall trends in groundwater storage for the four future climate scenarios, which reflects the variability in the projected precipitation for each scenario

Figure 2-30a Change in Pumpage, Stream Leakage, and Storage for GA2.

Figure 2-31b Change in Pumpage, Stream Leakage, and Storage for GB1.

Figure 2-32c Change in Pumpage, Stream Leakage, and Storage for PA2.

Figure 2-33d Change in Pumpage, Stream Leakage, and Storage for PPB1.

Figure 2-34 Simulated Hydrologic Budget Components 1976-2010.

Figure 2-35 Average Net Recharge 1976-2010.

In summary, climate change scenarios with projected pumping for water years 2011-2040, predicted the following trends:

- Streams losing surface water to groundwater increase, and groundwater discharges to streams (gaining streams) decrease, resulting in less baseflow

- For wetter scenarios (GB1 and PB1), the impact of pumping is offset by higher recharge due to surface percolation and increases in hydraulic heads (groundwater levels) over a larger area
- Drier scenarios (GA2 and PA2) projected pumping increases and groundwater level declines over a comparatively larger area. Compared to the 1981 to 2019 baseline, surface percolation groundwater recharge, groundwater ET, baseflows to streams, and boundary outflows are all reduced
- The four scenarios predict cumulative changes in groundwater storage
- GA2, the lowest average precipitation, results in declining storage compared to the baseline period
- GB1 is similar to the baseline period and storage declines and increases were generally balanced
- PA2 storage declined 2011-2027 and then increased due to increasing precipitation
- PB1, with the highest precipitation scenario, predicted storage increases that exceeded declines, resulting in overall storage gain

2.8.5 Model Limitations

The GSFLOW groundwater flow model is a very robust and advanced modeling tool for simulating potential changes in the SRPW hydrologic system. As with all models, in order to develop this tool, some data was not available or did not exist, so a number of assumptions had to be made. These assumptions result in data limitations and uncertainties.

The most significant model data limitations include uncertainties in:

- Estimates and spatial distribution of agricultural and rural domestic pumpage
- Amount and spatial distribution of precipitation
- Long-term streamflow discharge amounts
- Vertical distribution of hydraulic head in deeper aquifer zones

2.9 DATA NEEDS AND DATA GAPS

The study provides an improved and updated understanding of the Santa Rosa Plain Watershed. And like many studies, a number of data gaps were identified that need to be addressed in the future:

- Improved estimates and locations of unreported agricultural and domestic pumpage will help to refine the surface water-groundwater flow model.
- Depth dependent water level and water quality data are needed to improve the understanding of the hydrogeology and relationships between the shallow deeper aquifer system and flowpaths.
- Improved well location, lithology and construction information are needed to both better understand the hydrogeology and improve the groundwater model.
- Additional water quality data are needed to further evaluate the variability in water quality data in the Cotati subarea.
- Long-term groundwater level quality monitoring is essential to better identify and understand significant water quality trends.

3.0 EXISTING MANAGEMENT & PLANNING EFFORTS

This section summarizes existing management and planning efforts related to groundwater resources within the Plan Area that are conducted by a variety of local, state and federal agencies, as well as individual organizations and stakeholder groups. These existing efforts include regulatory and non-regulatory regional planning, management and monitoring efforts, which are grouped into the following general categories:

- Water Supply Planning
- Water Conservation
- Water Reuse
- Stormwater Management
- Water Quality Programs
- Monitoring Programs

The following sections summarize these efforts and programs as they relate to groundwater resources within the Plan Area and demonstrate the interest, support and continuing commitment of the individual agencies, organizations and stakeholders in managing local groundwater resources.

3.1 WATER SUPPLY PLANNING

3.1.1 North Coast Integrated Regional Water Management Plan

In November 2002, California voters approved Proposition 50, the Water Security, Clean Drinking Water, Coastal and Beach Protection Act of 2002. The Act encourages regional cooperation in water resources planning by providing grant funding for projects identified in a regional plan, referred to as an Integrated Regional Water Management Plan (IRWMP).

The North Coast Integrated Regional Water Management Plan (NCIRWMP) is an innovative, stakeholder-driven collaboration among local government, watershed groups, tribes and interested partners in the North Coast region of California (http://www.northcoastirwmp.net/). The North Coast comprises seven counties, multiple major watersheds, and a planning area of 19,390 square miles, representing 12% of California's landscape, including the Plan Area. The NCIRWMP's focus areas include restoring salmonid populations, enhancing the beneficial water uses, promoting energy independence, reducing greenhouse gas emissions, addressing climate change, supporting local autonomy and intra-regional cooperation, and enhancing public health and economic vitality in the region's economically disadvantaged communities.

The NCIRWMP serves as a comprehensive planning tool that links other water resources management plans and programs through collaborative processes, coordination and communication. In recognition of the importance of groundwater resources and the need for the North Coast to address groundwater management planning on a regional scale, the development of the Santa Rosa Plain Groundwater Management Plan was awarded funding as a pilot project through an NCIRWMP Planning Grant by DWR.

3.1.2 Urban Water Management Planning

Urban Water Management Plans (UWMP) are prepared every five years by California's urban water suppliers to support long-term resource planning and ensure adequate water supplies are available to meet existing and future water demands. Every urban water supplier that either provides over 3,000 acre-feet of water annually or serves more than 3,000 or more customers is required to assess the reliability of its water sources over a 20-year planning horizon considering normal, dry, and multiple dry years. The plans are submitted to DWR, which then reviews the submitted plans to make sure they have completed the requirements identified in the Urban Water Management Planning (UWMP) Act (Division 6 Part 2.6 of the Water Code §10610 - 10656).

Within the Plan Area, UWMPs are prepared by the Water Agency (as a wholesaler) and the Cities of Cotati, Rohnert Park, Santa Rosa and Town of Windsor (as water retailers). The City of Sebastopol has not yet reached the threshold of 3,000 customers, but is projected to do so in the next year or two and anticipates initiating development of an UWMP at that time. The Plans discuss and describe:

- Existing water supplies and infrastructure;
- Projected water demands over the next 25 years, based on population growth projections and growth policies in city and county general plans;
- Projected water supplies available over the next 25 years, the reliability of that supply, and general plans for water supply projects;
- Current and planned water conservation activities;
- A water shortage contingency analysis; and
- A comparison of water supply and water demand over the next 25 years under different hydrological assumptions (normal year, single dry year, four consecutive dry years).

As local groundwater makes up a portion of the urban water supply within the Plan Area (as further described in Section 4.3), the UWMPs also discuss and describe groundwater production facilities, historical and projected groundwater use and the conditions of the groundwater basin. Thus, UWMPs serve as a routine mechanism for local urban water providers to coordinate and plan for future urban groundwater use. The most recent projections for future urban groundwater use are incorporated into Section 4.8. However, it is noted that UWMPs do not consider rural residential, agriculture and small municipal/mutual water systems.

In addition to the UWMPs required by the state, local urban water providers perform other water supply planning activities related to groundwater, including development of water master plans, preparation of water-supply assessments for larger proposed developments (more than 500 dwelling units or equivalent), updates of city and county General Plans, and other activities. Information regarding some of these activities is summarized below:

- Water Master Plans have been developed by many urban water providers in the Plan Area, including the Cities of Cotati, Santa Rosa, Sebastopol and Town of Windsor, which assess water supply needs and describe planned projects. The City of Santa Rosa has also developed a draft Groundwater Master Plan to provide direction and recommended policies on the City of Santa Rosa's use of current and future groundwater resources for both peaking and emergency supply. The Groundwater Master Plan is available online at: http://ci.santa-rosa.ca.us/departments/utilities/groundwater/masterplan
- Beginning with passage of SB 610 in 2002, water supply assessments must be furnished to local governments for inclusion in any environmental documentation for certain projects that are subject to CEQA (as defined in Water Code 10912 [a]). The water supply assessments are required to determine water supply sufficiency for a 20-year projection in addition to the demand of existing and other planned future uses. Since 2002, a number of water supply assessments have been prepared in the Plan Area on behalf of local planning agencies.

3.1.3 Water Supply Strategies Action Plan

The Water Supply Strategies Action Plan was developed by the Water Agency in coordination with its water contractors to increase water supply system reliability, resiliency and efficiency in the face of limited resources, regulatory constraints and climate change uncertainties. Following an extensive public outreach program, nine Water Supply Strategies were approved by the Water Agency's Board of Directors in September 2010, which include prioritized actions to enhance the existing conjunctive use of the region's surface water and groundwater resources, develop groundwater management plans, and comply with recent groundwater monitoring requirements from the state. Immediate actions identified within the plan that are specific to groundwater include:

- Identify projects that limit flooding and increase groundwater recharge (Stormwater Management/Groundwater Recharge Study further described in Section 3.4.3).
- Improve water supply reliability and reduce peak demands that affect Dry Creek Flows through evaluation of a Groundwater Banking Program (further described in Section 3.1.5).
- Develop and continue non-regulatory groundwater management plans in the Santa Rosa Plain and Sonoma Valley that emphasize development of diversified water supply "portfolios".

- Comply with the State's California Groundwater Elevation Monitoring (CASGEM) Program by implementing a voluntary groundwater-level monitoring network within the county's groundwater basins (further described in Section 3.6.2).
- Continue research on the natural filtration capacity of Russian River alluvial materials at the Water Agency's Russian River riverbank filtration facilities.

The Water Supply Strategies Action Plan is updated on a regular basis (most recently June 2013) and the most recent version is available at http://www.scwa.ca.gov/water-supply-strategy/.

3.1.4 Climate Change Studies and Planning

Projected changes in climate include increased variability in precipitation and rises in air temperature, resulting in shorter wet season, longer dry season, more droughts and more extreme high flows. To face these potential changes in climate the Water Agency is working with federal and local partners, including the USGS, National Oceanic and Atmospheric Administration, and the U.S. Army Corps of Engineers to advance the science in our region in an effort to plan for and adapt to predicted changes. Findings from these efforts to date are summarized in Section 2.2.2.

3.1.5 Groundwater Banking Feasibility Study

In an effort to improve the region's water supply reliability, the Water Agency and its partners (Cities of Cotati, Rohnert Park and Sonoma, Valley of the Moon Water District, and the Town of Windsor) are conducting a feasibility study for designing a regional groundwater banking program. Conceptually, groundwater banking programs would divert surplus Russian River water from existing drinking water production facilities during wet winter and spring seasons, and pipe them to sites developed for storage in aquifers beneath the Santa Rosa Plain and/or Sonoma Valley. The stored water would then be available for subsequent recovery and use during dry weather conditions (i.e., the summer and fall seasons) or in emergency situations. The Water Agency and the study participants are exploring groundwater banking in a systematic and phased approach, using information from completed and ongoing scientific studies and groundwater management activities sponsored by the Water Agency and its partners.

3.2 WATER CONSERVATION

A number of regional and local water conservation programs are operational in the Plan Area. The Sonoma-Marin Saving Water Partnership represents 10 water utilities in Sonoma and Marin counties that are signatories to the California Urban Water Conservation Council (CUWCC) and have joined to create a regional approach to water use efficiency. Within the Plan Area, these utilities include the Cities of Cotati, Rohnert Park, Santa Rosa, Town of Windsor and the Water Agency. Each of these member utilities, in addition to the City of Sebastopol and California American Water Company, have water conservation programs to assist their communities reduce water use.

Water conservation and use efficiency program elements specific to the Sonoma-Marin Saving Water Partnership include:

- Establishing a conservation coordinator, water waste prohibition, assistance and water loss control programs (audits, leak detection and repair).
- Urban water metering, and conservation pricing (tiered structure).
- Developing and maintaining public information and school education programs on water and conservation.
- Specific urban residential programs for indoor (high efficiency toilets, fixtures, and washers) and outdoor landscaping assistance, surveys and retrofits for increasing conservation.
- Specific industrial and large landscape assistance, surveys and retrofits for increasing conservation.
- Rebate programs to replace top loading clothes washer with high efficiency front-loading clothes washers, and replace old toilets with high efficiency toilets.
- Qualified water efficient landscaper training that provides education on proper plant selection for local climates, irrigation system design and maintenance, and irrigation system programming and operation.
- Online water wise gardening website which offers a Mediterranean and native plant list, design and garden installation tips, and irrigation system design and maintenance information.
- Green business program that provides businesses with water and energy conservation information and incentives, to reduce waste and prevent pollution.
- Annual eco-friendly garden tour, providing information on graywater irrigation systems, rainwater catchment systems, permeable surfaces, living walls, native and drought tolerant plants, edibles, swales, chicken coops and lizard habitat, and cob furniture.

In 2009 the California Legislature established a statewide goal to reduce per capita water use 20% by the year 2020 with an interim goal of 10% reduction by 2015. As of 2011, each member of the Sonoma-Marin Saving Water Partnership has achieved the 2020 target goal. Average regional water usage by member utilities has declined from approximately 160 gallons per capita per day (gpcd) in the late 1990's to approximately 113 gpcd in 2011. Specific actions which have led to these reductions under the Sonoma-Marin Saving Water Partnership are exemplified by the following achievements in fiscal year 2011-2012:

- Water Efficiency Assessments – 3,031 water smart home evaluations were conducted by trained technicians to assist with improving home water efficiency, find and fix water leaks, and inform and educate homeowners on indoor and outdoor water use.
- Business Water Use Survey – 511 businesses participated in business water use surveys.
- Clothes Washers – 2,155 rebates were issued for high-efficiency clothes washer upgrades.
- Toilets – 1,757 rebates were issued to residences, and 317 rebates were issued

to businesses for high-efficiency toilet updates.

- Turf Conversion – 340,067 square feet of lawn were removed through turf conversion rebate programs.
- Landscapes – 202 landscapes were upgraded to be more water conserving, through rebate programs.
- Business Water Use Efficiency – 23,696,000 gallons of water per year is being saved by an increase in water use efficiency through process changes and equipment upgrades.
- Graywater – 57 graywater systems were installed.
- Rainwater Harvesting - 23,050 gallons of rainwater storage capacity have been added through rebate programs.
- Education Programs – High school and elementary school students and parents participate in a variety of water educational and training programs and tours.

More information is available at http://www.savingwaterpartnership.org/.

Windsor Efficiency “pay as you save®” (PAYS®) is a mechanism to provide efficiency upgrades for Windsor home and apartment occupants with no loan and no debt associated with repayment. After installation of eligible upgrade measures, participants pay a surcharge on their water bill with the assurance that their estimated savings on combined utility bills (energy and water) will exceed the bi-monthly water surcharge. The payment obligation stays at the installed site. If an installed measure fails at any time during the payment period and is not repaired, the payment obligation ends. Examples of water efficiency measures eligible under the program high efficiency showerheads, toilets, and faucet aerators drought resistant landscaping, and high efficiency clothes washers.

The State Legislature adopted the "Water Conservation in Landscaping Act of 2006" (AB 1881) requiring the Department of Water Resources to update the State Model Water Efficient Landscape Ordinance. All local land use agencies were required to adopt the model ordinance, or develop an ordinance that is at least as effective by January 1, 2010. The county and cities have all developed individual water efficient landscape ordinances. The new water efficient landscape ordinances require a landscape plan check for certain projects, as described in the ordinance. It includes requirements for landscape water budgets, landscape and irrigation design, and irrigation scheduling.

There are also a number of resources for implementing water conservation practices for rural landowners not connected to City water utilities or who are ineligible for urban water conservation program rebates. A great water conservation and stormwater management guide for all types of landowners is the “Slow it. Spread it. Sink it!” publication produced by the Southern Sonoma County Resource Conservation District (now Sonoma RCD) and the Resource Conservation District of Santa Cruz County. This homeowner’s and landowner’s guide offers many ideas and tips on practices that can help to protect and replenish groundwater resources, reduce erosion and pollution, prevent flooding and increase water conservation and stormwater management. The guide can be downloaded for free here: http://sonomarcd.org/pdf/Slowit.Spreadit.Sinkit.vfinal.pdf. Another useful guide focusing on rainwater catchment systems is the "Roof Water Harvesting for a Low Impact Water Supply" booklet produced by the Occidental Arts and Ecology Center's WATER Institute, which can be downloaded from the following link: http://www.sotoyomercd.org/OAEC-Roof-Water-Harvesting-Booklet.pdf.

Rural and agricultural landowners are encouraged to contact the Sonoma or Gold Ridge RCD for further information on technical assistance, water conservation practices and funding opportunities on agricultural or rural properties. Additional information on water saving tools for agricultural irrigation and frost protection can be found at
http://sonomarcd.org/programs-services-water-resource-ctools.php.

Additionally the California Agricultural Water Stewardship Initiative has a website with resources and case studies on water conservation and alternative water storage strategies on agricultural properties throughout California which can be found at: http://www.agwaterstewards.org/index.php/practices

The Sonoma RCD, Napa RCD, and the USDA Natural Resources Conservation Service developed the LandSmart program to promote productive lands and thriving streams through planning and on-the-ground implementation on beneficial management practices. The program is applicable to a variety of agricultural lands.

LandSmart Plans are developed by the agricultural producer, either independently, through workshops, or through one-on-one assistance from an RCD. Producers can also seek certification from the RCD's certification team once plans are complete. Plan templates and guidance materials are designed to assess current practices and identify recommendations for other practices that would benefit natural resources such as water quantity and quality. Practices are prioritized and tracked over time.

