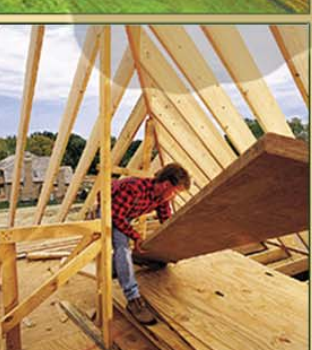
Groundwater Management Plan

CENTRAL SACRAMENTO COUNTY

GROUNDWATER MANAGEMENT PLAN

FEBRUARY 2006



MWH

WATER FORUM

SACRAMENTO COUNTY WATER AGENCY

Members of the Central Sacramento County Groundwater Management Plan Task Force

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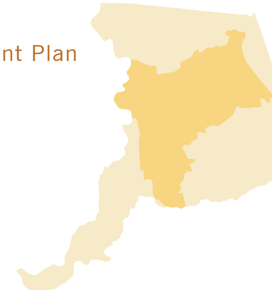
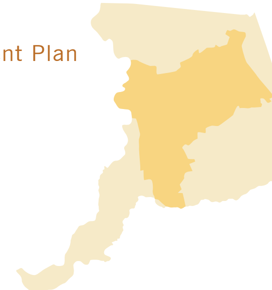
Executive Summary



Executive Summary

Table of Contents



Executive Summary

FOREWORD

The Central Sacramento County Groundwater Basin stakeholders, in coordination with the Sacramento County Water Agency and the Water Forum Successor Effort have developed the Central Sacramento County Groundwater Management Plan (CSCGMP). The CSCGMP represents a critical step in establishing a framework for maintaining a sustainable groundwater resource for the various users overlying the basin in Sacramento County between the American and Cosumnes Rivers. It includes specific goals, objectives, and an action plan to provide a "road map" for the governance body as the steps necessary to manage the basin are taken in coordination with the various stakeholders. This Executive Summary is an outreach component of the CSCGMP that brings forth the essence of the CSCGMP in a similar format but in a condensed manner that still allows a basic level of understanding. The reader is encouraged to refer to the larger CSCGMP document if additional detail is needed.

INTRODUCTION

The CSCGMP is the result of over a decade of negotiations and agreements between stakeholders in the region. In 2000, the Water Forum Agreement (WFA) was signed by regional stakeholders, and the Water Forum Successor Effort (Successor Effort) was formed to continue forward in regional water supply planning.

The WFA laid the foundation for the Successor Effort. One of the responsibilities of the Successor Effort was to facilitate negotiations among stakeholders in the Central Sacramento County Groundwater Basin (Central Basin) that would lead to the creation of a groundwater basin governance body. This governance body would be responsible for the protection, health and long-term viability of the underlying groundwater as a sustainable resource for both current and future users. **Figure ES-1** shows the locations of the groundwater basins within Sacramento County.

Under the aegis of the Successor Effort, the Central Sacramento County Groundwater Forum (CSCGF) was formed in February 2002 to provide recommendations on a basin governance body to the Successor Effort. Following concurrence by the Successor Effort, this recommendation would be adopted by the appropriate agencies.

The CSCGF stakeholder interest groups included representatives in the following areas:

- Agricultural
- Agricultural Residential Groundwater Users
- Business Interests
- Environmental/Community Organizations
- Local Government/Public Agencies
- Water Purveyors

The total number of stakeholder representatives was approximately 40 people. These representatives met monthly for approximately three years at which time a decision was made to create an Advisory Committee, composed of CSCGF stakeholders, to develop a groundwater management plan for the Central Basin. The Advisory Committee spent approximately one year in developing the CSCGMP for adoption by the full CSCGF.

PURPOSE OF GMP

A Groundwater Management Plan (GMP) is a planning tool that assists overlying water providers in maintaining a safe, sustainable and high quality groundwater resource within a given groundwater basin. This CSCGMP is intended to be adaptive to changing conditions within the groundwater basin and will be updated and refined over time to reflect progress made in achieving the CSCGMP's objectives.

What is required in a GMP?

The GMP is a tool used to help ensure a long-term reliable water supply for rural domestic, agricultural, urban, business/industrial, environmental, and development uses in the region. The California Water Code (CWC) requires that a GMP contain numerous technical provisions which are briefly summarized as follows:

- An inventory of water supplies and a description of water uses within a given region. This information is summarized in a water balance showing overall water demands and available water supplies.
- Basin Management Objectives (BMOs) that are designed to protect and enhance the groundwater basin.
- Monitoring and management programs that ensure the BMOs are being met.
- Description of stakeholder involvement and public information plan and programs for the groundwater basin.

How does a GMP benefit the basin stakeholders?

The CSCGMP provides information related to planning activities currently taking place in the Central Basin. This information serves the following purposes:

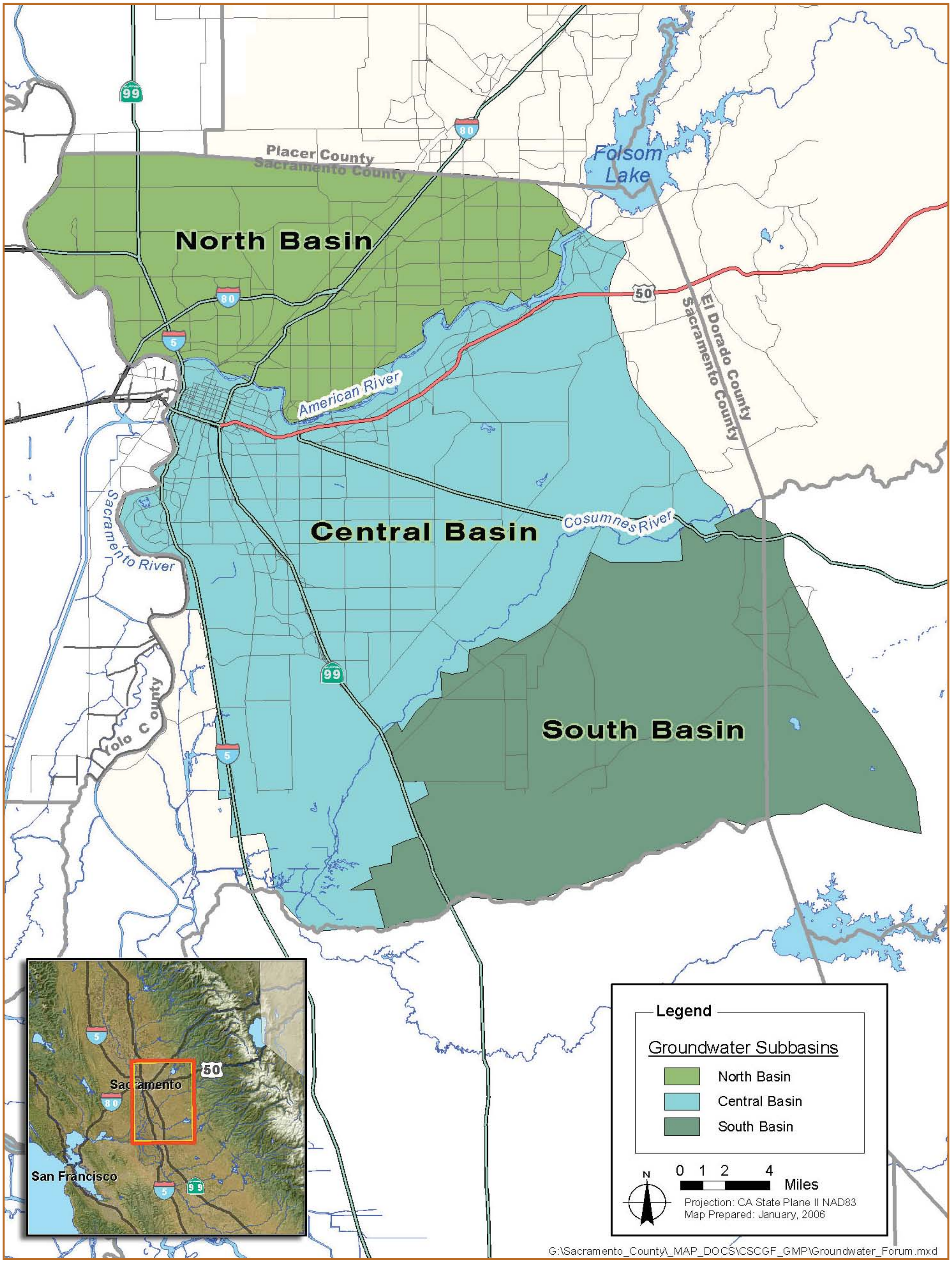
- It provides a management plan for the protection and preservation of groundwater resources.
- It underscores stakeholder interests and objectives.
- It ensures protection of groundwater quantity and quality.
- It assists in monitoring and maintaining groundwater elevations.

WATER RESOURCES SETTING

Physical Setting

Unique to Sacramento County are three major rivers each acting as a major source of recharge for the groundwater basin underlying the county. In some instances, the recharge process creates natural dividing lines along the rivers that can be used to delineate

Figure ES-1. Sacramento County Groundwater Basins



the individual sub-basins (i.e., North, Central, and South Basin as shown in **Figure ES-1**). Groundwater underlying the North Basin is currently managed by the Sacramento Groundwater Authority. Efforts are underway in the South Basin, led by the Southeast Sacramento County Agricultural Water Authority, to develop a groundwater management plan in accordance with the CWC and the provisions of the WFA.

The Central Basin

The Central Basin is made up of a variety of groundwater users (i.e., agriculture, agricultural residential, urban, and environmental). The Central Basin boundary was defined by the Sacramento County groundwater model that was used in the Water Forum process and took into account the hydrogeologic boundaries and the political boundaries of organized water purveyors/districts, cities (where they retail water within their boundaries), and the County of Sacramento.

In October 2004, the Sacramento County Water Agency (SCWA) adopted a GMP for the portion of the Central Basin that is served water through Zone 40 of the SCWA. The Zone 40 GMP was done to measure the effectiveness of the conjunctive use program outlined in the Zone 40 Water Supply Master Plan and for the purpose of seeking state grant funding to help finance large infrastructure projects that would benefit groundwater underlying the Central Basin. At the time of its adoption, the Zone 40 GMP recognized that a Central Basin GMP was necessary to meet the needs and interests of all the stakeholders in the Central Basin.

Groundwater underlying the Central Basin is contained within a shallow aquifer (Modesto Formation) and in a deep aquifer (Mehrten Formation). Groundwater is located from 20 to 100 feet below the ground surface depending on when and where the measurement is taken. The shallow aquifer is typically used for private domestic wells and typically requires no treatment. The deep aquifer is separated from the shallow aquifer by a discontinuous clay layer that serves as a semi-confining layer. The deep aquifer typically requires treatment for iron and manganese, which may cause mineral deposits and affect the taste of water. **Figure ES-2** contains a conceptual diagram of the aquifer.

Intensive use of groundwater over the past 60 years has resulted in a general lowering of groundwater elevations. Over time isolated groundwater depressions have grown and coalesced into a single cone of depression that is centered in the southwestern portion of the Central Basin (see **Figure ES-3** for Sacramento County Groundwater Elevations).

How does the CSCGMP address groundwater contamination problems in the Central Basin?

There are several sources of groundwater contamination within the Central Basin. These sources include: Mather Field, Aerojet, Boeing, the former Sacramento Army Depot, the Union Pacific railyards, and present and former landfills. The known extent of groundwater contamination and landfill sites are shown on **Figure ES-4**. The CSCGMP addresses the concerns well owners have regarding the potential for groundwater contamination threatening their wells.

Supply and Demand

The CSCGMP identifies available water supplies to meet the water demands of users within the basin. Water supplies include surface water, groundwater, recycled water, and remediated groundwater. Water demand is a result of rural, agricultural, private industrial, environmental, and urban activities. Demand reduction is being accomplished through water conservation measures identified in the WFA.

How much water supply does the Central Basin have?

Water supplies have been quantified in some detail in the CSCGMP. Availability and reliability of surface water is dependent on the particular contract or water right and the hydrologic year type (e.g., wet or dry years). **Figure ES-5** summarizes surface water supplies available to each of the surface water purveyors and identifies the river source from which they originate. Based on existing and projected contract and water right entitlements, the total surface water supply available to the Central Basin is approximately 350,000 AF/year.

In addition to surface water supplies, the Water Forum determined the estimated long term average annual sustainable yield of groundwater from the Central Basin to be 273,000 acre-feet per year (AF/year). Currently, groundwater extractions are estimated to be 250,000 AF/year.

Recycled water use in the Central Basin is planned for up to 4,400 AF/year by 2030. The Sacramento Regional County Sanitation District is currently developing a Recycled Water Master Plan that will evaluate the feasibility of increased recycled water use in the County.

Water that is extracted for purposes of groundwater contamination clean-up activities is included in the overall sustainable yield of the Central Basin aquifer. In-basin use of remediated groundwater is an objective of the CSCGMP. This issue is addressed more fully in the Groundwater Contamination Monitoring and Collaboration Program summarized in the Plan Implementation section.

Figure ES-2. Hydrogeologic Cross Section

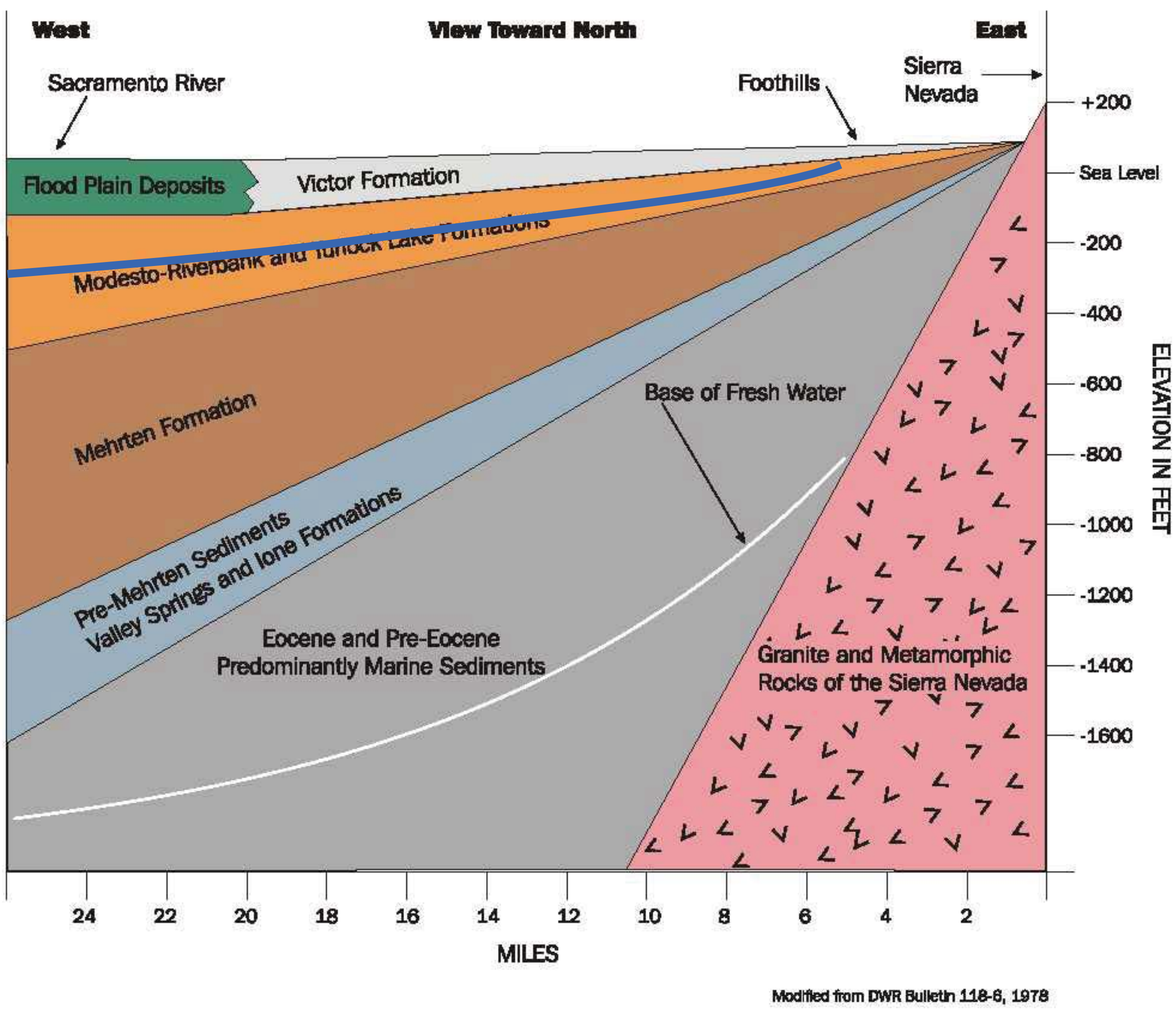


Figure ES-3. Spring 2004 Sacramento County Groundwater Elevation Contour Map

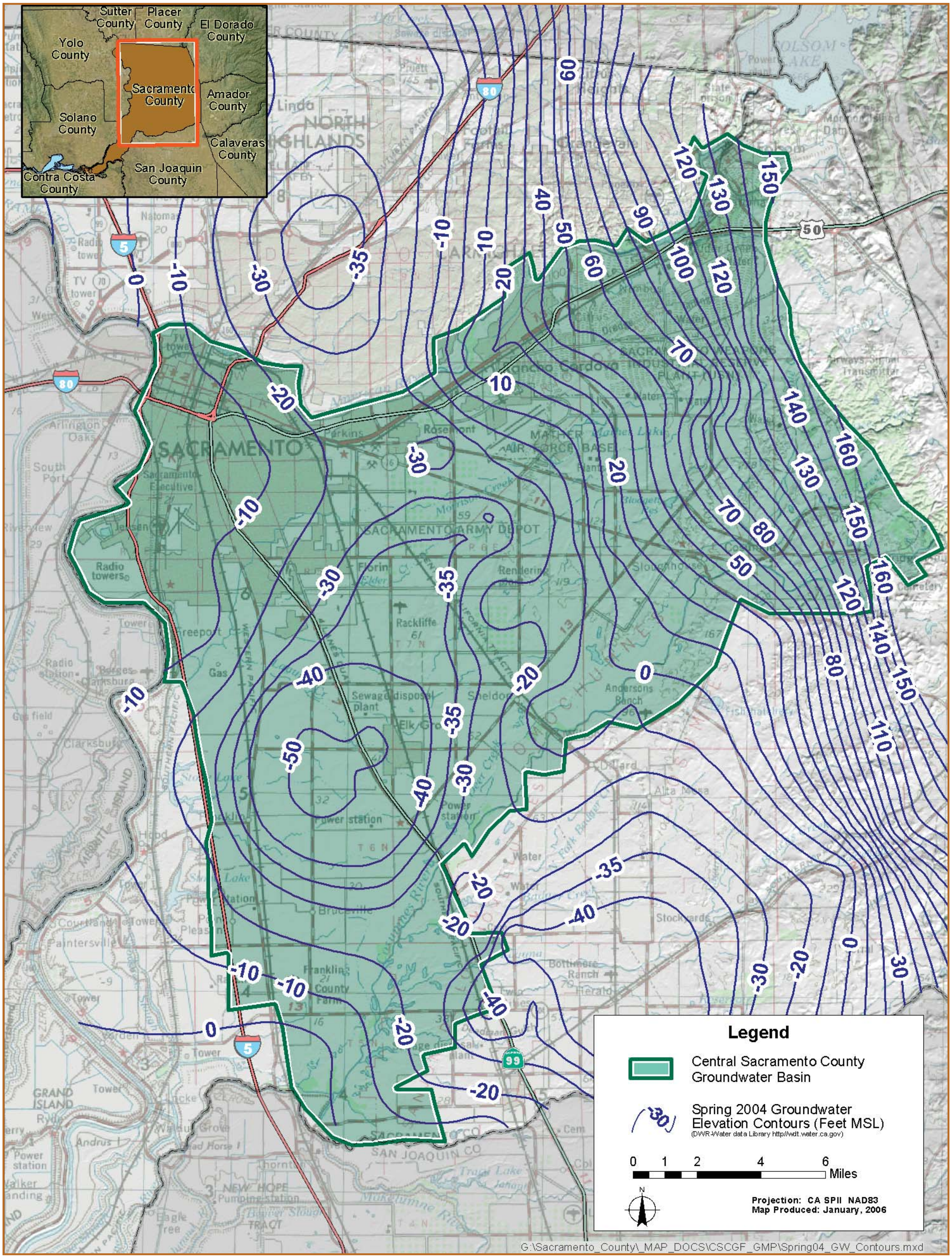
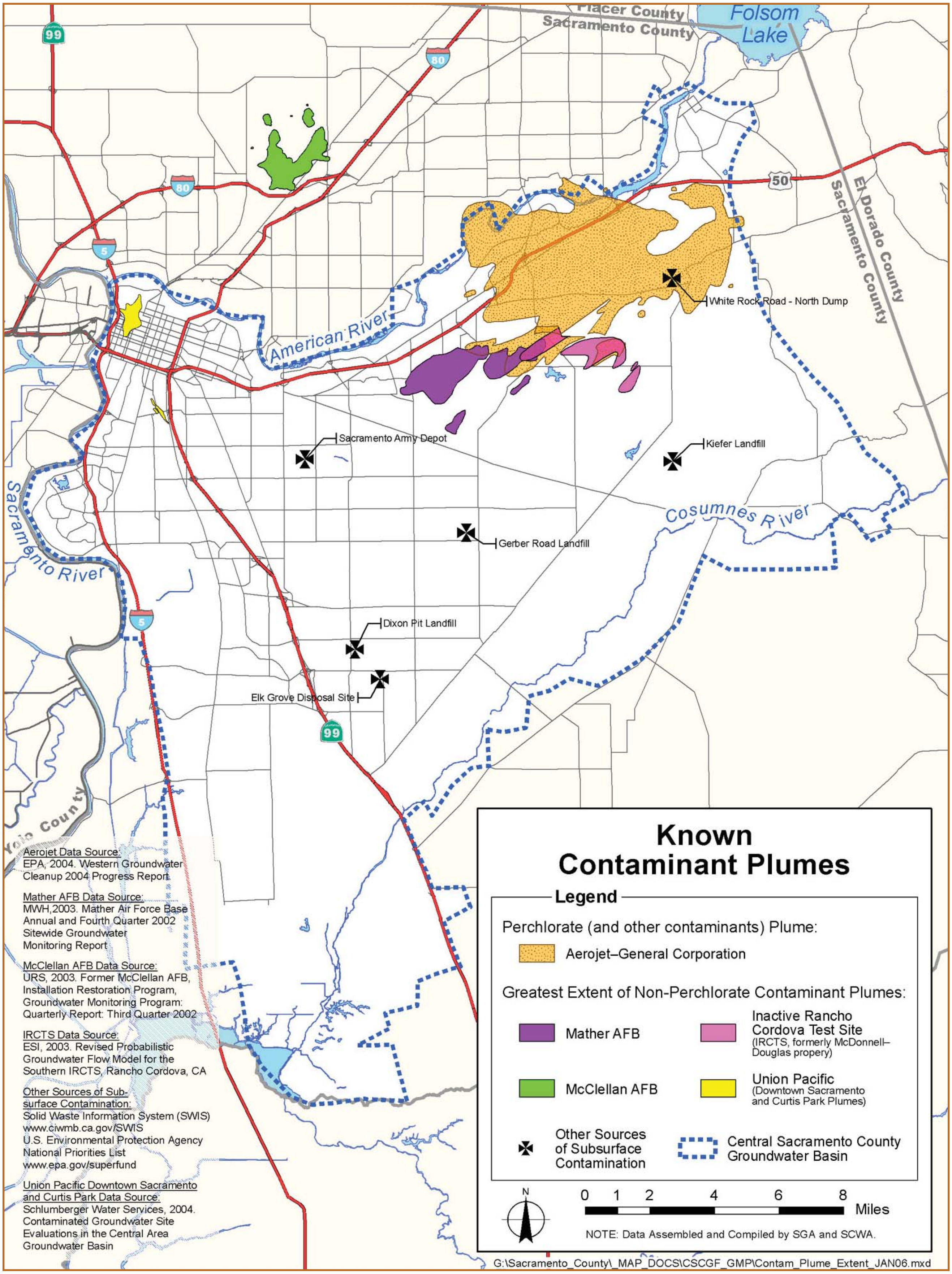


Figure ES-4. Known Extent of Contamination



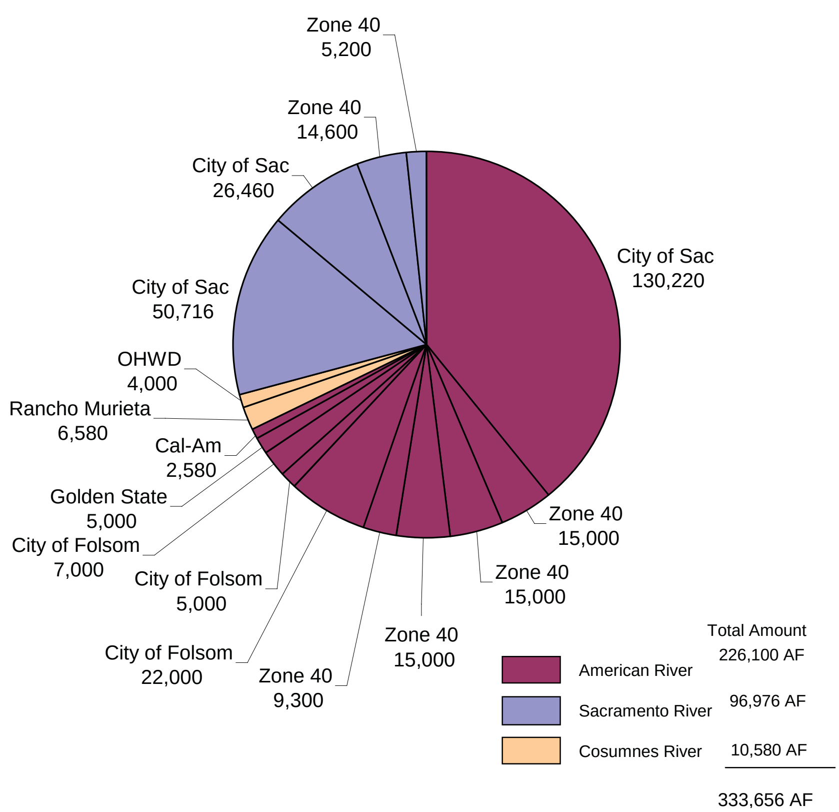
How are water demands calculated?

Water demands are determined using various methods based on identified uses of water. For instance, agricultural demands can vary significantly based on crop type. For agricultural-residential water users, demands are based on indoor usage, the amount of landscaped area around the home, and the amount of irrigated pasture for parcels that maintain livestock or other farm animals. Urban water demands are typically based on land use and zoning. Private industry and park district water demands are specific to the type of activity taking place at each site. Existing and future average annual water supply and demand is summarized in **Figure ES-6a and ES-6b** below. The graphs indicate that supplies meet demands and fluctuate depending on dry and wet hydrologic conditions, reflecting the conjunctive use of groundwater and surface water over the Central Basin by the various water purveyors and urban demand reductions during dry years. (In **Figure ES-6b**, conditions in 2030 demonstrate more clearly the results of existing and planned conjunctive use programs in full effect at that time). These demands also reflect the implementation of Best Management Practices (BMPs) for water conservation that are described in the WFA.

MANAGEMENT PLAN ELEMENTS

A goal of the CSCGMP is to ensure a viable groundwater resource for beneficial uses including water for purveyors, agricultural, agricultural residential, industrial, and municipal supplies that support the WFA's coequal objectives of providing a reliable and safe water supply and preserving the fishery, wildlife, recreational, and aesthetic values of the lower American River. In addition, the CSCGMP recognizes the need to maintain and enhance flows in the Cosumnes River because of its ecological significance.

Figure ES-5. Summary of Surface Water Rights and Contracts



Basin Management Objectives

Basin Management Objectives (BMOs) are used to help achieve groundwater basin goals. Five BMOs provide the foundation for the CSCGMP:

1) Maintain a long-term average groundwater extraction rate of 273,000 AF/year.
2) Establish specific minimum groundwater elevations within all areas of the basin consistent with the Water Forum "Solution."
3) Protect against any potential inelastic land surface subsidence.
4) Protect against any adverse impacts to surface water flows.
5) Develop specific water quality objectives for several constituents of concern.

Each of these objectives is fully described in **Section 3** of the CSCGMP.

Program Component Action Items

The Program Components listed below provide specific action items that will be implemented to help achieve the Basin Management Objectives.

Stakeholder involvement - several means of achieving broad stakeholder participation in the management of the Central Basin will be used, including: 1) involving the public, 2) involving other agencies within and adjacent to the Central Basin, 3) using advisory committees, 4) developing relationships with state and federal agencies, and 5) pursuing a variety of partnership opportunities.

Monitoring program - a good monitoring program is capable of assessing the current status of the basin and predicting responses in the basin as a result of future management actions. The CSCGMP includes actions related to monitoring of groundwater elevations, groundwater quality, the potential for land surface subsidence resulting from groundwater extraction, and developing a better understanding of the relationship between surface water and groundwater along the American, Cosumnes, and Sacramento Rivers.

Groundwater quality protection - groundwater quality protection is critical to ensuring a sustainable groundwater resource. Groundwater quality protection includes: 1) the prevention of contamination from entering the groundwater basin, and 2) the remediation of existing contamination.

Groundwater sustainability - the CSCGMP seeks to maintain or increase the amount of groundwater stored in the basin over the long-term. The WFA's groundwater management element provides a framework by which the groundwater resource in the Sacramento County-wide basin can be protected and used in a sustainable manner.

Planning integration - it is important to integrate water management planning on a regional scale (i.e., the development of an Integrated Regional Water Management Plan). The WFA provides a regional conjunctive use framework with commitments from individual purveyors concerning groundwater and surface water operations, including limitations on surface water diversions from the lower American River during dry years.

Figure ES-6a. 2005 Annual Average Water Balance

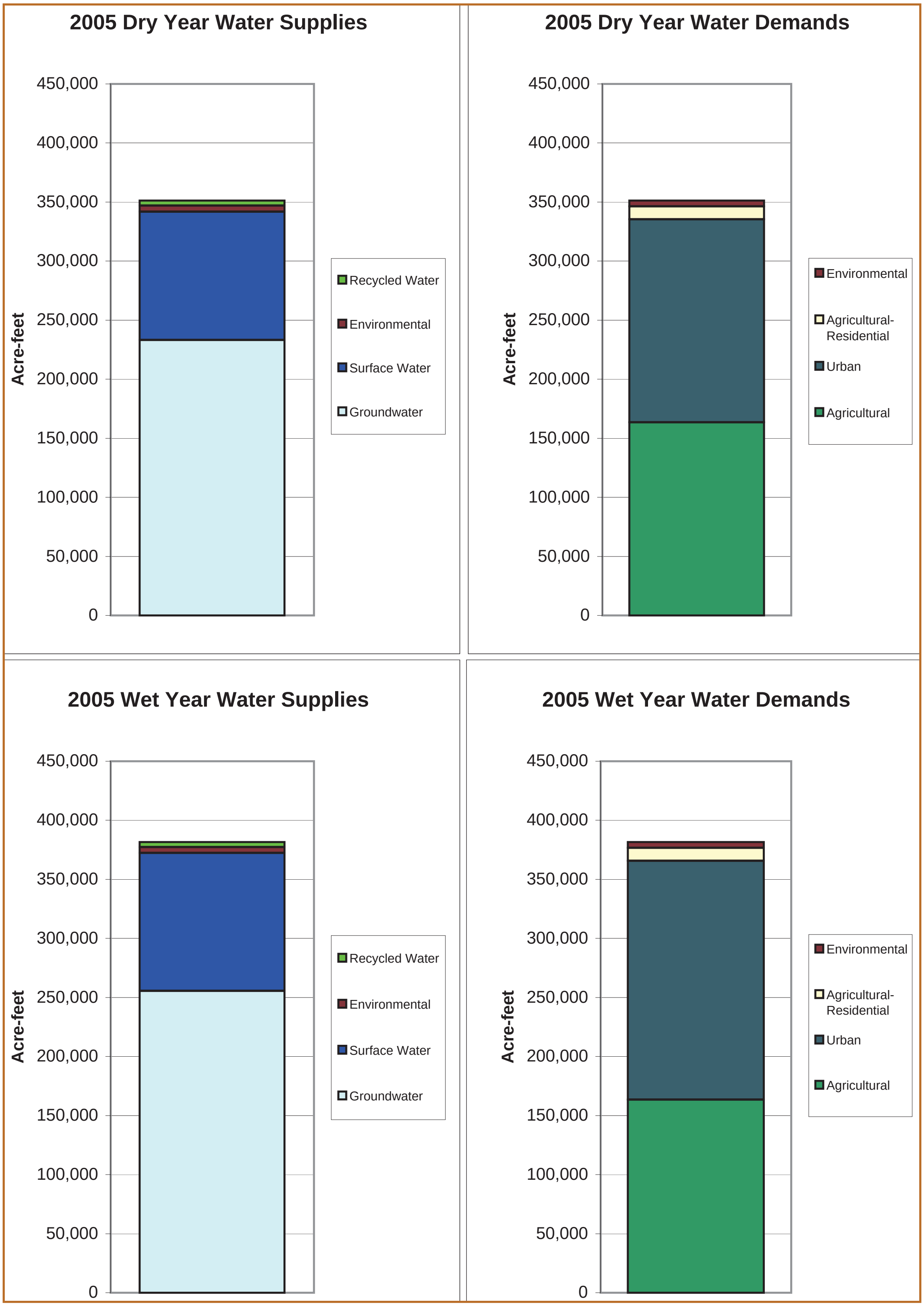
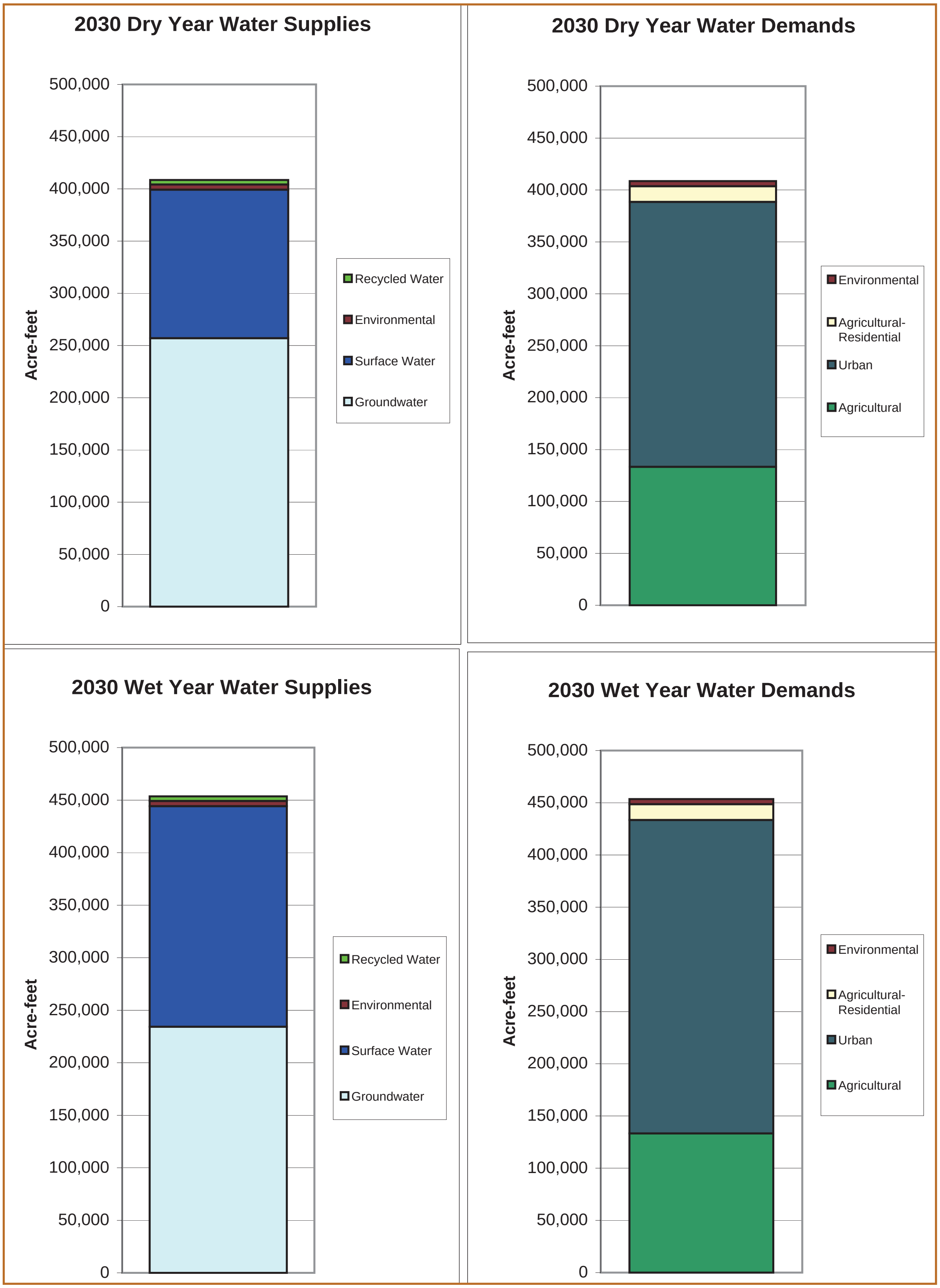


Figure ES-6b. 2030 Annual Average Water Balance



PLAN IMPLEMENTATION

An important element of a GMP is the establishment of trigger points and remedies necessary to fully implement the BMOs. Many of the remedies set forth in this GMP involve coordination with other local, state, and federal agencies. This coordination will begin upon adoption of the CSCGMP by the governance body.