LandSmart On-the-ground takes planning to the next level and assists producers in implementing practices identified in a LandSmart Plan. The RCDs offer educational workshops and field days to demonstrate practice implementation, assist producers in securing cost share funding from NRCS and other funding sources, and carry out comprehensive project management. For more information on LandSmart™ visit: www.LandSmart.org.

Members of Wine Institute and the California Association of Winegrape Growers introduced the Code of Sustainable Winegrowing Practices Self Assessment Workbook in 2002 to promote environmental stewardship and social responsibility in the California wine industry. More than 50 members of Wine Institute and CAWG developed the Sustainable Winegrowing Program and workbook over a two-year period with input from environmental groups, regulators, university educators and social equity groups. Since the workbook and program were initiated, nearly 70 percent of the winegrowers and producers in California have joined, and nearly half of the vineyards and production facilities in the state have completed self-assessments.

The workbook is a self-assessment tool for California's vintners and growers and provides practical information on how to conserve natural resources, protect the environment and enhance relationships with employees, neighbors and local communities. The workbook addresses a number of criteria for measuring performance, including Vineyard Water Management and Winery Water Conservation and Quality.

Winegrowers and producers conduct a self-assessment using the workbook and online tools. The Chapters on viticulture, soil management, vineyard water management, and winery water conservation include guidance and options for optimal vines selection, vineyard design, soil type and water demand management to improve measurement, management, water conservation and water use efficiency. The workbook provides guidance and options on ways to improve winegrowing management and wine production. Participants develop a work plan to make improvements and then evaluate progress over time. Another aspect is the certification program: winegrowers and producers can be third-party certified as a sustainable winegrowing facility.

More information on sustainable winegrowing practices is available at http://www.sustainablewinegrowing.org/.

3.3 WATER REUSE

Water reuse is recognized as an important tool in reducing the demand for potable water and groundwater used for irrigation, provided that the water meets the applicable water quality standards and is supplied in appropriate quantities for the intended uses. Water reuse currently occurs at many scales throughout the Plan Area, from large-scale, highly treated municipal recycled water programs to untreated graywater systems developed by individual property owners.

Municipal Recycled Water

Primary municipal recycled water systems within the Plan Area include the Santa Rosa Subregional Water Reuse System, the Airport-Larkfield-Wikiup Sanitation Zone and the Town of Windsor. The Santa Rosa Subregional Water Reuse System is the largest water reuse system in the Plan Area; it reclaims wastewaters received from homes, businesses and industry within the cities of Santa Rosa, Rohnert Park, Sebastopol, Cotati, the South Park Sanitation District and portions of the unincorporated county. The water is treated to a tertiary level with activated carbon filtration and UV disinfection.

The recycled water is distributed to the Geysers Steamfield outside the Plan Area, and to agricultural users, golf courses, and for use on public and private landscaping within the Plan Area. In 2010, the Subregional System delivered approximately 14,500 af of the recycled water to the Geysers Steamfield, approximately 5,000 af to agricultural irrigation customers and approximately 1,100 af to landscape irrigation customers. Recycled water delivered to the Geysers Steamfield is injected into deep underground wells that recharge the geothermal zone used to produce geothermal energy. More information is available at:
http://ci.santa-rosa.ca.us/departments/utilities/recycle/pages/default.aspx

A total annual average volume of about 10,200 acre-feet/year of recycled water from the Santa Rosa Subregional System is used for irrigation within the Plan Area. Other significant water reuse systems within the region include the Airport-Larkfield-Wikiup Sanitation Zone and the Town of Windsor, where tertiary-treated recycled water generated from these systems collectively supply approximately 2,600 afy of recycled water for agricultural and landscape irrigation. The Town of Windsor recently completed a project to allow for the delivery of an average 0.5 million gallons per day of its recycled water to the Geyers Steamfield.

Other Water Reuse Systems

Smaller-scale water reuse systems within the Plan Area, which generally undergo a lower level of treatment compared with municipal systems, include:

- Winery wastewater reuse systems, which typically reuse treated water from winery operations for irrigation. These systems are regulated by the North Coast Regional Water Quality Control Board.
- Small-scale graywater systems reuse untreated wastewater collected from showers, bathtubs, bathroom sinks, and clothes washing machines in individual homes. Such graywater is then utilized for landscape irrigation, generally on the same property that generates the gray water. PRMD issues permits for graywater systems in Sonoma County.

3.4 STORMWATER MANAGEMENT

The need for integrating appropriate stormwater management practices while protecting and preserving groundwater resources is increasingly recognized. Several initiatives within the Plan Area highlight efforts to protect local waterways from the potential polluting effects of stormwaters while also enhancing or preserving groundwater recharge.

3.4.1 Municipal Stormwater Permit Program

U.S. EPA intended that storm water discharges from separate municipal storm sewer systems (MS4s) be primarily addressed through implementing Best Management Practices (BMPs), through an iterative approach rather than numerical effluent limitations (61 FR 43761). This approach may better address the intermittent and variable nature of storm flows and pollutant concentrations, and the current lack of data on effluent and receiving waters.

California's Municipal Storm Water Permitting Program regulates storm water discharges from MS4s through a permitting program. MS4s consist of drains, pipes, and ditches, which convey stormwaters to nearby streams, rivers, lakes, estuaries, basins, wetlands, and oceans. Storm water permits require permittees to develop and implement a storm water management plan with the goal of reducing pollutant discharges to the maximum extent practicable by using best management practices. The program areas include public education and outreach, illicit discharge detection and elimination, construction and post-construction monitoring and good housekeeping for municipal operations.

The Sonoma County Water Agency is a co-permittee with the City of Santa Rosa and the County of Sonoma inside the same MS4 permit boundary, incorporating most of the Plan Area. The City of Santa Rosa and unincorporated areas near the cities of Healdsburg, Windsor, Santa Rosa, Rohnert Park, Cotati, and Sebastopol are included in the permit.

To comply with the MS4 permit, the City of Santa Rosa and County of Sonoma developed a Low Impact Development Technical Design Manual, providing technical guidance for project designs that require the implementation of permanent stormwater BMPs. Low Impact Development (LID), as it relates to storm water, aims for a design to mimic the hydraulic function of the undeveloped site by capturing, treating, and infiltrating storm water as close to the source as possible, and locating small scale landscape�based features throughout the project site.

3.4.2 Water Smart Development Guidebook

The Water Agency developed the Water Smart Development Guidebook to provide Sonoma County land developers, city and county planning officials, and environmental regulatory agencies with a reference guide that can help them avoid and minimize potential adverse impacts to water resources from development projects. The guidebook provides guidance for planning and designing water resource related project elements for residential and commercial developments . The three core guidebook sections focus on ways to increase water conservation and water reuse, and reduce stormwater impacts. The guidebook is available online at: http://www.scwa.ca.gov/watersmartdevelopment/

3.4.3 Stormwater Management/Groundwater Recharge Scoping Study

In Fall 2010, the Water Agency initiated watershed scoping studies for flood-control/groundwater recharge projects in the Laguna de Santa Rosa, Petaluma, and Sonoma Valley Watersheds. The goal of the initial scoping studies (one in each watershed) is to establish the project objectives, identify potential project concepts, and determine at a preliminary level, the technical and practical feasibility of projects aimed to reduce flooding, while providing additional community benefits. The benefits could include groundwater recharge, water quality improvements, water supply improvements, improved ecosystem functions, preserving agricultural land use, preserving or enhancing open spaces, better system sustainability, or such benefits as recreation, public access, or education.

These studies are consistent with one of the strategies of the Water Agency's Water Supply Strategies Action Plan. More information is available at http://www.scwa.ca.gov/stormwater-groundwater/. The initial phase of the studies was completed in late summer 2012.

3.5 WATER QUALITY PROGRAMS

3.5.1 North Coast Regional Water Quality Control Board Basin Plan

The California legislature assigned primary responsibility for protecting and enhancing California's surface water and groundwater quality to the State Water Resources Control Board (State Water Board), and the nine regional water quality control boards (Regional Water Boards; or RWQCB).

The State Water Board provides state-level coordination for the water quality control program by establishing statewide policies and plans for implementing state and federal laws and regulations. The regional water boards adopt and implement water quality control plans (basin plans), recognizing the unique characteristics of each region's natural surface water and groundwater quality, actual and potential beneficial uses, and surface water and groundwater quality problems. Article 3 of Chapter 4 of the Porter-Cologne Act directs regional water boards to adopt, review, and revise basin plans, and provides specific guidance on factors which must be considered in adoption of surface water and groundwater quality objectives and implementation measures. The format for basin plans is described in Sections 13241-13247 of Porter-Cologne.

The SRPW Plan Area is located within the North Coast Region, which encompasses a total area of approximately 19,390 square miles. The North Coast RWQCB Basin Plan contains a brief description of the North Coast Region, and describes its water quality and quantity problems and the present and potential beneficial uses of the surface and ground waters within the Region. The Implementation Plans section describes measures, including specific prohibitions, action plans, and policies that form the basis for controlling surface water and groundwater quality. Statewide plans and policies are included, with a description of Regional Water Board surveillance and monitoring activities. The Basin Plan contains provisions for public participation, complies with the requirements of the California Environmental Quality Act, and establishes a setting and the framework for the development of discharger regulation.

The NCRWQCB's general and specific surface water and groundwater quality objectives, contained in the Basin Plan, are prescribed to protect beneficial uses. Whenever the existing water quality is better than the water quality objectives established in the Basin Plan, the objective is to maintain the existing quality, unless supplanted by other provisions of the State Water Resources Control Board Resolution No. 68-16, Statement of Policy with Respect to Maintaining High Quality of Waters in California. Water Quality Objectives for surface waters and groundwaters are generally set to prevent adverse effects on designated beneficial uses.

In 1995 the US EPA approved a TMDL as the Waste Reduction Strategy for the Laguna de Santa Rosa's high ammonia levels and low dissolved oxygen concentrations. This Waste Reduction Strategy is focused on reducing nitrogen loading from point and non-point sources.

Regional Water Board staff are developing additional TMDLs for limiting nitrogen, phosphorus, dissolved oxygen, temperature, and sediment in the Laguna de Santa Rosa watershed, to address the many and continuing water quality impairments. These TMDLs will apply to the entire Laguna de Santa Rosa watershed, including Mark West Creek, Santa Rosa Creek, and all the tributaries.

Designated beneficial uses for the Santa Rosa Plain are listed in Table 3-1. The Basin Plan includes natural or artificial groundwater recharge as a designated beneficial use of water for purposes of future extraction, maintenance of water quality, or for halting saltwater intrusion into freshwater aquifers.

Table 3-1 Beneficial Water Uses - North Coast Region.

The NCRWQCB Basin Plan is available online at:
http://www.waterboards.ca.gov/northcoast/water_issues/programs/basin_plan/basin_plan.shtml

3.5.2 Salt & Nutrient Management Plan

The State Water Resources Control Board adopted a Recycled Water Policy in February 2009. The purpose of the Policy is to increase the use of recycled water in a manner that implements state and federal water quality laws. The Recycled Water Policy requires that Salt and Nutrient Management Plans (SNMP) be completed by 2014 to facilitate basin-wide management of salts and nutrients from all sources, to optimize recycled water use while protecting groundwater supply and beneficial uses, agricultural beneficial uses, and human health.

The City of Santa Rosa has prepared a salt and nutrient management plan for the Santa Rosa Plain groundwater subbasin within the Plan Area and submitted it to the NCRWQCB. SNMP development included several public workshops that included local stakeholders. Components of the SNMP include:

- Water recycling goals and objectives
- Salt and nutrient source identification
- Basin loading - assimilative capacity estimates
- Anti-degradation analysis

- Implementation measures
- Basin-wide water quality monitoring
- Consideration of emerging constituents of concern

The SNMP concluded that basin-wide levels of salts (specifically TDS levels) and nutrients (specifically nitrate values) generally are below Water Quality Objectives, and are projected to increase very slowly over time. The contribution of future projected recycled water levels within the groundwater subbasin was estimated to be a minor component of projected increases. A groundwater quality monitoring program is recommended as part of SNMP implementation. The Santa Rosa Plain SNMP groundwater subbasin is available at: http://ci.santa-rosa.ca.us/departments/utilities/groundwater/SNMP

3.6 PERMITTING AND MONITORING OF WELLS

Sonoma County Permit and Resource Management Department (PRMD) is the local agency responsible for administering permits for wells within the Plan Area. PRMD reviews all development proposals within unincorporated areas that will rely on wells for water supply.

3.6.1 Permitting of Wells

The Sonoma County Well Ordinance contains regulations and requirements for constructing wells to prevent groundwater contamination from the surface, and between multiple water bearing zones in (Ordinance 25B). The well construction standard does not regulate flow volumes or rates, nor does it evaluate water availability or local hydrogeology.

PRMD has developed a four-tier classification system, based on geologic information and water yields, to designate general areas of groundwater availability (Figure 3-1). Class 1 areas are Major Groundwater Basins; Class 2 areas are Major Natural Recharge Areas; Class 3 areas are Marginal Groundwater Availability Areas; and Class 4 areas are Areas with Low or Highly Variable Water Yield. The web url is: http://www.sonomacounty.org/prmd/gisdata/pdfs/grndwater_avail_b_size.pdf

Figure 3-1 PRMD Groundwater Availability Classification Map.

PRMD uses this groundwater classification system map for reviewing certain development and building permit applications. Discretionary applications in Class 3 and 4 areas are required to include hydrogeologic reports to establish that groundwater quality and quantity are adequate and will not be adversely impacted by the cumulative developments and uses allowed in the area. The aim is to avoid causing or exacerbating an overdraft condition in a groundwater basin or subbasin. In addition, discretionary applications in Class 4 areas are required to complete an aquifer pumping test.

Additionally, the County commissioned a pilot study of 3 areas it determined to have relatively scarce groundwater, including portions of the Plan Area (Bennett Valley and Mark West Study Areas). The study examined climate, land use and the depths of wells drilled over time (Kleinfelder, 2003). Based on this pilot study, PRMD established permit requirements and guidelines for performing pump tests on new water-wells in water scarce areas. The study also recommended further studies of these water scarce areas.

Since 2004, PRMD has required groundwater-level measurement and volume reporting on a quarterly or monthly basis from commercial and industrial projects requiring a use permit, and using more than 0.5 afy of water.

3.6.2 Groundwater Level Monitoring

Numerous organizations within the Plan Area collect groundwater-level measurements, including: the State DWR, the Water Agency, Cities of Cotati, Rohnert Park, Santa Rosa, and Sebastopol; Town of Windsor, California American Water Company, Sonoma State University and many operators of small mutual water systems. PRMD also collects groundwater level data on certain commercial and high-capacity water wells. Groundwater levels are measured from a combination of private wells, dedicated monitoring wells and inactive and active public water supply wells. Additionally, local groundwater-level monitoring programs have been developed by the Sebastopol Water Information Group in the western portions of the Plan Area and by the Federated Indians of the Graton Rancheria in the southern portions of the Plan Area. Details of current groundwater-level monitoring efforts, and plans for coordinating and expanding the monitoring, are provided in Section 5.2.

The Water Agency is working on behalf of the County of Sonoma to comply with the recent California Statewide Groundwater Elevation Monitoring (CASGEM) Program (http://www.water.ca.gov/groundwater/casgem/). In the Santa Rosa Plain, a preliminary groundwater monitoring network has been established and data are being submitted to the CASGEM program online.

3.6.3 Groundwater Quality Monitoring

Groundwater quality monitoring is currently conducted by municipal water suppliers (e.g., Water Agency, Cotati, Rohnert Park, Santa Rosa, Sebastopol, Windsor), small water distribution systems, mutual water companies, historic long-term water quality monitoring by DWR. These state-mandated monitoring efforts, which help ensure that the public is provided with a safe, reliable drinking water supply, include the following existing programs:

- Water Agency, Cotati, Rohnert Park, Santa Rosa, Sebastopol, Windsor, small water distribution systems, and mutual water companies public supply wells are monitored as required by the California Department of Public Health (DPH).
- DWR monitors 35 private volunteer wells for specific water quality parameters including minerals, physical properties and temperature.

- USGS collected groundwater quality samples from 34 wells as part of the SRP Study and the GAMA study.
- Extensive water quality monitoring is also conducted at numerous contaminant release sites within the Plan area and reported to state and local regulatory agencies.

More information on these existing groundwater quality monitoring programs is provided in Section 5.2.

3.7 CITY AND COUNTY PLANNING AND WATER RESOURCES

There are a number of current city and county planning activities that are directly or indirectly linked with water supply and groundwater management. These include:

- General Plans
- California Environmental Quality Act
- Implementation of Green Building Standards

3.7.1 General Plans

Counties and cities are required to develop and adopt comprehensive general plans to guide future local physical development, as required in California State Government Code Title 7, Division 1, Article 5, Section 65300 et seq. Each general plan must contain a statement of policies, including maps or diagrams and text, setting forth objectives, principles, standards, and plan proposals. City general plans are focused on providing guidance on growth and development in the urban setting, while the county general plan focuses on the unincorporated areas of the county.

The seven mandatory elements of a general plan are Land Use, Circulation, Housing, Conservation, Open Space, Noise and Safety, although the degree of specificity and level of detail varies dependent upon local circumstances and programmatic needs. The Conservation element is typically where water resources are addressed in a general plan, although other water related topics may also addressed in other elements.

3.7.1.1 Sonoma County General Plan 2020

In recognition of the importance of water resources within unincorporated areas of the county, an optional, new Water Resource Element (WRE) was developed and included in the Sonoma County General Plan 2020. The main purpose of the Water Resources Element is to ensure that Sonoma County's water resources are sustained and protected. To achieve this main purpose, the Water Resources Element states that water resource management should consider the amount of quality water that can be used without exceeding the replenishment rates over time or causing long term declines or degradation in available surface water or groundwater resources.

The Water Resources Element includes goals, objectives and policies for water quality, groundwater, public water systems, conservation & reuse, importing &

exporting, and watershed management. These goals, objectives and policies include supporting local groundwater studies and management programs, encouraging activities that protect natural groundwater recharge areas. The Water Resources Element for the Sonoma County General Plan 2020 can be reviewed at http://www.sonoma-county.org/prmd/gp2020/wre.pdf.

The Water Resources Element groundwater related goals include:

- Protect, restore, and enhance the quality of surface and groundwater resources to meet the needs of all reasonable beneficial uses.
- Manage groundwater as a valuable and limited shared resource.
- Assure that new proposals for surface and groundwater imports and exports are consistent with Sonoma County's ability to sustain an adequate supply of high quality water for all its water uses and dependent natural resources.
- Improve understanding, valuation and sound management of the water resources in Sonoma County's diverse watersheds.

Other water related topics incorporated in the Sonoma County General Plan 2020 include water availability as a factor in Land Use Map densities that is addressed in the Land Use Element. The Open Space and Resource Conservation Element addresses riparian corridors, wetlands, wildlife protection, tree protection, fishery resources and other biotic resources, water oriented recreation, soil erosion, forestry, and mineral resources. The Public Facilities and Services Element addresses connections to public water systems. The Public Safety Element addresses flood hazards, fire suppression, and hazardous materials. The Agricultural Resources Element addresses aquaculture.

3.7.1.2 Municipal General Plans

City General Plans guide growth and development in the urban community, and typically involve an urban growth boundary and significant community involvement. The Urban Water Management Plans and General Plans are clearly linked: UWMPs calculate future water demand based on growth and development projected in the General Plan.

3.7.2 California Environmental Quality Act

The California Environmental Quality Act (CEQA) requires state and local agencies to identify the significant environmental impacts of their actions and to avoid or mitigate those impacts, if feasible. CEQA applies to certain activities of state and local public agencies. A local agency must comply with CEQA when it undertakes an activity defined by CEQA as a "project." A project is an activity undertaken by a public agency or a private activity that must receive some discretionary approval (meaning that the agency exercises judgment in deciding whether to approve or deny a requested permit, as opposed to using only fixed, objective standards) from a government agency, which may cause either a direct physical change in the environment or a reasonably foreseeable indirect change in the environment.

Most proposals for physical development in California are subject to the provisions of CEQA, as are many governmental decisions that do not immediately result in physical development (such as adoption of a general or community plan). Every development project that requires a discretionary local agency approval will require at least some environmental review pursuant to CEQA, unless an exemption applies.

A CEQA environmental review imposes both procedural and substantive requirements. At a minimum, an initial review of the project and its environmental effects must be conducted to assess if the proposed project will have a significant impact on resources, for example verifying that the proposed project will maintain the predevelopment level of recharge. Depending on the potential effects, a further, and more substantial review may be conducted in the form of an environmental impact report (EIR). A project may be approved as submitted if feasible alternatives or mitigation measures are proposed that can substantially lessen the potential significant environmental effects of the project.

3.7.3 California Green Buildings Standard Code

The California Green Building Standards Code (CALGreen Code), Part 11 of 12 of the California Building Standards Code, California Code of Regulations, Title 24, updated in 2010, became effective at the beginning of 2011. A green building, also known as a sustainable building, is a structure that is designed, built, renovated, operated, or reused in an ecological and resource-efficient manner. Green buildings are designed to meet certain objectives such as protecting occupant health; improving employee productivity; using energy, water, and other resources more efficiently; and reducing the overall impact to the environment. The CALGreen Code requires by law that all new construction projects must apply Low Impact development (LID) approaches to decentralize and integrate into design stormwater treatment. The LID approach may include use of pervious paving, rain gardens, rain water collection, swales, infiltration structures etc., to maintain predevelopment hydrologic condition on the post development site.

City and County Agencies are responsible for implementing the CALGreen Code requirements. Local agencies have developed specific requirements that meet or exceed the CALGreen requirements for building and landscape plans and construction. For a new construction project, a local agency reviews the required plans and design before issuing a building permit. The local agency also inspects progress during construction and at the project's completion to assure compliance.

3.8 WATER-ENERGY NEXUS

The interconnection between water and energy use is recognized as being an important nexus: significant amounts of energy are commonly needed to extract and transport water from its source to place of use and significant amounts of water are commonly needed for energy production. Therefore, measures to reduce water use and improve water use efficiency have the added benefit of reducing energy needs and measures that reduce energy use can also conserve water resources.

Recognizing this connection, many efforts have been made in Sonoma County to conserve water (described above in Section 3.2) and energy. For example, being the largest energy user in Sonoma County, in 2006, the Water Agency committed to the goal of operating a carbon free water system by 2015. To achieve this goal, the Water Agency is actively working to diversify its energy portfolio and reduce its energy and fuel needs through efficiency and renewable energy production.

Additionally, Sonoma Clean Power (SCP) is the new, locally controlled electricity provider in Sonoma County. Sonoma Clean Power provides residential and business customers across the county the option of using environmentally friendly power generated by renewable sources (like solar, wind, and geothermal).
Several other local initiatives and programs are also underway to facilitate the reduction of the carbon footprint of our water supply and operations.

- **Applied Solutions -** Applied Solutions is a group of counties and cities across the country that is working to develop replicable, integrated, and sustainable community infrastructure projects. These communities are developing infrastructure that achieves four goals: 1) reduces water use; 2) reduces energy use; 3) reduces petroleum-based single-car transportation; and 4) reduces greenhouse gas emissions.
- **Sonoma County Efficiency Financing (SCEF) Program** - The Sonoma County Water Agency is launching a program to finance energy efficiency and water efficiency retrofits for public and non-profit facilities.
- **Bay Area Green Business Certification -** The Bay Area Green Business Program is a partnership of environmental agencies and utilities. This partnership recognizes and certifies the efforts of businesses that protect, preserve, and sustain the environment. It also offers incentives and verifies that members conserve energy and water, minimize waste, prevent pollution, and shrink their carbon footprints.
- **Sonoma County Energy Independence Program (SCEIP) -** The County of Sonoma partnered with the Water Agency to launch this innovative program in late March 2009. SCEIP is a financing mechanism through the County to help home and building owners finance energy and water efficiency retrofits, as well as installation of renewable energy systems.

4.0 GOALS & OBJECTIVES

4.1 INTRODUCTION

This Plan includes an overall goal and a set of basin management objectives, described in the following sections. Section 5 describes in more details the plan management components that outline a series of activities and actions necessary to meet the Plan goal and basin management objectives. The Plan goal, objectives and management components are listed in Table 4-1.

4.2 PLAN GOAL

The goal of the Plan, developed by the Panel, is to locally manage and protect groundwater resources by a balanced group of stakeholders through non-regulatory measures to support all beneficial uses, including human, agriculture, and ecosystems, in an environmentally sound, economical, and equitable manner for present and future generations.

4.3 BASIN MANAGEMENT OBJECTIVES

The Basin Management Objectives (BMOs) are the measurable and/or verifiable accomplishments required to meet the overall goal of the groundwater management program (see Section 1.0). For each BMO identified in this section, cross-references are provided to plan actions identified in subsequent chapters of the Plan.

Panel members developed the BMOs were developed through an iterative and collaborative process, which included outreach by Panel members to constituency groups for input and feedback from the larger stakeholder community. The BMOs described below have been grouped into the following general focus areas:

- Stakeholder Involvement and Public Awareness
- Monitoring and Modeling
- Groundwater Protection
- Increase Water Conservation
- Increase Water Reuse
- Integrated Groundwater Management

4.3.1 Stakeholder Involvement and Public Awareness

Stakeholder involvement and public awareness helps facilitate a healthy, productive groundwater management plan development and program implementation; it is also required under the California Water Code. The Plan calls for an ongoing stakeholder forum, and for disseminating information and current media releases to educate and improve the public and stakeholder awareness of water and groundwater supplies and management issues, help secure local support of the plan,

Goal: *to locally manage and protect groundwater resources by a balanced group of stakeholders through non-regulatory measures to support all beneficial uses, including human, agriculture, and ecosystems, in an environmentally sound, economical, and equitable manner for present and future generations.*	
Stakeholder Involvement and Public Awareness	
BMO-1	Public Information Accessibility and Forums - Provide useful information through the internet and public forums to members of the public, and receive public input at key milestones
BMO-2	Increase Public Water Awareness - Provide information to increase public awareness of current surface water and groundwater supplies and demands, and consider climate change scenarios
Monitoring and Modeling	
BMO-3	Groundwater Elevations - Measure groundwater elevations and foster activities aimed at maintaining groundwater elevations to support all beneficial uses
BMO-4	Surface Water-Groundwater Interaction - Evaluate surface water and groundwater interactions and protect against adverse impacts
BMO-5	Water Quality – Monitor groundwater quality and foster activities promoting protection and improvement
BMO-6	Land Subsidence – Monitor for land subsidence and foster activities aimed at protecting against loss of groundwater storage capacity
BMO-7	Rainfall – Monitor rainfall to improve understanding of rainfall distribution and intensity
BMO-8	Modeling – Maintain and update the integrated surface water/groundwater model at an appropriate frequency based on new data availability to track and assess the water budget
Groundwater Protection	
BMO-9	Recharge Area Protection – Identify, map and encourage protection of recharge areas
BMO-10	Wells and Groundwater Protection - Encourage best practices and proper permitting for the construction, placement, reconstruction and destruction of all wells
Increase Water Conservation	
BMO-11	Water Conservation and Efficiency - Promote actions to conserve and reduce water usage and increase water and energy efficiency
Increase Groundwater Recharge	
BMO-12	Recharge Enhancement – Consider, evaluate, and where appropriate, promote activities to enhance groundwater recharge (i.e. supply) while protecting or improving groundwater quality
Increase Water Reuse	
BMO-13	Water Reuse - Increase water reuse in a safe and environmentally sound manner
Integrated Groundwater Management	
BMO-14	Interagency Coordination and Partnerships - Improve coordination and interaction between water resource management agencies and further cultivate state and federal partnerships for program implementation
BMO-15	Conjunctive Management - Conjunctively manage surface water and groundwater
BMO-16	Water-Land Use Planning Coordination - Coordinate surface water and groundwater management with land use planning and development
BMO-17	Urban-Rural Shared Stewardship - Foster shared management and stewardship responsibilities among urban and rural stakeholders
BMO-18	Climate Change Planning - Promote water supply reliability and drought resiliency by incorporating climate change planning into existing and future local and regional plans

Table 4-1 Plan Goal, Objectives and Management Components.

and ensure collaboration in addressing future challenges during program implementation.

BMO-1 Public Information Accessibility and Forums - Provide useful information through the internet and public forums to members of the public, and receive public input at key milestones

The Plan envisions continual access to available information about the groundwater plan and program implementation process management resources, activities, and results through open Panel and TAC meetings, other public forums, the news media, and the program website. Public input from sources outside the stakeholder advisory groups will be sought for specific Plan projects and at key Plan implementation milestones. The Plan intends widespread public noticing and outreach efforts to stimulate attendance at forums, and solicit public feedback to strengthen the groundwater management program. The Plan also calls for making information easily accessible and understandable to varied audiences.

BMO-2 Increase Public Water Awareness - Provide information to increase public awareness of current surface water and groundwater supplies and demands, and consider climate change scenarios

The Plan calls for efforts to increase public awareness of historical and current surface water and groundwater supplies and demands (per capita use), and how they may be affected by climate change including droughts. Potential hydrologic effects from climate change suggest more frequent, less intensive rainfall events will be replaced by less frequent more intensive extreme weather events than have been recorded since the 19th Century settlement of the Plan Area. The projected conditions may produce less reliable surface water and groundwater supplies in the future. Providing information on current water supplies and the likely impacts of climate change on water supply reliability will help increase public awareness of future challenges to providing and managing a reliable water supply for existing and growing populations.

4.3.2 Monitoring and Modeling

Monitoring and modeling have been identified by the Panel as key for measuring and assessing water resources in the Plan Area and simulating and planning for various climate and proposed project scenarios. The Plan will provide consistent and ongoing comprehensive data collection, data management, and monitoring programs and analytical tools.

BMO-3 Groundwater Elevations - Measure groundwater elevations and foster activities aimed at maintaining groundwater elevations to support all beneficial uses

The lowering of groundwater levels can have adverse impacts that include increased energy costs for pumping, the need to deepen existing wells or construct new ones, and adverse impacts on water quantity and quality. The Plan intends to minimize potential impacts related to groundwater pumping and maintain or improve overall groundwater levels in the Plan Area for the foreseeable future.

BMO-4 Surface Water-Groundwater Interaction - Evaluate surface water and groundwater interactions and protect against adverse impacts

The Plan is committed to preserving the fishery, wildlife, recreational and aesthetic values of the streams and the Laguna de Santa Rosa, and also to assuring a stable supply of water for residences, agriculture, and businesses. Use of groundwater for rural and urban water supplies should not decrease surface water flows in streams, thus impacting water quality and ecosystems. The Plan also calls for establishing a better understanding of potential impacts from local groundwater discharges to surface water channels that may contribute to total dissolved solids content. The Plan identifies surveys and studies to better understand the interaction between surface water flows and groundwater for improved management and possible mitigation measures if necessary.

BMO-5 Water Quality – Monitor groundwater quality and foster activities promoting protection and improvement

Beneficial uses of groundwater in the Plan Area should not be limited by contamination, and should not degrade water quality. Where contamination is documented, or occurs in the future, the Plan provides that appropriate state and federal regulatory agencies coordinate actions that will contain and eventually remediate the contamination. The Plan calls for continued and enhanced monitoring of groundwater quality trends, and for studies to assess any significant pollution issues in the Plan Area. The Plan investigates potential water management strategies including increased irrigation with recycled water, groundwater recharge, and conjunctive use, all of which would be designed to help protect and improve groundwater quality in the Plan Area.

BMO-6 Land Subsidence – Monitor for land subsidence and foster activities aimed at protecting against loss of groundwater storage capacity

Land subsidence can cause significant damage to essential infrastructure and decrease the capacity of the underlying groundwater reservoir. With no physical evidence of groundwater extraction-related land subsidence, such as damage to wells or infrastructure, potential subsidence related to past, present, or future groundwater pumping has not been fully evaluated in the Plan Area. The Plan calls for efforts to evaluate the present potential for groundwater extraction-related land subsidence, and to periodically assess the potential for future subsidence. The Plan also calls for reducing potential groundwater pumping impacts and improving groundwater levels in the Plan Area to help protect against land subsidence and the possible loss of groundwater storage capacity.

BMO-7 Rainfall – Monitor rainfall to improve understanding of rainfall distribution and intensity

Rainfall distribution is highly variable in the Plan Area, especially across highlands, and current rainfall monitoring is inadequate measuring the Plan Area rainfall variability. New studies of rainfall patterns show the presence and influence of atmospheric rivers, which are long, narrow streams of precipitation that concentrate rainfall in narrow bands, reducing the opportunity for recharge as would occur with more widely distributed rainfall, and also which can cause flooding in the Plan Area. The Plan calls for additional rainfall monitoring to improve the understanding of the water budget and surface water-groundwater model for the Plan Area.

BMO-8 Modeling – Maintain and update the integrated surface water/groundwater model at an appropriate frequency based on new data availability to track and assess the water budget

The USGS study (USGS, 2013) identifies data gaps in the current understanding of the Plan Area water interactions, and outlines the need for additional streamflow and groundwater use data, and additional information on hydrogeologic connections. The Plan calls for maintaining and improving the database developed for the study, and for updating and improving the groundwater simulation model over time through the incorporation of new and additional data from future monitoring, surveys and studies.

4.3.3 Groundwater Protection

Protection of the quantity and quality of groundwater supplies for future beneficial uses is essential. Land use activities involving hazardous substances can degrade water quality, and constructed hardscapes can impede direct percolation and increase runoff. The Plan intends to advance groundwater protection of groundwater and enhance recharge through its management objectives.

BMO-9 Recharge Area Protection – Identify, map and encourage protection of recharge areas

Identifying and delineating groundwater recharge areas are critically important actions for protecting and enhancing groundwater recharge in the Plan Area. The Plan calls for studies to further identify and map groundwater recharge areas, and to share information from the studies with planners for incorporating and promoting groundwater recharge protection in land use planning and development.

BMO-10 Wells and Groundwater Protection - Encourage best practices and proper permitting for the construction, placement, reconstruction and destruction of all wells

Improperly constructed wells can act as conduits that connect aquifers and provide a pathway for mixing waters of varying quality with the potential for groundwater quality degradation. Abandoned wells that are not properly destroyed and sealed also raise the potential for groundwater quality degradation if contamination reaches the well. The Plan will provide input to local agency permitting requirements that might assist to reduce the risk of groundwater quality degradation from improperly constructed or abandoned wells. The Plan includes additional actions and activities to provide well owners with information on well maintenance and to encourage the proper destruction and sealing of abandoned wells.