BMO Trigger Point Activities

Trigger Point activities involve monitoring and assessing trends in the basin to determine the adequacy of the monitoring network for meeting the goals and objectives of the CSCGMP. These assessments will be made as new monitoring data become available for review by the basin governance body and results documented in an annual State of the Basin report. As mentioned in the introduction, this GMP is adaptive and relies on monitoring data, evaluation of remedies based on monitoring data and input from basin stakeholders. It requires that the basin be managed in a manner that makes the most practical sense in light of on-going collection and analysis of data.

Protection of Privately Owned Wells

The CSCGMP includes two programs that were negotiated by the stakeholders in the Central Sacramento County Groundwater Forum: the Well Protection Program and the Groundwater Contamination Monitoring and Collaboration Program.

How is an existing private well protected?

The Well Protection Program grew out of discussions that took place in the CSCGF and stems from the need to protect domestic and agricultural irrigation wells. Protection of existing privately owned wells is of fundamental importance to the stakeholders of the CSCGF. As part of this program, a trust fund will be put in place to cover costs of deepening or replacing any existing well that provides water for agricultural or domestic use that may be impacted by future development. The trust fund revenue will be generated from a fee assessed on every new building permit and permit to drill a new well. In 2005, the fee is estimated to be less than $100 per equivalent dwelling unit (e.g. single family home) within the basin.

How is the private well owner kept notified of groundwater contamination clean-up efforts?

The Groundwater Contamination Monitoring and Collaboration Program is focused on maintaining a clear line of communication between the designated Responsible Parties for groundwater contamination clean-up activities and private well owners. The program encourages the use of remediated groundwater in urbanized areas to keep the groundwater in the basin. This program also envisions the Regional Water Quality Control Board requiring designated Responsible Parties to survey private wells within 2,000 feet of any identified contamination plume. Assistance will also come from the Sacramento County Environmental Management Department (EMD). EMD is encouraged to exercise the strictest vigilance to ensure that all permitting

requirements are enforced and that, if requirements are not met, EMD will undertake whatever rigorous enforcement actions are effective.

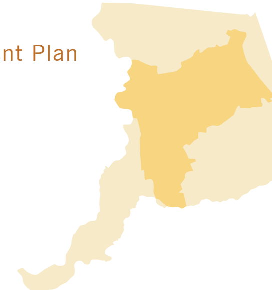
Basin Governance Body

The governance body is responsible for implementing the actions contained within this CSCGMP. The governance body will initiate the trust fund of the Well Protection Program, take over its administration, and provide annual reporting on the program. In addition, it will pursue any grant opportunities available to the Central Basin and participate in the Integrated Regional Water Management Plan that is currently underway. This is a regional planning document that is a prerequisite if a region is to pursue Proposition 50 implementation grant monies. Lastly, the governance body will collect, evaluate, and report on all of the data and management activities that have been taken in the Central Basin once a year in a State-of-the-Basin Report.

Plan Implementation Costs

First year program startup costs are estimated at $280,000. This is essentially 1.2 full-time people working throughout the year on setting up monitoring programs, taking measurements, compiling data, and reporting data. Future program costs will be evaluated on an annual basis by the basin governance body.

GROUNDWATER MANAGEMENT PLAN



Foreword

The genesis of the Central Sacramento County Groundwater Management Plan (CSCGMP) stems from events that began in the early 1990s and continues to the present day. Foremost among these was the formation of the Sacramento Area Water Forum (Water Forum). At the culmination of the Water Forum process (1993 to 2000), a Water Forum Agreement (WFA) was signed by participating agencies (described in more detail in **Section 1**). After signing the WFA the Water Forum Successor Effort (Successor Effort) was formed to carry forward the work outlined in the WFA.

One of the objectives of the Successor Effort was the formation of a basin governance body for the Central Sacramento County Groundwater Basin (Central Basin). See **Figure 1-1** for the geographic location of the Central Basin and **Figure 1-2** for the location of existing organized water purveyors in the Central Basin. As a result, the Central Sacramento County Groundwater Forum (CSCGF) was established; each member or stakeholder of the CSCGF has an interest in the groundwater underlying the Central Basin (details of CSCGF membership are described further below). The stakeholders are listed as follows:

1. Local Government/Public Agencies Interests
2. Business Interests
3. Agricultural Interests
4. Agricultural/Residential Interests
5. Environmental/Community Organizations Interests
6. Water Purveyor Interests

In order to assist in the development of the basin governance body a recommendation was made to the CSCGF to first develop a groundwater management plan for the Central Basin. The stakeholders recognized that development of a groundwater management plan would help them focus on an appropriate structure for the basin governance body once they had an understanding of the responsibilities and requirements for implementing a groundwater management program. The CSCGF agreed by consensus to act on this recommendation and formed a smaller group of CSCGF stakeholders (GMP Task Force) that were tasked with developing the CSCGMP.

The CSCGMP is a tool that is designed to ensure a long-term reliable groundwater supply for beneficial use within the Central Basin. It should be noted that the CSCGMP is not a land use policy tool. However, it is understood that a groundwater management plan may effect land use decisions simply through its influence on water use in a groundwater basin.

The structure of the CSCGMP is described below:

Section 1. Introduction. Describes the political and geographic setting and the activities taking place by water purveyors and interested stakeholders in the Central Basin.

Section 2. Water Resources Setting. Prior to managing a basin available water supplies have to be identified and quantified. In this section information is presented to assist the reader in understanding the availability of different water supplies and how they can be used within the Central Basin. This section provides a primer on the unique hydrogeology and setting within the Central Basin, it also provides an understanding of water quality issues and the groundwater and surface water infrastructure that is currently in-place. The relationship between water demands, water supplies, and land use are considered in the development of a water balance that examines current and future (2030) water supply needs.

Section 3. Components of the Groundwater Basin Management Plan. This section identifies the six components that constitute a groundwater management plan as described in the California Groundwater Management Guidelines (Groundwater Resources Association of California, Second Edition 2005). An important aspect of this section is the identification of Basin Management Objectives (BMOs) and the elements necessary for their implementation.

Section 4. Plan Implementation. Using the BMOs a set of threshold criteria (trigger points) have been developed to assist in reviewing and analyzing monitoring actions throughout the year. Once a trigger point is exceeded a recommended action takes place. Because the CSCGMP is based on adaptive management, trigger points and recommended actions can be changed by the basin management body. The section also includes a Well Protection Program that provides for the protection of domestic and agricultural and a Groundwater Contamination Collaboration Program to assist private well owners in understanding the risk of groundwater contamination to their wells.

Section 5. References. This section provides a compilation of references used in the development of the CSCGMP.

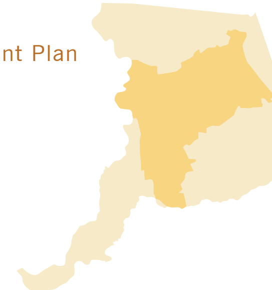


Table of Contents

FIGURES

TABLES

APPENDICES

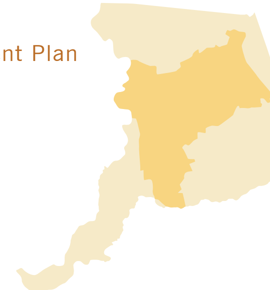
ABBREVIATIONS AND ACRONYMS

μg/L	micrograms per liter
AB	Assembly Bill
Aerojet	Aerojet-General Corporation
AF	acre-feet
AF/year	acre-feet per year
AFB	Air Force Base
AFRPA	Air Force Real Property Agency
ag/res	agricultural/residential
Agency Act	State of California Sacramento County Water Agency Act
ARWRI	American River Water Resources Investigation
ASR	aquifer storage and recovery
bgs	below ground surface
BMO	Basin Management Objective
BMP	best management practice
BVID	Brown's Valley Irrigation District
Cal-Am	California-American Water Company
CALFED	CALFED Bay-Delta Program
CCR	California Code of Regulations
Central Basin	Central Sacramento County Groundwater Basin
CEQA	California Environmental Quality Act
cfs	cubic feet per second
City	City of Sacramento
CMP	Sacramento Coordinated Water Quality Monitoring Program
COC	contaminant of concern
Cooperating Agencies	American River Basin Cooperating Agencies
CSCGF	Central Sacramento County Groundwater Forum
CSCGMP	Central Sacramento County Groundwater Management Plan
CSD	Community Service District
CSUS	California State University, Sacramento
CVP	Central Valley Project
CVPIA	Central Valley Project Improvement Act
CWC	California Water Code
DAU	Data Analysis Unit
Delta	Sacramento/San Joaquin Delta
DHS	California Department of Health Services
DMS	Data Management System
DTSC	State of California Department of Toxic Substance Control

DWR	California Department of Water Resources
DWSAP	Drinking Water Source Assessment and Protection Program
EBMUD	East Bay Municipal Utility District
EIR	Environmental Impact Report
EIS	Environmental Impact Statement
EMD	Sacramento County Environmental Management Department
EPA	United States Environmental Protection Agency
FMS	Flow Management Standard
Folsom	City of Folsom
FRCD/EGWS	Florin Resource Conservation District/Elk Grove Water Service
GMP	Groundwater Management Plan
gpm	gallons per minute
GSWC	Golden State Water Company
GWNT	Groundwater Negotiation Team
ID	irrigation district
IGSM	Integrated Groundwater and Surface Water Model
InSAR	Interferometric Synthetic Aperture Radar
IRTCS	Inactive Rancho Cordova Test Site
JPA	Joint Powers Authority
LSCE	Luhdorff & Scalmanini Consulting Engineers
LUFT	leaking underground fuel tank
LUST	leaking underground storage tank
M&I	municipal and industrial
Mather AFB	Mather Air Force Base
McClellan AFB	McClellan Air Force Base
MCL	maximum contaminant level
MFP	Middle Fork Project
MG	million gallons
mg/L	milligrams per liter
mgd	million gallons per day
msl	mean sea level
NAWQA	National Water Quality Assessment
NCMWC	Natomas Central Mutual Water Company
NDMA	n-nitrosodimethylamine
NEPA	National Environmental Policy Act
NGS	National Geodetic Survey
NPDES	National Pollutant Discharge Elimination System
PBE	physical barrier effectiveness
PCA	potentially contaminating activities
PCE	tetrachloroethene

PCWA	Placer County Water Agency
PL	Public Law
PMT	Project Management Team
POU	Place of Use
PSA	Purveyor-Specific Agreement
Reclamation	United States Department of the Interior, Bureau of Reclamation
RWA	Regional Water Authority
RWQCB	Regional Water Quality Control Board
SACOG	Sacramento Area Council of Governments
SCWA	Sacramento County Water Agency
SCWC	Southern California Water Company
SGA	Sacramento Groundwater Authority
SMUD	Sacramento Municipal Utility District
SMWA	Sacramento Metropolitan Water Authority
SOP	standard operating procedure
SRCSD	Sacramento Regional County Sanitation District
SSCAWA	Southeast Sacramento County Agricultural Water Authority
SWRCB	State Water Resources Control Board
SWTR	Surface Water Treatment Rule
TDS	total dissolved solids
Title 22	California Code of Regulations, Title 22
USACE	United States Army Corps of Engineers
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
Water Forum	Sacramento Area Water Forum
WD	water district
WEP	Water Efficiency Program
WFA	Water Forum Agreement
WPP	Well Protection Program
WSMP	Water Supply Master Plan
WTP	water treatment plant
WWTP	wastewater treatment plant
Zone 40	area within the Central Basin that includes Laguna, Vineyard, Elk Grove, and Rancho Cordova

Introduction



Section 1

Introduction

This section describes the CSCGMP, provides relevant background information, describes activities in the North, Central, and South Sacramento County groundwater basins, summarizes ongoing master planning in the context of various regional planning efforts taking place throughout the Sacramento County area, discusses the authority under which the CSCGMP is being prepared, and lists required and voluntary components of the CSCGMP.

1.1 THE CENTRAL SACRAMENTO COUNTY GROUNDWATER MANAGEMENT PLAN

In order to maintain a sustainable, high-quality groundwater resource for the users of the groundwater basin underlying the Central Basin (see **Figure 1-1**) the CSCGMP has been prepared to inform and guide the basin governance body, stakeholders and other interested parties in the management of the basin.

It is the intent of this document to quantify as much as practicable every aspect of the Central Basin including but not limited to: the historical context of the CSCGMP, a description of each stakeholders interest, projects and programs being implemented within the Central Basin by various stakeholders and regional partners, and the management and monitoring strategy to achieve a long-term sustainable yield from the basin. The CSCGMP also contains a Well Protection Program (WPP). The WPP is designed to protect private wells from going dry or becoming non-operable as a result of CSCGMP related activities. The Trial Balloon on Well Protection developed by the CSCGF outlines the premise of the WPP. The WPP is described in more detail in **Section 4**.

Described in the subsections below is the historical context of the CSCGMP. The reader will quickly understand that the concept of groundwater management of the Central Basin is not a new concept to this basin. Beginning from the time when wells were first dug by hand and then drilling technologies allowed for deeper and higher capacity yields from the basin, there has been data showing a consistent decline in groundwater elevations, spurring on management efforts at different stages in time and in different forums than that used in the development of this GMP. Because of the lengthy history, a synopsis of the more recent and more relevant events that have taken place is provided below.

Figure 1-1. Groundwater Basins in Sacramento County

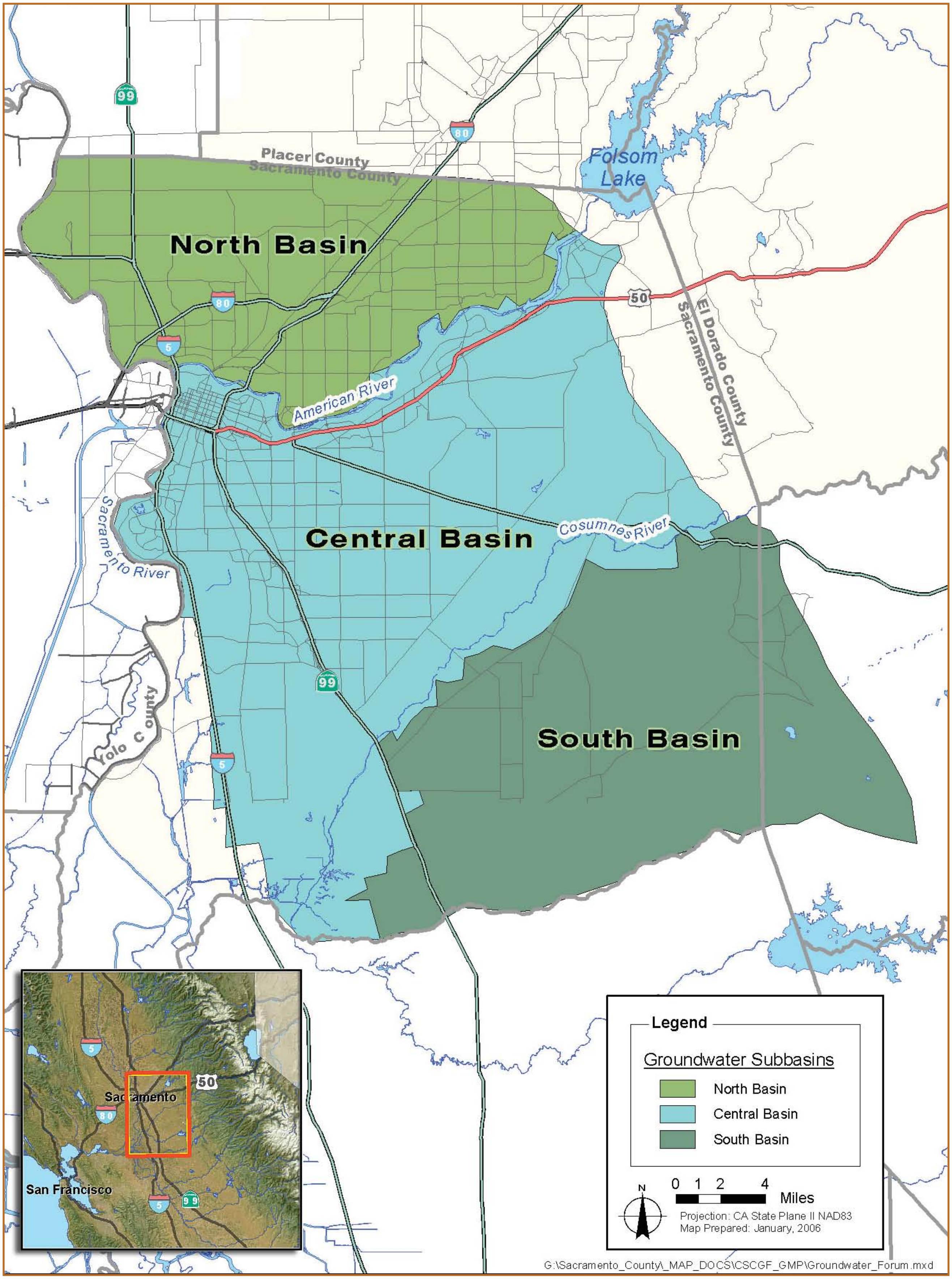
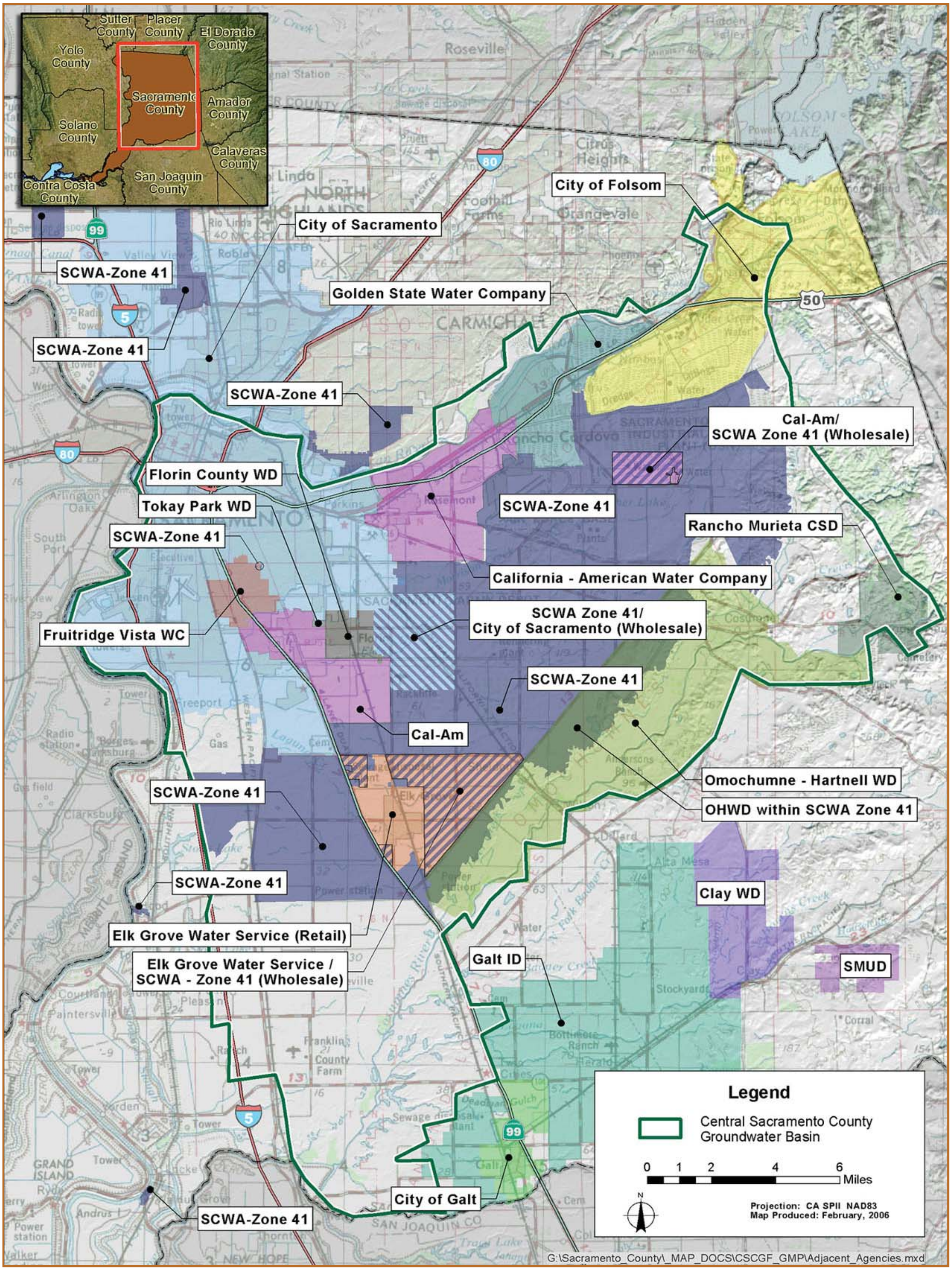


Figure 1-2. Water Purveyors In the Central Basin



1.1.1 Water Forum as the Basis for the Central Sacramento County Groundwater Management Plan

Beginning in 1993, the Water Forum process brought together a diverse group of stakeholders comprising business and agricultural leaders, citizens' groups, environmentalists, water managers, and local governments to evaluate available water resources and the future water needs of the Sacramento region, including communities from Sacramento, Placer and El Dorado counties. These stakeholders identified two coequal objectives to guide in the development of the WFA:

- Provide a reliable and safe water supply for the region's economic health and planned development through the year 2030
- Preserve the fishery, wildlife, recreational, and aesthetic values of the lower American River

After a six year consensus-based stakeholder process, the WFA was completed. The WFA prescribes a regional conjunctive use program for the lower American River and connected groundwater basin. The Water Forum also completed an "Environmental Impact Report for the Water Forum Proposal" (State of California Clearinghouse Number 95082041). This document was certified by the two lead agencies of the Water Forum, the City and County of Sacramento, in December 1999.

One of the seven elements of the WFA is groundwater management. Implementation of this element includes adherence to an agreed-on long-term average annual pumping limit (sustainable yield) for each of the three geographic subareas of the groundwater basin within Sacramento County (see **Figure 1-1**): 131,000 acre-feet (AF) for the North Basin (north of the American River); 273,000 AF for the Central Basin (between the American and Cosumnes rivers); and 115,000 AF for the Galt or South Basin (south of the Cosumnes River). Any proposed water supply project or groundwater management structure must satisfy the groundwater conditions specified in the WFA for the 2030 projected level of development based on the 1993 Sacramento County General Plan.

In 2005, the County of Sacramento Planning Department, in partnership with the Sacramento Area Council of Governments (SACOG), released to the public conceptual land use plans for the next General Plan Update that will take development beyond 2030 and include the General Plans for the City of Sacramento, City of Folsom, City of Elk Grove, and the City of Rancho Cordova. This GMP recognizes that this effort is taking place and that it has direct and significant implications on groundwater management in the Central Basin; however, it is assumed that until the General Plan Update is adopted by the Sacramento County Board of Supervisors, this GMP will continue to reflect the current General Plan.

The WFA includes Purveyor-Specific Agreements (PSA) which define the benefits each water purveyor will receive as a stakeholder and actions each must take to receive these benefits. PSAs for the County of Sacramento/SCWA, City of Sacramento, and the Sacramento Municipal Utility District (SMUD) also describe commitments by the City of Sacramento, SMUD, and SCWA to address issues related to wheeling and wholesaling of surface water, Central Valley Project (CVP) water transfers, and dry year water supply.

1.1.1.1 Central Basin Signatories to the Water Forum Agreement

Excerpts from the WFA PSAs for Central Basin Water Purveyors signatory to the WFA follow (in some PSAs certain activities are or have already taken place or are included in adopted programs by the individual agencies.):

1.1.1.1.1 County of Sacramento/Sacramento County Water Agency

The **Sacramento County Water Agency (SCWA)** is responsible for providing wholesale water to an area within the Central Basin that includes the Laguna, Vineyard, Elk Grove and Rancho Cordova communities, and is commonly referred to as Zone 40. SCWA will divert firm and intermittent surface water from at, or near, the mouth of the American River or from the Sacramento River. SCWA will use groundwater and surface water conjunctively to meet water system demands.

A portion of Zone 40 is situated within the Place of Use (POU) for the City of Sacramento's American River water entitlements (see **Figure 1-3**). It is assumed that these entitlements would be used to serve significant portions, entirely or by conjunctive use, of this portion of Zone 40. Conditions for the use of this water will be consistent with the conditions outlined in the City of Sacramento's PSA related to diversions of American River water.

All signatories to the WFA endorse SCWA's PSA, which provides for constructing SCWA's water supply facilities identified in their Zone 40 Water Supply Master Plan. These facilities include a diversion structure at or near the mouth of the American River or on the Sacramento River, water treatment plants (WTP), pumping stations, wells, storage facilities, and transmission pipelines.

Stakeholder support is contingent on project-specific compliance with the California Environmental Quality Act (CEQA), and where applicable, the National Environmental Policy Act (NEPA), federal Endangered Species Act, California Endangered Species Act, and California Public Utilities Commission, and Local Area Formation Commission (LAFCO) approval.

1.1.1.1.2 City of Sacramento

The City of Sacramento (City) has rehabilitated its Fairbairn Water Treatment Plant (WTP) diversion facility and expanded its Fairbairn WTP treatment capacity by another 100 million gallons per day (mgd). This will allow the City to divert and treat an additional 155 cfs consistent with the terms described below. Concurrent with the expansion of the Fairbairn WTP, the City has also constructed other facilities such as expansion/rehabilitation of the Sacramento River WTP and river intake to assure that a reliable alternative supply (groundwater, pump-back, and/or diversion from the Sacramento River) is available when it is needed.

During periods when lower American River flows are sufficient (i.e., above the "Hodge" criteria, the City could fully use its increased diversion capacity at the Fairbairn WTP. In drier periods when lower American River flows are not sufficient (i.e., below the "Hodge" criteria), the City could not divert water from the American River for the full capacity of the Fairbairn WTP.

Additional diversions from the Sacramento River, and/or groundwater in the North Basin, also may be used by the City to meet 2030 demands.

Stakeholder support is contingent on project-specific compliance with the California Environmental Quality Act (CEQA), and where applicable, the National Environmental Policy Act (NEPA), federal Endangered Species Act, California Endangered Species Act, and California Public Utilities Commission, and Local Area Formation Commission (LAFCO) approval.

1.1.1.1.3 California-American Water Company (formerly Citizens Utility Company of California)

California-American Water Company (Cal-Am) has a number of service areas within the metropolitan area of Sacramento County. These service areas are located within the North Basin (identified as the North Area in the PSA) and the Central Basin (identified as the South County municipal and industrial (M&I) area and the City's American River water rights POU area in the PSA).

Cal-Am has contracted with the City to use 2,580 AF annually from the City's Fairbairn WTP and the Sacramento River WTP for use in its Southgate service area, which also is within the City's POU.

For other Cal-Am service areas within the POU (including the Arden area, portions of the suburban Rosemont areas, and a portion of the Parkway area), when a contract with the City for delivery of surface water beyond the existing contract for the Southgate area is proposed, signatories to the WFA will meet in good faith with the objective of developing mutually acceptable provisions consistent with the two coequal objectives of the WFA.

Cal-Am will contract for use of a portion of the surface water provided through the County of Sacramento/SCWA for its service area in the south portion of Sacramento County. In addition, Cal-Am will continue to use groundwater to meet water supply needs in each of its service areas.

Stakeholder support is contingent on project-specific compliance with the California Environmental Quality Act (CEQA), and where applicable, the National Environmental Policy Act (NEPA), federal Endangered Species Act, California Endangered Species Act, and California Public Utilities Commission, and Local Area Formation Commission (LAFCO) approval.

1.1.1.1.4 City of Folsom

The City of Folsom (Folsom) will increase its average and wet year American River diversions from an agreed upon baseline amount of 20,000 AF to a 2030 level of 34,000 AF. In drier years, Folsom will divert and use a decreasing amount of surface water from 34,000 AF to 22,000 AF (or the equivalent, as described in the example below), in a three-stage stepped and ramped reduction in proportion to the decrease in the March through November unimpaired inflow (unimpaired inflow implies that there is no upstream storage occurring prior to water entering Folsom Reservoir) to Folsom Reservoir of 950,000 AF to 400,000 AF.

Under stage 1, Folsom will divert a decreasing amount, from 34,000 AF to 30,000 AF, in proportion to the decrease in March through November when the unimpaired inflow to Folsom Reservoir is greater than 870,000 AF but less than 950,000 AF.

Under stage 2, Folsom will divert a fixed amount of 27,000 AF when the March through November unimpaired inflow to Folsom Reservoir is greater than 650,000 AF but less than or equal to 870,000.

Under stage 3, Folsom will divert a fixed amount of 22,000 AF when the March through November unimpaired inflow to Folsom Reservoir is equal to or greater than 400,000 AF but less than or equal to 650,000 AF.

In the driest years, when the March through November unimpaired inflow to Folsom Reservoir is less than 400,000 AF, Folsom will reduce diversions (or the equivalency, as described in the example below) to 20,000 AF. Also, Folsom will reduce diversions in the driest years by encouraging additional, extraordinary conservation to reduce diversions to 18,000 AF.

As an example of how Folsom will meet its needs during drier and driest years, Folsom will reduce diversions by imposing additional conservation levels, and will continue to divert water from Folsom Reservoir for the balance of its needs. However, Folsom will enter into agreements with other suppliers that have access to both surface water and groundwater for an equivalent exchange of the amount of reduction in diversion needed by Folsom, as outlined above in the three stages of reduction. Under these arrangements, suppliers located north and possibly south of the American River will use groundwater in lieu of surface water equivalent to the amount that Folsom will continue to divert.

Stakeholder support is contingent on project-specific compliance with the California Environmental Quality Act (CEQA), and where applicable, the National Environmental Policy Act (NEPA), federal Endangered Species Act, California Endangered Species Act, and California Public Utilities Commission, and Local Area Formation Commission (LAFCO) approval.

1.1.1.1.5 Florin County Water District

Florin County Water District (FCWD) will use groundwater to meet its 2030 water demands. When a contract between the City and FCWD for delivery of surface water is proposed, signatories to the WFA will meet in good faith with the objective of developing mutually acceptable provisions consistent with the two coequal objectives of the WFA. FCWD is located within the POU for the City's American River entitlement.

Negotiations on specific conditions for delivery of surface water under this contract will be undertaken by the Water Forum Successor Effort and FCWD.

1.1.1.1.6 Omochumne-Hartnell Water District

At this time, the **Omochumne-Hartnell Water District (OHWD)** does not purvey water within the boundaries of the district. Private groundwater wells provide almost all of the water demands for the agricultural and rural residential community within OHWD. Surface water supplies are available to only a small number of agricultural users located adjacent to the Cosumnes River or Deer Creek. The unpredictable and limited nature of these waterways precludes the development of any significant surface water supplies.

Historically, OHWD has imported supplemental surface water from the Sly Park Unit of the CVP. Imports ranged from 800 to 5,300 AF per year (AF/year) from 1966 to 1974. After the completion of the Folsom South Canal (in the early 1970's) OHWD was only able to acquire supplemental water on an interim basis. Over the past 20 years, no reliable supplemental water has been made available from the Folsom South Canal.

OHWD currently maintains and operates four flashboard dams on the Cosumnes River to facilitate increased groundwater recharge from the river channel. The flashboard dams, which were historically operated to facilitate diversions, are now put in place in the early summer months when flows are receding to increase the wetted perimeter of the river channel and increase percolation to groundwater.

1.1.1.1.7 Golden State Water Company (formally Southern California Water Company)

Groundwater constitutes about 70 percent of the water supply for the portion of **Golden State Water Company (GSWC)**, south of the American River. Available groundwater supplies are conjunctively used with surface water with 5,000 AF of American River water entitlements diverted from the Folsom South Canal. GSWC has a Pre-1914 water right to 10,000 AF of American River water with 5,000 AF currently leased to the City of Folsom.

1.1.1.1.8 Aerojet-General and Other Self-Supplied Industries Through Business Interests

Aerojet-General Corporation (Aerojet) and other privately supplied industries have demonstrated a commitment to supporting reliable water supplies that will attract new industries and development to the community. The business community, as a signatory to the WFA, has agreed that they play a pivotal role in the region's water supply solution and should contribute to and support efforts that meet WFA goals.

1.2 NORTH SACRAMENTO COUNTY GROUNDWATER BASIN ACTIVITIES

The Water Forum process led to the establishment of the Sacramento Groundwater Authority (SGA). As an example of how a groundwater management plan is implemented, SGA is a governing body formed through a joint powers agreement. SGA uses the police powers of the cities of Sacramento, Citrus Heights, and Folsom, and the County of Sacramento to implement its adopted groundwater management plan. SCWA is a member of SGA through SCWA's Zone 41 service area located north of the American River; the cities of Sacramento and Folsom and California-American and Golden State water companies also are SGA members.

1.3 CENTRAL SACRAMENTO COUNTY GROUNDWATER BASIN ACTIVITIES

As discussed previously, the WFA calls for an interest-based negotiation process to provide all segments of the community an opportunity to participate in developing a groundwater management structure for the Central Basin. This stipulation in the WFA led to the creation of CSCGF under the auspices of the Successor Effort.

Acting on behalf of the Successor Effort, the Sacramento City-County Office of Metropolitan Water Planning signed a Memorandum of Understanding with the California Department of Water Resources (DWR) and initiated the CSCGF. The CSCGF supports discussion among stakeholders representing all segments of the community with an interest in developing a groundwater basin management body and ultimately a groundwater management plan for the Central Basin. Stakeholders were selected through an area-wide assessment performed by the Successor Effort to identify concerns and develop a process for stakeholders to work together. Interviews were held with 94 stakeholders, resulting in the establishment of six interest groups: agriculture, agriculture/residential, business, environmental/community organizations, local governments/public agencies, and water purveyors. Each interest group is represented by five individuals who participate in the collaborative process known as the CSCGF.

1.4 SOUTH SACRAMENTO COUNTY GROUNDWATER BASIN ACTIVITIES

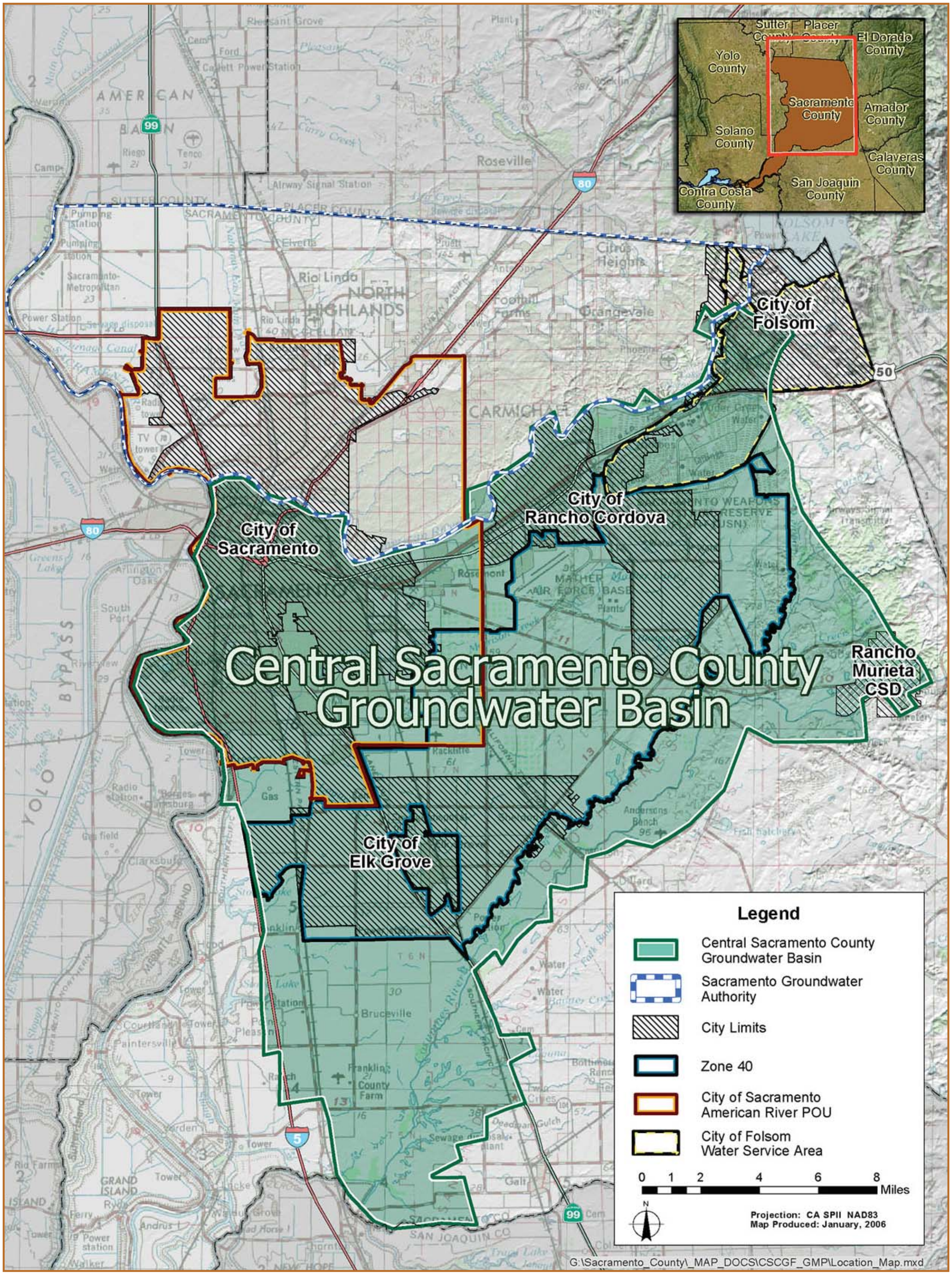
Groundwater-related activities south of the Cosumnes River are guided predominantly by the Southeast Sacramento County Agricultural Water Authority (SSCAWA). SSCAWA is a joint powers agency comprising three agricultural districts: OHWD, Galt Irrigation District, and Clay Water District.