4.3.4 Increase Water Conservation

The Plan recognizes the need for improved water conservation, and water and energy efficiency practices and approaches. Increased water conservation and efficiency can help contribute to reducing water demands and wastewater volumes, and increase water supply reliability.

BMO-11 Water Conservation and Efficiency - Promote actions to conserve and reduce water usage and increase water and energy efficiency

Many successful water conservation programs are currently being implemented, and the Panel acknowledges that more conservation can be implemented across the Plan Area. Actions proposed in the Plan, including outreach to the general public for added conservation and efficiency in residential and agricultural practices, are intended to highlight and improve all aspects of water conservation, and increase efficient use of water and energy.

4.3.5 Increase Groundwater Recharge

Sustaining the quantity of groundwater supplies for future beneficial uses is essential. Several studies to increase recharge are looking at capturing stormwater and recharging Russian River water when it is available. The Plan intends to enhance and increase groundwater recharge through its management objectives.

BMO-12 Recharge Enhancement – Consider, evaluate, and where appropriate, promote activities to enhance groundwater recharge (i.e. supply) while protecting or improving groundwater quality

Engineering projects to enhance groundwater recharge are typical components of conjunctive management programs, and are being studied as potential components of the Plan. Actively recharging groundwater with wells and spreading basins provides the opportunity to raise groundwater levels where they have lowered and bank groundwater for drier years. The Plan includes actions and activities to further assess the feasibility of recharging groundwater with wintertime Russian River water flows and with local stormwater, when available, while protecting or improving water quality.

4.3.6 Increase Water Reuse

The Plan recognizes water reuse, where feasible and appropriate, as an important tool for reducing the irrigation demand for potable water and groundwater. Water reuse currently occurs across multiple scales throughout the Plan Area, ranging from large-scale municipal recycled water programs to graywater systems developed by individual property owners. The Plan intends to promote the increased responsible and appropriate reuse of water to the extent feasible.

BMO-13 Water Reuse - Increase water reuse in a safe, appropriate and environmentally sound manner

Increased use of recycled water (water reuse), where appropriate and feasible, is a key water management option for the Plan Area to enhance water supply reliability and reduce demands on groundwater and surface water resources. Compared to other water management options, the use of recycled water for irrigation has already increased significantly in the Plan Area, with more capacity for future expansion. The Plan calls for an assessment of the public acceptability, feasibility and capacity to increase appropriate recycled water use at the local level.

4.3.7 Integrated Groundwater Management

Integrated groundwater management means developing management objectives and actions, and adopting policies that recognize the connections between groundwater and all components of the watershed including rivers, wetlands, other ecosystems, and surface water and groundwater users. Groundwater management is integrated when planning and policy decisions consider the way groundwater uses affect surface water resources, land uses, and the natural ecosystems in a changing climate, and how surface water uses may affect groundwater supplies. The Plan views groundwater management as a means to recognize and help to address potential impacts on surface waters and groundwater resources, including groundwater-dependent ecosystems, while not constraining groundwater use.

BMO-14 Interagency Coordination and Partnerships - Improve coordination and interaction between water resource management agencies and further cultivate state and federal partnerships for program implementation

Managing water resources involves a complex of policy, legal, institutional, technical and economic factors for decision-making. A number of federal, state and local agencies are involved in water resources management decision-making which affect the Plan Area. Improving coordination and interaction between these various agencies will help facilitate integrated groundwater management at the local level. State and federal partnerships are fundamental to helping position the Plan for funding opportunities. The Plan provides the collaborative and institutional foundation to seek state and federal grant and loan opportunities and in-kind services to carry out activities. The Plan intent is to further develop and cultivate long-term relationships and partnerships with a number of state and federal agencies.

BMO-15 Conjunctive Management - Conjunctively manage surface water and groundwater

Conjunctive management (or conjunctive use) is the planned and coordinated management of both surface water and groundwater resources to meet water requirements in a manner that balances and optimizes the supplies of both, and improves water supply availability and reliability. During seasonally wet times and periods of above-normal precipitation, the Plan seeks to promote the use of available surface water sources and recharge of groundwater supplies (as feasible), thereby conserving groundwater supplies for dry periods and droughts.

BMO-16 Water-Land Use Planning Coordination - Coordinate surface water and groundwater management with land use planning and development

Water resource availability and water supply source identification need to be better coordinated in land use planning decision-making. The Panel proposes to coordinate and inform land use planning with planning and implementation of surface water and groundwater management programs and activities. The Plan will provide an informational resource of best available science to all participants (water providers, planners, decision-makers, business, urban, agricultural environmental, and rural stakeholders) for integrating groundwater management concepts into the planning and development process. The Plan also calls for advancing and encouraging increased coordination between Sonoma County, local municipalities and water providers on General Plan and other land use planning activities.

BMO-17 Urban-Rural Shared Stewardship - Foster shared management and stewardship responsibilities among urban and rural stakeholders

As described in the Basin Advisory Panel Charter and Governance Proposal, the Panel developed this voluntary, non-regulatory Plan and guides its implementation by working towards consensus as a fundamental principle. The Panel is composed of a broad base of stakeholders, including urban and rural groundwater users, who share the responsibility to guide implementation of the Plan. Panel members will engage urban and rural groundwater user constituencies to develop shared management; both are groundwater users with demands to be met and stewardship responsibilities for maintaining sustainable supplies.

BMO-18 Climate Change Planning - Promote water supply reliability and drought resiliency by incorporating climate change planning into existing and future local and regional plans

Preparing for a future of rapid climate change implicates water supply, water quality, flooding, drought, and ecosystem health requiring local and regional information on potential changes to climate patterns, and on the subsequent response of the hydrologic and ecosystems. The Plan calls for water supply management decision-making based on the best available science and information at the basin scale. The Plan supports ongoing and additional region- and basin-specific climate change studies to assess the potential effects on surface water and groundwater supplies, along with additional vulnerability and resilience studies. These climate change studies form the basis for preparing and planning a reliable and drought-resilient future water supply. The Plan also calls for conjunctive management operations and enhanced groundwater recharge, which is to assist in securing a reliable water supply under future changing climate conditions. The Plan also calls for improving coordination and interaction between federal, state and local agencies to more effectively incorporate the potential affects of altered climate patterns on surface water and groundwater supplies into existing and future local and regional planning processes.

5.0 GROUNDWATER MANAGEMENT PLAN COMPONENTS

The Plan includes a variety of components that are required by Water Code § 10753.7, recommended in DWR Bulletin 118 California's Groundwater (DWR 2003), and identified as optional programs under Water Code § 10753.8. It also includes groundwater management elements already in place. These components are grouped into five general categories:

5.1 Stakeholder Involvement
5.2 Monitoring Program & Modeling
5.3 Groundwater Protection
5.4 Increase Conservation & Efficiency
5.5 Increase Groundwater Recharge
5.6 Increase Water Reuse
5.7 Integrated Groundwater Management

These components or programs are presented in this section and summarized in Table 5-1 for reference. The table correlates the activities that are related to one or more BMO. Each component includes discussion, recommended actions, and identification of the objectives toward which the component is directed. Recommended actions can fall under the categories of projects, which are implementations actions to address a particular BMO, and studies, which are efforts to gather data in order to implement an eventual project. Recommended actions that are implemented are to protect and enhance the reliability of our groundwater resources based on the best science and technology currently available. Note that the proposed management components are logically sequenced but that none are necessarily more important than others, and many actions will require funding and their implementation is thus dependent on obtaining such funding. Coordination of agencies and organizations conducting or planning water and groundwater related activities, studies and projects is strongly encouraged, although Panel approval is not required prior to implementing any activity, study or project.

Table 5-1 Summary of Groundwater Management Objectives and Management Components.

5.1 COMPONENT 1 – STAKEHOLDER INVOLVEMENT

Stakeholder involvement forms the foundation for a continued, collaborative process of decision-making and action during Plan implementation. The Plan calls for active participation of a broad group of stakeholders as a key component to sustaining a successful, collaborative process during Plan implementation, as outlined in the SRPGMP Communication and Outreach Plan (CCP 2012) (Section 6.1).

Several methods to achieve broad stakeholder participation will be employed during the implementation of the Plan, including: 1) involving the public, 2) using advisory groups, 3) informing public agencies, stakeholders, and public schools, and 4) facilitating partnerships between stakeholders and agencies. Each of these methods is discussed further below

5.1.1 Involving the Public

The Water Agency and Panel will involve the public in Plan implementation. Involving the public includes regular communications about the Plan implementation, conducting outreach and education, and notifying the public on key issues and milestones. The Plan supports engaging the public in groundwater management and providing opportunities for individuals and groups for access to information and involvement at regular meetings to comment on implementation issues. The Water Agency and Panel will implement a public outreach plan with strategies for managing a web site and carrying out these activities with the aim of communicating with urban, rural, agricultural, business and environmental stakeholder audiences both within and outside the Santa Rosa Plain Watershed.

In 2010, the Agency created a website for the project: http://www.scwa.ca.gov/srgroundwater/. The Water Agency will use its website to distribute information on Plan implementation activities to the public, and to ensure program information is readily accessible through the Internet.

Recommended Actions:

1) Circulate copies and publish the adopted Plan and subsequent periodic reports on website.
2) Develop an informational flyer on the Plan to accompany mailings from water agencies and companies, as well as mailings to private well owners.
3) Develop and execute a Public Outreach Plan for Plan implementation, which will help maximize outreach on implementation activities, and will encourage public attendance at key advisory meetings and workshops for input.
4) Develop outreach information that is comprehensible by public members with different levels of education and technical knowledge.
5) Conduct public forums at key milestones to encourage public participation.
6) Maintain email and postal mail lists to announce meetings and keep interested parties informed about Plan implementation.
7) Invite interested parties to participate in Panel meetings.
8) Meet with representatives from interested organizations as appropriate and get feedback.
9) Coordinate meetings and conduct briefings within the SRPW to provide information and solicit and report input on the management responsibilities and activities relative to this Plan.

5.1.2 Advisory Groups

The Water Agency will seek and follow recommendations of the Panel in the implementation of the Plan as described in Section 6.1. Additionally, the Water

Agency will continue to convene a TAC on an as-needed basis for regular input on technical aspects of Plan implementation.

Recommended Actions:

1) Following Plan adoption, the current Panel will discuss and recommend the composition of the Panel and the Technical Advisory Committee for Plan implementation.
2) Conduct quarterly meetings with the Panel to inform and seek guidance on implementation.
3) Conduct monthly TAC meetings, as needed, to obtain technical input on the various aspects of Plan implementation.

5.1.3 Informing Stakeholders & Public Agencies

The Water Agency and Panel will maintain good communication and foster further involvement with public agencies and stakeholders. Once implementation of the Plan begins, the Water Agency and Panel will be responsible for ensuring relevant public agencies and elected officials are informed on the activities conducted under the Plan.

Recommended Actions:

1) Continue to maintain and further develop relationships with local, state and federal agencies and organizations to benefit Plan implementation while maintaining local control.
2) Coordinate and inform land use planning with surface water and groundwater management activities by providing periodic briefings on water and groundwater management activities to local land use planning agencies.
3) Conduct briefings with the elected officials who have adopted the Plan in conjunction with implementation milestones and annual reporting.
4) Provide information to increase public awareness of current and future water supplies, demands, and trends in reliability related to a changing climate.

5.1.4 Partnerships & Coordination

The Panel will facilitate partnerships and develop relationships at the local, state, and federal levels. Over the past decade, the SRPW area water users and other local leaders have made great strides in regional planning and collaboration on water issues. Several important partnerships have facilitated project implementation providing benefits to water agencies, their customers, and other groundwater users. For example, the Water Agency, City of Cotati, City of Sebastopol, City of Santa Rosa, Town of Windsor, County of Sonoma, and the California American Water District formed a cooperative partnership to fund the development of this Plan; and the same local agencies and the USGS conducted an assessment of SRPW groundwater resources (USGS, 2013) through a cooperative agreement.

Facilities necessary to implement and expand conjunctive use programs in the SRPW could help to achieve broader regional and statewide benefits. These facilities, however, would require substantial resources, and might best be pursued through partnerships with potential beneficiaries, and through seeking grant funding. Potential partners include California Department of Water Resources, State Water Resources Control Board, California Department of Public Health, and US Army Corps of Engineers.

Recommended Actions:

1) Continue to promote partnerships that achieve goal and objectives of the Plan
2) Coordinate Plan implementation activities, collaborate and work to the extent practicable with resource conservation districts, watershed groups, local stewardship groups, water interest groups, land use planning and management agencies, and state and federal regulatory agencies that have jurisdiction in areas related to Plan activities.
3) Coordinate efforts to seek grant funding for Plan recommended actions in the Plan Area.

5.2 COMPONENT 2 – MONITORING PROGRAM & MODELING

Monitoring and modeling have been identified by the Panel as a key component of the Plan to be able to measure and assess the water resources in the Plan Area and to simulate and plan for various climate and proposed project scenarios.

5.2.1 Monitoring Program

An important component of the Plan is to establish a comprehensive, long-term monitoring program capable of evaluating changes in groundwater resources within the Plan Area over time, and validating the hydrogeologic conceptual model and numerical flow model. Groundwater management cannot be accomplished without the monitoring and measurement of basic hydrologic parameters in the basin, because:

- Groundwater systems are dynamic and adjust continually to short-term and long-term changes in climate, groundwater withdrawal and recharge, and land use.
- Monitoring provides information on the status of the resource.
- Monitoring is the principal source of information about the hydrologic stresses on aquifers and the way these stresses affect groundwater recharge, storage and discharge.

A monitoring program is also a required component in the Water Code (Reference Section 1.0).

The Plan monitoring program contains the following elements (Table 5-1):

1) Groundwater-Level Elevation Monitoring.
2) Groundwater Quality Monitoring.
3) Inelastic Land Surface Subsidence Monitoring.
4) Surface Water-Groundwater Interaction Monitoring.
5) Hydro-Meteorological Monitoring.
6) Monitoring Protocols.

7) Data Management.
8) Prioritizing Data Needs.

The monitoring data will be used on an annual or bi-annual basis to comprehensively evaluate the state of groundwater resources within the Plan Area, to periodically update and improve the monitoring program, and to help make decisions on water management strategies.

Goals of the Plan Monitoring Program

The following goals have been developed for the Plan Monitoring Program:

- Develop and maintain sufficient data of adequate quality to assess the status and trends of groundwater-levels, groundwater quality and surface water/groundwater interaction within the basin and responses to future management actions.
- Establish monitoring protocols to ensure the adequacy, quality and consistency of data collected, and a framework and format for data collection and maintenance.
- Provide data to evaluate model predictions and to support updates and improvements to the surface water-groundwater flow model.
- All available monitoring data should be screened, qualified, and either incorporated in the database or archived.
- Make non-confidential data available to all stakeholders in the Plan Area.

Data Objectives have also been developed for each monitoring element, and are listed in the monitoring elements subsection.

Statutory Groundwater Management Plans require that the local agency shall adopt monitoring protocols designed to detect changes in groundwater levels, groundwater quality, and also to investigate inelastic surface subsidence for basins in which subsidence has been identified as a potential problem. The monitoring protocols should also be able to detect changes in the flow and quality of surface water that directly affect groundwater levels or quality, or that are caused by groundwater pumping in the Plan Area. The monitoring protocols shall be designed to generate information that achieves these standards and promotes efficient, effective groundwater management.

5.2.1.1 Groundwater-Level Monitoring

Table 5-2 and Figure 5-1 show current groundwater level monitoring programs (CASGEM, DWR, water suppliers and other volunteer efforts) in the Plan Area. Additional details on the existing groundwater-level monitoring wells, including the well depth range (where known) and the type of well and associated program are in Appendix F.

Figure 5-1 Groundwater Level Monitoring Well Locations.

Table 5-2 Existing Monitoring Program.

Groundwater Level Monitoring - Existing

DWR has measured groundwater levels in a network of wells within the Santa Rosa Plain Groundwater Subbasin for a number of decades. Most of these wells were incorporated into DWR's monitoring network between the mid-1950's and 1981. Measurements are generally collected from these wells semiannually in the spring and fall, although a subset of wells are monitored on a monthly basis. DWR currently monitors a total of 23 private wells in the Santa Rosa Plain Groundwater Subbasin.

Since 2004, PRMD also administers the Use Permit Groundwater Monitoring Program, which requires the measurement and reporting of groundwater-levels on a quarterly or monthly basis for commercial and industrial projects requiring a use permit and using over 0.5 afy of water. Ten private water wells are currently monitored and reported to PRMD under this program within the Santa Rosa Plain Groundwater Subbasin.

Groundwater-level measurements are also collected by the Water Agency, Cities of Santa Rosa, Rohnert Park, Cotati, Sebastopol, Town of Windsor, California American Water Company, Sonoma State University and many operators of small mutual water systems from a combination of dedicated monitoring wells and inactive and active public water supply wells. In addition, the SWRCB GeoTracker program provides groundwater level monitoring data on a number of soil and groundwater cleanup sites in the Plan Area.

The DWR CASGEM program is a state program to compile groundwater level monitoring data statewide from local monitoring programs. A subset of the Plan Area groundwater level monitoring data are reported to the CASGEM program.

Some parts of the Plan Area still have inadequate groundwater level monitoring to assess their trends and status. The following general areas have been preliminarily identified as potential data gaps in the proposed monitoring program:

- Northern portions of the Plan area (vicinity of the Town of Windsor).
- East-central portions of the Plan area (vicinity of the City of Santa Rosa).
- Southwestern portions of the Plan area.
- Upland areas underlain by the Sonoma Volcanics and bedrock.

Groundwater Level Monitoring - Proposed

Based on evaluation of spatial well distribution, well-screened intervals and hydrogeology, an expanded groundwater level monitoring program is envisioned. Additional groundwater level monitoring wells are planned to be added to the current Plan Area monitoring effort beginning in the first year of Plan implementation. As part of the process for establishing the groundwater-level monitoring network, criteria will be developed for selecting suitable wells to be used for monitoring, such as known well construction details, age and condition of the well, and access for monitoring instrumentation.

A long-term groundwater level monitoring program for the Plan Area is planned to be established that incorporates:

1) Coordinate collection of groundwater elevations on a minimum semiannual basis (spring and fall), and prioritize specific areas where more frequent groundwater elevation monitoring may be desirable (e.g., quarterly or monthly, in recharge and discharge areas).
2) Existing groundwater level monitoring efforts described above (i.e., wells monitored and/or reported by DWR, local water suppliers, PRMD, and others).

Additional wells will also be considered for inclusion into the groundwater level monitoring program and may include the following:

1) Wells historically monitored by DWR with long-term records that might be reactivated.
2) Selected wells of small water distribution systems (wineries, restaurants, schools and parks) and mutual water companies (non-urban residential subdivisions).
3) Wells that improve the spatial density and depth distribution of the well-monitoring network by recruiting new private well volunteers in locations where additional data is needed to understand groundwater elevation trends in the Plan Area.
4) New multi-depth monitoring wells to better understand the distribution of groundwater hydraulic heads, flow and water quality with depth.
5) Groundwater level data from wells along and in adjacent basins, where underflow is considered a factor in the water budget.

Data Objectives

The following data objectives have been developed for groundwater level monitoring:

- Provide essential information to evaluate groundwater level trends over time.
- Provide estimate of amount of groundwater in storage in the basin.
- Identify linkages between groundwater level data to surface water quality and flow information.
- Develop information for groundwater models, water budget, and to forecast trends.

Recommended Actions:

1) Conduct systematic, coordinated groundwater elevation monitoring of existing programs and assess groundwater elevations on an annual basis for trends, conditions and adequacy of the existing groundwater level monitoring network.

2) Develop an outreach program to obtain groundwater level data from volunteer private well owners, private producers, and mutual water companies in the Plan Area.
3) Coordinate with local, state and federal agencies to investigate opportunities to develop better information on groundwater level monitoring, including projects such as groundwater recharge to incorporate project-specific monitoring.
4) Expand existing groundwater level monitoring network to establish more extensive long-term monitoring well network. Expand groundwater elevation monitoring through cooperative and volunteer efforts and through the installation of new multi-depth monitoring wells.

5.2.1.2 Groundwater Quality Monitoring

Groundwater quality information is available from records of public water supply wells being monitored by municipal water suppliers (e.g., Water Agency, Cotati, Rohnert Park, Santa Rosa, Sebastopol, Windsor), small water distribution systems, mutual water companies, historic long-term water quality monitoring by DWR, and USGS sampling. These state-mandated monitoring efforts, which help ensure that the public is provided with a safe, reliable drinking water supply, include the following existing programs:

- Water Agency, Cotati, Rohnert Park, Santa Rosa, Sebastopol, Windsor, small water distribution systems, and mutual water companies public supply wells are monitored as required by the California Department of Public Health (DPH) under California Code of Regulations (CCR) Title 22 (which includes organic compounds, inorganics, metals, microbial, and radiological analytes).
- DWR monitors 35 private volunteer wells for water quality parameters including major ions (including calcium, magnesium, potassium, sodium, carbonate, bicarbonate, chloride and sulfate), iron, manganese, boron, nitrate, total dissolved solids, total alkalinity, specific conductance (referred to as either specific conductance [USGS] or electrical conductivity [DWR]), pH, and water temperature.
- USGS collected groundwater quality samples from 34 wells as part of the SRP Study and the GAMA study.
- Extensive water quality monitoring is conducted at numerous contaminant release sites within the Plan area and reported to regulatory agencies, including the North Coast RWQCB, County of Sonoma Environmental Health Department, and the California Department of Toxic Substances Control.

Data Objectives

The following data objectives have been developed for groundwater quality monitoring:

- Track status and trends of groundwater quality within basin.
- Protect the health of basin users.
- Assess effect of human and natural factors on quality of groundwater and surface water.

- Use groundwater quality characteristics to help understand groundwater flowpaths within the basin.

Recommended Actions:

1) Assess water quality on an annual or biennial basis for trends, conditions and adequacy of the groundwater quality monitoring network. This will include preparing tables of analytical results, and developing water quality plots and figures, in conjunction with well hydrographs and groundwater level contour maps for the Periodic Plan Implementation Report, described in Section 6.3.
2) Identify opportunities to capture and integrate existing water quality data for areas where current data is insufficient, including contributions from the DPH, small water distribution system operators (wineries, restaurants, schools and parks), mutual water companies (non-urban residential subdivisions), and other entities.
3) Integrate other monitoring programs established through efforts such as the NCRWQCB Dairy Program, local recycled water projects and the Salt and Nutrient Management Plan for the Santa Rosa Plain.
4) Project to conduct groundwater quality monitoring: Establish and fund a basin-wide, standardized, coordinated, long-term groundwater quality monitoring network in conjunction with groundwater level monitoring. Consider selecting an appropriate sampling of wells (both public supply and volunteer private wells) to monitor for groundwater quality through cooperative and volunteer efforts.

5.2.1.3 Inelastic Land Surface Subsidence Monitoring

Land subsidence monitoring will be conducted periodically to monitor for the potential lowering of the land surface that could be caused by groundwater extractions. The monitoring program would aim to measure and document any changes in land surface elevation that could be associated with elastic or inelastic subsidence due to groundwater extraction.

Data Objectives

The following data objectives have been developed for subsidence monitoring:

- Assess the potential for inelastic land subsidence due to groundwater extraction in the Plan Area
- Ensure adequate spatial coverage, precision and accuracy of land surface monitoring measurements.

Recommended Actions:

1. Identify the available data related to potential inelastic land subsidence due to groundwater extraction in the Plan Area:
   a) Existing survey data
   b) Plate Boundary Observatory (PBO) GPS Stations (Figure 2-25)
2. Evaluate potential benchmark locations for periodic monitoring of land subsidence related to groundwater extraction in the Plan Area: Discuss and

coordinate among the Agency, Cotati, Rohnert Park, Santa Rosa, Sebastopol, and Windsor to determine suitable benchmark locations and/or supply wells in the Plan Area, to aid the analysis of potential land subsidence.

3. Develop an outreach program to City, County and other institutions responsible for infrastructure to provide information regarding likely indicators of subsidence.
4. Develop monitoring program and network for assessing the potential for inelastic land subsidence due to groundwater extraction; long-term land surface elevation changes to determine whether such changes are elastic and/or inelastic. Potential components could include:
   a) Semiannual surveying of a network of benchmarks and other survey points in areas where previous data and (or) groundwater-level declines within confined aquifer zones suggest the potential for subsidence
   b) Continued monitoring of sites recorded and reported through the existing PBO GPS stations.

5.2.1.4 Surface Water-Groundwater Interaction Monitoring

Surface water-groundwater interaction monitoring is a key area of interest to many stakeholders and is also an area of opportunity particularly with the groundwater flow model. It is also an important area of focus due to the relationship with wetlands and ecosystem values.

An appreciable number of streamflow gages are located within the Plan Area, but the interaction between surface water and groundwater is not being systematically monitored. Additional information on shallow groundwater levels close to stream courses, and tributary inflows between existing gages, will be needed to define and assess the surface water/groundwater relationship. Figure 5-4 shows the nine currently active and two inactive USGS streamflow gages, and three active stream gages, monitored by the Center for Ecosystem Management and Restoration (CEMAR) through the Russian River Coho Partnership within the Plan area. Table 5-3 summarizes the locations and parameters that the gages record, along with the periods of recording.

Most of the streamflow records in the Plan Area are relatively recent (2 to 5 years), but four have 11 to 12 year records. Consequently, the Plan area lacks a good, long-term estimate of the amount of water moving through water courses and discharging to the Russian River, and the effects of surface water and groundwater have on the quality and quantity of each are not well understood. Preliminary results of USGS surface water-groundwater model flow simulations suggest that watercourses in the Plan Area vary in time and space, seasonally and annually, in terms of losing or gaining streamflow.

Data Objectives

The following data objectives have been developed for subsidence monitoring:

- Develop a better understanding of the relationship between surface water and groundwater flow and quality, and provide information for determining water budget.
- Provide information on locations of groundwater recharge and discharge areas
- Evaluate seasonal and long-term changes in groundwater recharge and discharge.

Figure 5-2 Streamflow Gage Locations.

Table 5-3 Streamflow Gaging Information, Plan Area.

***Recommended Actions*:**

1) Continue to compile available stream gauge data and information on tributary flows in the Plan Area.
2) Determine current surface water quality sampling being conducted in the Plan Area.
3) Project to analyze and as necessary re-activate existing Stream Gauges and Install New Gauges in the Plan Area: Three stream gauging stations that measure discharge and stage in the Plan Area would be analyzed for priority and need of evaluating water budget and surface water-groundwater interaction evaluation purposes Stream gauges would be re-activated or added based on need and usability.
4) Project to install new shallow monitoring wells along major watercourses: Install new wells along major watercourses to further assess surface water and groundwater interactions.
5) Project to conduct seepage runs along major watercourses: Conduct seepage runs to further assess surface water and groundwater interactions. Correlate groundwater level data from wells in the vicinity of stream gauges to further establish connectivity of the creek water and groundwater.
6) Project to conduct Stable Isotope Study to Understand Surface Water-Groundwater Flow: Analyze existing samples and collect new surface water and groundwater samples for isotopic and other natural or anthropogenic tracers to evaluate surface water and groundwater interactions.

5.2.1.5 Hydrometeorological Monitoring

Various levels of hydrometeorological monitoring, which take place at 15 weather stations in the Plan Area (Figure 5-5 and Table 5-4), provide part of the information necessary for forecasting weather conditions, flood preparedness, drought preparedness, water supply planning, and for determining the Plan Area water budget. Hydrometeorological monitoring stations may include sensors to collect data on rainfall, air temperature, relative humidity, wind speed and direction, solar radiation, soil temperature and moisture. Additional hydrometeorological data may be collected by other stakeholders in the Plan area. Additional rainfall data in Sonoma County is collected under the Community Collaborative Rain, Hail & Snow Network (CoCoRAS).

Figure 5-3 Weather Station Locations.

Table 5-4 Weather Station Information, Plan Area.

The Water Agency is working collaboratively with the National Oceanic and Atmospheric Administration and US Geological Survey to develop better information on weather conditions, weather and river level forecasting and climate change. Additional hydrometeorological stations and data will collected through this effort and will be incorporated into the GIS database to benefit stakeholders in the Plan areas, and for future Plan project planning and activities.

Data Objectives

The following data objectives have been developed for weather monitoring:

- Provide estimates and create a database of Plan Area rainfall, air temperature, relative humidity, wind speed and direction, solar radiation, soil temperature and moisture values.
- Produce information on factors such as evapotranspiration (ET) to be used by stakeholders for improving water use efficiency and conservation.
- Provide estimates of annual rainfall amounts and distribution in the Plan Area
- Produce essential information for evaluating changes over time and for estimating climate change factors.
- Develop hydrometeorological data that can be used for weather forecasting, flood preparedness, drought preparedness, water supply planning, determining the Plan Area water budget, and to educate the public about climate and hazard preparedness.
- Develop information for surface water-groundwater modeling, calculating water budget, and for forecasting trends.

Recommended Actions:

1) Develop inventory of existing hydrometeorological stations including sensors, and of data collection and management protocols and plans for future expansion.
2) Develop a protocol and work plan for compiling rainfall data on a water-year basis to develop isohyetal maps as warranted, for comparison with groundwater level trends, to augment periodic GMP reports and update the model.
3) Evaluate rainfall data distribution and determine the need for additional data; consider CoCoRAS and automated systems for possible rainfall monitoring station expansion, and develop plans for future efforts.
4) Identify and develop strategies for collecting hydrometeorological data needs for surface water-groundwater flow model, working with and leveraging resources of the NOAA Earth Sciences Research Laboratory and Scripps Center For Western Weather and Water Extremes.

5.2.1.6 Monitoring and Reporting Protocols

Comparing both Plan Area groundwater elevation and quality data on a basin-wide basis requires a set of consistent data collection techniques, sampling intervals, documentation methodologies, and good quality assurance practices to maintain the accuracy and precision of monitoring data.

Recommended Actions:

1) Develop a schedule to coordinate the time of sampling and the sampling interval (time between samples) to ensure consistent data collection frequency.
2) Use a Standard Operating Procedure (SOP) for the collection of groundwater level data for wells (Appendix G – Monitoring Protocols).
3) Provide DPH guidelines on the collection, pretreatment, storage, and transportation of water samples intended for water quality (Appendix G).
4) Develop field and office quality assurance practices for the program. For future individual studies in the Plan Area, review project-specific quality assurance/quality control procedures for collecting groundwater quality samples.
5) At the onset of the GMP monitoring program, prepare and distribute a stand-alone Sampling and Analysis Plan incorporating the management program component elements for use by monitoring organizations.
6) Provide training on water level sampling to volunteer well owners as needed.
7) Coordinate the various existing and planned monitoring efforts including the Russian River data management framework to ensure uniform, standard water quality data collection protocols are followed.

5.2.1.7 Data Management

A comprehensive, central GIS data management system for monitoring data in the Plan Area will be required for organizing, managing, and storing the monitoring data, and for accessing data for periodic evaluations and use in additional studies. In cooperation with the Agency, the USGS undertook a study to evaluate the surface water and groundwater resources of the Plan Area, which included developing a GIS data management system. The GIS system includes topography, hydrology, geology, land and water use layers, and data on surface water quality, groundwater level and quality, groundwater extraction, land-cover correlated with water use, well location and construction details, and other necessary information for future studies and modeling.

Recommended Actions:

1) Maintain and update the central GIS data management system including GIS layers and other data formats related to groundwater, hydrology, geology, land use, and relevant imagery.
2) Work with cooperating agencies, including DWR, Cotati, Rohnert Park, Santa Rosa, Sebastopol, Windsor, PRMD, and any other non-governmental entity, to provide data for updating the database periodically.
3) Adopt flexible, standard formats for data collection, transfer protocols, reporting, and quality assurance-quality control checks to facilitate regularly scheduled data updates.
4) Use the GIS data management system to assist in periodic data evaluations and prepare the Periodic Plan report summarizing groundwater conditions within the Plan Area and documenting groundwater management activities conducted

in the previous year, while protecting any confidential information, per requirement of Water Code, Division 7, Chapter 10, Article 3, Section 13752.

5) Project to compile, screen and review State Department of Public Health, DWR Well Logs and PRMD records as an additional data source, especially for aquifer test data and parameters, to improved aquifer parameterization and maps.
6) Make data in the GIS data management system data publically available to Plan Area stakeholders and the wider public, while protecting any confidential information.
7) Project to develop and coordinate related data including GIS layers and other data formats on topics that include low flow conditions, recharge and discharge areas, impervious areas, land cover, drainage networks, historical hydrology and land cover, seasonal springs and areas of seepage, and wetlands distribution.

5.2.1.8 Data Gaps and Needs Prioritization

In addition to providing an improved and updated understanding of the Santa Rosa Plain Watershed, the USGS study identified a number of data gaps that will need to be addressed in the future:

- Improved estimates and locations of unreported agricultural and domestic pumpage will help to refine the surface water-groundwater flow model being developed.
- Depth-dependent water level and water quality data are needed to improve the understanding of the hydrogeology and of relationships between the shallower deeper aquifer system and flowpaths.
- Improved well location, lithology and construction information are needed to both better understand the hydrogeology and improve the groundwater model
- Additional water quality data are needed to further evaluate the variability in water quality data in the Cotati subarea.
- Long-term groundwater level quality monitoring is essential to better identify and understand significant water quality trends.

5.2.2 Modeling

Modeling is a tool used to conceptualize and study hydrologic and groundwater flow processes, assist in problem evaluation, provide additional information for decision-making, and help recognize limitations in data and guide collection of new data. The GSFLOW model for the Plan Area (Section 2.8) is a suitable predictive tool to assess benefits of different recommended actions during plan implementation, and to help analyze the effects of local conceptual projects on regional groundwater conditions. All models have limitations resulting in uncertainties in predictions, and significant areas for refinement of the Plan Area GSFLOW model include pumping information, precipitation distribution, streamflow discharge amounts and data on vertical head distribution. As significant new information becomes available, the model should be updated and re-calibrated periodically, on the order of three to five years, data and application dependent.