The delineation of the Central Basin as determined by the WFA (see **Figure 1-3**) and the South Basin as reflected in SSCAWA's AB 3030 groundwater management plan adopted in 2002 (2002 GMP) are recognized as conflicting in the area of OHWD, which lies in both the Central and South Basins. Through cooperative participation in both groundwater basins, OHWD has acknowledged that activities which may take place within its boundaries can have a direct effect on both Central and South basins.

SSCAWA is working on updating the 2002 GMP to include additional local partners and to complete a more comprehensive groundwater management plan (South Sacramento County Groundwater Management Plan or SSCGMP) that can be integrated with the CSCGMP for the development of an Integrated Regional Water Management Plan (IRWMP) for the region south of the American River. New partners in the South Basin groundwater management plan include the City of Galt, Rancho Murieta Community Services District (also in the Central Basin), The Nature Conservancy (TNC), and SCWA. One of the primary objectives of the SSCGMP will be the development of a conjunctive use program that utilizes 15,000 AF of SMUD's CVP entitlement allocated to south Sacramento County agriculture through the WFA.

It has been demonstrated through real-time monitoring and scientific analysis that groundwater management programs adopted in the SSCAWA region and along the Cosumnes River corridor will have beneficial effects on the Central Basin (TNC and UC Davis, 2005). Recognizing this, a close working relationship between SSCAWA and the CSCGF has been developed to ensure that the interests and objectives of both basins are considered while developing their respective groundwater management plans. As a result of this relationship, SSCAWA, TNC, and SCWA have executed an agreement that actively investigates opportunities for flow restoration, conjunctive management, and enhanced recharge within the Cosumnes River corridor.

Figure 1-3. Location Map of Central Basin



1.5 ROLE OF THE TWO PRIMARY WATER RESOURCES MANAGERS IN THE CENTRAL BASIN

To understand how the CSCGMP fits into the various programs described in the following sections it is necessary to describe the role of the two primary water resources managers, the City of Sacramento and SCWA, and their respective goals.

1.5.1 Sacramento County Water Agency

SCWA was formed in 1952 by a special legislative act of the State of California: the Sacramento County Water Agency Act (Agency Act). The Agency Act defines SCWA's purposes including, but not limited to:

- Making water available for any beneficial use of lands and inhabitants
- Producing, storing, transmitting, and distributing groundwater in accordance with an approved Master Plan

SCWA's boundaries include all of Sacramento County (excluding the Cities of Folsom, Galt, Isleton, and Sacramento), and the agency is governed by a Board of Directors (ex officio, the Sacramento County Board of Supervisors). Under the Agency Act, the Board may contract with the federal government under reclamation laws with the same powers as irrigation districts, and may contract with the State of California and federal government with respect to the purchase, sale, and acquisition of water. SCWA also may construct and operate any required capital facilities.

Currently, several benefit zones exist within SCWA that are related to both water supply (Zone 13, Zone 40, Zone 41, and Zone 50) and drainage (Zone 11, Zone 12, and Zone 13). Each has a unique purpose and generates revenue internally for carrying out that purpose. Zone 40 is discussed in more detail in the following sections.

1.5.1.1 Zone 40

Historically, Zone 40 has relied on the underlying groundwater basin for agricultural, industrial, and residential water supplies. Over the past 10 years, Zone 40 has supplemented the use of groundwater supplies with surface water, recycled water, and education on and enforcement of water conservation. To address increasing demands for water in the region, SCWA updated and approved its Zone 40 Water Supply Master Plan (WSMP) in February 2005. As indicated in the WSMP, a primary role of Zone 40 is to meet growing urban water demands in a way that protects and maintains the groundwater basin and existing groundwater users. Through a policy that requires construction of groundwater wells to target portions of the underlying aquifer that are not used by private domestic wells, Zone 40 has developed approximately 40 mgd of groundwater capacity. All groundwater production is treated before distribution to retail and wholesale customers. Through firm surface water contracts with the US Bureau of Reclamation (Reclamation) and wheeling agreements with the City, Zone 40 currently has the ability to deliver 12,350 AF/year) of surface water. Zone 40 also delivers approximately 3 mgd of recycled water from SRCSD's Sacramento Regional Wastewater Treatment Plant (WWTP) to customers in the City of Elk Grove.

Zone 40 with its conjunctive use program (use of groundwater in conjunction with surface water) and recycled water from the Sacramento Regional County Sanitation District (SRCSD) is pivotal to the success of groundwater management in the Central Basin.

1.5.2 City of Sacramento

The City is a regional partner in that they provide surface water to areas within the Central Basin that are both inside and outside City boundaries. Through its American River water rights permit and settlement contract with Reclamation, the City's ability to deliver surface water extends to the American River POU boundary, as shown in **Figure 1-3**.

Through partnerships with retail purveyors the City wholesales its American River water to areas that historically have been solely dependent on groundwater. In the case of SCWA, the City currently provides surface water treatment and conveyance of a portion of SCWA's CVP contract water to the Laguna area of Zone 40. In the future, the City plans to provide American River water to areas of Zone 40 located within the American River POU (see **Figure 1-3**).

The City's commitment to deliver surface water in a timely manner is and will continue to be critical in meeting the Central Basin's groundwater management objectives as described in **Section 3**. Maximizing the ability of the City to deliver surface water by establishing relationships with groundwater purveyors within the City's American River POU also is a critical goal of the CSCGMP.

1.6 OTHER REGIONAL MANAGEMENT EFFORTS

Over the past several decades, regional water supplies have been affected by the following:

- Extended drought and wet periods
- Increased push to dedicate surface water for environmental purposes
- Groundwater contamination cleanup efforts ordered by the United States Environmental Protection Agency (EPA), Central Valley Regional Water Quality Control Board (RWQCB), and California Department of Toxic Substance Control (DTSC)
- Declining groundwater levels
- Ongoing and potential impacts to surface water quality and groundwater quality

At the same time, demand for water in the region has continued to grow. To address these challenges, water purveyors in the region have invested substantial time and resources in a series of regional planning efforts. Planning efforts and agencies most relevant to CSCGMP include the following:

- Completion of the Zone 40 Water Supply Master Plan (SCWA, February 2005) and the Draft Environmental Impact Report for the 2002 Zone 40 Water Supply Master Plan (EDAW, November 2003)
- Creation and Implementation of the Freeport Regional Water Authority (FRWA)
- The Nature Conservancy (TNC)
- Southeast Sacramento County Agricultural Water Authority (SSCAWA)
- Regional Water Authority (RWA)
- Sacramento Groundwater Authority (SGA)
- Other ongoing activities related to groundwater cleanup and monitoring

These regional planning efforts are discussed further in the following subsections.

1.6.1 Zone 40 Water Supply Master Plan and Environmental Documentation

The Zone 40 WSMP identifies a study area (2030 study area) within Zone 40 that consists of existing and developing industrial, commercial, office, and residential land uses consistent with the City of Elk Grove and Rancho Cordova General Plans, and the Sacramento County 1993 General Plan.

Based on these General Plans, water demand is expected to be concentrated within the identified 2030 study area. However, developments can be proposed and approved anywhere within Zone 40 where they are consistent with the framework and requirements provided in the various General Plans, Community Plans, Comprehensive Plans, Specific Plans, and zoning and subdivision ordinances.

Three retail water purveyors provide service within Zone 40, these include: SCWA Zone 41, Florin Resource Conservation District (FRCD)/Elk Grove Water Service (EGWS), and Cal-Am. Zone 40 currently provides wholesale water to a portion of the FRCD/EGWS service area under the terms of the First Amended and Restated Master Water Agreement. It has been assumed that Cal-Am will purchase wholesale water supplies from Zone 40 to serve its Security Park franchise area located in the northern portion of Zone 40.

1.6.2 The Freeport Regional Water Authority (FRWA)

FRWA, a joint powers authority (JPA) developed between SCWA and East Bay Municipal Utilities District (EBMUD), is currently pursuing a project that will design and construct a diversion structure on the Sacramento River and a raw water pipeline between the diversion structure and the Folsom South Canal. FRWA's efforts are focused in the following five areas: (1) formal state and federal environmental review; (2) public information and outreach; (3) detailed engineering studies and project design; (4) permitting and land acquisition; and (5) construction. The implementation process is expected to take up to four to five years, with actual construction beginning in 2006 and a target operational date of 2009.

While planning, design, and construction activities move forward on the FRWA facilities, Zone 40 will continue work on the surface water treatment plant, groundwater wells, groundwater treatment, raw and treated water transmission pipelines, and storage facilities necessary to fully implement SCWA's conjunctive use plan in the Central Basin.

1.6.3 The Nature Conservancy

The lower Cosumnes River watershed has been a major focus of conservation efforts in the Central Valley and is identified as a priority for ecosystem protection and restoration by both the California Bay-Delta Authority (formerly CALFED) and the USFWS Anadromous Fish Recovery Program, as well as in the Sacramento County General Plan.

The Cosumnes River channel and its associated floodplains are a major source of recharge for the Central Basin, and declining groundwater levels have adversely affected the river's salmon fishery and other environmental values. One of the goals of the WSMP environmental documentation was to assess the extent of impairment of Cosumnes River flows and aquatic values that has resulted from historic and ongoing groundwater pumping (both M&I and agricultural), and to explore programmatic opportunities for restoring and maintaining these aquatic values through integrated water management. The supporting documentation for this effort is included in the environmental documentation for the WSMP and subsequent studies included as a separate effort under the Water Forum Successor Effort and the Sacramento County Water Agency (WRIME, December 2005b).

The Cosumnes River conservation partnership includes federal, state, and local government, nonprofit land owners, and local water purveyors and sanitation districts. TNC has represented the Cosumnes River conservation partnership in the CSCGF. Because the ecological values of the Cosumnes River corridor have statewide significance, and the river presents opportunities for integrated water management, goals of the CSCGMP include the recognition, enhancement, and maintenance of the ecological values of the Cosumnes River.

1.6.4 Southeast Sacramento County Agricultural Water Authority

The SSCAWA is in the process of updating its 2002 GMP to include the remaining water management entities in the South Basin: Rancho Murieta CSD (also included in the Central Basin) and the City of Galt. While they have no authority to implement groundwater or surface water management programs, TNC is being included in the SSCGMP for the same reasons that they are included in the CSCGMP. These entities are developing an MOU as the first step to jointly preparing the SSCGMP. The MOU and resulting groundwater management plan will be structured to facilitate integration with the CSCGMP and development of an IRWMP for the region south of the American River.

The SSCGMP will focus on developing a conjunctive use program that optimizes the utilization of natural recharge areas associated with the Cosumnes River and explores opportunities for utilizing supplemental water supplies for recharge. The development of a viable conjunctive use program by the SSCAWA and its partners that protects and enhances groundwater resources for local users and the environment can also contribute to management objectives defined in the CSCGMP.

1.6.5 Regional Water Authority

Regional Water Authority (RWA) represents a number of water supply interests and assists members in protecting and enhancing the reliability, availability, affordability, and quality of water resources. One of the principal missions of RWA is to help implement the conjunctive use program prescribed by the WFA. The RWA currently has 18 member agencies and three associate members, spanning Placer, Sacramento, and El Dorado counties.

1.6.6 Sacramento Groundwater Authority

SGA is a JPA created to manage groundwater in the North Basin (see **Figure 1-1**). SGA's formation in 1998 was a result of a coordinated effort by the Sacramento Metropolitan Water Authority (now RWA) and the Water Forum to establish an appropriate management structure for the North Basin.

SGA draws its authority from a JPA signed by the cities of Citrus Heights, Folsom, and Sacramento, and the County of Sacramento to exercise their common police powers to manage the underlying groundwater basin. With this authority, SGA manages the basin through representatives of 14 local water purveyors and representatives from the agricultural and self-supplied pumpers who serve as the Board of Directors.

At the core of the SGA's management responsibility is a commitment to not exceed the long-term average annual sustainable yield of the North Basin, which was estimated to be 131,000 AF in the WFA. To accomplish this objective and to provide a safe, reliable water supply for the North Basin, SGA adopted a groundwater management plan in December 2003.

1.6.7 On-going Groundwater Cleanup and Monitoring Related Activities

A number of on-going groundwater cleanup and monitoring activities currently underway within or adjacent to the Central Basin. Coordination among these efforts will be discussed in more detail later in **Section 3** and **4**. Many of the activities are in various states of clean-up. Activities closely related to CSCGMP groundwater management efforts include, but are not limited to, the following:

- Groundwater contamination investigation and remediation activities related to the former Mather Air Force Base, now called Mather Field.
- Groundwater contamination investigation and remediation activities related to operations at the Aerojet and McDonnell-Douglas (Boeing) facilities.
- Groundwater contamination investigation and remediation activities related to operations at the Kiefer Landfill, and other abandoned landfills within the Central Basin.
- Monitoring of groundwater levels and quality through participation in the DWR Well Monitoring Program.
- Monitoring of groundwater levels and quality at California State University, Sacramento (CSUS).
- Monitoring of groundwater quality by the United States Geological Survey (USGS) as part of its National Water Quality Assessment Program.
- Monitoring of site investigations and remediation efforts at known leaking underground storage tanks (LUST) coordinated by the Sacramento County Environmental Management Department (EMD) and the RWQCB.

1.7 AUTHORITY TO PREPARE AND IMPLEMENT A GMP

In order to initiate development of the CSCGMP, SCWA's Board of Directors held a public hearing and adopted Resolution of Intent (ROI) WA-2590 on April 19, 2005. In accordance with provisions of the California Water Code (CWC § 10753.4(a)) the CSCGMP must be adopted by the basin governance body within two years of adoption of the ROI.

1.8 CSCGMP COMPONENTS

The CSCGMP includes both required and voluntary components. **Table 1-1** lists these components and indicates the section(s) in which each component is addressed.

Table 1-1. Location of GMP Components

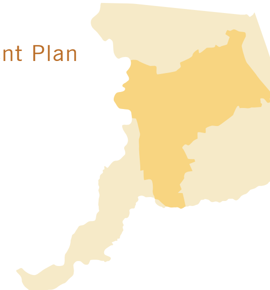
Description	Location in CSCGMP
A. CWC § 10750 et seq., Required Components[1]	
1. Documentation of public involvement statement.	Section 3.2.1.1
2. Basin management objectives (BMO).	Section 3.1
3. Monitoring and management of groundwater elevations, groundwater quality, inelastic land surface subsidence, and changes in surface water flows and quality that directly affect groundwater levels or quality or are caused by pumping.	Section 3.2.2
4. Plan to involve other agencies located within groundwater basin.	Section 3.2.1.2
5. Adoption of monitoring protocols by basin stakeholders.	Section 3.2.2.5
6. Map of groundwater basin showing area of agency subject to GMP, other local agency boundaries, and groundwater basin boundary as defined in DWR Bulletin 118.	Figures 1-1, 1-2, 1-3, 2-27
7. For agencies not overlying groundwater basins, prepare GMP using appropriate geologic and hydrogeologic principles.	N/A
B. DWR's Recommended Components[2]	
1. Manage with guidance of advisory committee.	Section 3.2.1.3
2. Describe area to be managed under GMP.	Sections 1, 2
3. Create link between BMOs and goals and actions of GMP.	Section 3.3.4.2
4. Describe GMP monitoring program.	Section 3.2.2
5. Describe integrated water management planning efforts.	Section 3.2.5
6. Report on implementation of GMP.	Section 4.5.1
7. Evaluate GMP periodically.	Section 4.6
C. CWC § 10750 et seq., Voluntary Components[3]	
1. Control of saline water intrusion.	Section 3.2.3.6
2. Identification and management of wellhead protection areas and recharge areas.	Sections 3.2.3.3, 3.2.3.4
3. Regulation of the migration of contaminated groundwater.	Section 3.2.3.5
4. Administration of well abandonment and well destruction program.	Section 3.2.3.2
5. Mitigation of conditions of overdraft.	Section 3.2.4
6. Replenishment of groundwater extracted by water producers.	Section 3.1
7. Monitoring of groundwater levels and storage.	Sections 3.2.2.1, 3.2.4
8. Facilitating conjunctive use operations.	Sections 3.2.1.2, 3.2.4, 3.2.5
9. Identification of well construction policies.	Section 3.2.3.1
10. Construction and operation by local agency of groundwater contamination cleanup, recharge, storage, conservation, water recycling, and extraction projects.	Sections 1.5, 1.6, 2.1, 2.2.3, 2.3.7, 2.3.9, 2.4, 3.2.4, 3.2.5, 4.3, 4.4
11. Development of relationships with federal and state regulatory agencies.	Section 3.2.1.4
12. Review of land use plans and coordination with land use planning agencies to assess activities that create reasonable risk of groundwater contamination.	Section 3.2.5

[1] CWC § 10750 et seq. (seven required components). Recent amendments to the CWC § 10750 et seq. require GMPs to include several components to be eligible for the award of funds administered by DWR for the construction of groundwater projects or groundwater quality projects. These amendments to the CWC were included in Senate Bill 1938, effective January 1, 2003.

[2] DWR Bulletin 118 (2003) components (seven recommended components).

[3] CWC § 10750 et seq. (12 voluntary components). CWC § 10750 et seq. includes 12 specific technical issues that could be addressed in GMPs to manage a basin optimally and protect against adverse conditions.

Water Resources Setting



Section 2

Water Resources Setting

This section provides an in-depth review of available water supplies, their origins, and usage within the Central Basin. The review of each water supply includes a brief description of the local, state, and federal policies governing how that supply of water is used in the basin, and how these policies affect how much water is available from year to year. The section then describes the water demands associated with the identified land uses in the basin. Lastly, the water balance between supply and demand is described along with an examination of the different growth and water use scenarios that could occur in the region.

2.1 WATER USE UNDER THE WATER FORUM AGREEMENT

As summarized in **Section 1.1.1**, the Water Forum was formed in 1993 by a diverse group of water managers, business and agricultural leaders, environmentalists, citizen groups, and local governments in Sacramento. Local governments in Placer and El Dorado counties joined later. In the context of water supply availability in the Central Basin, it is vital to reiterate the importance of the Water Forum and the WFA as they relate to how surface and groundwater supplies were allocated and the importance of water conservation.

2.1.1 Water Forum Agreement and Environmental Water

The WFA included stakeholders representing most of the water interests in the Central Basin (i.e., some water purveyors elected not to participate or be signatory to the WFA). In April 2000, these stakeholders adopted and agreed to the principles set forth in the WFA. The WFA describes a conjunctive use program for the Central Basin to meet the region's water demands, and includes an updated Flow Management Standard (FMS) for the lower American River. The FMS essentially provides environmental protection for the lower American River while at the same time providing for increased water diversions by municipal purveyors. The Cosumnes River, which flows through the Central Basin, was evaluated in the Water Forum technical studies but was not considered to be impacted significantly by the WFA. Therefore, discussion and negotiation of issues for the Cosumnes River was not included in the Water Forum (See **Section 1.1.1**). The importance of environmental water on the Cosumnes River and the river's connection with groundwater are explained later in this section. The CSCGMP does not overlook the environmental water concerns of the American River, but goes forward with the understanding that the American River was adequately addressed in the WFA.

A programmatic EIR for the WFA was completed in October 1999. The EIR indicated that the Water Forum Plan was the environmentally preferred alternative with significant and potentially significant impacts to the lower American River and Folsom Reservoir, including effects on certain fisheries, recreational opportunities, and cultural resources. Potential mitigation measures were identified as a part of the Habitat Mitigation Element of the WFA.

The seven elements of the Water Forum Plan preferred alternative (included as Section 3 of the WFA) are as follows:

1. Increased surface water diversions
2. Actions (e.g., conjunctive use, and water conservation) to meet customer's needs while reducing diversion impacts (on the lower American River) in drier years
3. Support for improved pattern of fishery flow releases from Folsom Reservoir
4. Lower American River habitat management
5. Water conservation
6. Groundwater management
7. Water Forum Successor Effort

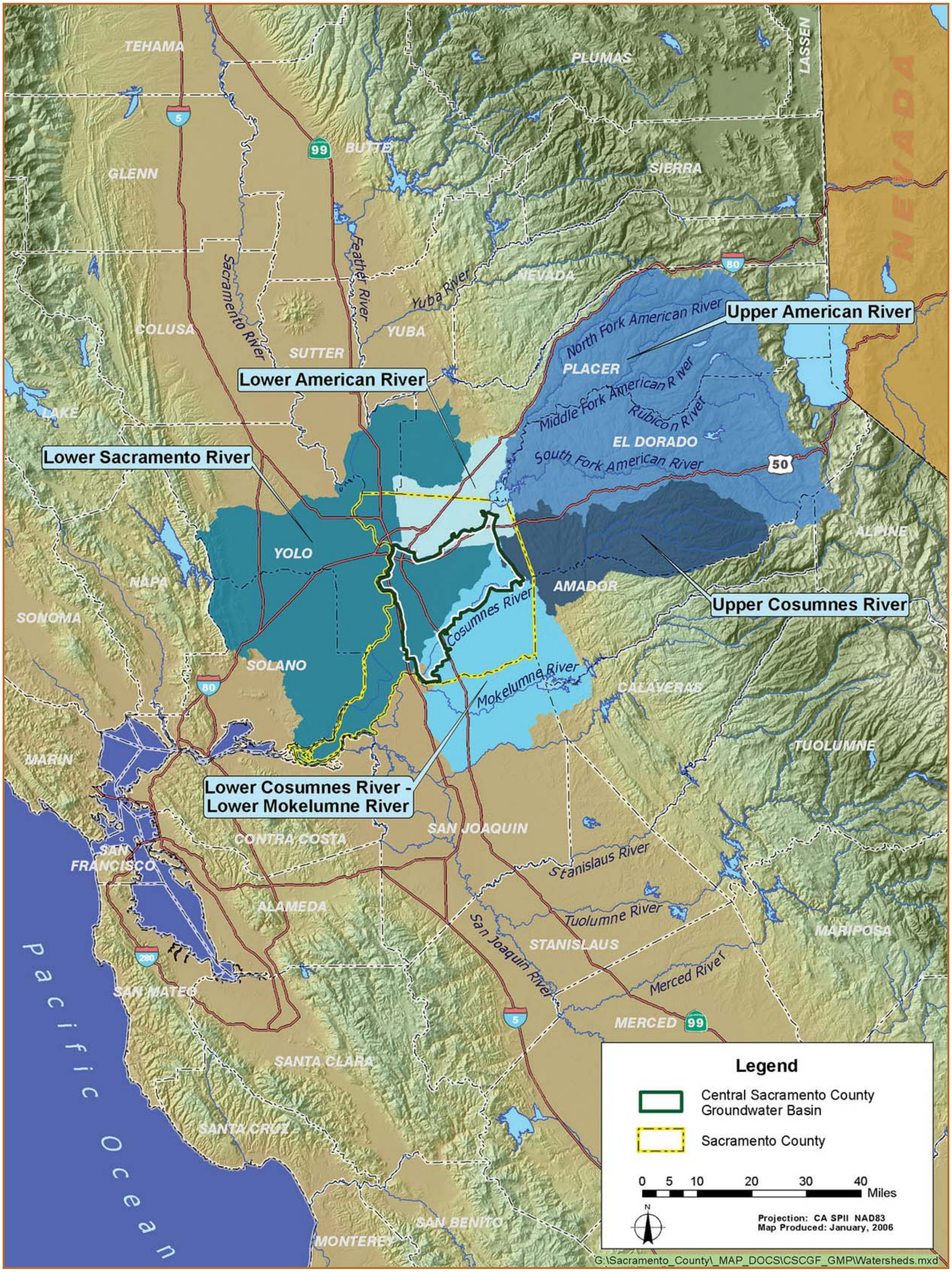
The following are examples of on-going regional projects/programs that are implementing parts of the WFA. These projects/programs are located primarily north of the American River.

1. **Placer County Water Agency (PCWA)/Sacramento Suburban Water District (SSWD) Groundwater Stabilization Project**. In August 1995, PCWA and SSWD entered into a 25-year contract to implement a groundwater stabilization project. PCWA agreed to supply Middle Fork of the American River Project (MFP) water to replace up to 29,000 AF/year of groundwater use by SSWD.
2. **American River Basin Cooperating Agencies (ARBCA) Regional Water Master Plan**. Water purveyors in southern Placer County and northern Sacramento County formed ARBCA and initiated work on implementing the type of regional conjunctive use program that was envisioned by the Water Forum. Under the auspices of this organization, conjunctive use pilot studies have been implemented and large-scale programs are being developed.
3. **PCWA American River Pump Station Project**. This project is a permanent pump station located near the former Auburn Dam site that provides year-round MFP water supply to PCWA. While the initial design capacity of the pump station is 100 cfs (maximum annual diversion of up to 35,500 AF), it has a potential ultimate diversion capacity of 225 cfs (100 cfs to accommodate additional PCWA demands of 35,000 AF and 25 cfs to meet Georgetown Divide Public Utility District's future needs).
4. **City of Sacramento Water Facilities Expansion Project**. The City has expanded its Fairbairn and Sacramento River WTPs to meet increasing demand in its service area. Expansion of the Sacramento River WTP will enable diversions to be shifted from the American River to the Sacramento River whenever the flow bypassing the expanded diversion at the Fairbairn WTP is less than the Hodge Flow criteria. While the City is not bound by Judge Hodge's 1990 decision, Environmental Defense Fund et al. v. East Bay Municipal Utility District, it has agreed to restrict diversions at the Fairbairn WTP when the Hodge Flow criteria apply as stipulated in the WFA.

2.2 SURFACE WATER SUPPLIES

Surface water for the Sacramento region comes from three major river watersheds; the Sacramento, American, and Cosumnes. The region also includes a portion of the Mokelumne River watershed south of the Cosumnes River (this area is technically not within the Central Basin). The Central Basin is roughly bound by the American River to the north, the Sacramento River to the west, the Cosumnes and Mokelumne Rivers to the south, and the Sierra foothills to the east (see **Figure 2-1**). The watershed areas for rivers identified on **Figure 2-1**, as well as the upland foothill regions, serve as the major source of groundwater recharge in the Central Basin. The role and mechanism of stream recharge to the aquifer is discussed more fully in **Section 2.3.3.1**.

Figure 2-1. Major River Watersheds in the Central Basin



2.2.1 River Systems

To understand the role of surface water as a major source of water in the Central Basin, it is important to have an overview of each surface water supply source. A description of each major river along with the current and future availability of water under different hydrologic conditions is provided below. Hydrologic conditions are an important consideration in determining the availability of surface water supplies. For example, in years when rainfall is low and snow pack is reduced, less surface water is available for storage behind dams. Lack of storage results in reduced availability of water for agriculture and urban supply requirements in dry months.

2.2.1.1 Exceedance Diagrams

The availability of surface water supplies often is presented in an exceedance diagram. In this type of diagram, the amount of water flowing in a particular surface water course is measured in terms of the percentage of time that a certain amount of water is expected to be present in that stream or river. Low flow or constrained conditions are most important; therefore, an interest always exists in how often a low-flow condition occurs during times of the year when high demands are expected (e.g., irrigation months). Exceedance curves represent average stream flows over the seasons of a particular year, and do not account for isolated storm events that produce instantaneous stream flow rates higher than the norm of any particular year.

2.2.1.2 Sacramento River Watershed

The Sacramento River watershed, upstream from the Central Basin, encompasses approximately 23,500 square miles and produces an average annual runoff of about 17,000,000 AF, as measured at the Freeport gauging station (below the confluence with the American River). Principal reservoirs regulating flows in the Sacramento River include Lake Shasta (storage capacity - 4,552,100 AF), located on the Sacramento River upstream from Redding; Trinity Lake (storage capacity - 2,448,000 AF), which regulates deliveries to the Sacramento River from the Trinity River watershed; Lake Oroville on the Feather River (storage capacity - 3,538,000 AF); and Folsom Reservoir on the American River (storage capacity - 975,000 AF).

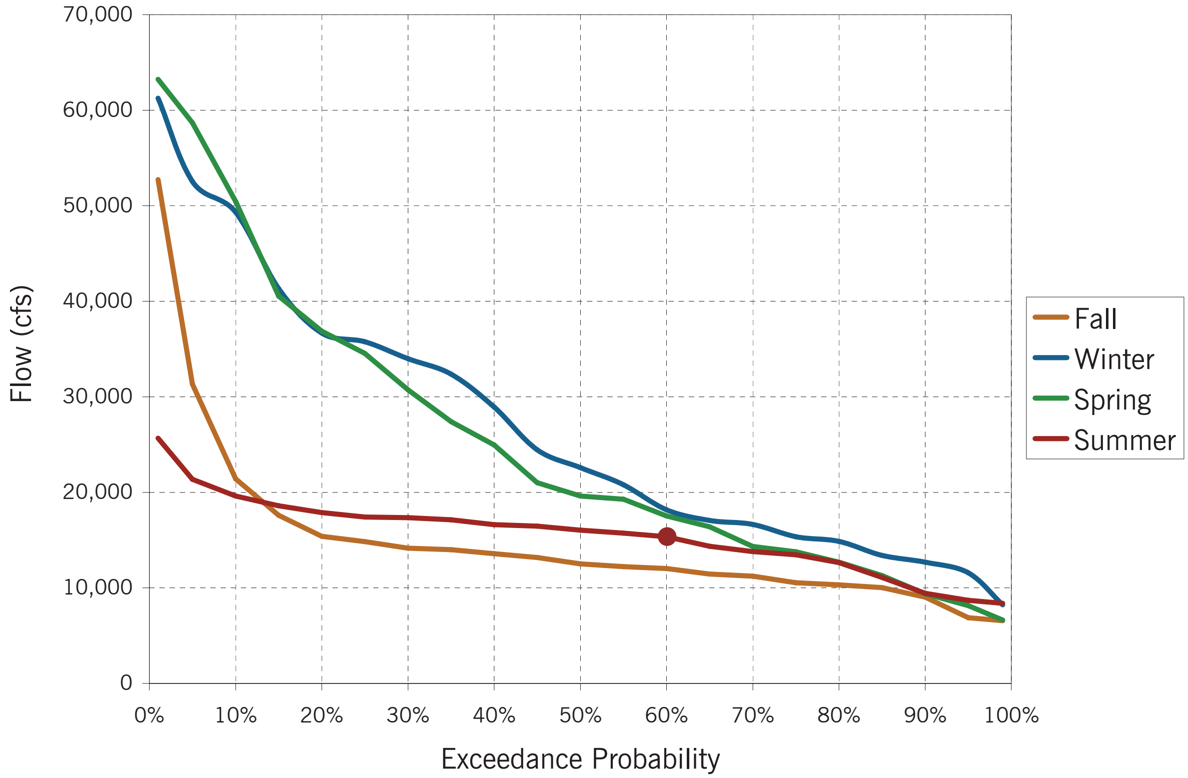
Based on 30 years of data records (1968 through 1998) and spanning a variety of water year types, individual monthly average flows in the Sacramento River have ranged from a low of 4,500 cfs in October 1978 to a maximum of 87,000 cfs in January 1997. Overall, average monthly flows for the 30 years of record range between 13,000 and 40,600 cfs, with the lowest flows occurring in October and highest flows in February. The 30-year average monthly flow during the wetter months of December through May is 32,200 cfs. During the typically drier months of June through November the average monthly flow is 16,500 cfs.

The exceedance diagram for the Sacramento River, based on 2020 forecasted conditions (this year is used in statewide surface water models), for each season is provided in **Figure 2-2**. Forecasted conditions project the operation of reservoirs and regulation of stream flows into the future while imposing 73 years of historical hydrology on this operational scheme. For example, **Figure 2-2** indicates that up to approximately 15,000 to 27,000 cfs of Sacramento River water flows through Freeport during the summer 60 percent of the time (see location of red dot on **Figure 2-2**). This is the general cutoff point for a dry year condition. The remaining 40 percent of the time, approximately 8,000 cfs to 15,000 cfs flows through Freeport. More important is that approximately 8,000 cfs is flowing in the Sacramento River in all seasons (100 percent of the time), even in the most critically dry conditions.

2.2.1.3 American River Watershed

The American River watershed encompasses approximately 1,900 square miles. Folsom Reservoir is the principal reservoir in the watershed with a capacity of 975,000 AF. Several smaller upstream reservoirs contribute 820,000 AF of storage capacity. Nimbus Dam impounds Lake Natoma, located immediately downstream from Folsom Dam, and regulates releases from Folsom Reservoir to the lower American River. The entrance facilities to the Folsom South Canal are located along the south shore of Lake Natoma immediately upstream from Nimbus Dam. The mean annual flow in the lower American River (1968 to 1998) is 3,300 cfs. The design capacity of the American River channel (for flood flows) is 115,000 cfs.

Figure 2-2. Seasonal Exceedance Diagram for the Sacramento River at Freeport



Two exceedance diagrams are provided for the American River (**Figure 2-3** and **Figure 2-4**). **Figure 2-3** relates to requirements in the WFA regarding where unimpaired inflow into Folsom Reservoir is evaluated. The WFA includes provisions for replacement water to the Lower American River in drier years from PCWA through reoperation of its MFP facilities to mitigate projected increases in American River diversions above the 1995 baseline condition. Replacement water is not needed when the projected March through November unimpaired inflow into Folsom Reservoir is more than 950,000 AF. When the projected unimpaired inflow is less than 400,000 AF, PCWA replacement water of 27,000 AF will be provided. When the projected unimpaired flow is between 950,000 AF and 450,000 AF, needed PCWA replacement water will be determined by linear interpolation between 0 and 27,000 AF. PCWA replacement water supplies cannot be diverted or stored until the replacement water flows through the lower reach of the American River to its confluence with the Sacramento River. **Figure 2-4** shows the lower American River at the Fairbairn WTP.