Recommended Actions:

1) Develop and run groundwater management scenarios using the model to assess the benefits of different recommended actions and options.
2) Assess optimal hydrologic monitoring locations to help best address the most significant model limitations and uncertainties.
3) Periodically update the integrated surface water-groundwater flow model (GSFLOW) including GIS layers and other data formats.

5.3 COMPONENT 3 – GROUNDWATER PROTECTION

Protecting groundwater resources is a key component of importance to the Panel. Ground protection comes in many forms, and may include developing actions to maintain quantity and quality, improving the management of wells and protecting recharge areas, and better informing the public on ways to improve groundwater protection.

5.3.1 Maintain Groundwater Levels

Maintaining groundwater levels over the long-term is a fundamental objective of the Plan and Panel, which favors non-regulatory, voluntary strategies and actions to achieve this objective. To achieve this goal will require the collaborative development of solutions to reduce demands and augment supplies.

Recommended Actions

1) Should monitoring data indicate persistent groundwater level declines in a particular part of the Plan Area, provide notifications to groundwater users regarding declining trends to promote awareness of the issue and foster increased conservation efforts and reduced groundwater demands.
2) Support and enhance water conservation goals for reducing groundwater demands, with local and region-wide incentive programs.
3) Evaluate historical groundwater level trends in the Plan Area, and identify subareas and scenarios that are more vulnerable to groundwater level declines.
4) Provide information to the public on the importance of groundwater monitoring maintaining groundwater levels and promoting voluntary groundwater level monitoring across the Plan Area.
5) Where feasible, promote and support small- and large-scale groundwater recharge, water conservation and increased recycled water use, where feasible, to help maintain groundwater levels and reduce groundwater demands.

5.3.2 Prevent Adverse Interactions Between Groundwater and Surface Water

In areas where surface water and groundwater are directly connected, changes in one can affect the other, for example, declining groundwater levels within a shallow aquifer can lead to decreases in streamflow. Conversely, degraded surface water quality can affect shallow groundwater quality in areas where surface water recharges groundwater. Surface water-groundwater interaction monitoring can help identify areas of concern and vulnerability, and assist in the developing possible actions to address potential adverse outcomes.

Recommended Actions

1) Encourage activities that protect surface water quality with a particular focus on areas where surface water recharges groundwater.
2) Support a surface water-groundwater interaction monitoring program to better understand the potential for adverse interactions and identify vulnerable areas.
3) Where reductions in streamflow related to shallow groundwater level declines may be identified, inform local stakeholders and encourage activities to adjust the amount, location and/or timing of groundwater pumping to reduce potential impacts. Such activities may include additional conservation measures, adjusting pumping scenarios spatially and in time, and using alternative water sources if available.

5.3.3 Well Construction, Maintenance, Protection, Abandonment and Destruction

PRMD administers the well permitting program for Sonoma County. The standards for permitting, construction, abandonment, and destruction are contained in Chapter 25B of the Sonoma County Code. The well standards are consistent with those recommended in State Water Code Section 13801 and incorporate standards listed in *California Well Standards, Bulletin 74-81*. PRMD also has adopted policies, procedures and guidelines for:

- Monitoring guidelines for large capacity water wells and industrial projects (No. 8-1-3)
- Well pump testing in water scarce areas (No. 9-2-28)
- Disinfecting wells (WLS-011)

The County's General Plan 2020 has a provision within the Water Resource Element, 3.2 Groundwater, policy WR-2c, #4 "in areas where a groundwater management plan has been approved and has been accepted by the County, require the issuance of well permits and any limitations imposed on well permits to be consistent with the adopted plan" (PRMD, 2008).

Improperly abandoned wells can be conduits for contaminating groundwater resources. Because standardized practices for permitting of well construction, abandonment, and destruction practices did not start until the late 1960s or early 1970s, the Plan Area likely has a number of abandoned wells in the Plan Area that have not been properly destroyed.

Identification of wellhead protection areas is a component of the Drinking Water Source Assessment and Protection (DWSAP) Program administered by the DPH, formerly DHS. DPH set a goal for all licensed water distribution systems statewide to complete Drinking Water Source Assessments by mid-2003. Assessments are completed by performing the three major components required for public water supply wells by DPH:

- Delineation of capture zones around extraction sources (wells)
- Inventory of Potential Contaminating Activities (PCAs) within protection areas
- Vulnerability analysis to identify the PCAs to which the source is most vulnerable

While these assessments are only required for public water supply wells, they represent good practices for private well owners.
The actions listed below will provide improved protection of groundwater resources within the Plan Area.

Recommended Actions

1) Review Chapter 25B and provide suggestions to PRMD on the well permit application requirements to improve the collection of hydrogeologic information through working with drillers, well owners, and other parties familiar with groundwater conditions in the Plan Area.
2) Identify management approaches that can be used to protect the water supply from potentially contaminating activities including voluntary control measures, public education, zoning restrictions or ordinances, development of contamination contingency plans, and minimizing pollution around wellhead protection zones.
3) Conduct an inventory and survey of active and inactive wells in the Plan Area to identify potential abandoned wells, and develop an approach for possible grant funding which would provide incentives to properly destroy abandoned wells. Prioritize efforts in areas where known improperly abandoned wells are known to present water quality concerns.
4) Distribute the *WELLness Guide* to local well owners within the Plan Area which covers the County's well construction, abandonment and destruction requirements, well head protection information, and tips for ensuring that wells are properly maintained, and monitoring.
5) Provide *recommendations*, as appropriate, to Sonoma County on well construction and destruction for well owners, operators, and licensed well drillers and service providers.
6) Conduct a study to obtain better information during well installations by designing a program to obtain better hydrogeologic information on new well completions in the Plan Area. Such information can be obtained by requesting, on a voluntary basis, the well permittee to allow for collection of additional geologic information during drilling.

5.3.4 Mapping and Protecting Groundwater Recharge Areas

A Plan objective includes the identification and protection of groundwater recharge areas and enhancing of groundwater recharge where appropriate. Groundwater recharge is recognized as one of the most difficult components of the hydrologic budget to quantify. The extent to which water recharges an aquifer depends on a number of factors, including land use, soil permeability, slope, precipitation patterns, type of surficial deposits, thickness of surficial deposits, vegetation, and connection of surficial deposits with underlying aquifers. A wide variety of techniques can be applied to investigate groundwater recharge. Scanlon et al. (2002a) classified these recharge estimation techniques into physical (lysimeter, zero flux plan, and Darcy's Law), tracer (chemical, heat, and isotope), and numerical modeling approaches, and recommended using multiple adaptive techniques to provide the most reliable estimates. Techniques employed to date for mapping recharge areas within the Plan Area include numerical modeling (USGS, 2013) and GIS-based approaches (Todd, 2012).

The Plan recognizes that improved understanding and delineation of groundwater recharge areas are critically important for effectively managing groundwater resources. It includes the following actions to continue refining the potential groundwater recharge area map and encourage activities that retain the function of natural recharge areas.

Recommended Actions:

1) Provide the groundwater recharge area map to and meet with PRMD, the County and local planning agencies to be sure that of groundwater recharge factors are considered in local land use planning decisions.
2) Provide recommendations on the areas that are most vulnerable to loss of recharge capacity and to water quality impacts from land use activities.
3) Collaborate with local organizations (e.g., the Sonoma County Agricultural Preservation and Open Space District, Land Trust, etc.) to encourage protection and preservation of recharge areas.
4) Develop site/project guidelines and provide recommendations for protecting groundwater recharge areas and on the areas that are most vulnerable to loss of recharge capacity and to water quality impacts from land use activities.
5) Discourage land use activities that have higher potential to contaminate groundwater resources from being sited in recharge areas.
6) Periodically, and particularly at milestones, such as completion of additional study, review and update the Plan's groundwater recharge area map.

5.3.5 Evaluate Distribution and Remediation of Contaminated Groundwater

Groundwater contaminant sites present in the Plan Area are generally located along major thoroughfares, in urban and industrial areas, and typically include localized contamination of shallow groundwater by industrial point sources such as dry cleaning facilities and fuel stations, street runoff and agricultural runoff.

While the Lead Agency and the Panel do not have authority or the responsibility for the oversight, control and remediation of contamination, they will coordinate with state and local water quality regulatory agencies to keep Plan Area stakeholders informed about the status of potential contamination issues when it is relevant to implementation of the Plan. The actions listed below will provide improved protection of groundwater quality from contamination within the Plan Area.

Recommended Actions:

1) Provide rural well owners with Sonoma County Department of Health Services guide, *What You Need to Know About Water Quality in Your Well*.
2) Coordinate periodically with the RWQCB and Sonoma County Environmental Health Department regarding any new reports of contaminant sites that are potential threats to groundwater.
3) Incorporate GIS layers showing mapped contaminant plumes and contaminant sites, supplied by the Regional Water Quality Control Board (RWQCB) and Sonoma County Environmental Health Department into the GIS data management system.
4) Share available information on impacted wells, mapped contaminant plumes and contaminant sites with Plan Area licensed water system operators and private well owners.

5.3.6 Identify and Provide Information to the Public on Groundwater Protection

Protecting groundwater involves water suppliers, businesses, and agricultural users, but also the general public, many of whom own a private well and septic system in a rural setting. Given the importance of groundwater as a source of drinking water for so many communities and individuals and the cost and difficulty of cleaning it up, the best way to ensure continued supplies of clean groundwater is to protect groundwater resources and prevent contamination. The Plan objective is to provide a number of resources to the public, including guides on well and septic system maintenance to prevent groundwater contamination, safe practices for household hazardous substances disposal (also pharmaceuticals and personal care products) both on the web, including the Plan project website, and at periodic meetings and forums.

Recommended Actions:

1) Conduct a periodic forum on groundwater in the Plan Area and develop educational materials in hard copy, electronic for web-based sites and YouTube, and make them easily accessible on the Plan Project website.
2) Review and as necessary and appropriate, update the ***WELLness – A Guide to You Water Well*** document, prepared by the Sonoma County Department of Environmental Health Services, to address the Plan objective for this management component. Post the updated guide on the Plan Project website for easy access, and distribute information to the public on the availability of this resource.

5.4 COMPONENT 4 – INCREASE CONSERVATION & EFFICIENCY

Water conservation lessens development impacts by reducing the demand for potable water resources (both surface and groundwater supplies), and decreases the amount of wastewater to be treated. Through fostering water supply sustainability and lessening water demand and withdrawals, water conservation approaches reduce environmental impacts by protecting groundwater levels, water quality conditions, base level streamflow, and the riparian vegetation and wildlife supported by water resources.

5.4.1 Continue and Increase BMPs for Urban Water Conservation

The Water Agency and its Contractors are undertaking several water conservation programs. As signatories to the CUWCC MOU, they agreed to implement BMPs for water conservation (see Section 3.2). The Plan intends to continue and increase BMPs for urban water conservation.

Recommended Actions:

1) Continue Implementing BMPs and Report Annually: Continue implementing, maintaining and updating CUWCC BMPs, as appropriate, for urban areas. Annually report estimated savings for ongoing water conservation programs.
2) Increase water use efficiency and demand reduction by shifting landscape irrigation to evenings, and so reduce evapotranspiration. Include development of educational materials and a public outreach component.
3) Assess current successes and develop potential options to increase BMPS for urban water conservation.

5.4.2 Voluntary Water Conservation BMPS for Unincorporated Areas

Many grape growers already employ water conservation practices that contribute to sound water management. These practices include adopting a water management strategy, using water conserving irrigation systems, and using water budgets and deficit irrigation techniques. Sound water management contributes to sustainability through increasing fruit quality (economic), reducing the need for water and fertilizers (environmental, social and economic), and preventing pollution from soil erosion and off-site movement of nutrients.

Rural dwellings in the unincorporated areas are not eligible for the rebates and incentives for increasing water conservation as is provided in urban areas. The Plan intends to develop options and incentives for voluntary water conservation BMPs and promote the incentives in unincorporated areas in the Plan Area.

Recommended Actions:

1) Develop or utilize existing water conservation BMPs for voluntary agricultural and agricultural-residential water users, and adding additional water conservation measures for agricultural operations. Examples of BMPs include those developed by Sonoma Resource Conservation District, the Natural Resources Conservation Service (NRCS), and UC Cooperative Extension Explore updating existing BMPs.
2) Develop new programs or utilize existing programs and technical assistance available for water savings through vineyard irrigation efficiency and other

practices. Examples include existing programs through the UC Cooperative Extension, Sonoma RCD, Gold Ridge RCD, and NRCS.

3) Encourage viticulture agriculture to increase water conservation by developing new or using existing BMPs. Examples of existing BMPs are included in the Code of Sustainable Winegrowing Practices Workbook (Wine Institute and California Association of Winegrape Growers, 2013) and LandSmart Vineyard Plan programs (Sonoma and Napa County RCDs, NRCS, 2014).
4) Encourage rangeland agriculture to increase water conservation by developing or using existing BMPS. An example of existing BMPs are included in the LandSmart Ranch Plan Program.
5) Develop program, incentives and funding for voluntary implementation of CUWCC water conservation BMPs in the unincorporated County areas not served by existing conservation programs
6) Develop incentives for conservation BMP retrofits during real property transactions in unincorporated County areas not served by existing conservation programs.

5.5 COMPONENT 5 – INCREASE GROUNDWATER RECHARGE

To ensure a long-term, viable, sustainable supply of groundwater, the Plan seeks to increase the amount of groundwater recharge ("managed aquifer recharge") in the Plan Area over the long term. Managed aquifer recharge can be accomplished through diverting captured stormwater into spreading basins over areas that have high permeability soils, and allowing the ponded water to percolate into the subsurface. Understanding the distribution of soil permeabilities, how groundwater recharges the Plan Area, and identifying and maintaining viable recharge areas will all be important for a program aimed to successfully increase groundwater recharge and storage. Another option is aquifer storage and recovery (ASR) and groundwater banking with wells to recharge water directly into the aquifer. The source water for groundwater banking would be Russian River drinking water. The source water for spreading basins would be captured stormwater runoff.

Increasing groundwater recharge by optimizing the use of surface water during wet years and during the wet season, and using more groundwater during the dry years, is called conjunctive use. Conjunctive use comes in many forms, but always involves the optimization of surface water and groundwater supplies to increase water supply reliability and availability.

Implementing groundwater recharge options would entail site-specific studies that build on the previously completed Groundwater Banking Feasibility Study (2013), and Stormwater Management/Groundwater Recharge Scoping Study (2012). Site-specific studies would include, but are not limited to, evaluation of the proposed site-specific hydrogeology, source water and receiving water chemistry, and water availability, and would involve the use of the USGS numerical model (USGS 2014) to consider optimal, integrated design of combined water management options.

5.5.1 Stormwater Recharge by Infiltration

Stormwater recharge is one of the key water management options for groundwater sustainability in the Plan Area. Stormwater runoff from our cities, highways, industrial facilities and construction sites can carry pollutants that harm water quality and may impair the beneficial uses of our waters. As a result, stormwater is regulated with the goal of using it as a resource and to reduce harmful pollutants, fertilizers, debris and other materials carried into storm drains, drainage systems and ultimately our rivers, lakes, and ocean. Stormwater regulatory programs fall into three main areas:

1) Construction - Projects that disturb one or more acres of soil or that disturb less than one acre but are part of a larger common plan of development, are required to obtain coverage under the General Permit for Discharges of Storm Water Associated with Construction Activity.
2) Industrial: Specific industrial activities must use the best technology available to reduce pollutants in their discharges.
3) Municipal: Large and small municipal sewer system operator s must comply with permits that regulate storm water entering their systems under a two phase system.

Each permit and re-permit may present an opportunity for increasing stormwater recharge.

A number of stormwater management initiatives have been conducted in the Plan Area (Section 3.4) upon which to build plan actions, such as reducing potential water quality impacts to local waterways, while also enhancing or preserving groundwater recharge. The actions listed below include studies to identify areas with suitable soil permeabilities and geology, alternatives for preserving these recharge areas for the future, feasibility studies to capture rainfall and stormwater, and recharge projects incorporating stormwater capture and the use of spreading basins or dispersed recharge areas.

Recommended Actions:

1) Review local agencies stormwater management efforts over the past 10 years, to define where additional effort is appropriate.
2) Conduct feasibility level analysis and pilot scale testing of stormwater capture and groundwater recharge to assess volumes, timing, best locations, estimate costs and potential benefits of implementation.
3) Project to develop and implement pilot-scale and subsequent large-scale projects to recharge groundwater with stormwater runoff capture and rainfall harvesting in the Plan Area. Examples include:
    a. Off-stream spreading basins and percolation ponds.
    b. Temporary wet season flooding of public lands such as parks or open space.
    c. Rainfall harvesting and stormwater runoff recharge with dispersed, low impact development infiltration trenches and dry wells, with possible incentives for retaining water on-site.

4) Collect and analyze stream gauge data to evaluate potential stormwater capture projects.
5) Incorporate water quality sampling of high flow surface water and storm water flows on project specific basis for recharge.
6) Project to make controlled releases of captured stormwater to streams during late summer and early fall when conditions are typically dry in order to maximize the aquifer recharge and improve fish habitat conditions.