The resources of the lower American River and the land adjacent to the river (much of which is encompassed by the American River Parkway) are managed by a number of different agencies and organizations for a variety of purposes. One of the purposes of the WFA is to protect these resources and creatively partner with other resource managers to plan, fund, and implement projects that benefit the lower American River. The Water Forum monitors its success in five areas:

- Managing the lower American River to protect fish and river habitat
- Maintaining and/or improving habitats adjacent to the lower American River
- Meeting water quality goals and achieving regulatory standards for the lower American River
- Implementing lower American River levee stabilization and erosion control measures
- Communicating among lower American River stakeholders to inform and improve current and future management

Figure 2-3. Exceedance Diagram of Projected Volume of Water from March to November for American River Unimpaired Inflow into Folsom Reservoir

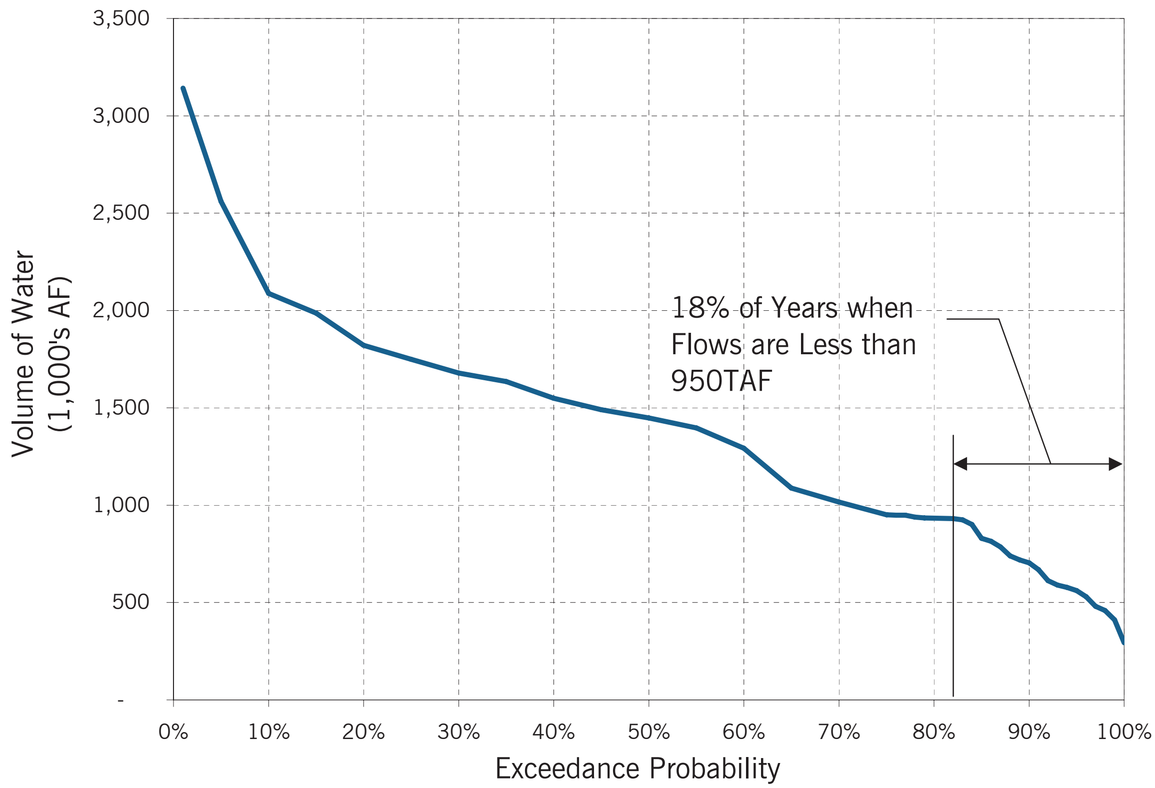
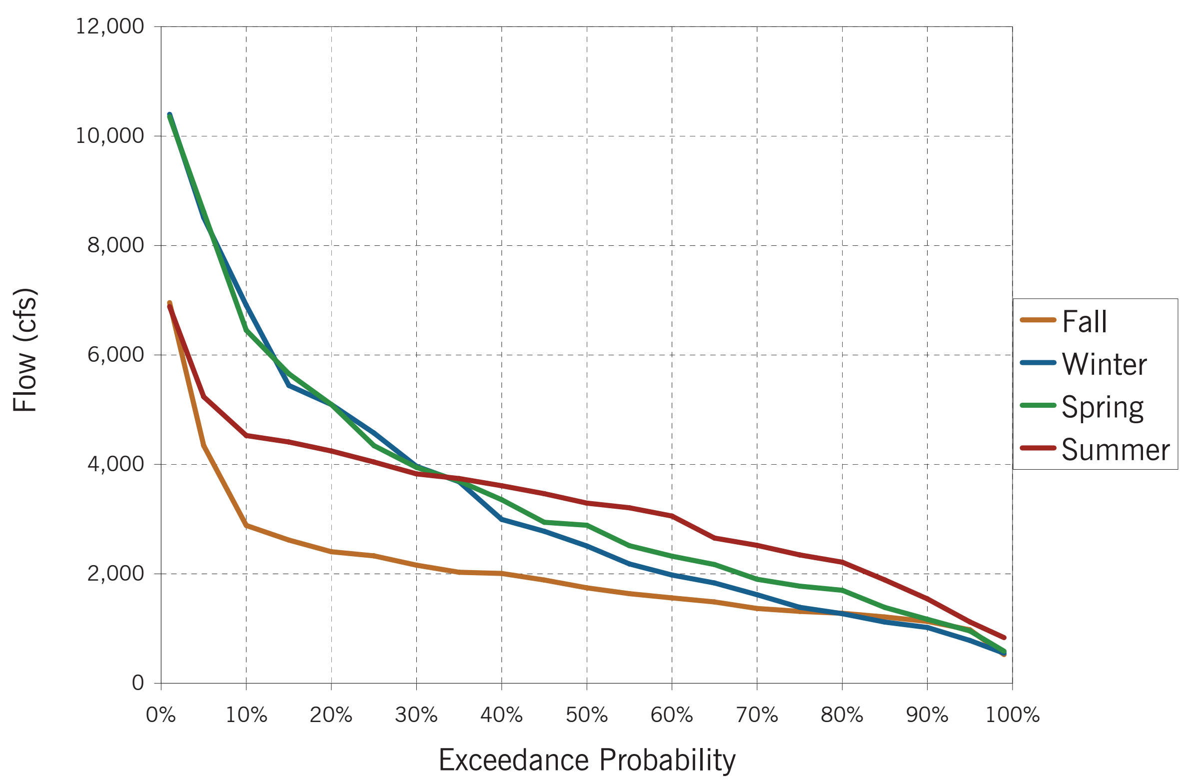


Figure 2-4. Seasonal Exceedance Diagram for Lower American River at Fairbairn Water Treatment Plant



2.2.1.4 Cosumnes River Watershed

The Cosumnes River watershed extends from its headwaters on the western slope of the Sierra Nevada to its confluence with the Mokelumne River. The Cosumnes River is one of the last major rivers in northern California with no major dam. Minor dams on the river are used more for recreational purposes than for water supply or flood control. The hydrology and use of the Cosumnes River have changed substantially over time. The river likely was the major source of surface water diversions for agriculture in the late 1800s prior to groundwater well technology becoming available and affordable. Until the 1940s, the Cosumnes River flowed year-round because it received a baseflow of water from an extensive floodplain aquifer (the aquifer was discharging water to the river). Historical data suggest that flow volumes in the lower reaches of the river decreased steadily from 1942 to 1982, with more frequent periods of very low or no flow. During September and October, flows in the river at Michigan Bar (the point which the river enters Sacramento County) are between 27 to 30 cfs. Currently, flows in the Cosumnes River cease in a 5- to 10-mile section of the river downstream from Michigan Bar (between Meiss Road and State Route 99) nearly every year at or before the end of the dry season (August through October). Studies using monitoring data and computer models have established a relationship between groundwater usage and river flows, leading to the conclusion that groundwater pumping is primarily responsible for the decline in fall river flows.

Since Cosumnes River flows are largely unregulated and considerable losses occur (in terms of percent of flow) to the groundwater system, the exceedance diagram in **Figure 2-5** is considerably different than those representing the Sacramento and American rivers. The diagram indicates a highly variable flow pattern for each season with flow primarily occurring in the winter and spring months and minimal flow in the summer and fall.

The ecological values of the Cosumnes River are of interest to many state, federal, and private institutions such as CALFED, Anadromous Fish Restoration Program, World Heritage Site, and TNC. Reduced flows in the Cosumnes River contribute to the degradation of fishery, wildlife, recreational, and aesthetic resources of the lower Cosumnes River. Water temperature also is an issue associated with flow impairment and poses a threat to the salmon fishery. These issues will be addressed more fully in the Basin Management Objectives outlined in **Section 3**.

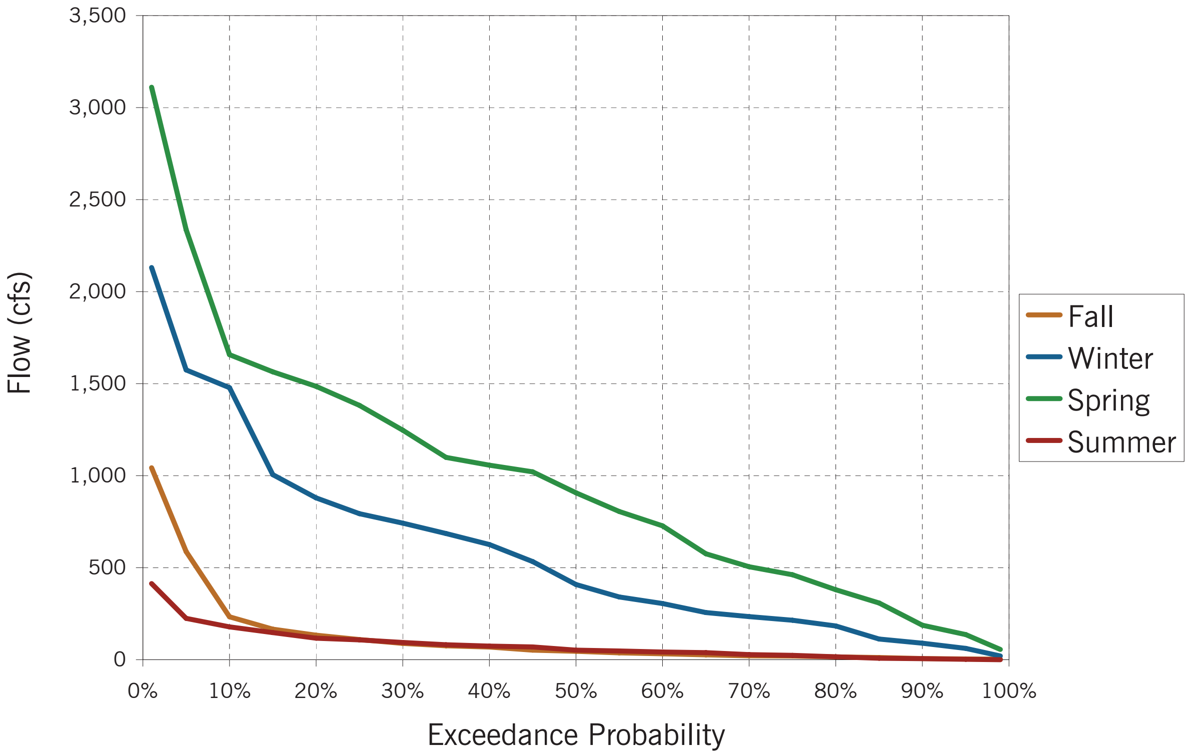
2.2.2 Surface Water Quality

The quality of surface water supplies is important when considering their use as a source of drinking water and agricultural supply. As a drinking water source, surface water must be of a high enough quality that it can be economically treated to meet all state and federal drinking water standards. For agriculture, past experience has shown that if certain constituents are present in applied surface water, such as salinity, these constituents can build up in the receiving soil over time, leaving the soil sterile and incapable of growing crops.

Based on the most current Watershed Sanitary Survey for the American and Sacramento rivers, both rivers are considered an excellent source of supply for drinking water in the Sacramento metropolitan area. These source waters can be readily treated to meet all California Code of Regulations (CCR) Title 22 drinking water standards using both conventional and direct filtration processes, including membranes. No persistent constituents are present in the raw water that require additional or more advanced water treatment processes. However, seasonal treatment requirements occur at times for rice herbicides found in the Sacramento River. These treatment requirements are addressed through chemical oxidation processes. High turbidities during storm events are a treatment challenge that can be managed by optimizing operations including adjusting chemical types and dosing schemes and by reducing plant flow (Montgomery Watson and Archibald & Wallberg, 2000).

Primary drinking water standards are set for constituents that cause adverse impacts to human health. Secondary drinking water standards are set for constituents that

Figure 2-5. Seasonal Exceedance Diagram for Lower Cosumnes River (at or near Highway 99 crossing)



cause unpleasing aesthetic impacts on water quality, and are not health-based standards. No chronic or persistent violations of primary or secondary drinking water standards have been reported in any treated surface water supply in the Sacramento area.

Like Sacramento area drinking water supplies, no known problems exist with surface water use for irrigation. No treatment or special considerations are typically given to agricultural diversions from rivers, with the exception of large river intakes and their ability to minimize fishery impacts. The subsections below address the drinking water aspects of each river and minor impacts associated with agricultural activities occurring upstream.

2.2.2.1 Sacramento River

Sacramento River water quality is largely influenced by a mass balance of water quality from upstream reservoir release operations, tributary flows (including the lower American River), agricultural runoff, subsurface drainage flows, and diversions with other impacts resulting from permitted discharges from M&I sources, urban runoff, and spills. In general, the quality of the Sacramento River is high in the vicinity of the Central Basin. Moderate amounts of alkalinity and minerals are present and low levels of disinfection by-product precursors. Turbidity levels in the Sacramento River are higher during the winter and early spring months, and are usually associated with reservoir releases or runoff from storm events. Very infrequent detections of organic chemicals occur, most of which are pesticides or herbicides from agricultural operations. Data collected to date indicate a low prevalence of *Giardia* and *Cryptosporidium* in the river, with protozoa only detected sporadically and at very low concentrations.

The characterization of Sacramento River water quality in the vicinity of the Central Basin is based on reports from the Sacramento River WTP (Sacramento River Watershed Sanitary Survey; 1995 Report and 2000 Update, prepared by MWH and Archibald & Wallberg).

The City diverts water from the Sacramento River at its Sacramento River WTP just downstream from the confluence with the American River. The City treats water using conventional treatment processes (i.e., flocculation, sedimentation, and filtration) with chlorine disinfection. Treated water quality meets or exceeds all state and federal drinking water standards under current operations. The City includes corrosion control in its treatment of the water. Finished water is supplied to City customers both north and south of the American River (i.e., North Basin and Central Basin).

2.2.2.2 American River

Surface water quality in the American River is a function of the mass balance of water quality from tributary streams, diversions, minor agricultural return flows, subsurface drainage flows, with other impacts resulting from permitted discharges from M&I sources, urban runoff, and spills. In general, the quality of water in the American River is high from the river's headwaters to its confluence with the Sacramento River. It is low in alkalinity, low in disinfection by-product precursor materials, low in mineral content, and low in organic contamination. Limited data also indicate that the water is low in microbial contamination from *Giardia* and *Cryptosporidium*. Turbidity levels in the American River tend to be higher in the winter than summer because of higher flows associated with winter storms.

The City diverts water on the lower American River at the Fairbairn WTP just downstream from the Howe Avenue crossing. This water is also used by other water purveyors within the American River POU on a wholesale basis. The POU boundary in the Central Basin is shown in **Figure 1-3**. Water diverted at the plant undergoes conventional treatment and disinfection. The treated water meets or exceeds all state and federal drinking water standards under current operations (Archibald & Wallberg and MWH, 2003).

2.2.2.3 Cosumnes River

Water quality in the Cosumnes River watershed is affected primarily by land use and land cover. Monitoring data indicate that most of the river's nutrients and suspended sediments originate in the lower portion of the watershed below the Michigan Bar gauging station. Nutrient loading is strongly affected by a few point sources and non-point sources related to urbanized areas and agricultural activity (Ahearn and Dahlgren, 2000).

2.2.3 Major Surface Water Facilities Infrastructure

The distinction between surface water and groundwater facilities is sometimes difficult to make. In service areas that conjunctively use surface water and groundwater, the parts of the system that are attributed to surface water are the intake or diversion structure, the pipe that conveys the water from the intake structure to the WTP, the WTP itself, and the large conveyance pipelines that move treated surface water throughout the distribution system to the retail or wholesale customer.

The following sections describe existing and planned capital facilities that are, or will be, owned and operated by public and private water purveyors in the Central Basin. Major surface water diversions, untreated (raw) water conveyance, treatment, storage, and treated water conveyance systems are shown in **Figure 2-6**. The emphasis of this section will be on facilities that divert and convey surface water and on treatment capacity that is available today or in the near future that provides water to the Central Basin.

2.2.3.1 City of Sacramento

The City diverts surface water supply through two treatment plants, the Fairbairn WTP and the Sacramento River WTP. Both WTPs have recently been expanded. The Fairbairn WTP's treated water output capacity is 200 mgd and the Sacramento River WTP's output capacity is 160 mgd. Currently, the City maintains nine enclosed treated water storage reservoirs with a total storage capacity of 39 million gallons (MG), as shown in **Figure 2-6**.

2.2.3.2 SCWA Zone 40

Existing SCWA surface water facilities include the Franklin Intertie (see **Figure 2-6**), which supplies water to SCWA through the City. SCWA's wheeling agreement with the City provides up to 11 mgd of non-dedicated capacity that is diverted and treated at the City's Sacramento River WTP. SCWA's wheeling agreement with the City also provides for converting non-dedicated capacity to dedicated capacity in the future (negotiations between SCWA and the City are currently taking place).

Planned SCWA diversions of surface water include a diversion structure located on the Sacramento River near the community of Freeport (see **Figure 2-6**), a raw water conveyance pipeline from the diversion structure to the central portion of Zone 40 (both constructed in partnership with EBMUD), a 100 mgd[4] (ultimate capacity) surface water treatment facility in the central portion of Zone 40, and appurtenant treated water conveyance pipelines. Other agreements currently in negotiation include expanded service from the City to the portion of Zone 40 that lies within the City's American River POU.

2.2.3.3 Golden State Water Company

Golden State Water Company provides water supply to its Cordova System in part with surface water treated at its 16 mgd Coloma and Pyrites WTPs. The Coloma and Pyrites WTPs divert American River water through a turnout on the Folsom South Canal.

2.2.3.4 City of Folsom

Folsom shares its surface water diversion facility at Folsom Reservoir with San Juan Water District and the City of Roseville. Folsom treats this water at the Folsom WTP, which is currently undergoing an expansion to a maximum capacity of 50 mgd. Folsom's water system includes eight treated water storage tanks with a total storage capacity of 19.5 MG and one raw water storage reservoir.

2.2.3.5 Rancho Murieta Community Services District (CSD)

Rancho Murieta CSD operates a surface water treatment plant located at the north end of Lake Clementia, with a total production rate of 3.5 mgd. The CSD relies on off-stream reservoirs using Cosumnes River water as their source of surface water. The majority of water is stored in the winter and spring months. The CSD also maintains two storage tanks with a total storage capacity of 4.2 MG.

2.2.3.6 Omochumne-Hartnell Water District

OHWD is the only organized agricultural water district with facilities to divert surface water within the Central Basin. While OHWD does not have surface water entitlements, they have historically operated four seasonal flashboard dams on the Cosumnes River to facilitate diversions by riparian water rights holders along the river. Diversions by riparian water rights holders are used on lands adjacent to the Cosumnes River and remain entirely within the Central Basin. The volume of water utilized by riparian users has decreased significantly over the past several decades. This is due to declining flows in the Cosumnes River during the irrigation season and the increasing use of drip irrigation for orchard and vineyards within the Cosumnes River and Deer Creek floodplain. As indicated previously, OHWD now operates their seasonal dams to facilitate groundwater recharge and only in limited instances are the impoundments formed by these dams used for diversions by riparian users.

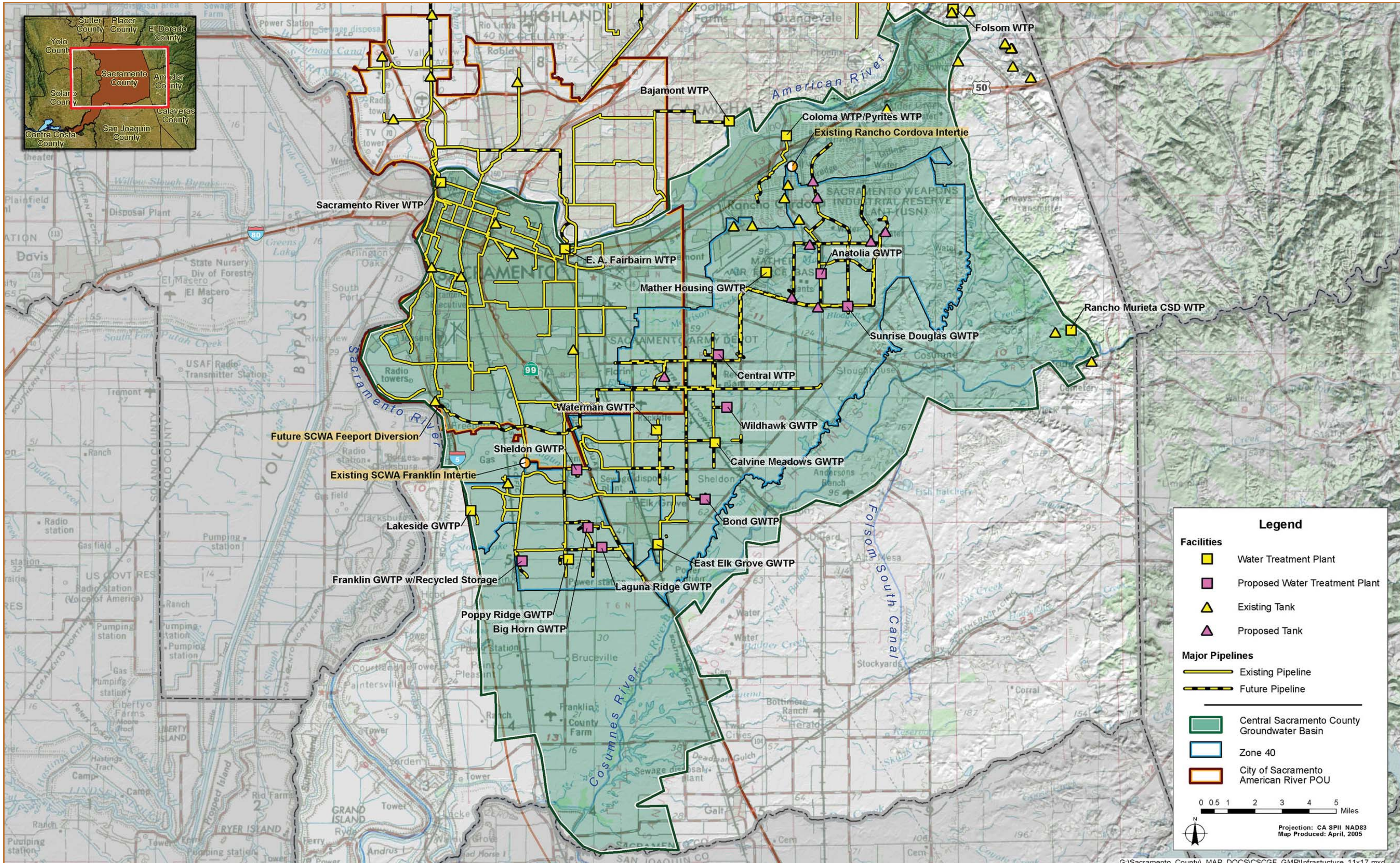
2.2.4 Surface Water Rights

The purpose of this section is to briefly discuss the different types of surface water rights as defined by state law. This section can be used as a resource when a water right is referred to in subsequent sections.

A surface water right is a legal right or contract entitlement to water that is generally not guaranteed in all hydrologic year types. In certain circumstances, water supply contracts are executed as a settlement proceeding which guarantee water supply availability, subject to certain stipulations, regardless of hydrologic year type. For this reason, it is important to understand which agencies have access to surface water, subject to certain constraints, as a component of groundwater management in the Central Basin. The different types of surface water rights and contract entitlements include the following:

[4] Fifteen mgd of this capacity is remediated groundwater discharged to the American River as part of the Eastern Sacramento County Replacement Water Supply Project, which is described more fully in the groundwater section.

Figure 2-6. Major Surface Water Infrastructure Facilities



Appropriative Right. This right is gained through diverting and using surface water for reasonable and beneficial use[5]. Because this right is not predicated on, and does not depend on, ownership of the land, the rights of an appropriator depend on actual physical control of the water (and since 1914, a permit for its beneficial use). The water stored by the state and Reclamation in reservoirs is through an appropriative water right. A CVP water contract is a contract with Reclamation that provides access to water that is stored and conveyed through CVP facilities. Typically, Reclamation allocates the water that is stored to municipal and agricultural water contract holders based on an estimate of the amount of water stored in Reclamation's reservoirs. This estimate is based on an estimate of watershed snow pack and potential runoff in the area tributary to Reclamation's reservoirs in March of every year.

Pre-1914 Water Right. The term "pre-1914 right" is often used in the context of a water right that is senior to most other water rights on a given stream.

USBR Settlement Water Contract. This water right is typically associated with riparian and Pre-1914 Water Right holders who settled under a contract agreement with Reclamation for water stored in a CVP reservoir that they normally would have received absent the reservoir.

Correlative Right. A correlative right has a mutual or reciprocal relationship to the rights of others, in the sense that the existence of one right necessarily implies the existence of the other right. For example, the rights of landowners adjacent to a stream (riparian) are correlative with all other landowners adjacent to the same stream.

Riparian Water Rights. Those who own property adjacent to a body of water possess the right to use the water from that body of water on the adjacent property for reasonable and beneficial uses. All riparian rights are correlative.

Area of Origin Water Rights. The California Water Code (CWC) contains a number of sections addressing certain rights, benefits, and obligations for upstream lands from which surface water originates. While discussed in a variety of informal venues, the "Area of Origin" provisions of the CWC have not yet been thoroughly tested and interpreted by the courts; therefore, no clear or definitive guidance exists regarding the application, interpretation, and functional operation of Area of Origin Statutes.

2.2.5 Surface Water Rights and Contract Entitlements Within the Central Basin

In **Section 2.2.4** the different types of surface water rights were briefly described. A basic understanding of surface water rights is important given the complexity of water right ownership, its quantity, and its reliability. The Integrated Groundwater Surface Water Model (IGSM) for Sacramento County is used to provide information on historical diversions (1968 to 1995) of surface water by each of the water providers. A graph of this usage is presented with each discussion. **Table 2-1** summarizes current water rights and contract entitlements in the Central Basin.

5 Reasonable and beneficial use refers to Article X, Section 2, of the California Constitution, which requires that all water use be reasonable and beneficial. Beneficial uses include irrigation, domestic, M&I, hydroelectric power, recreation, and protection and enhancement of fish and wildlife. Reasonable use is more easily defined by what it is not: waste or unreasonable use. Reasonableness is determined based on circumstances and can vary, according to the California Supreme Court.

Table 2-1. Existing Surface Water Rights/Contract Entitlements

Surface Water Sources	Place of Use	Entitlements (AF/year)	Contracts from or to Other Purveyors (AF/year)
City of Sacramento (Amount Available to Central Basin) [1]			
Water Rights Permits/Reclamation Settlement Contract (American River)	American River POU	142,100	-2,580[1], -9,300[5]
Reclamation Settlement Contract (Sacramento River)	City of Sacramento	50,716	
Pre –1914 Water Right (Sacramento River)	Not Applicable	26,460	
SCWA Zone 40			
SMUD 1 Assignment (CVP Supply) [2]	Zone 40	15,000	-
SMUD 2 Assignment (CVP Supply) [3]	Zone 40	15,000	-
Fazio Water (PL 101-514 CVP Supply) [4]	Zone 40	22,000	-7,000[4]
Future Agreement with City of Sacramento (American River Settlement Contract)	American River POU (Zone 40)	-	9,300[5]
Future Appropriative Water Right [6] (American and/or Sacramento River)	Zone 40	14,600	-
Future Other Water Contract	Zone 40	5,200	
City of Folsom [7]			
Pre-1914 Water Right	City of Folsom	22,000	-
Agreement with GSWC (water right)	City of Folsom	-	5,000[8]
PL 101-514 contract with SCWA (CVP supply)	East area	-	7,000[4]
Golden State Water Company [8]			
Pre-1914 Water Right (American River)	Cordova System	10,000	-5,000[8]
California American Water Company [9]			
Reclamation Settlement Contract (American River)	American River POU (Southgate)	-	2,580[1]
Rancho Murieta Community Service District [10]			
Appropriative Water Right (Cosumnes River)	Rancho Murieta CSD	6,368	-
Omochumne – Hartnell Water District [11]			
Riparian Water Rights (Cosumnes River)	Agricultural Lands Along Cosumnes River	4,000	-
Total Surface Water Contracts in Central Basin	**Approximately**	**350,000**	

Sources: Sacramento River Water Reliability Study, Initial Alternatives Report, Main Report and Appendix A, Revised January 2005.

SCWA Zone 40 Groundwater Management Plan, adopted October 26, 2004.

Notes:

[1] The City has a Reclamation Settlement Contract for the American and Sacramento rivers for 245,000 and 81,800 AF/year (the amounts shown here indicate only what can be guaranteed; the actual water right is much higher), respectively, and a Pre-1914 Water Right for up to 54,000 AF/year (this amount is still under research). The amounts

Table 2-1. Existing Surface Water Rights/Contract Entitlements (continued)

shown in the table are the result of the total contract amounts being reduced in proportion to the area within the City Limits and the American River POU that are located within the Central Basin. These percentages amount to 58 and 62 percent, respectively. Also identified is a water sale contract with Cal-American (up to 2,580 AF/year) and a future water sale to SCWA's Zone 40 (up to 9,300 AF/year).

[2] SMUD 1 Assignment. Under the terms of a three-party agreement (SCWA, SMUD, and the City), and in accordance with SMUD's PSA, the City is providing surface water to SMUD for use at two of SMUD's cogeneration facilities. In turn, SMUD has assigned 15,000 AF/year of its CVP contract water to SCWA for M&I use. Because the cogeneration facilities are located within the City's American River POU, authorization by the State Water Resources Control Board (SWRCB) was not required.

[3] SMUD 2 Assignment. SMUD's PSA directs SMUD to assign a second 15,000 AF/year to SCWA and for SCWA to construct groundwater facilities necessary to meet SMUD's dry year water shortages of up to 10,000 AF/year. This CVP contract assignment is complete.

[4] CVP Water Public Law 101-514 ("Fazio" Water). In April 1999, SCWA obtained a CVP contract pursuant to PL 101-514 that provides a permanent water supply to SCWA Zone 40 of 15,000 AF/year and a 7,000 AF/year subcontract to Folsom.

[5] The City is committed to serving American River water to all areas located within the City's American River POU.

[6] Appropriative Water. SCWA has submitted an application to the SWRCB for appropriation of water from the American and Sacramento rivers (SCWA's Board authorized submittal of this application on May 30, 1995). The number shown is the expected long-term average use of the water and not the water right amount. This water is considered intermittent water that typically would be available during the winter months of normal or wet years.

[7] Does not include Section 215 water or water supplied by San Juan Water District.

[8] Golden State Water Company has access to Pre-1914 water through the Natomas Ditch Company and associated POU. A portion of this water is contracted to Folsom.

[9] Does not include a potential surface water supply for Rosemont Service Area.

[10] Rancho Murieta CSD's rights are governed by various appropriative rights and associated restrictions, maximum annual use, and maximum annual storage. The total contract yield varies from year to year.

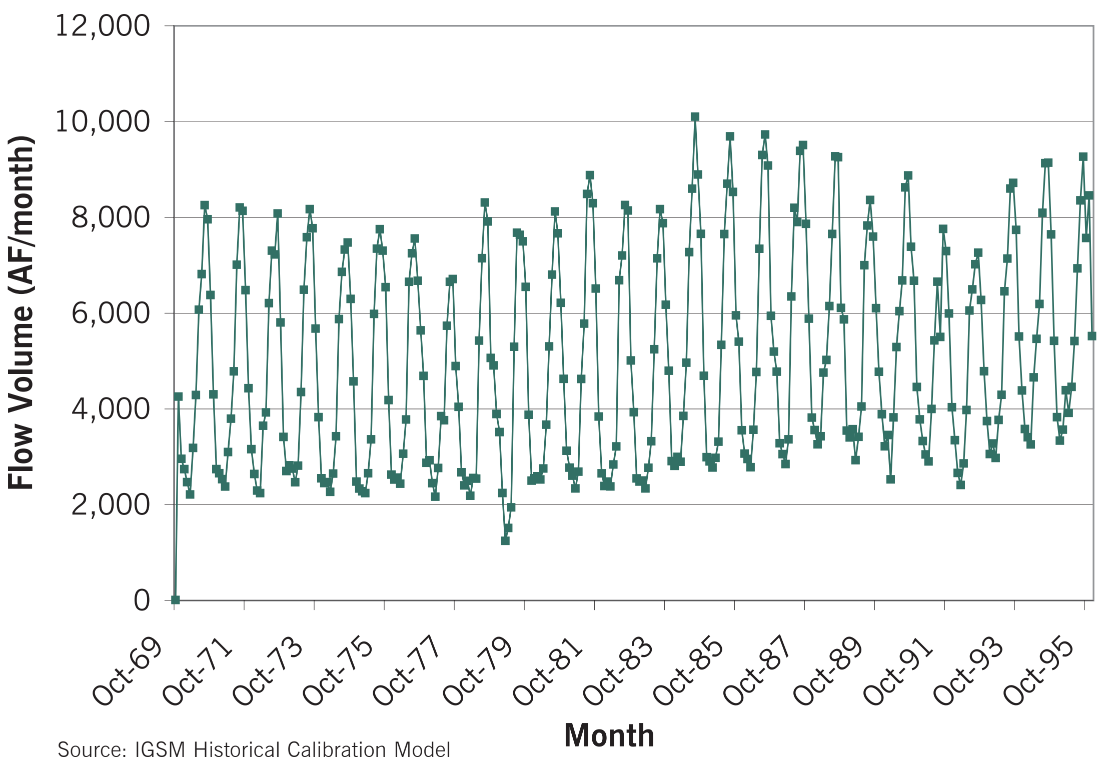
[11] OHWD contracted to the late 1970s with Reclamation for use of water stored at Sly Park Reservoir. Since the late 1970's OHWD has depended solely on riparian water supplies and infrequent supplemental purchase of spill water from the CVP, delivered through the Folsom South Canal. OHWD is assumed to continue to use riparian water rights of up to 4,000 AF/year (only because this value is assumed in the IGSM for diversions from the Cosumnes River to 1995, and because of the difficulty in accounting for riparian water use).

2.2.5.1 City of Sacramento

The City has water rights on both the Sacramento and American rivers. The City also has a settlement water contract with Reclamation that includes a delivery and storage schedule for use of their water entitlements. The City/Reclamation settlement agreement also incorporates an earlier SMUD contract with Reclamation. The City's current maximum water right/contract entitlements and existing surface water diversions are summarized in **Table 2-1**. Water available to the City's American River POU under its settlement contract is subject to a maximum annual diversion from the American River specified in the contract by a gradually increasing schedule. In 2030, the City's maximum diversion from the American River and Sacramento River is limited to 245,000 AF/year and 81,800 AF/year, respectively, under the City/Reclamation settlement contract. The City has agreed to limit its diversions under its settlement contract to not more than 225 cfs of Sacramento River water and not more than 675 cfs of American River water. In turn, Reclamation has guaranteed the availability of those amounts with no deficiencies in any hydrologic year-type.

As mentioned in **Section 2.1.1**, the WFA limits the City's American River diversions under certain flow conditions. The City may recover diversion reductions on the American River at its existing Sacramento River WTP. The City also may replace some of the water with Sacramento River water through a new intake at a future planned WTP located in North Natomas. The City's history of surface water use in the Central Basin is shown in **Figure 2-7**. Because the City's service area extends to both sides of the American River, and the water distribution system allows water to flow to either side, the information presented in this figure is only an approximation based on assumptions used in the IGSM. Based on the figure, very little change in the use of surface water has occurred over the period of record. Any change in surface water use would likely result in a change of the City's use of groundwater north of the American River, increased water conservation, and/or new growth.

Figure 2-7. City of Sacramento 1969 to 1995 Combined American River and Sacramento River Surface Water Diversion to Central Basin



Source: IGSM Historical Calibration Model

2.2.5.2 SCWA Zone 40

Currently, surface water meets approximately 12 percent of SCWA's Zone 40 water demands. SCWA's two CVP surface water contracts (termed "Fazio" and "SMUD" water) provide for two points of diversion, at or near the mouth of the American River, or just north of the community of Freeport on the Sacramento River.

SCWA has been diverting approximately 4,500 AF/year of surface water at the City's Sacramento River WTP. Under an existing wheeling agreement with the City this amount will increase to 12,350 AF/year. This water is treated and then wheeled through the City's conveyance facilities to a connection with Zone 40 facilities in Franklin Boulevard (Franklin Intertie) near the Sacramento Regional Waste Water Treatment Plant (WWTP) for use in the City of Elk Grove. Additionally, approximately 2,066 AF/year of interim surface water is used in the Mather/Sunrise portion of Zone 40; this interim surface water is purchased from Golden State Water Company as a short-term replacement for groundwater supplies lost as a result of groundwater contamination by Aerojet and Boeing. **Table 2-1** lists existing surface water supplies either acquired or currently being pursued. Each of the supplies is described in the table notes. Note that the CVP contracts have been acquired, whereas the appropriative water rights and other water rights or water contracts have not. **Table 2-2** summarizes water deliveries to Zone 40 through the Franklin Intertie with the City, beginning in 1995 with interim water supplies from Brown's Valley Irrigation District (BVID). After 1999 and into the future SCWA's "Fazio" water contract will be the sole supply of this water.

2.2.5.3 U.S. Bureau of Reclamation

U.S. Bureau of Reclamation (Reclamation), under contract with the United States Air Force and local farmers, supplied water from the Folsom South Canal to supply makeup water to a small lake located near the canal at Mather Field and for agricultural purposes. Diversions started in the late 1970s and ceased in the late 1980s because Reclamation restricted diversions as a result of the Central Valley Project Improvement Act[6] (CVPIA).

2.2.5.4 City of Folsom

Folsom's current water rights/contract entitlements are summarized in **Table 2-1**. Folsom has a Pre-1914 Water Right for up to 22,000 AF of American River water and a contract with Reclamation to deliver this water at a maximum rate of 38.8 mgd. An additional water entitlement is through a contract lease for 5,000 AF of Pre-1914 water rights with GSWC.

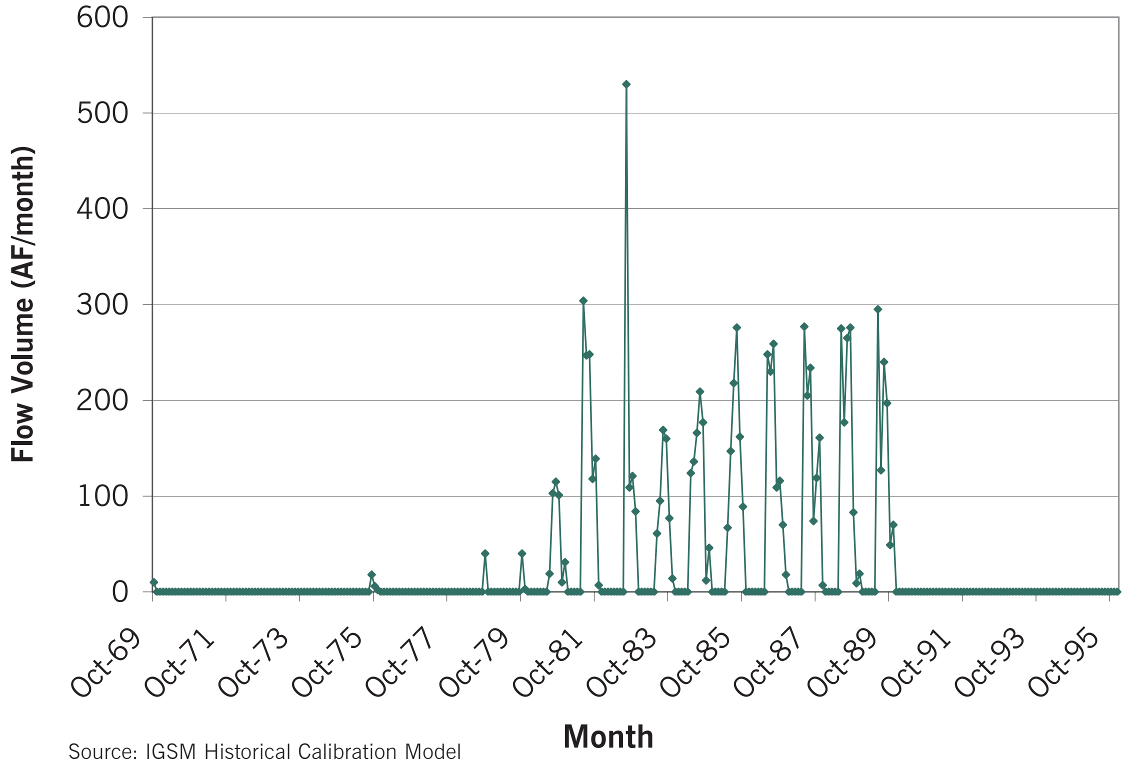
Folsom also has a subcontract with SCWA for 7,000 AF of American River water for delivery from Folsom Lake, as authorized by PL 101-514 (a portion of the "Fazio Water"). In addition, Folsom has a temporary contract with Reclamation for surplus water (often referred to as Section 215 water). Section 215 water is available on an intermittent basis only and is not storable in CVP facilities.

Table 2-2. Surface Water Diversions at the Franklin Intertie for Zone 40 from 1995 to 2003

Year	1995	1996	1997	1998	1999	2000	2001	2002	2003
Contract Source	BVID	BVID	BVID	BVID	Fazio	Fazio	Fazio	Fazio	Fazio
Surface Water Use AF/year)	537	2,471	848	1,468	2,000	2,200	3,967	4,300	4,261

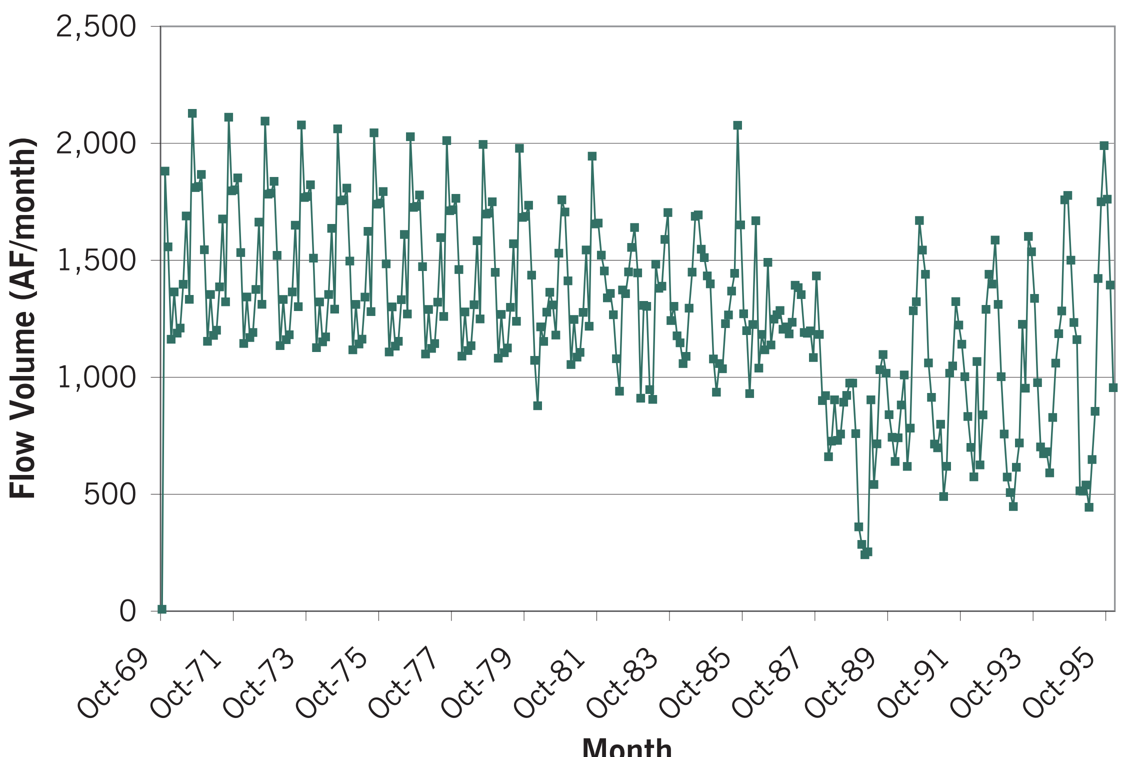
6 The CVPIA made significant changes in the policies and administration of the project and redefined the purposes of the CVP to include the protection, restoration, and enhancement of fish, wildlife, and associated habitats, and to contribute to California's interim and long-term efforts to protect the San Francisco Bay/Sacramento-San Joaquin River Delta Estuary.

Figure 2-8. U.S. Bureau of Reclamation 1969 to 1995 Surface Water Usage in Central Basin



Source: IGSM Historical Calibration Model

Figure 2-9. City of Folsom 1969 to 1995 Surface Water Usage in Central Basin



Source: IGSM Historical Calibration Model

The WFA limits Folsom's surface water diversions under certain hydrologic conditions (see **Section 1.1.1.1.4**). **Figure 2-9** provides a trace of the use of surface water by Folsom from 1969 to 1995. This figure shows a relatively stable use of surface water with a reduction during the 1987 drought period. Much of the growth that has occurred in Folsom over the past 10 years is not shown in this graph.

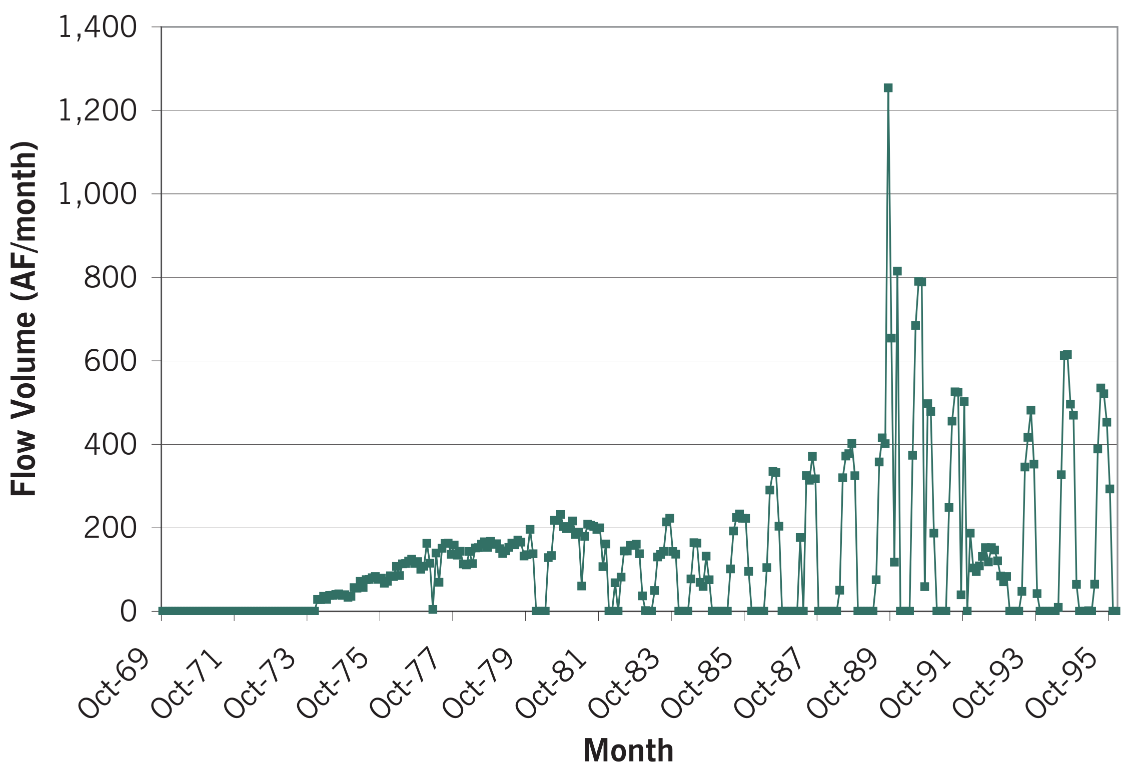
2.2.5.5 Golden State Water Company

GSWC has a 10,000 AF water right on the American River. This right and the Folsom's Pre-1914 Water Right for up to 22,000 AF of American River water are held in a co-tenancy agreement between the two purveyors. In 1994, Folsom and GSWC[7] entered into an agreement wherein GSWC agreed to sell Folsom 5,000 AF of water each year. GSWC diverts the remaining 5,000 AF/year of American River water from the Folsom South Canal for use in its Cordova System. GSWC's current water rights/contract entitlements are summarized in **Table 2-1**.

Figure 2-10 shows a buildup of surface water diversions to the Central Basin over the period of record due to growth and a higher reliance on surface water as a result of the loss of groundwater capacity from the contaminant plumes shown in **Figure 2-19**. Since 1995, GSWC has increased its capacity at the Coloma and Pyrites WTPs to 16 mgd to meet these higher demands.

SCWA purchases approximately 2,066 AF/year of interim surface water from GSWC for use in the Mather/Sunrise portion of Zone 40. This water serves as a short-term replacement for groundwater supplies lost as a result of groundwater contamination by Aerojet and Boeing.

Figure 2-10. Golden State Water Company 1969 to 1995 Surface Water Diversions in Central Basin



Source: IGSM Historical Calibration Model

7 Southern California Water Company (SCWC), previously known as Arden-Cordova Water Service, held the water right at the time the agreement was signed. SCWC has since become Golden State Water Company.

2.2.5.6 California American Water Company

Cal-Am does not have direct access to surface water. SCWA has reached an agreement with Aerojet and Boeing to replace water supplies lost by SCWA, GSWC, and Cal-Am as a result of groundwater contamination caused by past operations. Once an agreement is signed with SCWA, the affected Cal-Am service areas could receive replacement water supplies as part of SCWA's East Sacramento County Replacement Water Supply Project. This replacement water will be considered a groundwater source of supply, which will be described further in **Section 2.3.9**. Additionally, the Cal-Am service area located within the City's POU has the potential to receive wholesale surface water supplies from the City of Sacramento.

2.2.5.7 Rancho Murieta Community Service District

Rancho Murieta CSD has appropriative water rights on the Cosumnes River of up to 6,368 AF/year for municipal and agricultural, recreational, industrial, environmental, and stock watering uses. However, because of various constraints, annual usage is only about 6,000 AF. Water is diverted from the Cosumnes River at Granlee's Dam and pumped into off-stream lakes Calero, Chesbro, and Clementia from November 1 until May 31 of each year. Minimum flows in the Cosumnes River must be 76 cfs at Michigan Bar before water can be diverted. Surface water use by Rancho Murieta over the time period of 1969 to 1995 is shown in **Figure 2-11**. This graph indicates the steep increase in diversions in relationship to increased development of the Rancho Murieta community and construction of residential development.

2.2.5.8 Omochumne-Hartnell Water District

Within OHWD landowners adjacent to the Cosumnes River and Deer Creek have riparian water rights. Agricultural diversions have fluctuated in the past, but more recently have stabilized at approximately 4,000 AF per year (riparian water usage is difficult to monitor given the number of diverters and unmonitored diversion points. The high variability of flows in both of these water ways cause a wide fluctuation in the volume of water diverted by riparian users. In some years the lack of stream flow during the irrigation season can reduce diversions to near zero.

Historically, riparian users have diverted water from either the Cosumnes River or Deer Creek. Supplemental water obtained from the CVP and conveyed to OHWD via the Folsom South Canal is released to either the Cosumnes River, where riparian users can make their diversions. **Figure 2-12** shows the historical deliveries to OHWD via the Folsom South Canal. **Figure 2-13** shows the historical diversion of surface water from the either the Cosumnes River or Deer Creek. The later years shown in **Figure 2-13** reflect the current level of diversions occurring within OHWD. Water demands for irrigation or other needs that are not met from surface water are met from groundwater sources.

2.2.6 Surface Water Supply Summary

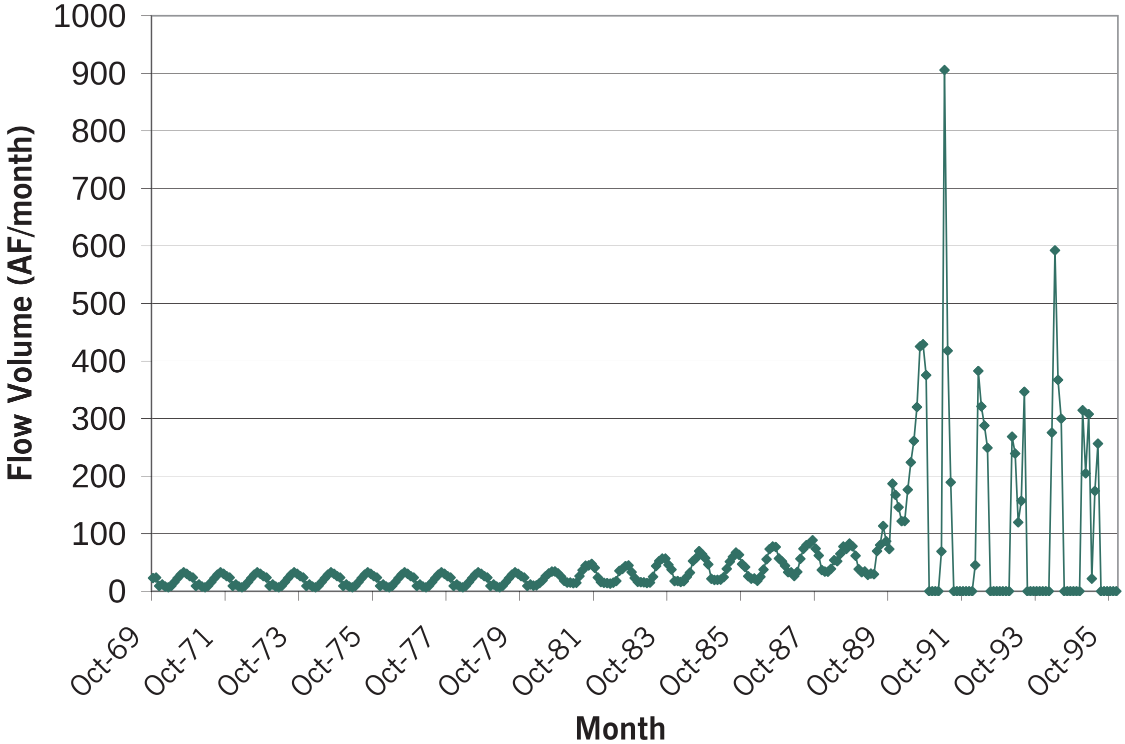
An overview of surface water supplies within the Central Basin is presented in a final water balance for the Central Basin on **Figures 2-25** and **2-26**. The figure shows that between 2005 and 2030, approximately 90,000 AF of additional surface water will be delivered to the Central Basin in wet years and approximately 30,000 AF in dry years.

The 2030 surface water supply shown in **Figure 2-26** should not be confused with the total amount of surface water available by contract to the basin given no curtailment in water contract amounts. Rather, the figure indicates the delivery of surface water based on municipal and agricultural demand patterns to meet the water demands of 2030. To make full use of all contract entitlements, would require above average rainfall, large offstream storage reservoirs to store the water for peak demand periods, and agreements to not use groundwater by purveyors who rely on groundwater to meet a portion or all of their water demands.

2.2.7 Other Available Surface Water Supplies

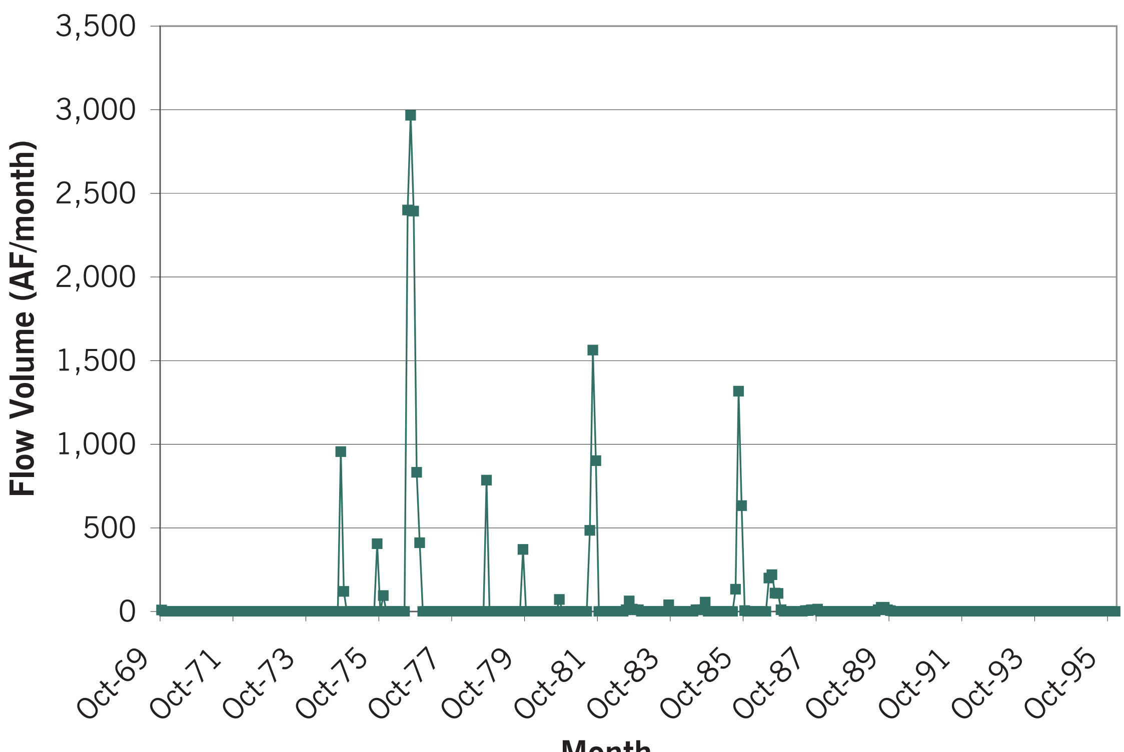
The availability of surface water supplies beyond those already under contract are not likely given the constraints and competition for water throughout the State of California. During critical year conditions, the

Figure 2-11. Rancho Murieta CSD 1969 to 1995 Surface Water Usage in Central Basin



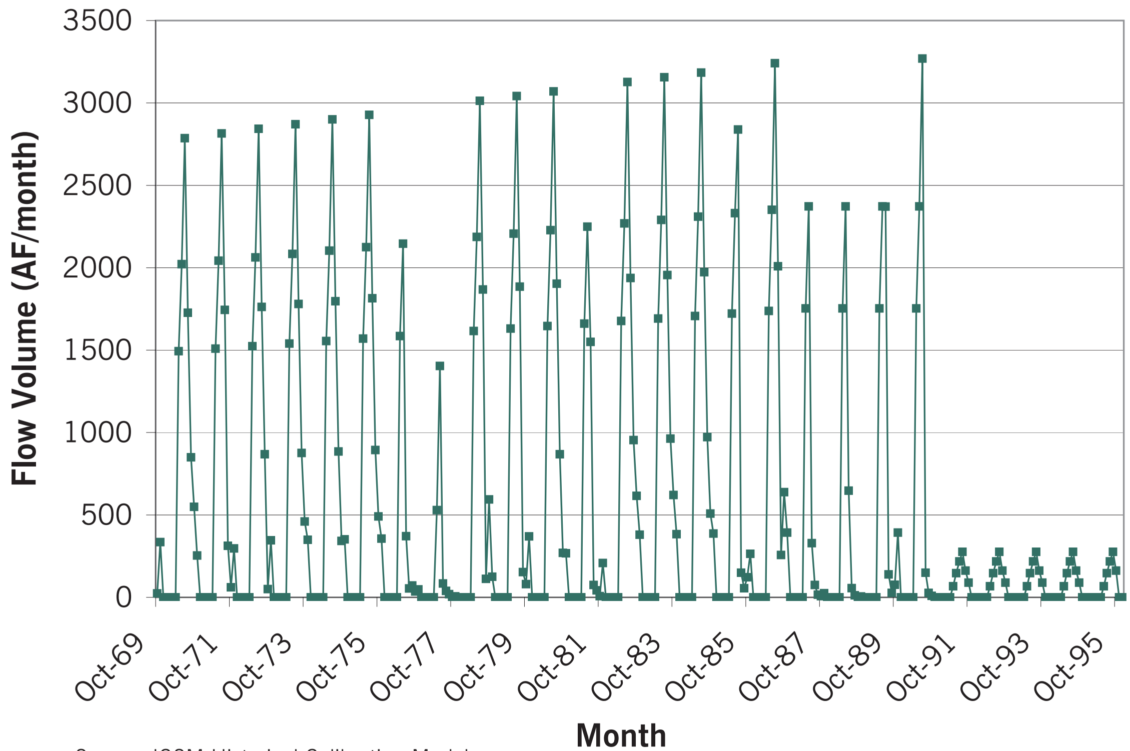
Source: IGSM Historical Calibration Model

Figure 2-12. OHWD 1969 to 1995 Surface Water Deliveries via the Folsom South Canal in Central Basin



Source: IGSM Historical Calibration Model

Figure 2-13. OHWD 1969 to 1995 Surface Water Usage from Cosumnes River and Deer Creek in Central Basin



Source: IGSM Historical Calibration Model

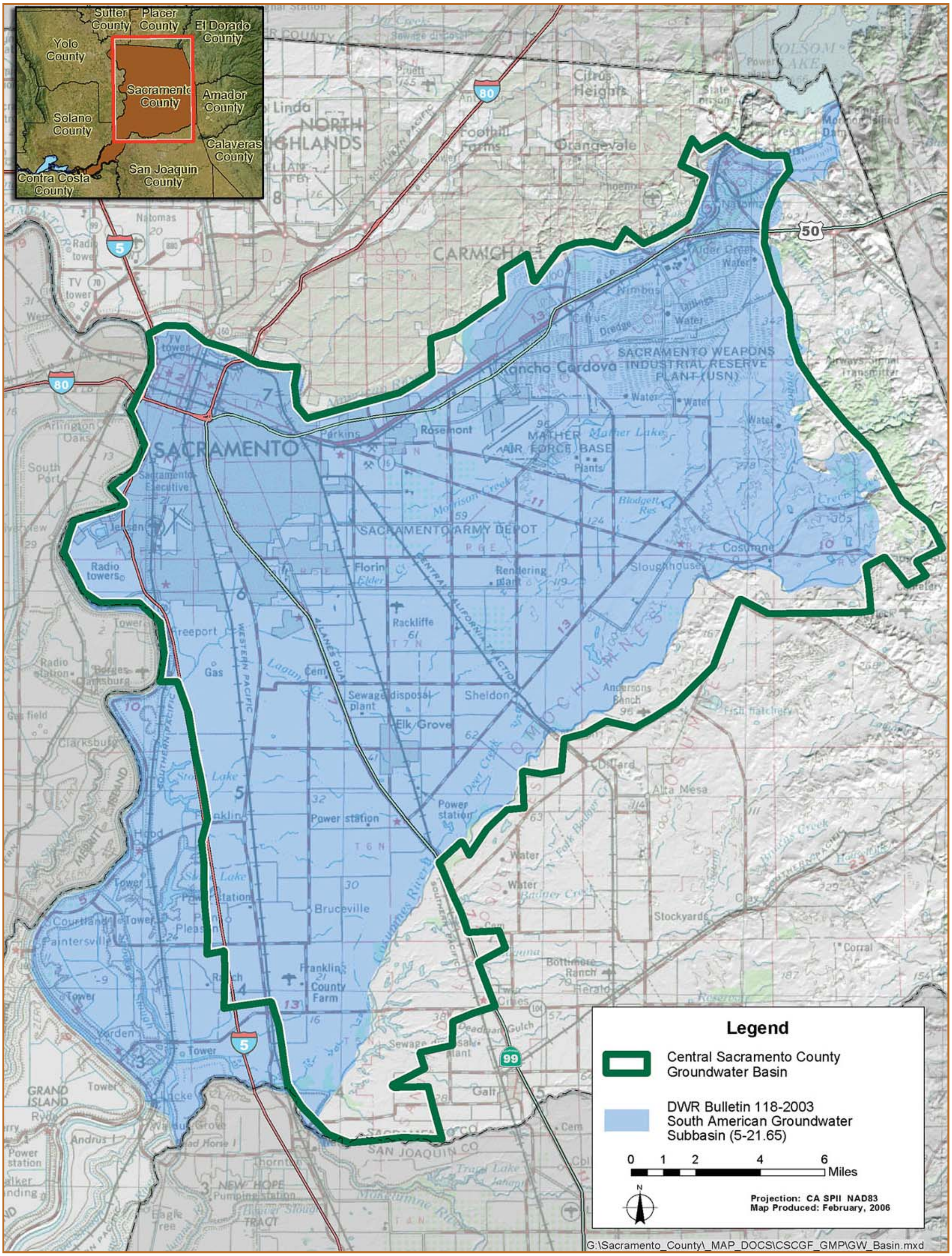
purchase of supplemental surface water from upstream Sacramento Valley water right holders may occur should those water right holders elect to fallow crops in return for compensation. SCWA has applied for an appropriative right on the Sacramento and American rivers for excess water. SCWA will most likely obtain this water right in 2008. Once appropriated, SCWA will use this water to meet municipal demands. SCWA also could potentially deliver water to agricultural areas that would have otherwise used groundwater, thus providing in-lieu recharge of the groundwater basin, or directly recharge the groundwater basin via recharge basins, and/or possibly treat and inject water with aquifer storage and recovery (ASR) wells. These options and strategies are discussed in later sections of this CSCGMP.

2.3 GROUNDWATER SUPPLIES

The groundwater basin underlying Sacramento County is divided into three subbasins, North, Central, and South, as shown in **Figure 1-1**. The Central Basin lies south of the American River, east of Interstate 5 and the Sacramento River, and north of the southern boundary of the OHWD and the Cosumnes and Mokelumne rivers. The eastern boundary of the Central Basin is approximately five to six miles west of the Sacramento County-El Dorado County boundary where the Sierra Nevada foothills begin to rise up from the Central Valley floor.

Essentially, the Central Basin boundary overlies State Department of Water Resources (DWR) South American Subbasin (DWR Bulletin 118-2003) (see **Figure 2-14**), however, the boundaries are slightly different because the Central Basin boundary was developed from the Sacramento County IGSM grid. An important artifact of this difference is that OHWD, which spans both sides of the Cosumnes River, lies entirely within the Central Basin for modeling purposes, but in fact half the district is in the Central Basin and the other half lies in the South Basin. This section provides a regional description of the geologic and hydrogeologic conditions of the underlying groundwater basin.

Figure 2-14. DWR Groundwater Subbasin



It is important to note that some municipal groundwater purveyors within the Central Basin did not actively participate in development of the CSCGMP. Rather than omit information relative to the Central Basin, the GMP Task Force obtained what information they could and have included it in this document. Because the CSCGMP is based on adaptive management, these stakeholders may participate, review, and provide data as part of the groundwater management plan program in the future.

2.3.1 Overview of Hydrogeologic Setting

The South American Subbasin, which the Central Basin is a portion, is defined as the area bounded on the west by the Sacramento River, on the north by the American River, on the south by the Cosumnes and Mokelumne rivers, and on the east by the Sierra Nevada Range. A full description about the South American Subbasin can be found on DWR's Web site (URL http://www.dpla2.water.ca.gov/publications/groundwater/bulletin118/basins/pdfs _ desc/5-21.65.pdf). A summary of more relevant information is provided below:

- Surface area: 388 square miles (Central Basin: 386 square miles).
- The perennial rivers that surround the subbasin generally create a groundwater divide in the shallow subsurface. It is clear that interaction occurs between groundwater of adjacent subbasins at greater depths.
- Average annual precipitation in the basin ranges from about 14 inches along the western boundary to greater than 20 inches along the eastern boundary.
- The eastern basin boundary is defined by the uprising foothills of the Sierra Nevada, and is a north-south line extending from Folsom Reservoir south to the small community of Rancho Murieta. This represents the approximate edge of the alluvial basin, where little groundwater flows into or out of the groundwater basin from the Sierra Nevada foothills. The western portion of the subbasin consists of nearly flat floodplain deposits from the Sacramento, American, and Cosumnes rivers, and several small east side tributaries.

2.3.2 Hydrostatigraphy of the Central Basin

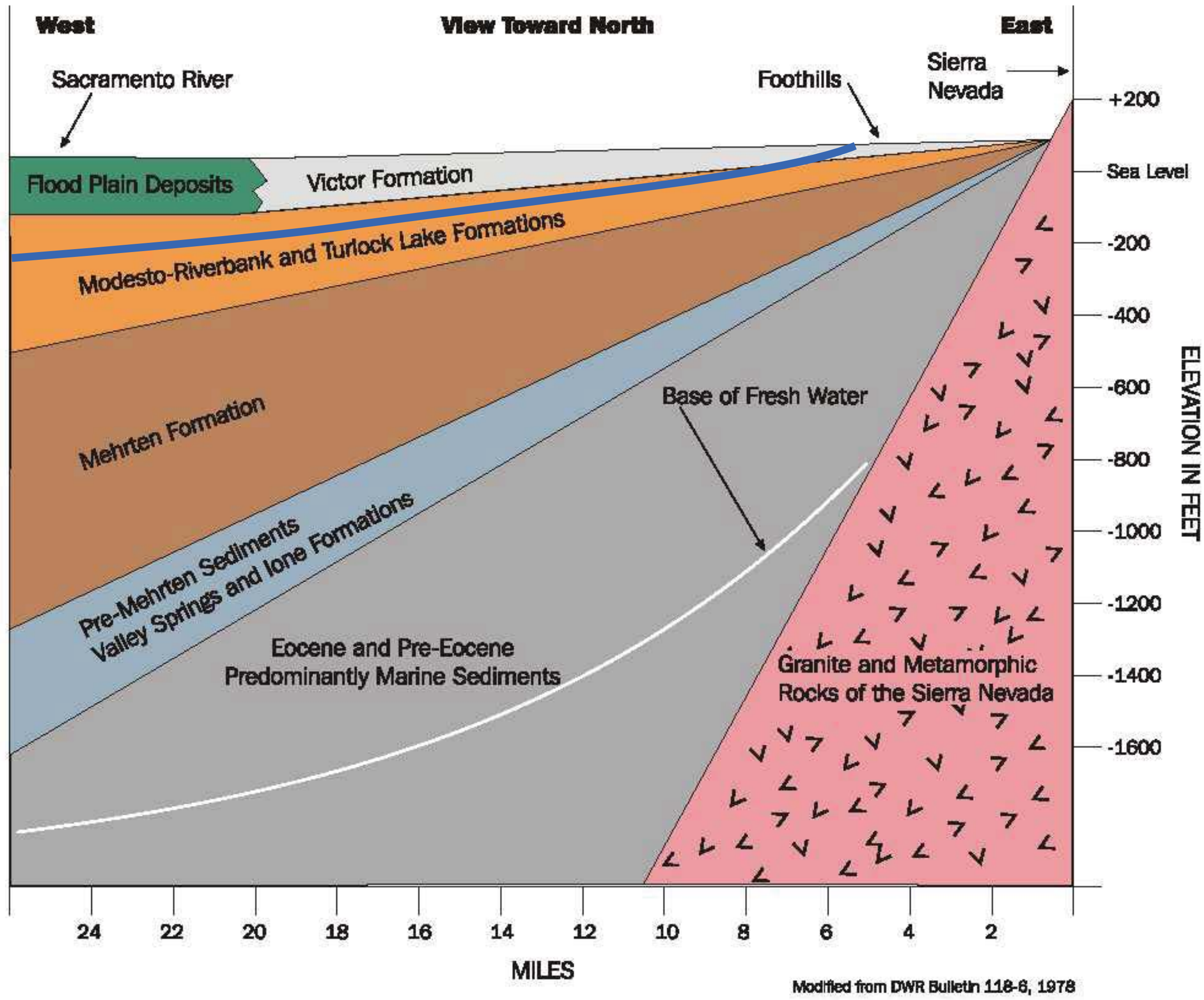
Bulletin 118-3 identifies and describes various geologic formations that constitute the water-bearing deposits underlying Sacramento County. These formations include an upper, unconfined aquifer system consisting of the Victor, Fair Oaks, and Laguna Formations (now known as the Modesto Formation), and a lower, semiconfined aquifer system consisting primarily of the Mehrten Formation, known for its fine black sands. These formations are shown in **Figure 2-15** and are typically composed of lenses of interbedded sand, silt, and clay, interlaced with coarse-grained stream channel deposits. **Figure 2-15** illustrates that these deposits form a wedge that generally thickens from east to west to a maximum thickness of about 2,500 feet under the Sacramento River. The Mehrten formation outcrops near the Sierra Foothills along the eastern Central Basin boundary and is typically characterized as a black sandy lens.

Groundwater in the Central Basin is generally classified as occurring in a shallow aquifer zone (Laguna or Modesto Formation) or in an underlying deeper aquifer zone (Mehrten Formation). Within the Central Basin, the shallow aquifer extends approximately 200 to 300 feet below the ground surface and, in general, water quality in this zone is considered to be good with the exception of arsenic detections in a few locations. The shallow aquifer is typically used for private domestic wells requiring no treatment unless high arsenic values are encountered, causing owners to possibly target other water-bearing strata.

The deep aquifer is separated from the shallow aquifer by a discontinuous clay layer that serves as a semiconfining layer for the deep aquifer. The base of the potable water portion of the deep aquifer averages approximately 1,400 feet below ground surface (bgs). Water in the deep aquifer typically has higher concentrations of total dissolved solids (TDS), iron, and manganese. Groundwater used in the Central Basin is supplied from both the shallow and deeper aquifer systems.

Older municipal wells and all domestic wells have been constructed in the shallow aquifer zone to avoid treatment.

Figure 2-15. Regional Geologic Cross Section



However, the policies and practices of SCWA in the Central Basin have led to the construction of larger municipal wells that target the Mehrten Formation where higher production rates can be achieved and less impact to private domestic wells would occur. This policy has in turn led to California Department of Health Services (DHS) requiring treatment of all municipal wells to meet primary and secondary drinking water quality standards.

2.3.3 Understanding Groundwater Changes in the Central Basin

Evaluating changes in aquifer conditions requires an understanding of the dynamic processes and interactions that are taking place as extractions and recharge of the aquifer occur. Conceptual models of the aquifer that describe induced recharge, aquifer storage, and differences between localized and regional effects on the aquifer are discussed below. These conceptual models are meant to clarify concepts; not all aspects of groundwater hydraulics are described. These models only apply to the Central Basin and adjoining basins within Sacramento County.