5.5.2 Aquifer Storage and Recovery and Groundwater Banking

Aquifer storage and recovery with wells (ASR) and groundwater banking is another one of the key water management options for groundwater sustainability in the Plan Area. Groundwater banking involves the conjunctive use strategy of optimizing the use of surface water and groundwater resources. Conjunctive use includes both combined use of surface water and groundwater systems to optimize resource use and minimize adverse effects of using a single source, and the development of groundwater banking opportunities with local partners after local needs are met. Imported surface water would be diverted when it is available during the wet season or during wet years, to store or bank the water in aquifers, to subsequently be withdrawn during the dry years. The Groundwater Banking Feasibility Study (Section 3.1.6) provides a foundation for water management options and project decisions and priorities in the Plan Area. Actions listed below include pilot projects, additional studies, and full-scale projects incorporating imported drinking water from the Russian River for groundwater banking.

Recommended Actions:

1) Conduct pilot scale testing of groundwater banking using drinking water from the Russian River to assess feasibility, potential water quality interactions, volumes, monitoring needs, timing, best locations, estimate costs and potential benefits of implementation.
2) Based on results from pilot-level ASR groundwater banking, assess the need for additional studies to further evaluate project- and regional opportunities for expanded conjunctive use in the Plan Area.
3) Based on the results of the pilot-scale testing, develop and implement full-scale ASR groundwater banking projects that use wet season and wet year Russian River drinking water for groundwater banking.

5.5.3 Surface Water Use In Lieu of Groundwater

In-lieu recharge (or indirect recharge), another form of conjunctive use, differs from direct recharge methods (e.g., surface spreading or ASR) in that water is not artificially placed into the aquifer system. Rather, surface water supplies are used in normal or wet years or months when it is available to partially or completely replace the use of local groundwater and allow groundwater to recharge through natural sources. Then in dry years, when surface water supplies may be reduced or not available, groundwater can be relied upon to meet those demands not met by the surface water supply, improving a region's overall supply reliability. In order for an in-lieu recharge program to be successful, the in-lieu surface water supply to be used should reduce the demand on the local groundwater system and not be used to accommodate additional increases in demand.

In effect, this method has historically been applied by the Water Agency and many of its Water Contractors. For example, increased deliveries of Russian River water to the City of Rohnert Park in 2002 offset groundwater pumping and facilitated the recovery of groundwater levels in that area.

Recommended Actions:

1) Evaluate potential funding opportunities for an in lieu recharge program.
2) Develop an integrated surface water/groundwater supply program to guide the conjunctive use of surface water and groundwater in a coordinated fashion. Parameters for the program would likely incorporate yearly and monthly climatic scenarios (e.g., precipitation and reservoir storage levels), historical groundwater pumping and groundwater level trends, and anticipated demands.

5.5.4 Low Impact Development (LID) in New Construction

LID stormwater management is a site design strategy to avoid and minimize hydrologic and water quality impacts associated with development. The strategy emphasizes design practices and techniques that effectively capture, filter, store, evaporate, detain, and infiltrate runoff close to its source. The stormwater management approach also seeks to conserve natural resources and preserve ecological functions. The LID concept is based on the premise that stormwater management involves more than just preventing flooding, and that runoff is a valuable resource if used wisely. Stormwater management recognizes the value of pre?existing hydrologic functions and their influence on the surrounding environment. The LID stormwater management approach in new development is generally more cost effective than older standard methods of altering the hydrology and managing stormwater (Water Smart Development Guide, SCWA, 2011).

LID stormwater management relies on four fundamental principles:

1) **Avoid** hydrologic impacts by integrating site topography, soil, and hydrology assets into the site plan and design features.
2) **Conserve** existing soils, vegetation, and hydrologic features.
3) **Minimize** impervious areas and maximize permeability.
4) **Manage** stormwater on?site through LID features.

Recommended Actions:

1) Provide information to local community planners and developers on the Water Smart Development Guide and promote LID in new construction.
2) Provide information to rural property owners on the Slow It Spread It Sink It Guide and promote LID in rural settings.
3) Develop incentives for local communities to employ LID in new construction such as reduced connection and permitting fees.

5.6 COMPONENT 6 – INCREASE WATER REUSE

Water reuse within the Plan Area includes highly treated municipal wastewater (recycled water) and untreated household graywater that can be beneficially reused in a variety of nonpotable applications thus providing environmental and water supply benefits. Recycled water is typically conveyed to end users through purple colored pipe distribution lines that are not directly connected to potable water supplies.

The State Water Resources Control Board (State Water Board) adopted a recycled water policy is 2009, which includes goals for increasing and beneficially using recycled water (Section 3.5.2). The SRWCB Recycled Water Policy includes requirement for the responsible application of recycled water, monitoring and salt and nutrient management plans.

Recycled water can be used in applications where potable water is often used (such as the irrigation of public parks and golf courses and for agriculture), where the conditions and applications timing and amounts are appropriate. In addition to allowing for potable water offsets, recycled water use can facilitate "in lieu groundwater recharge." For example, if a farm that has historically used well water for crop irrigation begins using recycled water instead, the groundwater aquifer beneath will "recover" through reduced pumping and natural recharge. Other benefits of recycled water include a local, reliable water supply that is less vulnerable to drought events. Recycled water allows potable supplies to be reserved for the best and highest use. Additionally, utilizing recycled water for irrigation also means a decrease in discharge of treated wastewater to local water bodies such as the Russian River.

Not all stakeholders perceive the use and application of recycled water as an environmentally sound practice. Continued information sharing on the appropriate use of recycled water is required to optimize safe use of recycled water resources. Additionally, at a minimum, monitoring for irrigation application of recycled water should be followed as developed by the Blue Ribbon Advisory committee and adopted by the State Water Board.

The use of recycled water is often limited by the ability to cost effectively deliver recycled water to the end users. For example, many cities could in theory meet the irrigation demands of all their public parks with recycled water but building the dual use pipelines to connect several parks to the treatment plant might be prohibitively expensive.

5.6.1 Increase Recycled Water for Agricultural Irrigation

Agriculture is a large user of groundwater in the Plan Area and many agricultural operations have utilized recycled water in lieu of groundwater to reduce pumping demands. Members of the public have expressed some concerns about the safety of irrigating agricultural crops with recycled water. Opportunities exist in the future to expand recycled water availability (Section 3.3) where conditions are appropriate, and this may require consideration of best available science, education and demonstration that agricultural irrigation with recycled water can be safe for humans and ecosystems.

Recommended Actions:

1) Where feasible and appropriate, promote and support increased recycled water use for large and small-scale agricultural irrigation to reduce groundwater demands.
2) Coordinate with local wastewater treatment plant operators to catalogue current operations and agricultural recycled water applications in the Plan Area.
3) Evaluate opportunities for the use and storage of recycled water during the wet season, and subsequent use during the dry season where conditions are appropriate.
4) Provide ongoing public education and outreach to local communities regarding recycled water use for agricultural irrigation, and to gage and address public concerns.

5.6.2 Increase Recycled Water for Landscape Irrigation

Landscape irrigation, especially at parks, golf courses and hotels, is a large user of groundwater in the Plan Area. Similar concerns about recycled water use, particularly of recycled water irrigation runoff into streams, have been expressed by the public regarding the safety of landscape irrigation application of recycled water. Opportunities exist in the future to expand recycled water availability for landscape irrigation where conditions are appropriate, and this may require consideration of best available science, education and demonstration that landscape irrigation with recycled water can be safe for humans and ecosystems.

Recommended Actions:

1) Promote and develop incentives for the installation of purple piping in new developments in areas where recycled water availability may increase.
2) Provide ongoing public education and outreach to local communities to continue to promote expansion of recycled water use expansion, and to gage and address public concerns.
3) Coordinate with local wastewater treatment plant operators to catalogue current operations and landscape recycled water applications in the Plan Area.
4) Evaluate opportunities for the use and storage of recycled water during the wet season, and subsequent use during the dry season.

5.6.3 Graywater for Domestic Landscape Irrigation

Graywater refers to the untreated wastewater that flows out of bathroom sinks, showers, and laundry equipment, and does not include wastewater from toilets, kitchen sinks and dishwashers. Graywater, along with rainwater harvesting (Section 3.2), is an onsite water source that can be used to supplement water supplies and thereby offset potable water demands. Typically, graywater is used for outdoor irrigation but in some instances it has been used for indoor applications such as toilet flushing. PRMD oversees permitting of graywater systems in Sonoma County.

In addition to offsetting potable water demands, graywater systems also reduce the load on sewer or septic systems. Graywater systems range from basic systems that directs residential washing machine (clothes washer) into prepared outdoor yard areas, to sophisticated commercial systems with multiple fixture connections and treatment processes.

Recommended Actions:

1) Make information available to the pubic that graywater systems are eligible for financing under the Sonoma County Energy Independence Program
2) Encourage and promote expanded graywater use by local authorities providing financial incentives such as rebates or low‐interest financing and by offering free technical support.
3) Develop and make readily available educational material that can help ensure that homeowners properly install and maintain graywater systems, including backflow prevention.
4) Encourage and promote local agencies and communities to develop plans and policies regarding graywater permitting requirements and potential public education efforts.

5.7 COMPONENT 7 – INTEGRATED GROUNDWATER MANAGEMENT

By definition, integrated groundwater management by definition includes identifying and implementing activities, developing strategies and adopting policies that recognize the links between groundwater and the broader hydrologic system of climate, rivers, wetlands & other ecosystems, and including users of connected water. In practice, this means integrating a number of processes and programs to provide linkages and connections. Specific focused management components include:

- Groundwater management and land use planning.
- UWMP tracking and integration.
- Multi-agency and organization integration.
- Climate change planning.
- Multi-benefit actions and activities.

5.7.1 Groundwater Management and Land Use Planning

Groundwater management and land use planning are not integrated in practice. Land use planning decisions do not typically take into account groundwater resources availability and groundwater management programs do not generally have influence over land use planning decisions. The main goal of this management component is to identify possible actions that can help to facilitate better integration between land use planning and groundwater management program implementation.

Recommended Actions:

1) Brief local agency planning departments periodically on groundwater management program activities and milestones.
2) Conduct an annual or biennial meeting between the Plan Panel and TAC and local agency planners in the Plan Area exchange information on processes and programs, and to identify constraints and barriers.

5.7.2 Monitor and Track UWMP Progress and Incorporate Revisions into GMP Updates

Within the Plan Area, UWMPs are prepared every five years by the Water Agency (as a wholesaler) and the Cities of Cotati, Rohnert Park, Santa Rosa and Town of Windsor (as retailers). The City of Sebastopol has not yet reached the threshold of 3,000 connections or 3,000 AF, but is projected to do so in the next year or two. The intent of this management component is to keep the GMP updated with UWMP updates and relevant information.

Recommended Actions:

1) Obtain updates every five years of all UWMPs prepared in the Plan Area.
2) Incorporate updated UWMP information into the GMP every five years.

5.7.3 Incorporate Multi-Agency and Organization Integration into GMP

There are many federal, state and local agencies and other organizations involved in water-related activities, projects, and programs in the Plan Area. These multiple agencies and organizations have a great diversity of interests, purposes, mandates and agendas. The Plan aims to devise ways to identify these agencies and organizations and develop opportunities for optimizing efforts, resources and outcomes, and to help to build stronger multi-agency and -organization relationships over time.

Recommended Actions:

1) Develop an inventory of all agencies and organizations with water-related interests, mandates or jurisdiction within the Plan Area and provide information to the identified agencies and organizations on the Panel's efforts and recommended actions.
2) Conduct workshops with and for interested agencies and organizations, as needed, to identify opportunities for integrating overlapping or supporting interests to optimizing efforts, resources, and outcomes.

5.7.4 Plan for and Adapt to Climate Change

Projected changes in climate in the Plan Area include increased variability in precipitation and rises in air temperature, resulting in shorter wet season, longer dry season, more droughts and more extreme high flows based on a regional climate change study (Section 3.1.5). Results indicated large spatial variability in climate across the region; although all projections indicate warming, but predicted potential changes in precipitation by the end of the 21st century differed. Hydrologic models predict that water supply could be subject to increased variability and reduced reliability due to greater variability in precipitation and water demands that are likely to steadily increase due to increased evapotranspiration rates and potential climatic water deficits during extended dry seasons. The Plan encourages regional and local water and land use planners to be aware of potential climate change effects on groundwater resources and recommends that climate change factors be incorporated into local and regional planning efforts. The Plan also encourages adaptation, which means anticipating the adverse effects of climate change and taking appropriate action to prevent or minimize the damage they can cause, or taking advantage of opportunities that may arise. It has been shown that well planned, early adaptation action saves money and lives later.

Recommended Actions:

1) Provide information on projected climate changes in the Plan Area to federal, state, local agencies and other organizations involved with water and land use planning, including summary results from the groundwater model report.
2) Provide information to increase public awareness of current and future water supplies, demands, and trends in reliability related to a changing climate.
3) Hold a facilitated workshop on climate change in the Plan Area involving federal, state and local agencies and organizations involved in water and land use planning.
4) Work with stakeholder groups to consider possible adaptation measures to implement. These may include but not be limited to: using scarce water resources more efficiently; adapting building codes to future climate conditions and extreme weather events; building flood defenses and raising the levels of flood control measures; developing drought-tolerant crops; choosing tree species and forestry practices less vulnerable to storms and fires; and setting aside land corridors to help species migrate.

5.7.5 Multi-Benefit Actions and Activities

Incorporating multi-benefit aspects and activities into actions and projects recommended in the Plan will help to address multiple concerns, and build broad and strong support from local stakeholders and potential funding sources. Actions that are principally designed to protect or sustain groundwater resources can often include other benefits, such as providing wildlife and aquatic habitat and diversity, ecosystem services, watershed enhancement and protection, soil conservation, scenic beauty, recreational value, increased flows and recharge, improved water quality, supply reliability and sustainability, and economic benefits. Additionally, projects that are designed primarily for other purposes, such as flood protection or habitat restoration, may also benefit groundwater resources. The Plan intends to recognize these principles and encourage the development of activities, projects and programs that recognize and provide multi-benefit outcomes.

Recommended Actions:

1) Identify funding opportunities, project and criteria and the schedule to apply for funds for multi-benefit activities, actions and projects for the Plan Area.
2) Hold a TAC meeting focused on discussing future potential multi-benefit activities, actions and projects for the Plan Area.
3) Prepare a list of Panel Principles to encourage the development of activities, projects and programs that provide multi-benefit outcomes.

Develop an inventory of multi-benefit activities, actions and projects currently being implemented or planned in the Plan Area.

6.0 GROUNDWATER MANAGEMENT PLAN IMPLEMENTATION

6.1 INTRODUCTION

This section presents the approach, schedule, approximate cost and funding information for meeting the Plan BMOs including implementing recommended actions identified in Section 5. The actions formulated for each management component are the foundation for meeting the Plan BMOs and Goal (Figure 6-1). Most of the recommended management actions are currently unfunded, with the exception of the majority of core management components, the monitoring and modeling program and stakeholder involvement. Strategies for obtaining funding and prioritizing actions are discussed in Section 6.2.

Figure 6-1 Plan Management Components and Actions for Meeting Goals and Objectives.

6.2 STRUCTURE FOR SANTA ROSA PLAIN PLAN IMPLEMENTATION

The Plan's implementation is structured in order to encourage an open, collaborative and cooperative process for conducting groundwater management actions, and optimizing coordination of the many actions envisioned by the Panel in the coming years. Plan studies, projects, and programs will be conducted under a lead agency, with advice and guidance from an advisory group and technical advisory committee. The Panel has expressed a strong desire to structure Plan implementation to encourage and provide strong coordination of all the directly and indirectly recommended actions listed Section 5. Figure 6-2 summarizes the organizational structure for Plan execution.

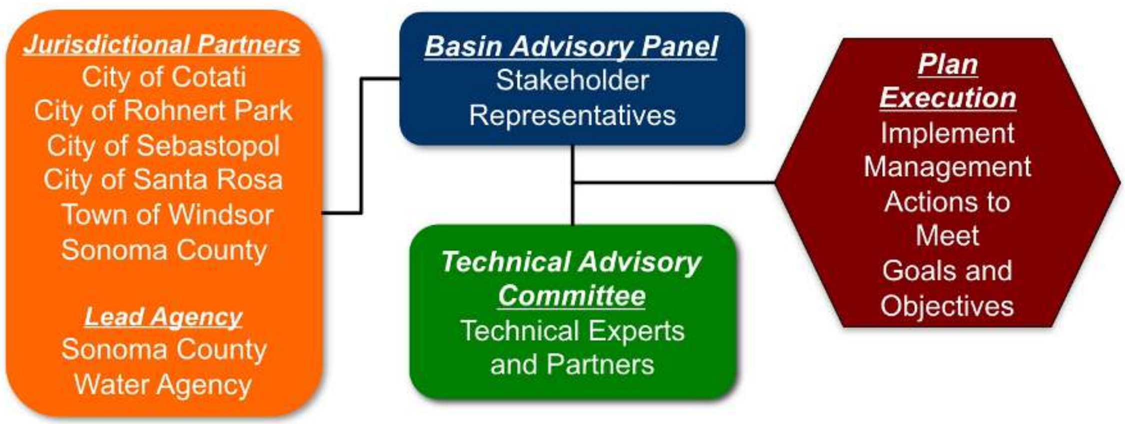

Figure 6-2 Groundwater Management Plan Implementation Organization Chart.