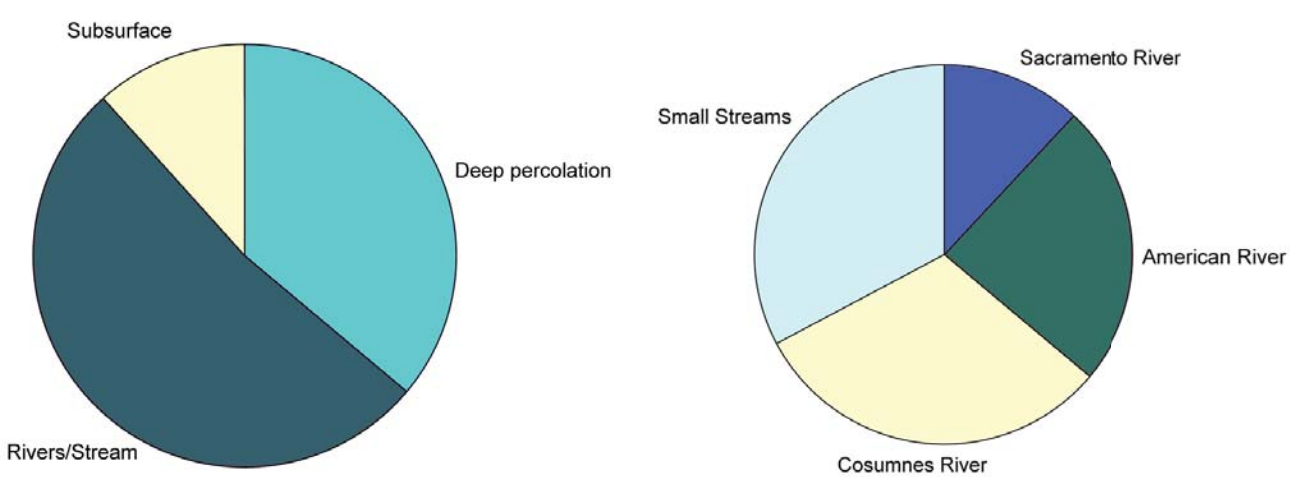
2.3.3.1 Groundwater Recharge Potential

Groundwater in Central Sacramento County moves from sources of recharge to areas of discharge (as shown in Figure 7 of the Conservation Element of the 1993 Sacramento County General Plan). Recharge of the local aquifer system occurs along active river and stream channels where extensive sand and gravel deposits exist, particularly along the American, Cosumnes, and Sacramento River channels. Additional recharge occurs along the eastern boundary of Sacramento County at the transition point from the consolidated rocks of the Sierra Nevada to the alluvial-deposited basin sediments. Recharge typically occurs through fractured granitic rock that makes up the Sierra Nevada foothills. This recharge is classified as subsurface recharge along with underground flow into and out of the Central Basin with adjacent groundwater basins. Other sources of recharge include deep percolation from applied surface water and precipitation. Induced recharge can occur from recharge basins and injection of water through ASR wells. The different sources of recharge and the approximate percentage that each provides to the Central Basin's overall natural recharge are provided in the pie chart shown in **Figure 2-16** below. The amount of natural recharge is important as it helps define when the basin is in a state of equilibrium and natural recharge roughly equals the amount of the groundwater extractions.

Changes in groundwater surface elevation (or piezometric surface) are a result of changes in groundwater extractions and can induce natural recharge at locations where rivers or streams and the aquifer are hydraulically connected. To the extent that a hydraulic connection exists, as groundwater conditions change, the slope or gradient of the groundwater surface may change as well. A steeper gradient away from the stream would induce higher recharge from the surface water source into the aquifer.

The rate of recharge from streams or rivers that are hydraulically disconnected from the groundwater surface is indifferent to changes in groundwater elevations or gradient. This is typically true with smaller streams where the groundwater surface is located far below the streambed. In such cases, surface water percolates through the unsaturated zone to the groundwater and its rate is a function of the aquifer materials underlying the streambed and the water level in the surface stream. The rate of infiltration under these conditions is not controlled by the change in elevation of the underlying groundwater. In the case of larger rivers, the American and Sacramento rivers are considered to be hydraulically connected and the Cosumnes River is considered to be hydraulically disconnected in the lower reaches of the

Figure 2-16. Central Basin Recharge Sources



river that flow through the Central Basin. The CSCGMP recognizes the importance of maintaining hydraulic connections with the larger river sources for sustainability of the groundwater supply, and the environmental benefits of keeping water flowing in the riverbed.

2.3.3.2 Localized Impacts of Groundwater Extraction

When extractions occur from a single well, a concentrated localized cone of depression is formed around the well. The shape and depth of the localized cone of depression depends on several factors including, but not limited to following: (1) the rate of extraction, (2) the presence of nearby sources of recharge and/or extraction, (3) aquifer transmissivity, (4) natural impervious barriers or earthquake faults, and (5) the "confined" or "unconfined" state of the aquifer, (i.e., storage coefficient). Over time, extraction from an unconfined aquifer can dewater the aquifer around the well. However, when extraction ceases, the water level within the aquifer can rebound to its preextraction condition over a relatively short period of time.

A confined or semi-confined aquifer behaves differently since the water is under pressure from a recharge source. Instead of dewatering the aquifer, a change in confining pressure occurs as a result of extractions; the aquifer remains saturated. In a confined aquifer, the pressure or piezometric surface elevation decline is more dramatic than in an unconfined aquifer; however, the recovery to pre-extraction conditions is typically much faster.

2.3.3.3 Regional Impacts of Groundwater Extraction

Large regional cones of depression can form in areas where multiple groundwater extraction wells are in operation. The location and shape of a regional cone of depression is influenced by the same factors as a single well. The regional cone of depression within the Central Basin is shown in **Figure 2-17**, as part of a water elevation contour map for spring 2004. This map was prepared using water elevation data from DWR's water data library available on-line at http://wdl.water.ca.gov. The map contours were determined using the Inverse Distance to a Power method.

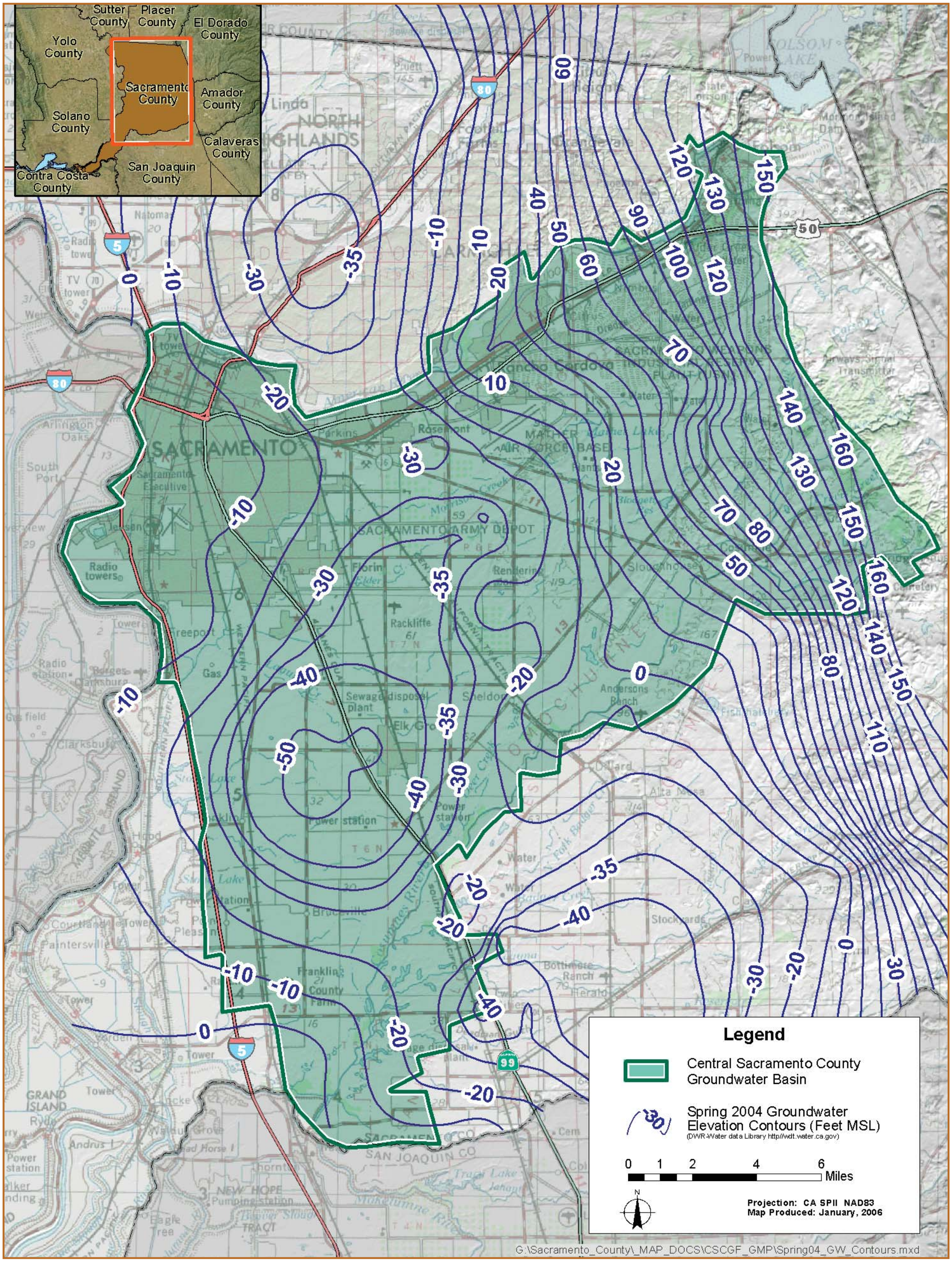
Fluctuations in regional cones of depression are measured over years and result from (1) changes in recharge and (2) changes in extractions from increasing and decreasing water demands. For example, a sequence of successive dry years can decrease the amount of natural recharge to the aquifer. If this is coupled with a coinciding increase in groundwater extraction, an imbalance is created between natural recharge and extractions. Consequently, groundwater elevations would decrease in response to this imbalance. Over time, the shape and location of the aquifer's regional cone of depression fluctuates.

Intensive use of the groundwater basin has resulted in a general lowering of groundwater elevations near the center (or centroid) of the basin away from the sources of recharge. As early as 1968, pumping depressions were evident in the Central Basin. These depressions have grown and coalesced into a single cone of depression centered in the southern portion of the Central Basin area, as shown in **Figure 2-17**.

2.3.4 Groundwater Level Trends

A review of 11 long-term hydrographs, shown in **Figure 2-18A** (within Zone 40) and **Figure 2-18B** (outside Zone 40), illustrates groundwater level trends through much of the Central Basin. Groundwater elevations generally declined consistently from the 1950s and 1960s to about 1980 on the order of 20 to 30 feet. From 1980 through 1983, water levels recovered by about 10 feet and remained stable until the beginning of the 1987 through 1992 drought. From 1987 until 1995, water levels declined by about 15 feet. From 1995 to 2003 most water levels recovered generally higher than levels prior to the 1987 through 1992 drought. Much of this recovery can be attributed to the increased use of surface water in the Central Basin, and the fallowing of previously irrigated agricultural lands transitioning into new urban development areas in accordance with the Sacramento County and City of Elk Grove General Plans. Below is a brief description of the hydrograph trends in different locations within the Central Basin (the geographic divisions were made to assist in the descriptions):

Figure 2-17. Spring 2004 Groundwater Elevation Contour Map



Southern Wells. The southern portion of the Central Basin extends from Interstate 5 to just east of Highway 99. Groundwater level trends in this area can be seen in hydrographs from DWR monitoring wells SWP-115, SWP-058, and SWP-054, shown in **Figure 2-18A**, and wells SWP-170, SWP-107, SWP-004, and SWP-063, shown in **Figure 2-18B**. The hydrographs for these wells show groundwater levels generally varying between 10 and 90 feet below mean sea level (msl).

Central Wells. The central portion of the Central Basin is the area between Highway 99 and Highway 16 (Jackson Highway). Groundwater level trends in this area can be seen in hydrographs from DWR monitoring wells SWP-121, SWP-124, SWP-125, SWP-128, SWP-188, shown in **Figure 2-18A**, and SWP-177, SWP-149, and SWP-154, shown in **Figure 2-18B**. The hydrographs for these wells show groundwater levels generally varying between 40 feet above to 40 feet below msl.

Northern Wells. The northern portion of the Central Basin is the area north of Highway 16 (Jackson Highway). The general trend of groundwater levels in this area is more stable than the other areas. Water level trends in this area can be seen in hydrographs from DWR monitoring wells SWP-255, SWP-202, and SWP-209, shown in **Figure 2-18A**, and SWP-185, SWP-250, and SWP-244, shown in **Figure 2-18B**. The hydrographs for these wells show declines of up to 40 feet since 1960.

2.3.5 Water Forum Groundwater Sustainable Yield

For each of the three groundwater subbasins in Sacramento County, the Water Forum Groundwater Negotiation Team (GWNT) developed an estimated long-term average annual pumping limit for meeting 2030 land and water use conditions (see **Section 1.1.1**). **Appendix A** provides a summary of the process used for developing the long-term average annual pumping limit of 273,000 AF/year that was negotiated for the Central Basin.

"Long-term average annual pumping limit" describes the hydrogeologic process under which groundwater can be pumped and not exceed average natural recharge over a long-term period of time. Under sustainable conditions, natural recharge is said to be able to make up for variations in the amount of pumping that occurs over the long-term, given wet and dry periods in the hydrologic record. As shown in **Figure 2-16**, natural recharge occurs primarily from streams, rainfall, and subsurface inflow.

To understand how the GWNT arrived at the 273,000 AF/year is a complex process that requires some discussion of the technical data that were developed to support that decision. Much of the data are based on evaluating future land and water use projections and describing the impacts associated with increased water demands, assuming that demand is met solely by groundwater. Comparing these results with existing conditions (1990 as the baseline) provided a level of impact that could be expected if groundwater pumping were increased beyond baseline conditions. In some cases, such as in the North Basin, the GWNT agreed that baseline levels of pumping were already at an acceptable level of impact.

Four quantifiable factors were used to determine the level of impact:

- Water quality degradation
- Dewatering of wells
- Higher cost of pumping
- Ground subsidence

Based on these four elements, a series of groundwater model runs quantified each condition in 10-year increments, beginning in 1990 and ending in 2030. Each model run was setup to reflect future land and water use conditions; then 70 years of historical hydrology were applied to each model run to determine how the aquifer might behave under wet and dry conditions.

After a comprehensive review and analysis of model data and real data, the GWNT concluded that using 2005 levels of groundwater pumping would provide the highest quantity of groundwater yield from the basin while minimizing impacts associated with the four elements of concern. By interpolating between 2000 and 2010, pumping at 2005 equates to a long-term average annual pumping limit of approximately 273,000 AF/year for the Central Basin.

2.3.6 Groundwater Quality

Water quality analysis of the aquifers underlying the Central Basin has shown that groundwater found in the upper aquifer system is of higher quality than that found in the lower aquifer system. This is principally because the lower aquifer system (specifically the Mehrten formation) contains higher concentrations of iron and manganese. The lower aquifer system also has higher concentrations of total dissolved solids (TDS), although this aquifer typically meets water quality standards as a potable water source. At depths of approximately 1,400 feet or greater (actual depth varies throughout the basin), the TDS concentration exceeds 2,000 milligrams per liter (mg/L) and groundwater is considered non-potable unless treated by reverse osmosis. Water from the upper aquifer (specifically the Laguna formation) generally does not require treatment (unless high arsenic values are encountered), other than disinfection for public drinking water systems.

2.3.6.1 Background Water Quality

Municipal wells meet all CCR Title 22 primary drinking water quality standards. A number of purveyor wells within the Central Basin exceed secondary drinking water standards for iron and manganese; many of these wells are treated to remove these constituents. Secondary standards were established for aesthetic concerns (e.g., staining of laundry and porcelain fixtures) and at elevated levels do not pose a health hazard. Arsenic concentrations in some wells exceed recently implemented (January 2006) federal drinking water standards of 10 micrograms per liter (μg/L); these regulations provide a timetable for compliance. Radon also has been detected in groundwater in the greater Sacramento area, although not at levels that exceed current drinking water standards.

This description of background water quality is based on data used to populate the Central Basin Data Management System (DMS). Groundwater quality data from monitoring activities between 1999 and 2003 were used to populate the DMS for portions of the Central Basin. The DMS can be used to query data and develop statistics and graphics for constituents of interest.

2.3.6.2 Total Dissolved Solids

TDS concentrations in most municipal wells are within secondary drinking water standards; therefore, TDS does not limit the potable use of groundwater.

2.3.6.3 Iron and Manganese

Iron and manganese are found in deeper municipal wells and treatment is required by DHS when a new well is constructed. Therefore, the presence of iron and manganese does not limit the potable use of groundwater. According to the DMS, iron concentrations range from nondetect (less than 10 μg/L) to 16,000 mg/L, although most wells have average values of less than 200 mg/L. Manganese concentrations range from nondetect (less than 2 mg/L) to 1,700 mg/L, although most wells have average values of less than 50 mg/L.

2.3.6.4 Arsenic

The U.S. Environmental Protection Agency (EPA) has adopted a revised MCL for arsenic of 0.010 mg/L, along with monitoring requirements, arsenic health effects language, and best available technologies for arsenic mitigation in public drinking water systems. The compliance date for the new MCL is January 23, 2006. Although DHS is in the process of adopting new regulations, it is unknown when the state regulations will be adopted. In the meantime, DHS plans to initiate implementation of the new federal requirements in January 2006.

DHS will require that untreated municipal wells that exceed the new arsenic standards be phased out of production or be treated to below the new 10 μg/L maximum concentration. The requirement does not apply to individual domestic wells. Water purveyor compliance through DHS will likely take place during 2006 within a set timeframe that the water purveyor can meet with DHS oversight. This provides for additional time to construct replacement facilities and close down existing wells that exceed the arsenic concentration, or, if needed, to meet the necessary treatment requirements.

Prior to the EPA ruling of 2004, arsenic concentrations of less than 50 μg/L were acceptable for potable

Figure 2-18A. Central Basin Groundwater Elevation Hydrographs Within SCWA Zone 40

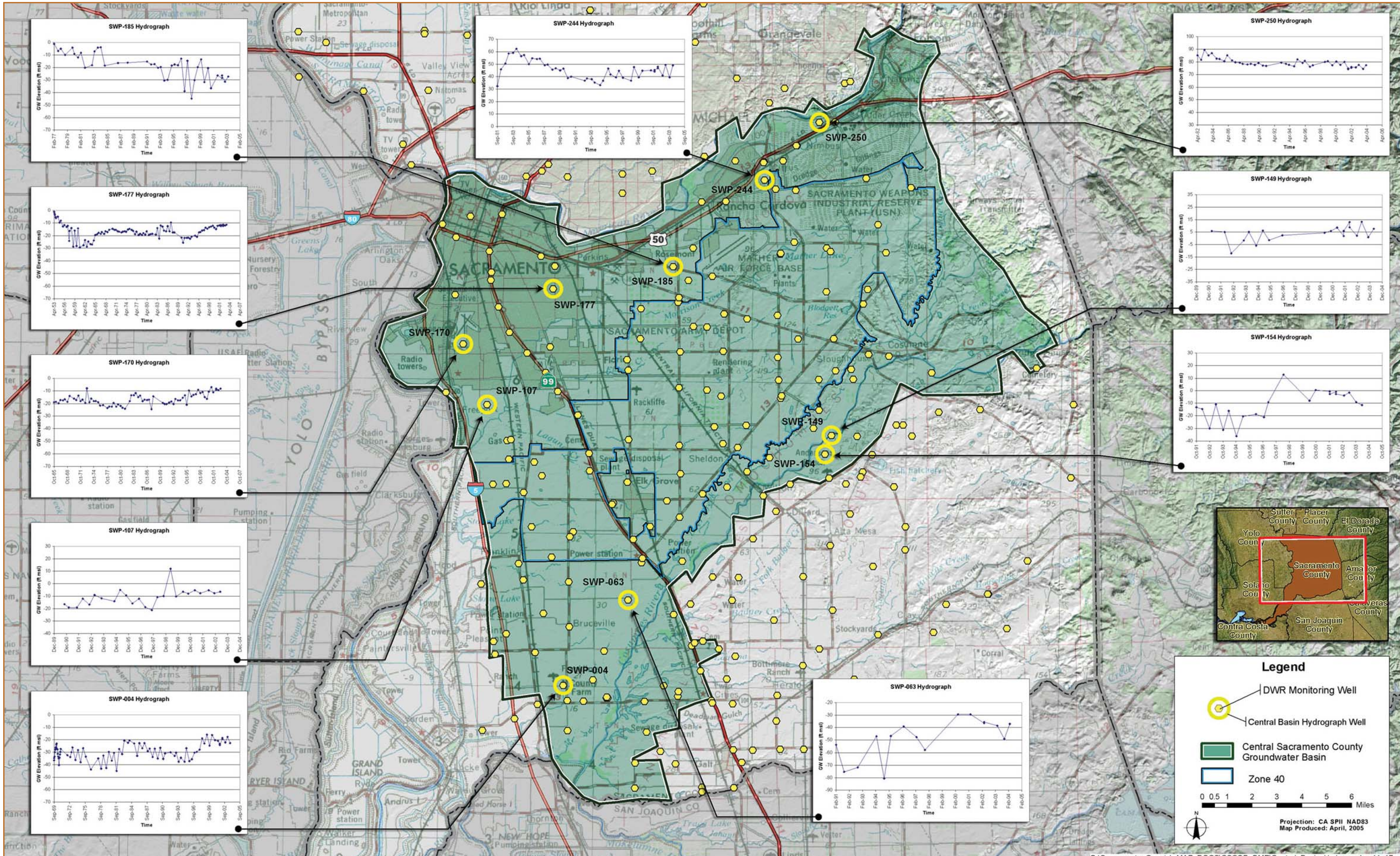
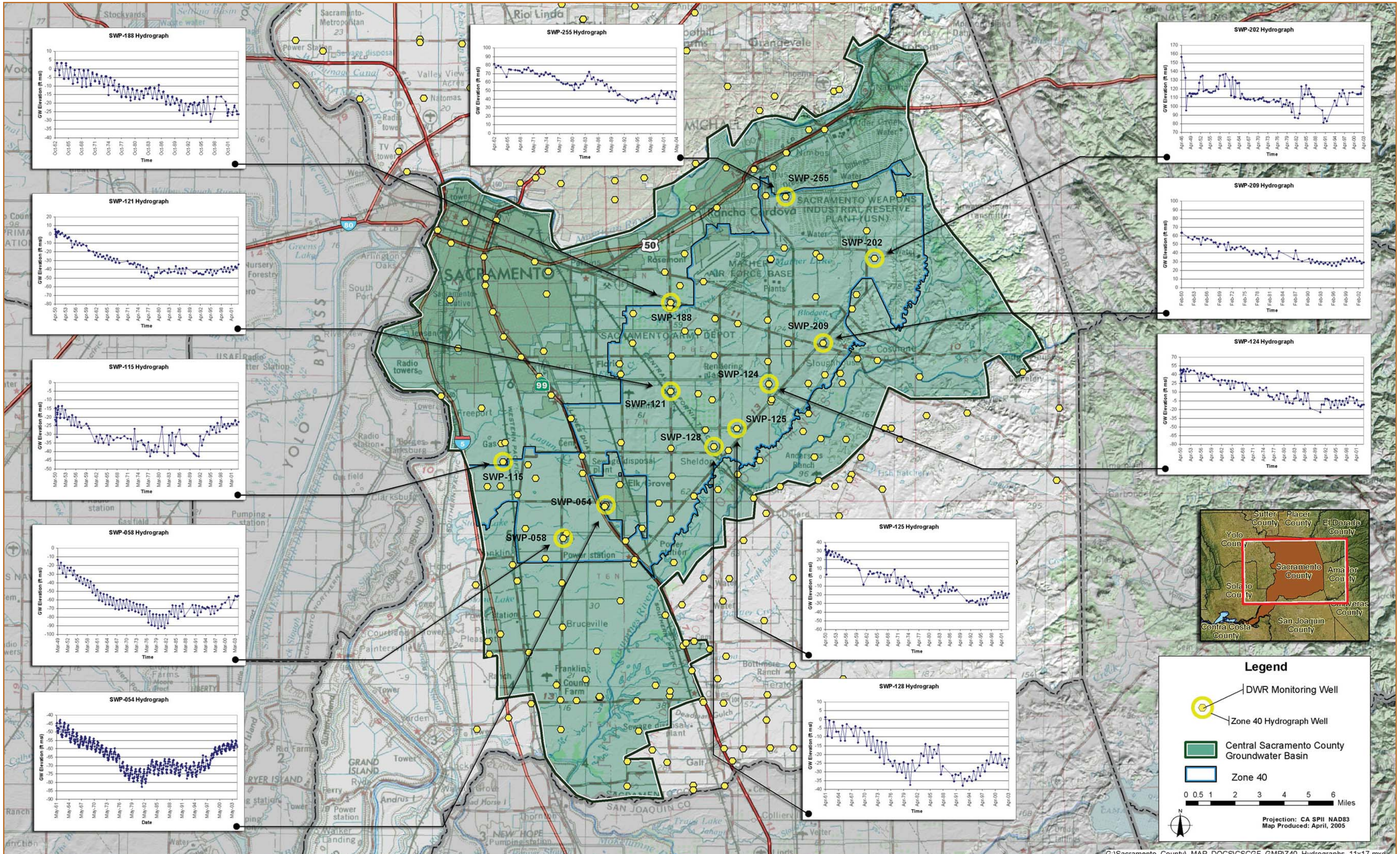


Figure 2-18B. Central Basin Groundwater Elevation Hydrographs Outside SCWA Zone 40



drinking water. Municipal wells within the Central Basin have historically met primary drinking water standards; therefore, arsenic has not limited the potable use of groundwater prior to December 2006.

2.3.6.5 Known "Principal" Contaminant Plumes

Principal groundwater contaminant plumes within or near the Central Basin are known to exist from source areas such as Mather Field, McClellan Air Force Base, Aerojet, Boeing, the former Army Depot, the former Southern Pacific and Union Pacific railyards, and various landfills. These plumes are shown on **Figure 2-19**. Contaminant plume data were collected from the following documents:

- MWH. Mather Air Force Base Annual and Fourth Quarter 2002 Sitewide Groundwater Monitoring Report. March 2003
- Aerojet Environmental Remediation. Aerojet General Corp Superfund Site Western Groundwater Cleanup 2004 Progress Report. 2004
- McDonnell Douglas/Boeing Environmental Remediation. McDonnell Douglas Sacramento Site, American River Study Area Groundwater Monitoring Results, April – June 2002. August 2002
- Disposal Sites. Integrated Waste Management Board.
- Environmental Simulations, Inc., Revised Probabilistic Groundwater Flow Model for the Southern IRCTS, Rancho Cordova, California. June 2003
- Groundwater Contamination Investigation for Central Basin 2004, Water Forum/Schlumberger Engineering)

Although other localized plumes exist in and around the Central Basin (e.g., small leaking under ground fuel tanks), the principal plumes shown in **Figure 2-19** are the largest and have the greatest current impact on existing groundwater use.

For the Mather Field plumes, the primary contaminants of concern (COC) are tetrachloroethylene (TCE), perchloroethylene (PCE), and carbon tetrachloride. The edges of Mather Field plume represent a composite COC concentration of 0.5 mg/L, which is one-tenth of the maximum contaminant level (MCL) for these constituents.

For the Aerojet and IRCTS plumes, the primary COCs are TCE, n-nitrosodimethylamine (NDMA), and perchlorate. Leaking underground fuel tank (LUFT) sites also exist within the Central Basin. It is assumed that these sites can be fully remediated; however, an inventory of the number of sites, their locations, and their clean-up status is kept by the Sacramento County Environmental Management Department (EMD). The aggregate impact on groundwater quality from undetected contamination (e.g., MTBE) in the basin cannot be determined at this time and may ultimately be considerable. Methods to inventory these undetected contaminants will likely be done under the purview of EMD.

2.3.7 Groundwater Facilities

In municipal water systems that are "groundwater only," water is fed into the system by individual wells (direct feed wells) or by centralized groundwater treatment plant(s) (ranging in size from 1 mgd to 12 mgd) that treat water from several wells.

Large capacity municipal wells are shown in **Table 2-3** and **Figure 2-20**. Agricultural and private wells are not shown due to insufficient data on the location and size of each well. Typical municipal capital facilities for groundwater production capacity include groundwater extraction wells (including raw water piping from the wells to the treatment plant), treatment, at grade storage tanks, booster pumps, and transmission pipelines to the distribution system. Treatment plants typically remove iron, manganese, and some arsenic. Capacity of groundwater facilities by agencies participating in development of the CSCGMP are summarized below:

- The City currently operates two active municipal groundwater supply wells plumbed to its distribution system within the city limits south of the American River. These two wells represent about seven percent of the City's total groundwater pumping capacity of 30 mgd.
- SCWA has a combination of direct feed wells and groundwater treatment facilities. Groundwater treatment plant capacity ranges from approximately 2 mgd to 11 mgd.
- GSWC provides a portion of the water supply to its Cordova System with direct feed wells with a combined capacity of approximately 24 mgd. The Cordova System has been significantly impacted

Figure 2-19. Known Principal Contaminant Plumes

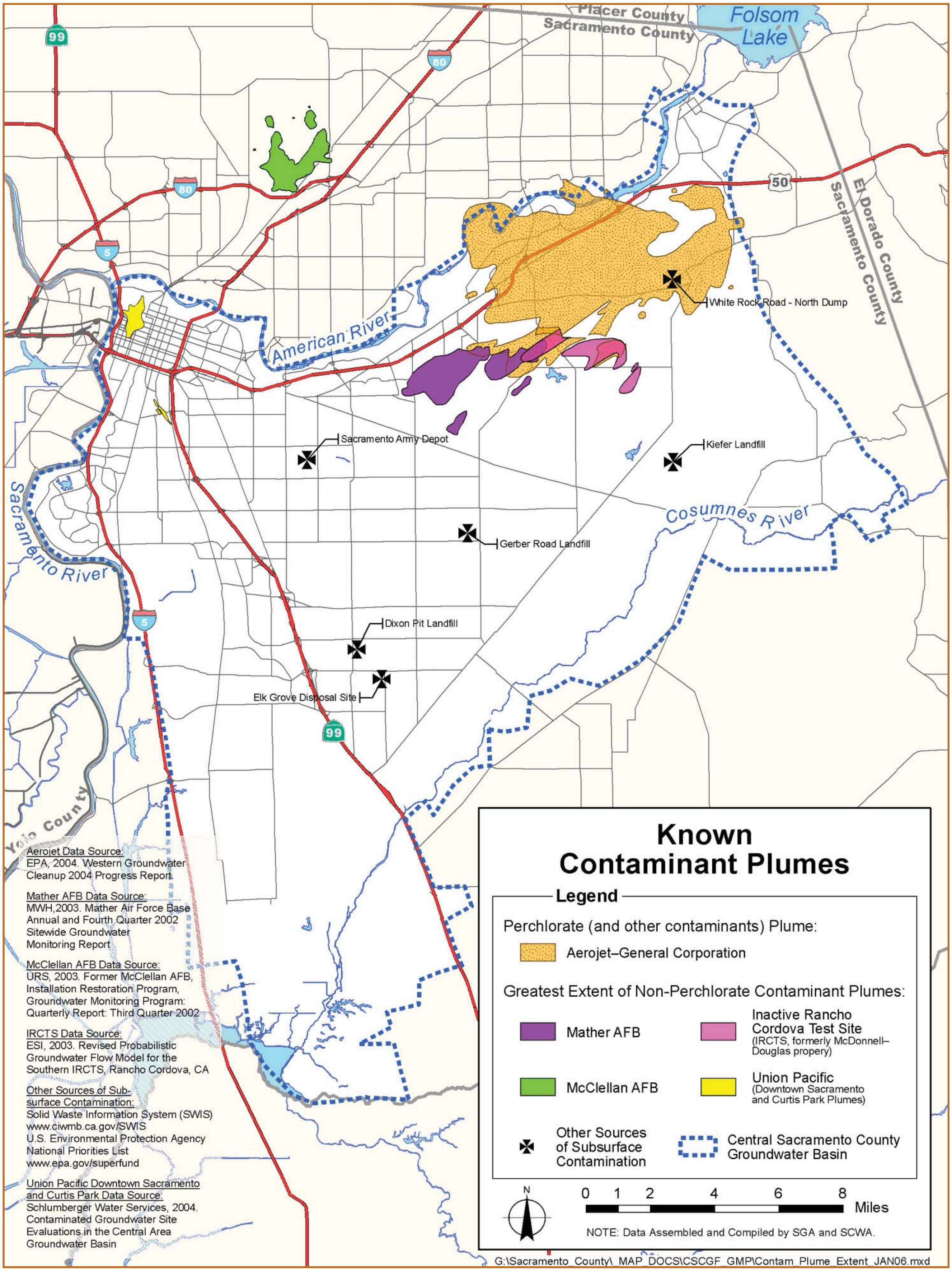
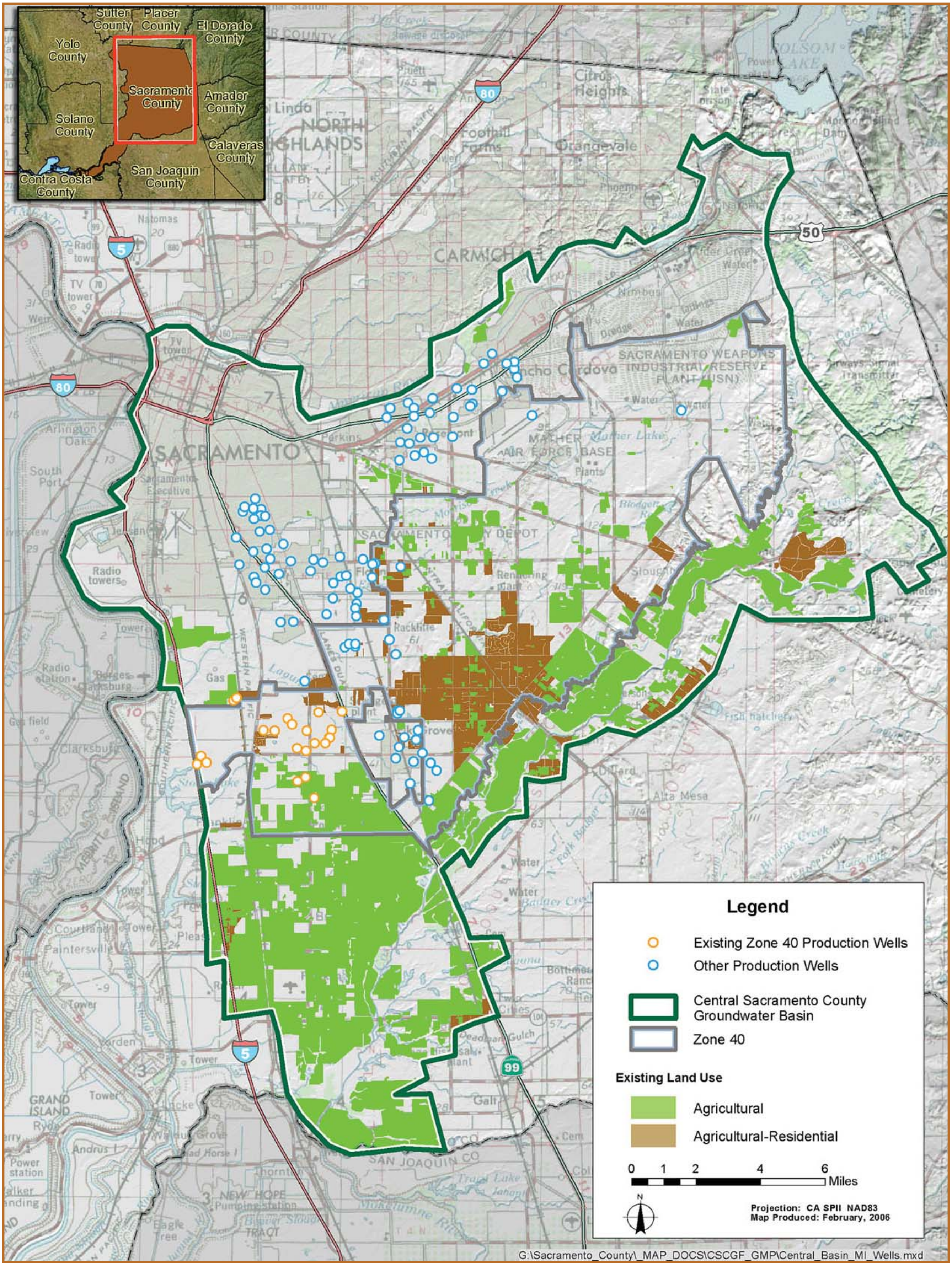


Table 2-3. Existing Purveyor "Larger" Production Wells

DMS Well ID	Well Name	State Well ID	Agency
134	WOODMAN	null	CAL-AM
135	SALMON F	null	CAL-AM
136	ROGUE RI	null	CAL-AM
137	WHITEWAT	null	CAL-AM
138	BUTTERFI	null	CAL-AM
139	FOLSOM/B	null	CAL-AM
153	CALDERA	null	CAL-AM
154	POINT REYES	null	CAL-AM
155	COLLEGE	null	CAL-AM
156	OAKEN BU	null	CAL-AM
157	SUTTERS	null	CAL-AM
158	WILDROSE	null	CAL-AM
159	TALLY HO #1	null	CAL-AM
160	SOUTHPORT	null	CAL-AM
161	WESTPORTER	null	CAL-AM
162	MOON BEAM	null	CAL-AM
163	TALLY HO #2	null	CAL-AM
164	SOUTHGATE	null	CAL-AM
165	A PARKWAY	null	CAL-AM
166	contaminated	null	CAL-AM
167	SKY PARKWAY	null	CAL-AM
168	contaminated	null	CAL-AM
169	abandoned	null	CAL-AM
170	STOCKER	null	CAL-AM
171	CONRAD D	null	CAL-AM
172	BRIGGS D	null	CAL-AM
173	LIPPI PARKWAY	null	CAL-AM
174	GERBER RD	null	CAL-AM
175	ROCKHURST	null	CAL-AM
177	ELSIE	null	CAL-AM
178	WILBUR #1	null	CAL-AM
179	WILBUR #2	null	CAL-AM
180	PARK SIT 2	null	CAL-AM
181	VINTAGEP #3	null	CAL-AM
182	LARCH CO SD #1	null	CAL-AM
183	LARCH CO #2	null	CAL-AM
244	CENTR	null	CAL-AM
246	CHETT	null	CAL-AM
249	COUNTRYSIDE1A	null	CAL-AM
250	COUNTRYSIDE #2	null	CAL-AM
255	EXPLO	null	CAL-AM
258	GOULD	null	CAL-AM
264	MALAG	null	CAL-AM
265	MARS	null	CAL-AM
266	MONTE	null	CAL-AM
267	NUT P	null	CAL-AM
273	ROCKI	null	CAL-AM
280	SWANS	null	CAL-AM
286	VINTAGE #1	null	CAL-AM
287	WEST	null	CAL-AM
289	WINCH	null	CAL-AM
436	FLORIN BOOSTER	null	CAL-AM
437	FLORINC	null	CAL-AM
438	FOLSOM-MH	null	CAL-AM
439	GOV CIRCLE	null	CAL-AM
440	RAFTCR	null	CAL-AM
441	ROSEMONT	null	CAL-AM
444	55TH ST	null	CAL-AM
448	PARKSITE#1(ELSIE1)	null	CAL-AM
477	POWER INN	null	CAL-AM
485	VINTAGE #2	null	CAL-AM
488	ISLETON #1	null	CAL-AM
489	ISLETON #2	null	CAL-AM
200	SAC-083	null	City of Sacramento
430	SAC-107	null	City of Sacramento
466	WELL	null	Elk Grove Fish and Habitat
467	WELL	null	Elk Grove Fish and Habitat
468	WELL	null	Elk Grove Fish and Habitat
303	MAIN	null	Elk Grove Water Service
304	MARVA	null	Elk Grove Water Service
305	WEBB	null	Elk Grove Water Service
306	EMERA	null	Elk Grove Water Service
307	EMERA	null	Elk Grove Water Service
308	PARKS	null	Elk Grove Water Service
309	WILLI	null	Elk Grove Water Service
310	POLHE	null	Elk Grove Water Service
311	FEICK	null	Elk Grove Water Service
312	DINO	null	Elk Grove Water Service
313	FALLB	null	Elk Grove Water Service
401	ADAMS	null	Elk Grove Water Service
492	HAMPTON VILLAGE	null	Elk Grove Water Service
321	DIANA	null	Florin County Water District
322	FLETC	null	Florin County Water District
323	FLORIN	null	Florin County Water District
324	FRENCH	null	Florin County Water District
325	KARA	null	Florin County Water District
326	MC COMBER	null	Florin County Water District
327	POWER INN	null	Florin County Water District
328	REESE #1	null	Florin County Water District
329	REESE #2	null	Florin County Water District
472	WEYAND	null	Florin County Water District
330	null	null	Fruitridg Vista Water District
331	null	null	Fruitridg Vista Water District
332	null	null	Fruitridg Vista Water District
333	null	null	Fruitridg Vista Water District
334	null	null	Fruitridg Vista Water District
335	null	null	Fruitridg Vista Water District
336	null	null	Fruitridg Vista Water District
337	null	null	Fruitridg Vista Water District
338	null	null	Fruitridg Vista Water District
339	null	null	Fruitridg Vista Water District
340	null	null	Fruitridg Vista Water District
341	null	null	Fruitridg Vista Water District
342	null	null	Fruitridg Vista Water District
343	null	null	Fruitridg Vista Water District
344	null	null	Fruitridg Vista Water District
452	AGGREGATE	null	Mather Air Force Base
184	VINTAGE PARK W-060	null	SCWA Zone 41
185	CAYMUS W-061	034/029-062	SCWA Zone 41
372	UNION INDUSTRIAL W-027	06N/06E-07Q02 M	SCWA Zone 41
373	SURVEY RD W-028	06N/06E-18A01 M	SCWA Zone 41
374	STOCKTON BL W-029	06N/06E-18J02 M	SCWA Zone 41
375	BRUCEVILLE W-040	06N/06E-18J02 M	SCWA Zone 41
376	SEASONS W-041	034/029-062	SCWA Zone 41
377	BANYON W-042	034/029-062	SCWA Zone 41
378	DUCK SLOUGH W-043	034/029-062	SCWA Zone 41
379	KILCONNELL W-044	034/029-062	SCWA Zone 41
380	ACROPOLIS W-045	034/029-062	SCWA Zone 41
381	ASHURST W-046	034/029-062	SCWA Zone 41
382	FEATHER CREEK W-047	034/029-062	SCWA Zone 41
383	WADENA W-048	034/029-062	SCWA Zone 41
384	SOARING OAKS W-049	034/029-062	SCWA Zone 41
385	BIG HORN SOUTH W-050	034/029-062	SCWA Zone 41
386	BIG HORN CENTER W-051	034/029-062	SCWA Zone 41
387	BIG HORN NORTH W-052	034/029-062	SCWA Zone 41
388	WHITE ROCK W-017	null	SCWA Zone 41
389	RECYCLE W-018	null	SCWA Zone 41
390	W-62 ANDAL	034/029-062	SCWA Zone 41
391	EQUINE W-063	034/029-062	SCWA Zone 41
396	3RD STREET W-019	06N/04E-14N01 M	SCWA Zone 41
397	HOOD-FRANKLIN RD (replace 398)	null	SCWA Zone 41
398	HOOD-FRANKLIN RD W-020	null	SCWA Zone 41
399	SWALE	null	SCWA Zone 41
447	OMEGA	null	SCWA Zone 41
483	WESTRAY W-064	034/029-062	SCWA Zone 41
484	SHELDON NORTH W-065	034/029-062	SCWA Zone 41
499	WATERMAN RD W-067	034/029-062	SCWA Zone 41
5172	null	null	SCWA Zone 41
5173	CALVINE MEADOWS W-066	null	SCWA Zone 41
5174	TILLOTSON W-068	null	SCWA Zone 41
5175	PERRY RANCH W-069	null	SCWA Zone 41
5176	DWIGHT RD RAW WATER WELL	null	SCWA Zone 41
5177	East Park W-073	null	SCWA Zone 41
5178	W. Stockton Blvd. W-074	null	SCWA Zone 41
5179	Legends W-076	null	SCWA Zone 41
5180	LW-78 POPPY RIDG	null	SCWA Zone 41
5181	LW-105 AZINGER	null	SCWA Zone 41
5182	LW-106 RODR CIR	null	SCWA Zone 41
5183	LW-109 TERRAZO	null	SCWA Zone 41
5184	LW-110 FERRAGAMO	null	SCWA Zone 41
5185	LW-113 BISHOP	null	SCWA Zone 41
5186	LW-114 WINDSOR D	null	SCWA Zone 41
5245	W-055	null	SCWA Zone 41
5246	W-056	null	SCWA Zone 41
5247	W-070	null	SCWA Zone 41
5248	W-075	null	SCWA Zone 41
5249	W-077	null	SCWA Zone 41
5250	W-007	null	SCWA Zone 41
5251	W-016	null	SCWA Zone 41
5252	W-020	null	SCWA Zone 41
5253	W-032	null	SCWA Zone 41
5254	W-081	null	SCWA Zone 41
5256	W-089	null	SCWA Zone 41
5257	W-099	null	SCWA Zone 41
5258	W-108	null	SCWA Zone 41
5259	W-B01	null	SCWA Zone 41
5260	W-B02	null	SCWA Zone 41
5261	W-B03	null	SCWA Zone 41
5262	W-DA	null	SCWA Zone 41
5263	W-M01	null	SCWA Zone 41
5264	W-T01	null	SCWA Zone 41
5265	W-T02	null	SCWA Zone 41
5266	W-T03	null	SCWA Zone 41
5267	W-T06	null	SCWA Zone 41

Note: "null" = no data

Figure 2-20. Existing Production Wells



by groundwater contamination from Aerojet and in some cases has installed well-head treatment to remove VOC contaminants prior to using groundwater as a potable supply.

- Cal-Am service areas are served primarily by direct feed groundwater wells within its service areas, but also has groundwater treatment facilities in its Parkway and Countryside systems. Cal-Am also is experiencing impacts from groundwater contamination from Mather, and in some cases, has installed well-head treatment such as carbon filters or air strippers to remove contaminants prior to using groundwater as potable supply. In addition, the Parkway and Countryside systems are believed to be potentially "at risk" of contamination due to past dry cleaner discharge of tetrachloroethene (PCE) into the sanitary sewer system.

2.3.8 Groundwater Rights

Since the groundwater basin underlying all of Sacramento County is not adjudicated, the rights to groundwater are based on the overlying water right of the property owner. Different types of groundwater rights are described more fully below.

Correlative Right. A correlative right has a mutual or reciprocal relationship to the rights of others, in the sense that the existence of one necessarily implies the existence of the other. For example, the rights of landowners in a given basin to extract groundwater are correlative with all other landowners in that basin.

Overlying Right. An overlying right is the right of a landowner to take water from the aquifer underneath their property for reasonable and beneficial use on the land overlying the aquifer. Overlying rights exist by virtue of land ownership.

Prescriptive right. A prescriptive right comes into existence only if a groundwater basin has no "surplus"[8] water available. Such a right is gained by appropriating nonsurplus water for a statutorily prescribed period.

Subordinate right. A subordinate right is one that is inferior to or secondary to a higher right.

Appropriative right. Appropriative rights to groundwater apply to pumpers who use water on nonoverlying lands. Most municipalities and agricultural water purveyors have appropriative rights to groundwater because they deliver groundwater to parcels they do not own, and in some cases to lands outside the basin. Appropriative use of groundwater is limited to water in excess of that required by overlying users. Unlike appropriative rights for use of surface water, no formal regulatory permitting process exists for appropriative use of groundwater.

Adjudication of a Groundwater Basin. Adjudication of a groundwater basin essentially removes the above mentioned rights to groundwater and the amount of water available to each groundwater pumper is allocated based on a court decision.

2.3.9 East Sacramento County Replacement Water Supply Project

Groundwater contamination emanating from the Aerojet project site, the Inactive Rancho Cordova Test Site (IRCTS), and the Mather Field site has significantly impacted groundwater resources in the Rancho Cordova area. In some instances, groundwater supplies have been impacted so severely that all wells within a purveyor's service area have been shut down. Typically, as an overlying appropriator, a municipal purveyor would use the underlying groundwater to serve homes and businesses that would be constructed within the purveyor's service area. However, because the underlying aquifer in much of the Rancho Cordova area is contaminated, this method of developing and delivering groundwater is unacceptable. Therefore, it is reasonable to consider a second approach to providing water. Aerojet and McDonnell-Douglas (Boeing) have been directed by various regulatory agencies to implement a groundwater remediation program that would stop the spread of contamination and perhaps remove it entirely. However, implementing the remedy will take a

[8] Surplus water is water in excess of environmental use and state and federal water projects.

significant amount of time and will not keep pace with the economic growth in the community.

Most of the current cleanup activities require extracting, treating, and discharging treated groundwater to a surface water body, primarily tributaries to the American River. This water then flows downstream through the Delta, resulting in a loss in the groundwater basin. A better use of this water would be to find a way to put it to beneficial use within the same groundwater basin that it is extracted from. The result would be that the overall impact of groundwater remediation would not affect the estimated long term average annual pumping limit of the basin. To achieve this objective, SCWA has entered into agreements with Aerojet and Boeing to ensure that the remediated groundwater does not leave the basin.

The project includes 1) extracting contaminated groundwater, 2) treating the contaminated groundwater to meet National Pollution Discharge Elimination System (NPDES) permit requirements, 3) discharging the treated groundwater to the American River, and 4) reusing the treated groundwater in the Central Basin. Reuse has been prioritized in the agreement as follows: 1) replacement of municipal groundwater supplies lost due to contamination, 2) water supply service to "Aerojet Lands," 3) new development in Zone 40, and 4) environmental uses.

Since the above agreements have been approved, additional agreements have been reached that more fully delineate how the replacement water will be used. These agreements include an agreement with EBMUD regarding use of the Folsom South Canal for delivery of replacement water supplies to GSWC and delivery of environmental water to the Cosumnes River, an agreement with SMUD on water quality in the Folsom South Canal, an agreement with GSWC for replacement water supply, and an agreement with TNC and SSCAWA on delivery of environmental water to the Cosumnes River. Currently, no agreement exists between SCWA and Cal-Am on how much water will be needed to meet their replacement water supply needs.

2.4 RECYCLED WATER SUPPLIES

Recycled water is a desirable source of water for outdoor landscape irrigation and other non-potable uses, especially in times of drought when surface water supplies are reduced and the groundwater system is being relied on more heavily to meet potable demands. For the Sacramento Region, use of recycled water provides an alternative to discharging treated wastewater from SRCSD's Sacramento Regional WWTP into the Sacramento River. Increasing use of recycled water may become a more cost-effective solution for SRCSD's 1.1 million ratepayers because wastewater regulations require ever higher treatment standards (and costs) for discharged effluent. Much of the need for higher quality water is because the background water quality of the river is already high in certain constituents from upstream agricultural and old mining activities. Significant discussion has occurred related to who "owns" the water once it is treated and discharged by SRCSD. The most current legal opinion is that the portion of wastewater stream that originated as groundwater in SRCSD's service area is owned by SRCSD and can be recycled (opinion referenced in Nolte, 2004). The surface water portion of the wastewater stream will likely continue to be discharged to the Sacramento River until further studies can be conducted to fully understand the impacts of a reduction in the amount of discharge

on downstream users and the Delta. However, since it is estimated that 50 percent of wastewater originates from a groundwater source, SRCSD will recycle up to 80 mgd, which is approximately half of the current average discharge flow to the Sacramento River, (SRCSD, 2005) This amount of recycled water is well above the SRCSD Board's adopted goal of recycling 30 to 40 mgd in the next 20 years.

The most commonly used recycled water is defined as wastewater that has been treated to tertiary standards that meet Title 22 of the California Code of Regulations (CCR). Recycled water treated to this level can be used for all outdoor irrigation demands in a community, including, parks, schools, street medians, residential front and backyard landscaping, public open space, and industrial uses such as cooling water. In addition, recycled water is commonly used for environmental purposes such as wetlands and habitat restoration.

In the Central Basin, SRCSD/SCWA have developed a recycled water pilot program that has been developed and is operational on a small scale. The 5 mgd project began as a pilot program to serve the communities of Laguna West, Lakeside, and Laguna Stonelake, and on-site needs of the Sacramento Regional WWTP. Recycled water is used in these communities for outdoor irrigation of public open space areas, commercial landscaping, schools, parks, and street medians. This pilot SRCSD Recycled Water Program is Phase 1 of a two-phase project.

Use of recycled water is regulated by DHS, SWRCB, RWQCB, and local EMD through a permitting process that minimizes the possibility for human contact either through cross connections with potable water supplies, or exposure to irrigation water from overspray or excess irrigation that drains off site.

Acceptance of recycled water as a source of water supply for the three communities has been very good. The future of recycled water in the Central Basin appears promising, especially because of the benefits recycled water brings to the region. SRCSD is currently developing a comprehensive Recycled Water Supply Master Plan that evaluates recycled water opportunities that could benefit the Central Basin, as well as other locations in the SRCSD service area. Recycled water can be provided to a community in one of two ways: first, through centralized treatment at the existing water recycling facility, or second, through satellite "polishing" plants that draw wastewater from large interceptor pipelines in the community, treat the wastewater to Title 22 standards, and provide the recycled water in the vicinity of the remote plant.

2.4.1 Recycled Water Facilities

Figure 2-21 depicts current and planned recycled water facilities in the Central Basin. A partnership between SCWA and SRCSD has led to construction and implementation of Phase 1 of the SRCSD Recycled Water Program. The Phase 1 service area consists of on-site uses at the Sacramento Regional WWTP complex and non-potable commercial and public landscape areas in the Laguna West, Lakeside, and Laguna Stonelake developments located within SCWA's service area immediately south of SRCSD's facility. The Phase 2 service area consists of the East Franklin and Laguna Ridge development areas located to the south and east of the Phase 1 system. Expansion of the SRCSD Recycled Water Program into the Phase 2 area requires a separate recycled water pipeline to be constructed from the Sacramento Regional WWTP to facilities owned and operated by SCWA. This work will be completed over the next several years. Much of the internal "purple" pipe distribution system is being constructed as part of new development.

2.4.2 Future Availability of Recycled Water Supplies

As mentioned, SRCSD is currently developing a comprehensive Recycled Water Master Plan as a future vision of recycled water in the community. Since much of the new growth taking place in Sacramento County is in the Central Basin, the opportunity appears favorable to expand the program in the Central Basin. The economic question of obtaining additional surface water supplies or making best use of recycled water supplies will be one of many factors in determining which areas are likely to move forward with recycled water. Other factors include avoided cost of wastewater treatment, environmental benefits, long-term sustainability of regional water supplies, as well as other societal and long-term benefits. Areas with existing reliable surface water rights may not be as likely to use recycled water. However, installation of a recycled water distribution system with new development may be necessary in advance of recycled water availability to preserve the opportunity of using recycled water in the future. It has been shown that the "retrofit," or installation of a recycled water distribution system after development has occurred is likely to be economically infeasible. In areas where groundwater supplies are not readily available or constrained, recycled water often is seen as a long-term reliable source of supply.

Use of recycled water for agriculture and wetlands/habitat restoration to supplement groundwater supplies is being developed as another option. The resulting reduction in groundwater use may provide more sources of supply elsewhere in the Central Basin. Additional benefits can be achieved by placing recycled water infrastructure close enough to communities to bring recycled water to urban areas or for potential recharge basins.

2.5 WATER DEMAND AND LAND USE

Determining existing and future water demands is necessary to establish the adequacy of available water supplies (i.e., groundwater, surface water, and recycled water). In addition, raw, treated, and recycled water facility sizing and operation are directly influenced by projections of water demand. Water conservation also is an element of water demand and is considered in the development of demand estimates. This section describes land use and water demands in the Central Basin. Much of the information about land use and water demands is taken from the EIR for the Zone 40 WSMP, which developed land and water use data for 2000 and 2030 levels of development within the Central Basin. The WSMP EIR was used instead of earlier work done by the Water Forum because the WSMP EIR contains more recent land use surveys.

2.5.1 Land Use

Water demands are based on the type of use taking place on a piece of property. Based on the type of use, the amount of water considered for indoor uses and outdoor irrigation can vary. The groundwater aquifer is mostly affected by land use from the amount of rainfall and irrigation that is capable of deep percolating into the ground on the property versus what becomes surface water runoff leading to storm drain collection systems. Land uses within the Central Basin are classified into five categories:

- Agricultural land, consisting of areas greater than 5 acres and currently used for agricultural purposes.
- Agricultural-residential land, consisting of 2- to 5-acre parcels zoned for agricultural and residential uses.
- Urban land use, consisting of municipal, commercial, and industrial developed areas.
- Native vegetation/undeveloped land uses, consisting of areas that have not been developed. These areas also may be used in the spring and early summer as dry pasture for livestock grazing.
- Riparian vegetation land uses, consisting of areas along waterways that are typically within the floodplain of the waterway and are typically covered with dense native vegetation.

A graphical pie chart distribution of year 2000[9] and projected year 2030[10] land uses within the Central Basin is shown in **Figure 2-22** and described below. Spatial geographic distributions of 2000 and 2030 land uses in the basin are shown in **Figure 2-23** and **Figure 2-24**, respectively. Major anticipated changes in land use are the expansion of urban acreage by 64 percent, from 80,387 acres to 132,145 acres, while native vegetation/undeveloped acreage will decrease by 50 percent, from 101,692 acres to 50,440 acres (see **Figure 2-22**).

[9] Based on 2000 DWR land use survey for Sacramento County

[10] Based on 2000 DWR land use survey for Sacramento County, DWR detailed Analysis Unit (DAU) crop acreage estimates, and Sacramento County General Plan land use mapping, and 2002 Zone 40 WSMP EIR.

Figure 2-21. Recycled Water Facilities

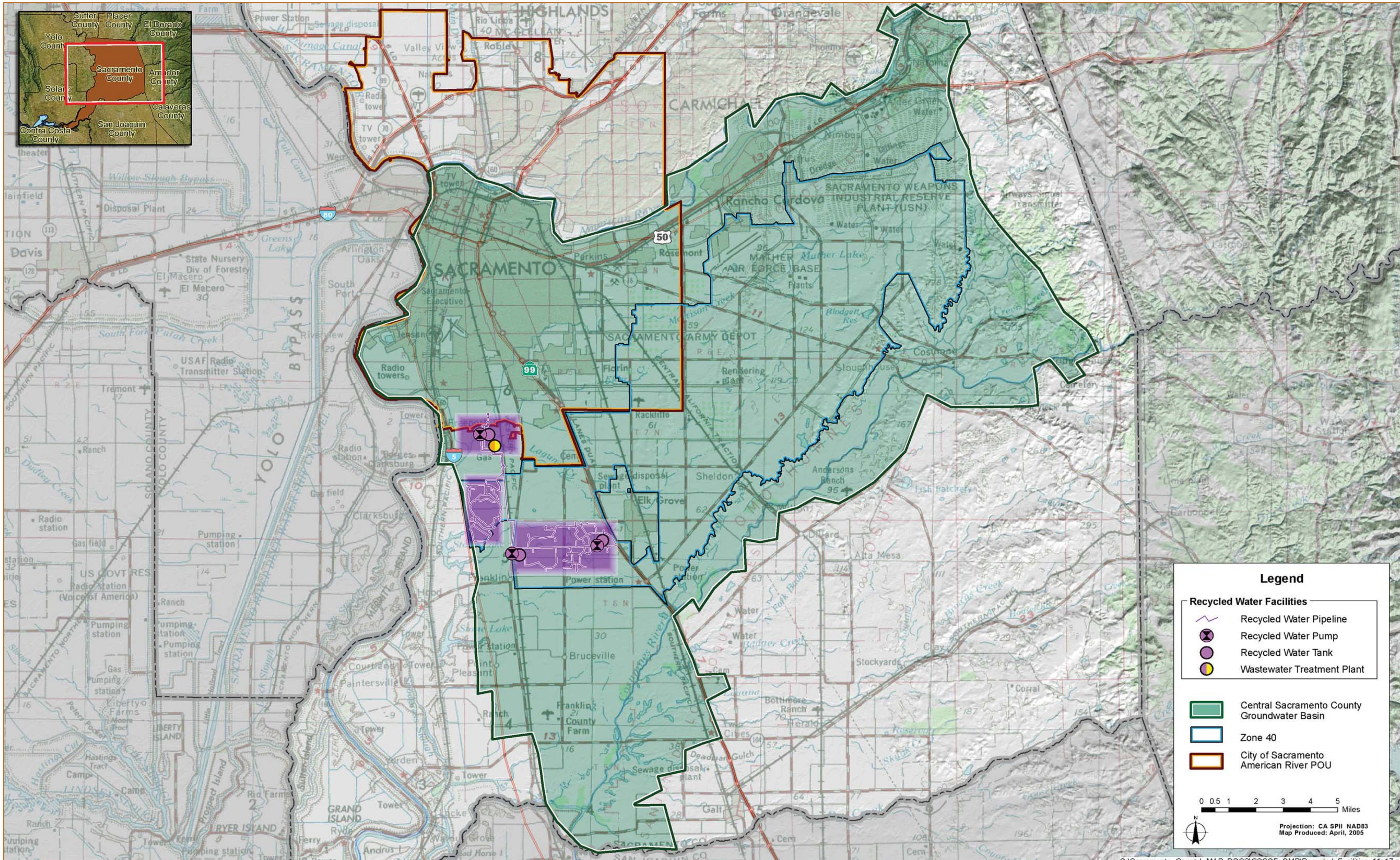
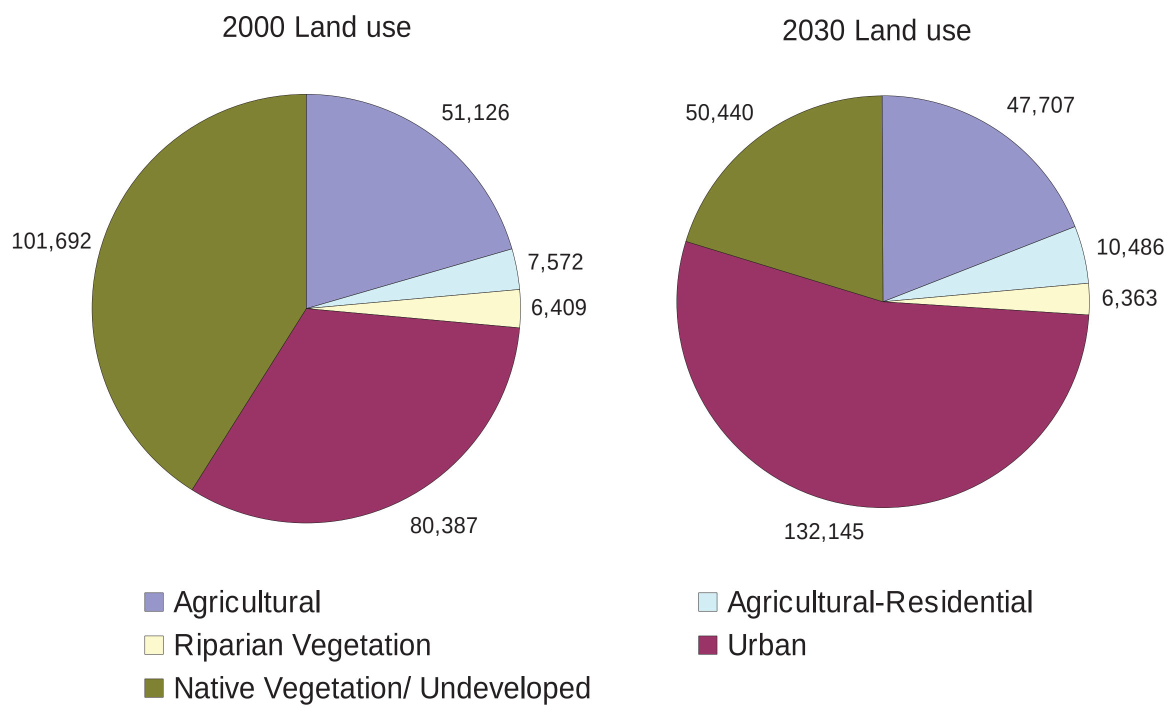


Figure 2-22. 2000 and 2030 Distribution of Land Uses in the Central Basin (acres)



2.5.2 Water Demands

Development of water demand information is important in describing the overall balance between available water supplies (i.e., surface water [see **Section 2.2**], groundwater [see **Section 2.3**], recycled water [see **Section 2.4]**) and demand. Water demand estimates are based on the land use data described above with refinements for land use differences in the urban category. These estimates are reported in four main categories: urban demands, agricultural demands, agricultural-residential demands, and environmental demands. Demands in these categories are calculated separately due to differences in land use and water application and the resulting variation in the amount of deep percolation and surface water runoff of applied irrigation and rainfall that can occur. **Figure 2-25** and **Figure 2-26** presents 2005 and 2030 estimated long-term average[11] water demands in the Central Basin. The bar chart shows an increase in annual water demands from 2005 to 2030 of approximately 70,000 AF in wet years and approximately 60,000 AF in dry years. Dry years have less of an increase due to water conservation.

2.5.2.1 Urban

An urban land use area is typically described being moderately to densely populated and provided with public services and infrastructure. In providing water service to an urban area, determining water demands includes the amount of water used both indoors and outdoors. In urban areas, water used indoors is discharged to a sewer collection system and then transported and treated at the Sacramento Regional WWTP. Treated effluent is then discharged either to the Sacramento River or diverted to the existing tertiary recycled water treatment plant to be reused to meet public and commercial irrigation needs in the Phase 1 recycled water service area.

Because water use practices change in urban areas as hydrologic conditions change over time, water use estimates require reviewing average water use over many

[11] Long-tern average estimates of water demand are developed based on a 74-year simulation using hydrologic condition data for the period 1922-1995. During each simulation run, land use remains unchanged at 2000 or 2030 levels of development.

years and then normalizing the water use to represent the design level of water use for water supply planning and facility designs.

Urban water demands also need additional refinement based on land use categories. Given the historical monitoring of water use for different land use categories, a separate water duty factor has been determined using statistical analysis of metered data for each of the major urban land use categories. Unit demand factors for each category are more fully described in a 1995 report completed for the Water Forum titled Estimate of Annual Water Demand within the Sacramento County-Wide Area (Boyle, 1995). This document is more commonly referred to as the Boyle Report.[12] The demand factors included in the Boyle Report are adjusted to reflect a 12 percent[13] conservation level in water demand for the 2000 level of development. The conservation factor used for 2030 urban water use is 25.6 percent, as per the WFA. After applying the conservation factors to each land use category, urban water demands at the 2005 (adjusted from the 2000 level of development are estimated as 202,292 AF/year, and 300,181 AF/year for the 2030 level of development. However in dry years, mandatory conservation efforts reduce these demands to 171,948 AF in 2005 and 255,154 AF in 2030.

2.5.2.2 Agricultural

No precise records of agricultural water demands in the Central Basin exist. However, agricultural water demands can be estimated through use of the Sacramento County IGSM, which can estimate consumptive crop water use. Using data for precipitation, crop acreage, soil moisture, field capacity, evapotranspiration, and irrigation efficiency, the Sacramento County IGSM calculates the estimated amount of applied water, how much water is consumptively used by the crop, and how much water enters the groundwater system. Long-term average annual water use is estimated at 163,454 AF per year for the 2005 level of development, which decreases to 133,275 AF per year for the 2030 level of development; this is a decrease in agricultural water use of an estimated 18 percent.

2.5.2.3 Agricultural-Residential

Agricultural-residential water demands are estimated using land use acreage and a demand factor of 1.44 AF/acre/year (Boyle Report, 1995). Since the Sacramento IGSM only reports urban and agricultural water uses, these two categories were used in combination to artificially reflect agricultural-residential uses by assigning 25 percent of the estimated agricultural-residential water demands to urban water use (2.7 AF/acre/year) and the remaining 75 percent to agricultural water use. The result for a typical 2-acre ranchette is approximately 1.4 AF/year assuming the agricultural portion is dry pasture (no applied water over 75 percent of the land area). Long-term average annual agricultural-residential water demands are estimated as 10,904 AF/year for the 2005 level of development, which increases to 15,100 AF/year for the 2030 level of development. Indoor water use is assumed to be a source of recharge to the groundwater basin through private septic and leach field systems.

2.5.2.4 Environmental Water

"Environmental water" has become a significant priority in the State's Water Supply Plan. One of the purposes of the CVPIA was to include water for the protection, restoration, and enhancement of fish, wildlife, and associated habitats. This effectively placed environmental water at the same level of priority as municipal, and possibly slightly higher than agricultural water uses.

While not discussed in the WFA, environmental water for the Cosumnes River is any water that provides ecosystem restoration or benefits along designated riparian areas. Discussions in previous sections described the interaction of the aquifer and the rivers, and the disconnect between the Cosumnes River and the regional aquifer. This disconnect caused late summer and fall flows in the river to recharge the groundwater basin, leaving no water in the river to support fisheries or riparian habitat. Unlike other water uses, environmental water use for the Cosumnes River is conceptual and

[12] Estimate of Annual Water Demand Within the Sacramento County-Wide Area (Boyle, May 1995)
[13] The 12 percent conservation value is prorated from the Water Forum's 25.6 percent level of conservation goal for 2030.

Figure 2-23. 2000 General Land Use in the Central Basin

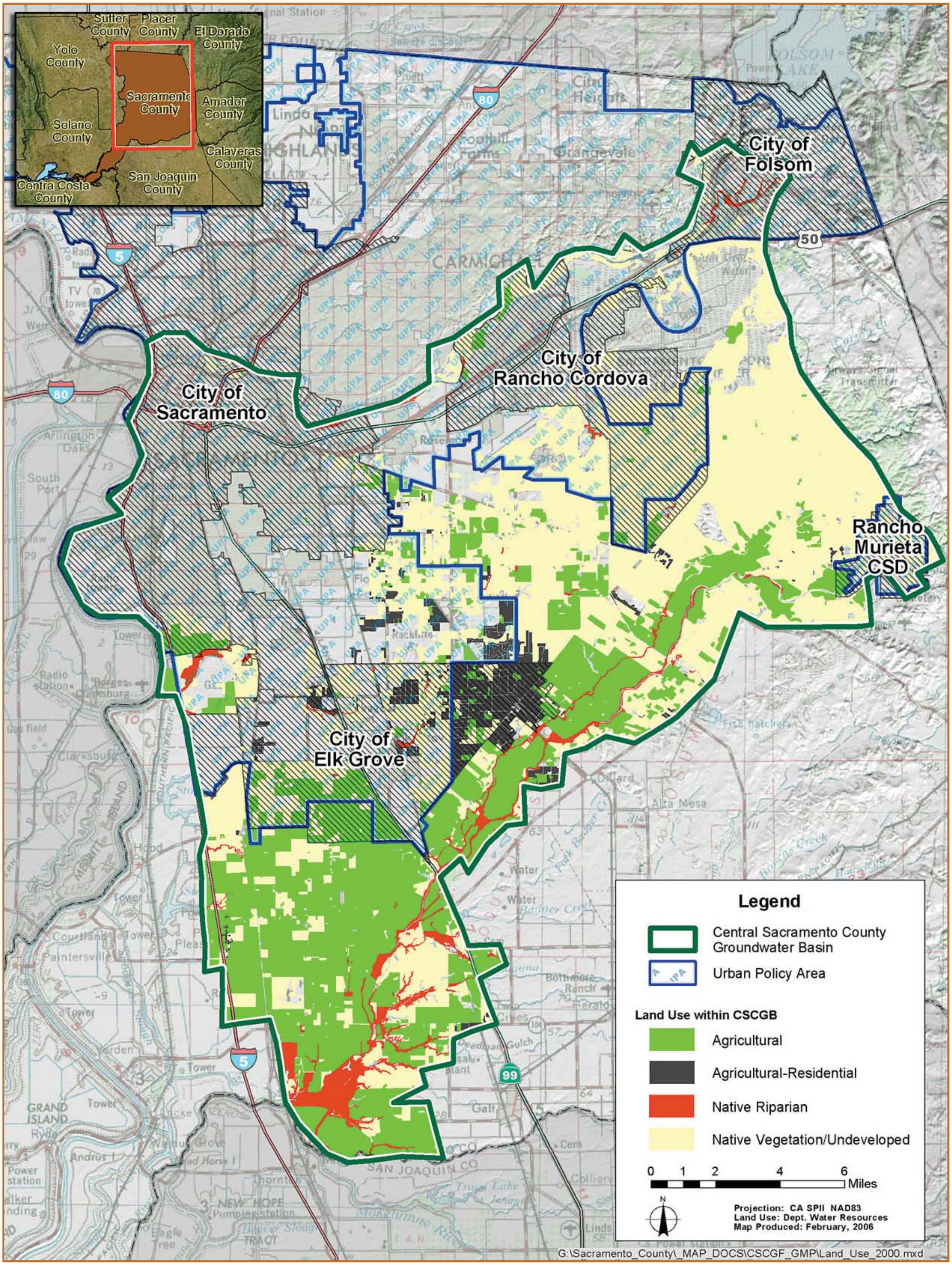
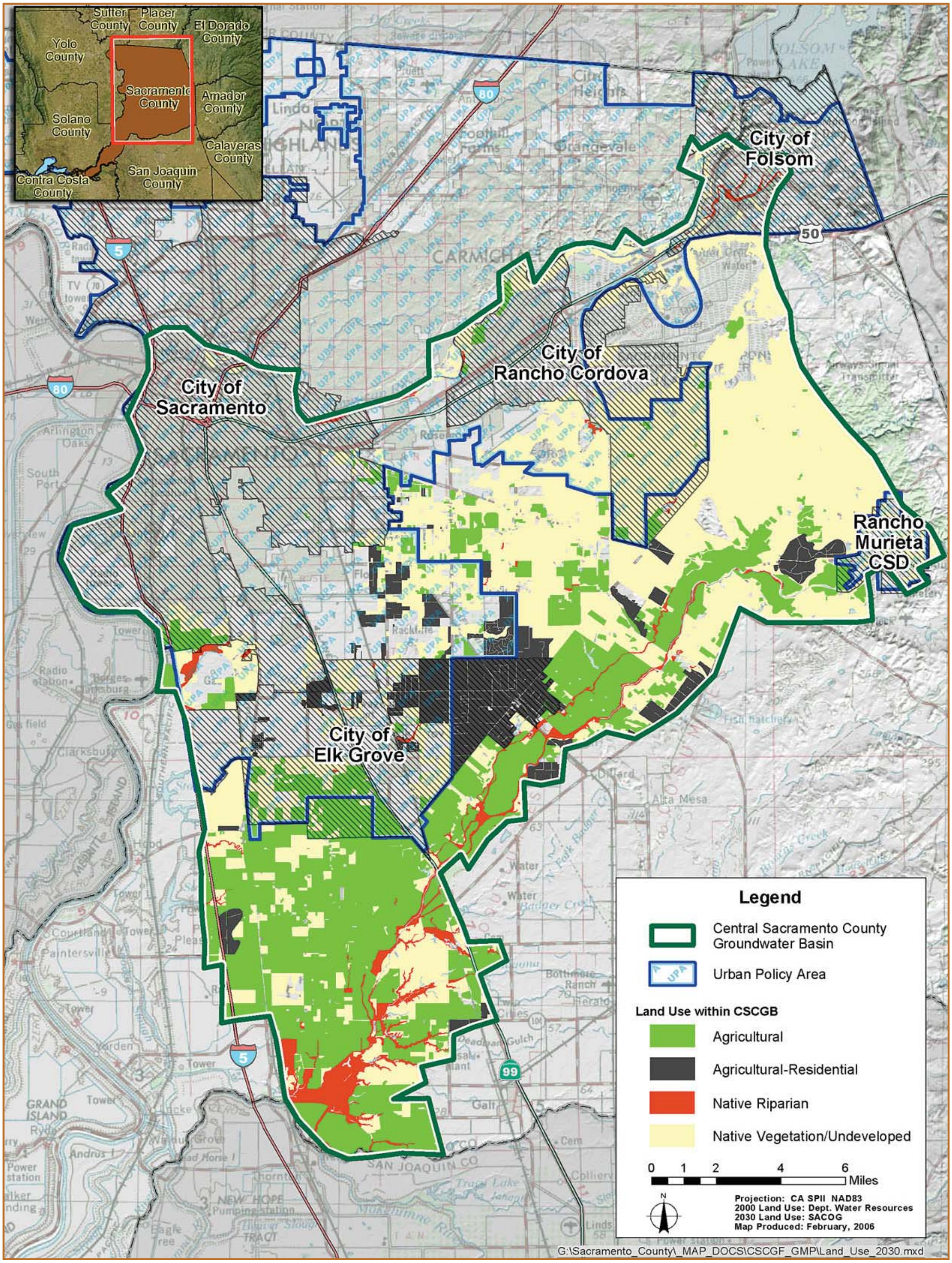


Figure 2-24. 2030 General Land Use in the Central Basin



subjective and is based on identifying problems and the amount of water needed to remedy the problems. For instance, water from the East Sacramento County Replacement Water Supply Project (see **Section 2.3.9**) provides a water supply during early fall to pre-wet the river prior to the first storm event to facilitate flow in the river when the first storm event occurs.