Lead Agency

The Sonoma County Water Agency, as the Lead Agency, has ultimate responsibility for Plan implementation including studies, projects, and programs it directly or indirectly funds. The Lead Agency role is to:

- Adopt and implement the Plan consistent with Panel input and consensus decision-making
- Participate as a member of the Panel
- Sponsor the Panel by providing project support, coordination, and facilitation as needed
- Coordinate and garner funding to implement the Plan
- Be accountable and responsible for implementing the Groundwater Management Plan in accordance with the Water Code and to remain eligible for state funding
- Provide in-kind staff support via a project manager to support Plan implementation
- Contract with technical consultants as needed to support implementation of the Plan
- Coordinate, as appropriate, with the cooperating funders to ensure continued support and involvement in implementing the Plan

- Develop and adopt proposed rules or regulations where necessary to achieve the Groundwater Management Plan objectives, as provided by AB 3030 only in collaboration with and with the concurrence of the Panel
- Explore options for funding groundwater management activities. In exercising this role, the Water Agency would propose fees and assessments only with Panel recommendation and approved
- Amend the Groundwater Management Plan with the concurrence and recommendation of the Panel

Basin Advisory Panel Role

The Panel develops the Plan and guides its implementation and will remain in existence as long as the Plan is being implemented. The Panel discusses, provides input, and develops consensus recommendations for all proposed activities to implement the plan. The Panel is responsible for recommending amendments to the Groundwater Management Plan for approval by the Water Agency's governing board.

The Panel has a collaborative governance structure: the Water Agency (as lead agency) and other agencies with jurisdiction within the Santa Rosa Plain will join with community organizations, business associations, and individuals to determine the best way to implement the Plan. All activities associated with implementing the Plan will be subject to Panel approval consistent with its charter.

Panel meetings are open to the public. The Panel's agenda will be posted prior to meetings and actions will be recorded in the meeting summary, including Panel member attendance. Members are responsible to attend in person or request that an alternate or Panel member represent his or her viewpoint in decision-making.

Basin Advisory Panel Composition

The Panel's continuing composition for implementation will be similar to the Panel during plan development. The Panel will continue to be composed of representatives of the Lead Agency, General Public, Agricultural Groundwater Users, Business & Developers, Residential Groundwater Users, Government (Tribal, County and City), Environmental Organizations, Natural Resources Management Organizations, Water Suppliers, and Groundwater Technical Expertise.

Upon approval of the Santa Rosa Plain Groundwater Management Plan, the Panel will continue to provide guidance for its implementation and for any amendments to the Plan as described in the Panel Charter. The Panel will formally revisit its membership each fall when formulating its work plan for the following year. The Panel can modify its charter using its decision-making protocols.

Panel members must either live or have jurisdiction in the Santa Rosa Plain watershed. Panel members are typically expected to serve at least 2-years. Members could serve multiple terms. An effort will be made to avoid having all new members in any one year.

Technical Advisory Committee (TAC) Role

The TAC will continue to work on specifics of implementation of the Plan goals and objectives; advise the Panel on technical matters, and to develop recommendations on general Plan implementation for the Panel's consideration. TAC participation is not limited to Panel members; others with groundwater or technical expertise can also participate. The TAC will assist the Panel on the following activities:

- Working with the technical consultant on Plan implementation,
- Reviewing technical data and analyses and/or recommending data analyses,
- Determining if data is adequate to address the basin management objectives, and
- Reviewing annual reports on Plan implementation.

6.3 IMPLEMENTATION PRIORITIZATION AND FUNDING

Recommended actions identified in Section 5 are listed in Appendix H. Recommended actions highlighted in "green" reflect preliminary priorities included in the first two years of implementation and shaded green as either (1) required under the Water Code as part of a groundwater management plan to continue to be eligible for state funding, or (2) needed for this comprehensive groundwater management program to be successful in implementation. Recommended actions highlighted in "orange" reflect additional opportunities that may be prioritized pending available funding. Recommended actions identified as "currently funded" have funding currently earmarked or set-aside for the project, or are being accomplished by ongoing programs of one of the implementing agencies.

The recommended actions were screened in two ways:

1) The TAC conducted an initial prioritization of additional potential recommended management actions, which constitute the "orange" list. The TAC engaged in a multi-voting exercise that enabled each member the opportunity to identify his or her top management priorities. Cumulative voting results, listed in Table H-1, H, indicate how the TAC, as a group, envisions GMP initial implementation priorities.
2) Criteria, generally qualitative in nature, were developed by the TAC and Panel for screening and prioritizing recommended "orange" list actions that included: relative cost, readiness to proceed, feasibility/implement-ability, leveraging opportunity, community and political support, and multi-objective/supportive of watershed health. These criteria are listed in Table H-2, Appendix H.

The plan components contain many unfunded recommended actions that will require studies, more data, feasibility analysis and pre-design before funding can be obtained. Implementation of many of these unfunded recommended actions are intended to begin a numbers of years in the future.

Table 6-1 lists actions recommended for implementation over the five years following Plan adoption, and includes an approximation of the relative cost for each action. The preliminary implementation schedule is based on the priorities that the Panel identified during Plan preparation, and in the screening and prioritization process described above. The primary areas identified by the Panel as most important include:

- Groundwater Protection
- Increase Conservation & Efficiency
- Increase Groundwater Recharge
- Increase Water Reuse
- Integrated Groundwater Management

Table 6-1 Management Components and Recommended Actions - Plans for Years 1 to 5.

Recommended actions to protect groundwater resources, increase conservation and efficiency, increase groundwater recharge, and expand water reuse, are included in the first five years of Plan implementation. Actions under integrated groundwater management that improve coordination of water resources and land use planning, climate change planning and fostering rural and urban sharing of information and building on state and federal agency partnerships are either already in progress or also planned for early program implementation. The Panel also identified the monitoring program, data management, and keeping the groundwater flow model current as key priorities, along with scenario planning using the model as a critical tool for groundwater basin management.

<u>First Two Years of Plan Implementation</u>

The first two years of Plan implementation include recommended actions shaded in "green" in Table 6-1. These recommended actions are funded under a cooperative agreement between the Water Agency and a number of other organizations including the cooperating cities and township identified in Figures 6-2.

Stakeholder Involvement plus the Monitoring Program and Modeling form the core components and foundation for the Plan. These are the basis for decision-making in the Plan Area (Figure 6-2). Stakeholder involvement and the Monitoring Program are required Plan components, which under the Water Code define the Plan's eligibility for state funding for groundwater projects. These core components are funded by the Water Agency's cooperative partnerships, and existing or new funding sources. The implementation schedule for the two years following Plan adoption therefore focuses on continuing the forums and mechanisms for involving basin stakeholders and gathering additional data about Santa Rosa Plain Watershed groundwater conditions through the establishment of a comprehensive monitoring program and other activities.

During Plan implementation, the Water Agency and the Panel will continue to prioritize and develop Plan Components, and seek funding and leveraging opportunities for implementing recommended actions, outreach, coordination, and partnerships. Funding for implementation of these actions is anticipated to come from a variety of sources including the Water Agency, funding and/or in-kind services from member agencies, state or federal grant programs, and partnerships at the local, state, and federal level. The SRP GMP also serves to coordinate all sorts of projects, actions and activities conducted by local agencies, non-governmental organizations (NGOs), and private parties as appropriate, to assist in collaborations and leveraging of limited resources.

6.4 IMPLEMENTATION REPORTING

The Water Agency will report periodically on implementation progress, to summarize groundwater conditions in the Plan Area and accomplishments of the Groundwater Management Program. These reports will include the following information:

- Activities and progress for Plan implementation
- Groundwater conditions and monitoring results and trends of groundwater levels and quality
- Improvements in Plan Area characterization based on continued data collection and analysis
- Discussion of whether management actions are meeting BMOs based on monitoring results
- Any plan component changes, including modification of BMOs during the period covered by the report
- An outline of future Plan Area management actions

Initial implementation reports will be developed on an annual basis for the first three years, changing to a five-year interval with brief annual data and progress summaries. The Water Agency will provide copies of the reports to the implementing agencies, the Panel and the TAC, and make these reports available to stakeholders and the public on the website.

6.5 FUTURE REVIEW OF PLAN

The Plan is a living document that will continually evolve as more information about the Plan Area becomes available. Additional actions may be identified as the Panel continues to evaluate the outcomes of implemented actions, and adjusts objectives to determine how well they are serving the overall Plan goal. In the annual implementation report, the Panel will summarize any resulting updates to the Plan and will provide this summary to the Water Agency Board for review and approval.

Review of the Plan will occur every five years at a minimum, to ensure its continued relevance as a tool to manage, protect, and enhance groundwater resources in the

Plan Area for future generations. Plan reviews will be documented in the implementation reports.

7.0 REFERENCES

Brown and Caldwell, 2011, 2010 Urban Water Management Plan, Sonoma County Water Agency, 130 p.

California Department of Finance, 2012a, Population Totals by Township and Place for California Counties: 1860 to 1950: Sacramento, Calif., State of California, accessed October 18, 2012, at URL http://www.dof.ca.gov/research/demographic/reports

California Department of Finance, 2012b, E-4 Historical Population Estimates for Cities, Counties, and the State, 2001–2010, with 2000 and 2010 Census Counts: Sacramento, Calif., State of California, accessed October 18, 2012, at URL http://www.dof.ca.gov/research/demographic/reports.

California Department of Water Resources, 1974, 1974 Sonoma County Land Use Survey data: unpublished data located at Division of Integrated Regional Water Management, North-Central Region, West Sacramento, California, 1:24,000 scale.

California Department of Water Resources, 1979, 1979 Sonoma County land use survey Data: unpublished data located at Division of Integrated Regional Water Management, North-Central Region, West Sacramento, California, 1:24,000 scale.

California Department of Water Resources, 1980, Groundwater Basins in California—a Report to the Legislature in Response to Water Code Section 12924: California Department of Water Resources, Bulletin 118-80, 73 p.

California Department of Water Resources (DWR), 1982. Evaluation of Groundwater Resources: Sonoma County – Volume 4 – Sonoma Valley. DWR Bulletin 118-4, 72 p.

California Department of Water Resources, 1986, 1986 Sonoma County Land Use Survey Data: unpublished data located at Division of Integrated Regional Water Management, North-Central Region, West Sacramento, California, 1:24,000 scale.

California Department of Water Resources, 1999, 1999 Sonoma County Land Use Survey Data: Sacramento, Calif., State of California, digital map accessed on January 28, 2011, at *http://www.water.ca.gov/landwateruse/lusrvymain.cfm*

California Department of Water Resources (DWR), 2003, California's Groundwater: Bulletin 118 – Update 2003, 246 p. at URL *http://www.water.ca.gov/groundwater/bulletin118/update2003.cfm*

California Geological Survey, 2002, California Geomorphic Provinces Note 36: Sacramento, Calif., State of California, Department of Conservation, accessed November 16, 2011, at URL *http://www.consrv.ca.gov/cgs/information/publications/cgs_notes/note_36/Documents/note_36.pdf*.

Cardwell (1958). Geology and Ground Water in the Santa Rosa and Petaluma Areas, Sonoma County, California: U.S. Geological Survey Water Supply Paper 1427, 273 p.

Dawson, Arthur, and Sloop, Christina, 2010, Final Report, Laguna de Santa Rosa Historical Hydrology Project Headwaters Pilot Study: Laguna de Santa Rosa Foundation and Sonoma Ecology Center, Santa Rosa, CA: accessed May, 2010 at URL: *http://www.lagunadesantarosa.org/knowledgebase/*

Flint, L.E., and Flint, A.L., 2012, Simulation of Climate Change in San Francisco Bay Basins, California: Case Studies in the Russian River Valley and Santa Cruz Mountains: U.S. Geological Survey Scientific Investigations Report 2012–5132, 55 p.

Ford, R.S., 1975, Evaluation of Ground Water Resources: Sonoma County, Volume 1: Geologic and Hydrologic Data: California Department of Water Resources, Bulletin 118-4, 177 p.

Herbst, C.M., Jacinto, D.M., and McGuire, R.A., 1982, Evaluation of Ground Water Resources, Sonoma County, Volume 2: Santa Rosa Plain: California Department of Water Resources, Bulletin 118-4, 107 p.

Hevesi, J.A., Woolfenden, L.R., Niswonger, R.G., Regan, R.S., and Nishikawa, Tracy, 2011, Decoupled Application of the Integrated Hydrologic Model, GSFLOW, to Estimate Agricultural Irrigation in the Santa Rosa Plain, California, *in* Maxwell, R.M., Poeter, E.P., Hill, M.C., and Zheng, Chunmiao, eds., MODFLOW and More 2011: Integrated Hydrologic Modeling–Conference Proceedings, June 5–8, 2011: Golden, CO, International Groundwater Modeling Center, p. 115–119.

Jenkins, O. P., 1938, Geomorphic Map of California: State of California Department of Natural Resources, Bulletin 158, Plate 2.

Kadir, T.N. and McGuire, R.A., 1987, Santa Rosa Plain Ground Water Model: California Department of Water Resources Central District, 318 p.

Kulongoski, J.T., Belitz, Kenneth, Landon, M.K., and Farrar, Christopher, 2010, Status and Understanding of Groundwater Quality in the North San Francisco Bay Groundwater Basins, 2004: California GAMA Priority Basin Project: U.S. Geological Survey Scientific Investigations Report 2010-5089, 88 p.

Markstrom, S.L., Niswonger, R.L., Regan, R.S., Prudic, D.E., and Barlow, P.A., 2008, GSFLOW-Coupled Groundwater and Surface-Water FLOW Model Based on the Integration of the Precipitation-Runoff Modeling System (PRMS) and the Modular Groundwater Flow Model (MODFLOW-2005): U.S. Geological Survey Techniques and Methods 6–D1, 240 p.

Muir, K. S., Johnson M. J., 1979. USGS Open File Report 79-1065. Classification of Ground-Water Potential in Three Parts of Santa Cruz County, California

Nishikawa, Tracy, ed., (2013), Hydrogeologic and Geochemical Characterization of the Santa Rosa Plain Watershed, Sonoma County, California: U.S. Geological Survey Scientific Investigations Report 2013-5118, 199 p.

Niswonger, R.G., Panday, Sorab, and Ibaraki, Motomu, 2011, MODFLOW-NWT, A Newton Formulation for MODFLOW-2005: U.S. Geological Survey Techniques and Methods 6–A37, 44 p.

North Coast Regional Water Quality Control Board, 2011, Water Quality Control Plan for the North Coast Region.
http://www.waterboards.ca.gov/northcoast/water_issues/programs/basin_plan/basin_plan.shtml

Sesser, B., DiPietro, D., Lawton, R., and Trotta, M., 2011, Sonoma Valley Groundwater Recharge Potential Mapping Project, 14 p.

Simley, J.D. and Carswell Jr., W.J., 2009, The National Map – Hydrography: U.S. Geological Survey Fact Sheet 2009-3054, 4 p.

Sloop, Christina; Honton, Joseph; Creager, Clayton; Chen, Limin; Andrews, E.S.; and Bozkurt, Setenay, 2009, Hydrology and Sedimentation, Chap. 4, *of* The Altered Laguna: A Conceptual Model of Watershed Stewardship: Santa Rosa, Calif., Laguna de Santa Rosa Foundation, p. 63–110, *http://www.lagunafoundation.org/knowledgebase/?q=node/182*.

Sowers, J.M., Noller, J.S., and Lettis, W.R., 1998, Quaternary Geology and Liquefaction Susceptibility, Napa, California 1:100,000 Quadrangle; a Digital Database: U.S. Geological Survey Open-File Report 98-460, 20 p., 1 sheet, scale 1:100,000.

Sweetkind, D.S., Hevesi, J.A., Nishikawa, Tracy, Martin, Peter, and Farrar, C.D., 2013, Hydrology of the Santa Rosa Plain Watershed, Sonoma County, California, Chap. B *of* Nishikawa, Tracy, ed., Hydrologic and Geochemical Characterization of the Santa Rosa Plain Watershed, Sonoma County, California: U.S. Geological Survey Scientific Investigations Report 2013–5118, p. 27–112.

Todd Engineers, 2012, Santa Rosa Plain Groundwater Recharge Potential Mapping, Memorandum to Winzler & Kelly, p. 27.

West Yost, 2013, City of Santa Rosa Groundwater Master Plan, Final Report.

Winzler & Kelly, 2012, Laguna-Mark West Creek Watershed Planning Scoping Study, Screening Technical Memorandum, prepared for Sonoma County Water Agency, 17 p.

Woolfenden, L.R., and Nishikawa, Tracy, eds., (2014), Simulation of Groundwater and Surface-Water Resources of the Santa Rosa Plain Watershed, Sonoma County, California: U.S. Geological Survey Scientific Investigations Report 2014-5052, 258 p.

U.S. Army Corps. Of Engineers, 2002, Santa Rosa Creek Ecosystem Restoration Feasibility Study; Sonoma County, California: Hydrologic Engineering Office. August 5, 2002.

U.S. Department of Agriculture, 2007, Natural Resources Conservation Service, Soil Survey Geographic (SSURGO) Database for Sonoma County, California: Washington D.C., U.S. Department of Agriculture, Natural Resources Conservation Service, accessed on May 14, 2009, at *http://soildatamart.nrcs.usda.gov*.

U.S. Geological Survey, 2011, National Water Information System data available on the World Wide Web (Water Data for the Nation), accessed May 13, 2011 at URL: *http://wdr.water.usgs.gov/wy2009/pdfs/11466800.2009.pdf*.