Environmental water requirements for other natural and restored streams in the area, such as the Upper Laguna Creek Multi-Functional Corridor, have not been defined. If environmental water needs are identified in the future they will be addressed by the basin governance body.

2.6 WATER BALANCE

In preceding sections, water supplies and demands were discussed based on information provided by participating water purveyors and information developed as part of the Water Forum process and the SCWA Zone 40 WSMP. Water supplies for the Central Basin come from surface water entitlements, groundwater, and recycled water. As shown in **Table 2-1**, the current estimated surface water entitlements for use in the Central Basin are 350,000 AF/year (assumes maximum availability of surface water in above normal to wet years, with no CVP reductions); the estimated long-term average groundwater pumping limit, as established by the WFA, is 273,000 AF/year; and the estimated recycled water supply is 4,400 AF/year. Therefore, the total estimated annual water supply for the Central Basin is 627,400 AF/year.

Current and projected future supplies and demands in the Central Basin also are shown in **Figure 2-25** and **Figure 2-26**. These demands are based on applied water for agriculture and delivered water for M&I use, which are greater than the actual amount of water consumed by these demand centers. For example, not all water applied to crops is used by the plants or evaporated – some of the water returns to the water supply, either through percolation to the groundwater table or through drainage return flow into the rivers. Similarly, not all of the water delivered to homes is consumed, as some of it flows through the sewer system (or leachfield) and some water used for landscaping percolates to the groundwater table. Although some modeling studies have been performed to help quantify the difference between applied/delivered water and consumed water, additional studies will be required (as discussed in the following sections of this report) prior to incorporating these data into Central Basin planning efforts.

Current and future water balances can be estimated by comparing supplies and demands for the Central Basin (**Figures 2-25** and **2-26**). Overall, the water balances show that supplies should be sufficient to meet both current and future demands to 2030. However, it is important to note that meeting water demands depends on more than simply having sufficient supplies. Meeting specific demands also requires the necessary infrastructure, as well as an appropriate institutional and political framework, to enable water resources in the Central Basin to be delivered and managed in a sustainable manner. In some cases, existing and future water wholesale agreements between various water purveyors will be necessary to move surface water supplies throughout the Central Basin[14]. Given the anticipated growth and potential environmental needs of the Central Basin, significant new infrastructure will be required as identified in the various water supply master plans for water purveyors with boundaries that lie within the Central Basin. The following chapters of this report present groundwater management objectives for the Central Basin and the programs and policies that will be developed to achieve these objectives.

[14] This specifically applies to purveyor areas within the City of Sacramento's American River POU and purveyor areas within Zone 40. See individual water supply master plans for the City of Sacramento and Zone 40 for specific information on how much water is planned for wholesale to affected water purveyors.

Figure 2-25. Annual Average Water Balance for the Central Basin - 2005 Water Balance

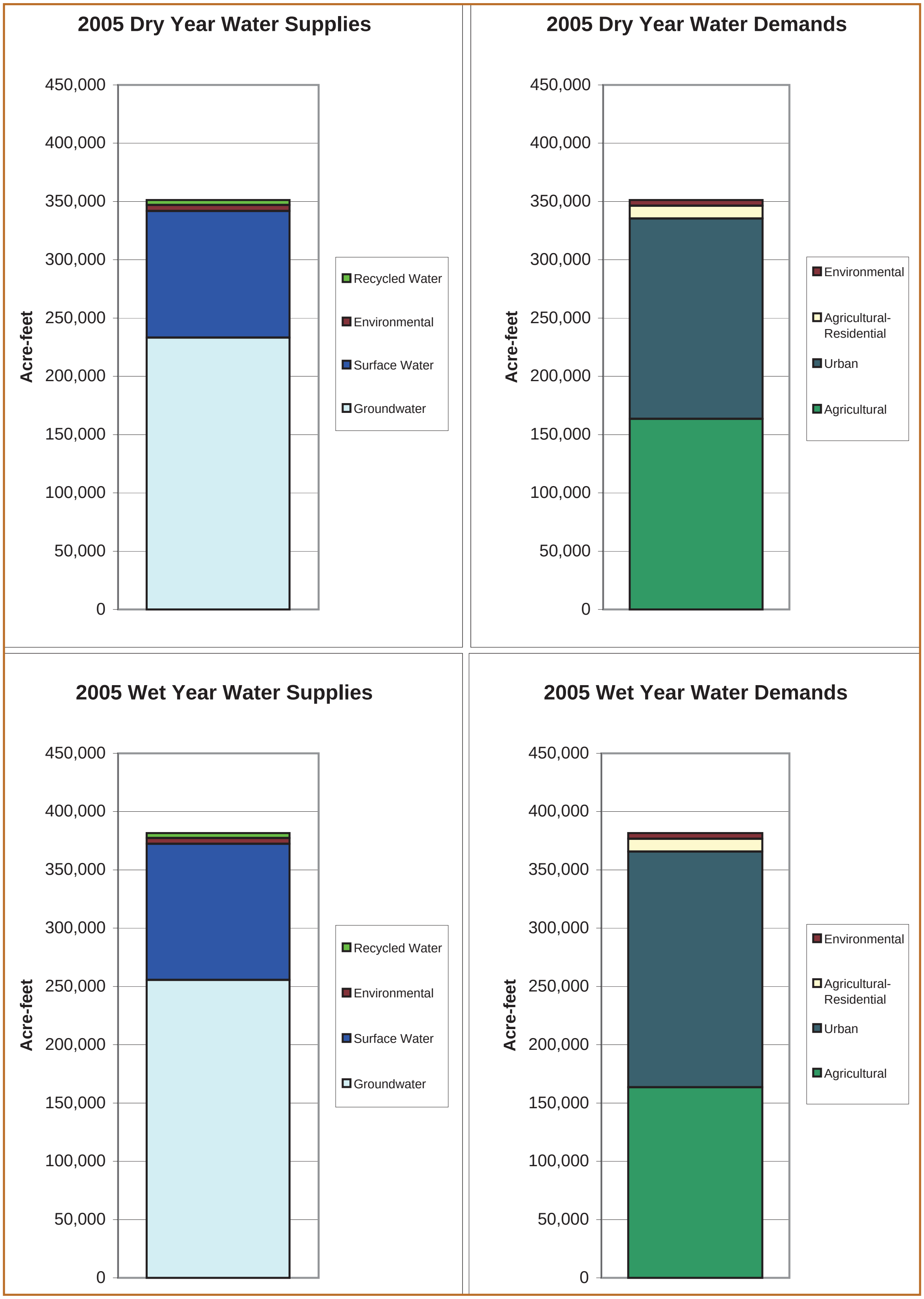
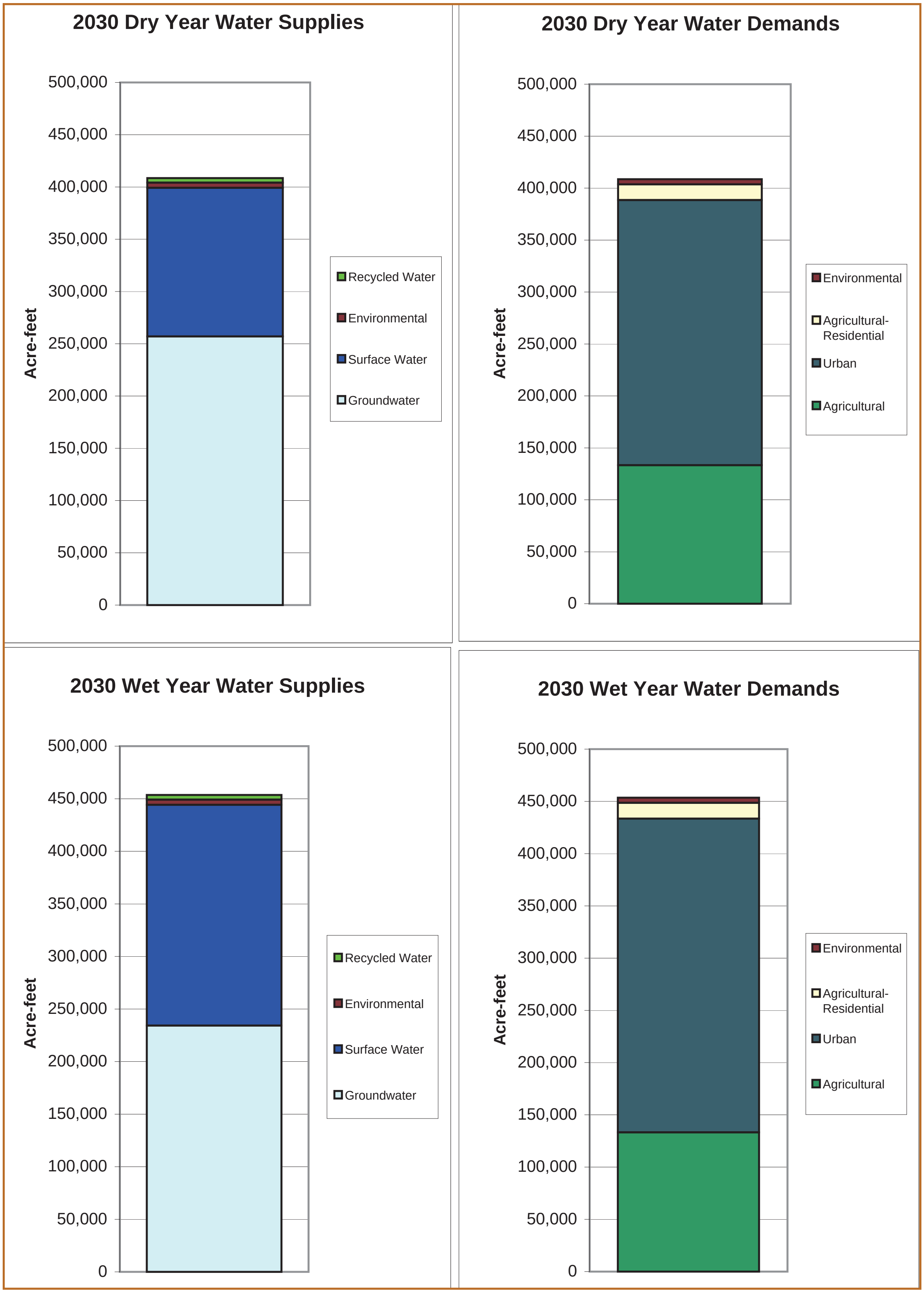
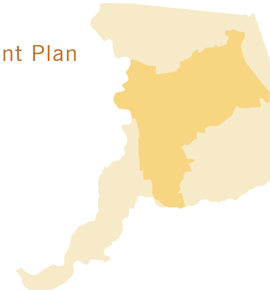


Figure 2-26. Annual Average Water Balance for the Central Basin - 2030 Water Balance



Management Plan Elements



Section 3

Management Plan Elements

This section discusses five BMOs proposed for the Central Basin based on feedback from basin stakeholders. Each BMO focuses on managing and monitoring the basin to benefit all groundwater users in the basin. The five BMOs are intended to be specific enough to result in numerical criteria for the basin, but also able to be modified or adapted to new information on groundwater basin behavior over time (as monitoring data are collected).

3.1 INTRODUCTION

A BMO has four main characteristics: 1) specific, measurable criteria that can be scientifically collected and established, 2) a clearly defined monitoring program that validates the BMO's performance, 3) a reporting method for monitoring data that identifies success or problems with the groundwater basin using early warning detection, and 4) programs that are available to remedy a problem in the groundwater basin, if one is determined to exist.

BMOs should have sufficiently specific numerical criteria so that implementation of the plan, through its monitoring and management programs, is scientifically defensible. For example, a BMO might have a criterion that groundwater elevations should not fall below 100 feet below ground surface in any location within a basin. A monitoring program could then be developed to measure groundwater elevations at key locations in the basin twice a year. These data would be entered into a database management system (DMS) that compares measured results to the BMO criterion to determine performance. A report would be generated to allow the governance body of the groundwater basin to evaluate the data, make a judgement on the level of concern, and, if needed, perform certain functions to remedy the problem (i.e., implement specific programs).

Because hydrologic and land use conditions change from year to year and exert differing stresses on aquifers, a remedy may or may not be applied in the area where a problem occurs. A good example is the regional cone of depression in the Central Basin. The regional cone is influenced by pumping throughout Sacramento County, including the North and South basins to a certain degree. Therefore, a problem in one management area may require actions in another management area(s) as a remedy.

3.1.1 BMO No. 1. Maintain the long-term average groundwater extraction rate at or below 273,000 AF/year.

The concept of "long-term average pumping limit" is discussed in **Section 2.3.5** and **Appendix A**. The CSCGMP defines "long-term average" as the average groundwater extraction from the basin calculated over a period of time. Said period of time commencing at the time of adoption of the CSCGMP to when the calculation is made. Each new year of data is added to the next and then averaged over the entire period of record. Agricultural groundwater extractions will be estimated based on land use and crop type every five years using DWR Land Use Surveys. Agricultural estimates remain constant for the five year period, unless specific information from this extraction amount is known during the respective 5-year intervals. An interpolation method also may be considered to adjust agricultural extractions in the intervening years.

For example, 2000 groundwater basin extraction data will be added to 2001 extraction data, which will be added to 2002 extraction data, etc., with urban extractions changing monthly and agricultural and other private well extractions likely changing only once every five years. The "long-term average" is the average of the total extraction over the period of record (i.e., 2000 to 2002 in this example).

The reason for using average groundwater extraction is that aquifer recharge varies depending on groundwater elevations. This variation stems from the effect the slope of the peizometric surface of the groundwater has on the natural recharge taking place from the rivers and subsurface inflow to the basin. The Water Forum recognized this variation when it selected 273,000 AF/year as an acceptable long-term average annual groundwater extraction rate. This decision recognized that the groundwater basin can be managed and maintained, on average, at an extraction rate that does not present undo risk to private and public well owners by dewatering wells, degrading water quality, creating ground subsidence, and adding cost to pumping groundwater from lower elevations.

3.1.2 BMO No. 2. Maintain specific groundwater elevations within all areas of the basin consistent with the Water Forum "solution"

Over time, extensive groundwater extraction by agriculture and more recently urbanization, have resulted in a persistent cone of depression in the southern Central Basin area. With the recent fallowing of some agricultural lands and importation of surface water into Zone 40, groundwater elevations at or near the cone of depression have stabilized and in some areas have recovered (see Hydrograph SWP-058 in **Figure 2-18A**). However, Water Forum studies indicate that with continued growth, coupled with dry hydrologic conditions, groundwater elevations can decrease to a point where adverse impacts may be seen. These impacts will occur to all groundwater users, ranging from increased energy costs to the need to deepen existing private and public wells or even constructing new wells.

As more surface water is delivered to users in the Central Basin by SCWA, the City of Sacramento, and other jurisdictions, groundwater elevations in the basin will rise in some areas of the basin more than others. Construction of SCWA Zone 40's Central WTP and interties with the City will provide the means to deliver more surface water to the basin and will allow the urbanized service area of Zone

40 to reduce groundwater extractions significantly. As urbanization proceeds according to the various land use authorities (the Cities of Sacramento, Elk Grove and Rancho Cordova and Sacramento County) General Plans, full implementation of the Zone 40 conjunctive use program will occur. As a conjunctive use program relies on the availability of surface water and groundwater during different hydrologic years full implementation of the program may result in a short-term drawdown in groundwater elevations below previous historical levels (this is a result of additional groundwater extraction during the drier and driest years). The intent of this BMO is to quantify overall groundwater elevations within the basin and to maintain an acceptable "operating range" for groundwater elevations throughout the basin.

A methodology for developing specific objectives to manage groundwater elevations requires a systematic, repeatable, and scientific basis. This methodology must define areas within the basin that are sufficiently distinct in hydrogeology, land use, groundwater and surface water use, and share some of the same institutional realities. The term "institutional reality" is defined as the ability of various jurisdictions or water purveyors to work together to develop and implement a program for a specific purpose. For example, an institutional reality might be the ability to implement a conjunctive use program involving all water purveyors having jurisdiction within the City's American River POU. Developing a program like this requires gaining the trust and commitment of the purveyors involved prior to establishing this area as a focus for management activities that would involve the higher use of POU water. The approach laid out below is intended to assist in the selection of areas that are sufficiently distinct and share many of the same goals and objectives.

An operating range for groundwater elevations in the basin has been developed by the Water Forum that define the upper and lower groundwater elevation threshold that will minimize the impacts stated above. For the range in values, two groundwater contour maps are provided in **Figure 3-1** and **Figure 3-2**. A polygon grid overlying the basin is used to implement and report on this BMO as shown in **Figure 3-3**. Each polygon is a 5 square mile management unit with lower and upper elevation attributes according to **Figure 3-1** and **Figure 3-2**, respectively. Monitoring wells are assigned to one or more polygons to compare actual groundwater elevations to the two reference points assigned to the polygon. In areas where there are insufficient wells to assign a single well to each polygon, a nearby well may be used as a surrogate until the basin governance body has either identified an existing monitoring well or constructs a new well for monitoring purposes. Achieving one well per polygon will take place over time as various priorities are satisfied and sufficient funding becomes available. A full discussion on the use of polygons is provided in **Appendix B**.

3.1.3 BMO No. 3. Protect against any potential inelastic land surface subsidence by limiting subsidence to no more than 0.007 feet per 1 foot of drawdown in the groundwater basin

Land subsidence can cause significant damage to essential infrastructure. Historic land surface subsidence within the Central Basin has been minimal, with no known significant impacts to existing infrastructure. Given historical trends, the potential for land surface subsidence from groundwater extraction in the Central Basin appears to be remote. However, the basin governance body intends to cooperate with adjacent groundwater management agencies such as SGA to monitor for potential land surface subsidence. If inelastic subsidence is documented in conjunction with declining groundwater elevations, the basin governance body will investigate and take appropriate actions to avoid adverse impacts. A limit of 0.007 feet per 1 foot of groundwater decline along survey control lines is considered to be the threshold at which implementation of mitigation programs may need to be implemented by the basin governance body.

Figure 3-1. Groundwater Elevation Contours for Lower Threshold

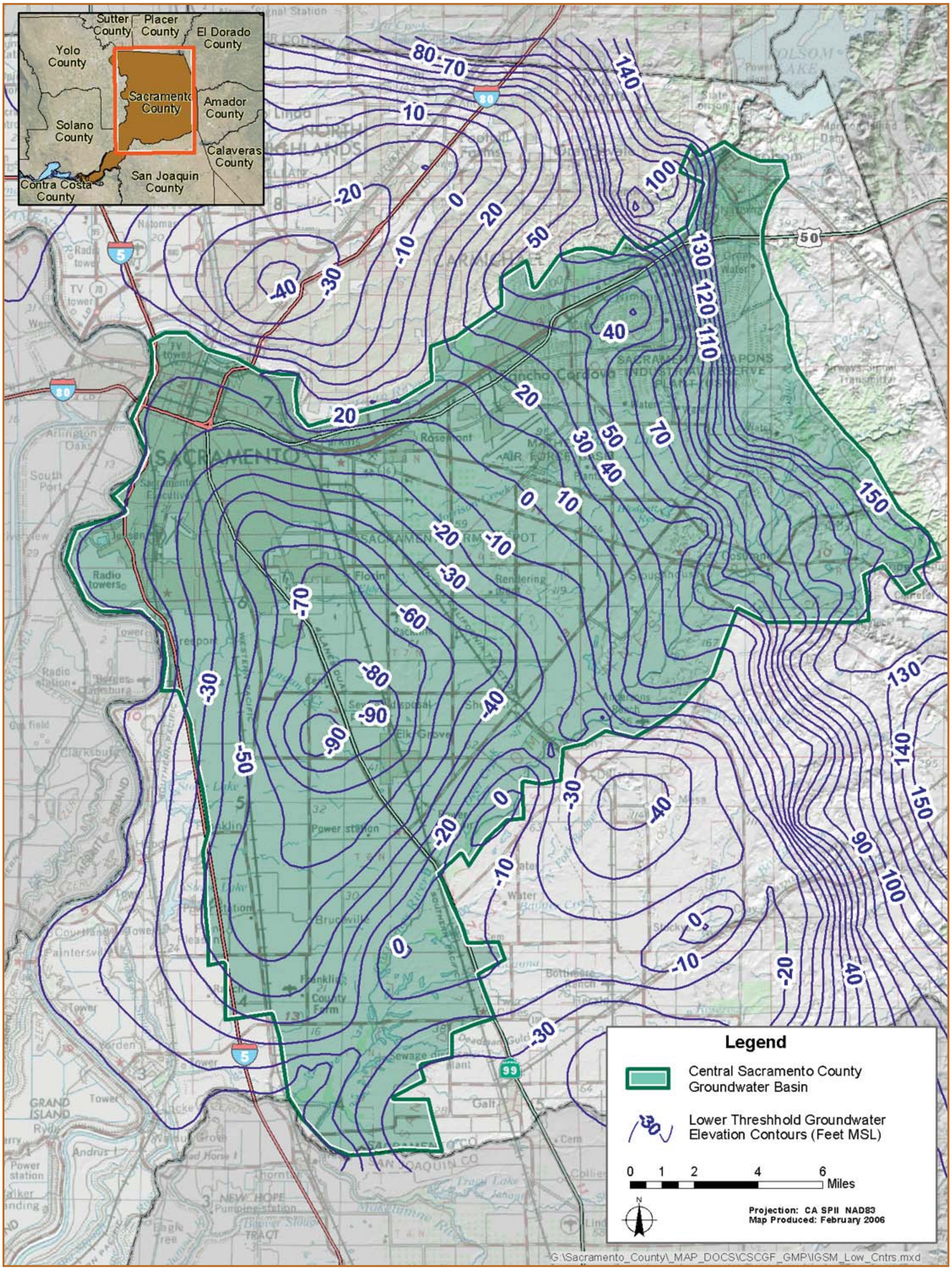


Figure 3-2 Groundwater Elevation Contours for Upper Threshold

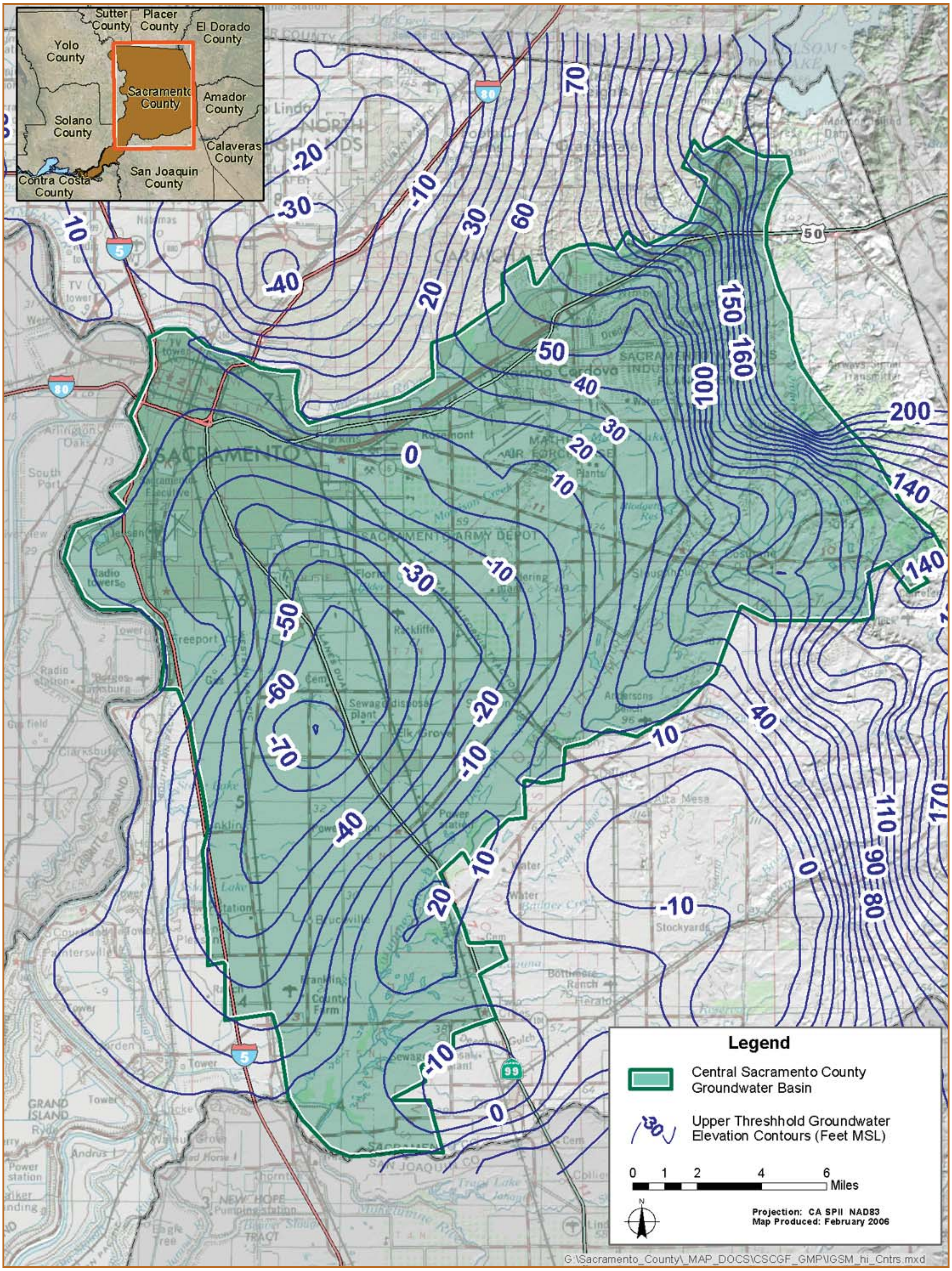
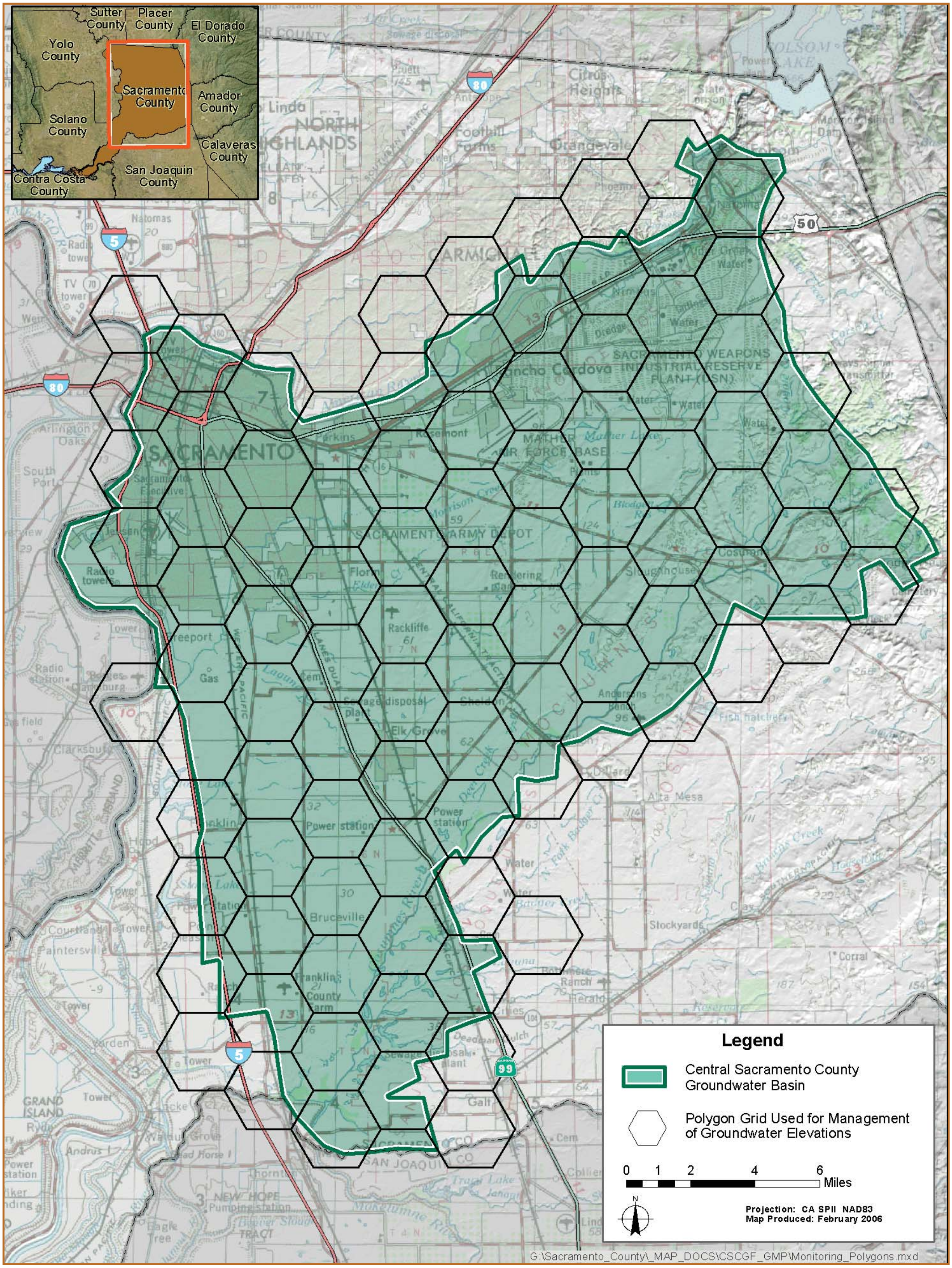


Figure 3-3 Polygon Grid Used for Management of Groundwater Elevations



3.1.4 BMO No. 4. Protect against any adverse impacts to surface water flows in the American, Cosumnes, and Sacramento rivers

Among other important uses, the American, Cosumnes, and Sacramento rivers provide habitat for a variety of fish and wildlife species. The basin management body is committed to the objectives of the WFA, which include preserving the fishery, wildlife, recreational, and aesthetic values of the lower American River. Important elements of the WFA include commitments to reduce lower American River diversions during dry years and to not exceed the agreed on long-term average annual groundwater extraction of 273,000 AF/year. In addition, the CSCGMP incorporates monitoring and evaluation data in cooperation with SGA and others (if any) between groundwater pumping and adjacent river or stream flows.

The CSCGMP also includes goals to restore and preserve the fishery, wildlife, recreational, and aesthetic resources of the lower Cosumnes River and to assure a stable supply of water for agriculture in the lower Cosumnes River floodplain area. Another goal is to protect against adverse impacts to water quality resulting from interaction between groundwater in the basin and surface water flows in the American and Sacramento rivers. In most natural settings, groundwater is higher in TDS than most other constituents found in surface water. At the present time, the flow regime is such that groundwater is not discharging to the river systems (i.e., rivers within the Central Basin are termed as losing streams to the groundwater). It is possible that future actions could temporarily alter that condition. It is the intent of the CSCGMP that controllable operations of the groundwater system would not negatively impact the water quality of the area's rivers and streams. The basin governance body will seek to gain a better understanding, in cooperation with SGA and others, of the potential impacts of discharging local area groundwater to major rivers adjacent to the Central Basin.

The basin governance body shall coordinate with other responsible regional, county, and local agencies to ensure that surface water flows in the other natural and restored streams in the area are not adversely impacted as a result of implementation of the CSCGMP.

3.1.5 BMO No. 5. Water quality objectives

The following are water quality goals for the Central Basin:

1. Total Dissolved Solids (TDS) concentration of less than 1,000 mg/l

   The Central Basin is currently not threatened by salinity intrusion typically equated to concentrations of TDS from boundary influences. The upwelling of poor quality water from depths exceeding 2,000 feet is of primary concern and is typically addressed by constructing wells in a way that prevents poor quality water from reaching potable drinking water supplies. Monitoring of TDS is not only for detecting potential salinity intrusion from the deeper aquifer but also as a possible surrogate for other problems that may be occurring in the aquifer system such as naturally occurring salts or minerals that may pose a health risk.

   TDS is considered by DHS to be an aesthetic quality falling under the category of a Secondary Drinking Water Standard. The existing requirement for privately owned wells to collect this type of data at least once (a one-time monitoring requirement) was established some years ago to provide DHS staff with sufficient information to determine whether the water quality would be within an acceptable range for drinking purposes. "Acceptable" is a subjective term; however, DHS staff have sufficient field experience to identify sources that would be likely to pose problems (e.g., avoidance by consumers), even for nonresident consumers.

   Currently DHS lists a Secondary MCL for TDS of 1,000 mg/l. For purposes of the CSCGMP, this value will be used for purposes of taking action.

2. Nitrate (NO3) concentration of less than 45 mg/l

   The Central Basin has many land use types, and differing types of sewage disposal and agricultural fertilizer application. These activities could cause nitrates to be introduced into the groundwater. DHS has set the Primary Drinking Water MCL for nitrate at 45 mg/l. Under this GMP, this should apply to both privately and publicly owned wells.

3. Volatile Organic Compounds (VOC)

   Various sources of VOCs exist within the basin including old landfills, wrecking yards, military bases, and research and development facilities. Significant concern exists regarding the movement of these compounds from the vadose or unsaturated zone to the saturated zone or aquifer. Once these compounds are mobilized in groundwater, their movement will depend on many different factors one of which could be management activities within the basin. A need exists to monitor VOC migration within the basin for the protection of public and private wells. A concentration limit is not identified for VOCs given that many constituents fall under this category. Any measurable trace of VOC in a private or public well should be considered significant and action should be taken in accordance with the programs identified in the CSCGMP and by the regulatory agencies having jurisdiction in addressing VOC contamination.

3.2 PROGRAM COMPONENT ACTION ITEMS

There are five program components with action items to assist in meeting the BMOs. They are as follows:

1. Stakeholder involvement
2. Monitoring program
3. Groundwater resource protection
4. Groundwater sustainability
5. Planning Integration

These components are described further in the following sections.

3.2.1 Component No. 1: STAKEHOLDER INVOLVEMENT

Management actions taken by the basin governance body may impact a broad range of individuals and agencies that have a stake in the successful management of the basin. Customers of the water purveyors may be most concerned about water rates or assurances that each time the tap is turned on a steady, safe stream of water is available. Industrial, agricultural, or agricultural-residential well owners will want their wells to be protected from dewatering, water quality degradation, and significantly higher energy costs. Furthermore, the degree to which the basin can achieve local supply reliability provides an opportunity to advance banking and exchange programs that could support state and federal water programs in meeting other water needs, particularly in drier years.

The basin governance body will pursue several means of achieving broad stakeholder participation in the management of the Central Basin including: 1) involving the public, 2) involving other agencies within and adjacent to the Central Basin, 3) using advisory committees, 4) developing relationships with state and federal water agencies, and 5) pursuing a variety of partnership opportunities.

3.2.1.1 Involving the Public

Groundwater in California is a public resource, and the basin governance body is committed to involving the public in implementing the CSCGMP. In accordance with CWC § 10753.2, a public hearing was held and a Resolution of Intent (WA-2590) to prepare a groundwater management plan for the Central Basin was adopted by the Board of Directors of the SCWA on April 19, 2005. Upon adoption of the resolution, the text of the resolution was published in the Sacramento Bee on April 27, 2005 and May 4, 2005 (**Appendix C**).

Development of the CSCGMP included representatives of interested basin stakeholders (see **Section 1.3**). Upon completion of the CSCGMP all required public notification will be made prior to adoption of the document by the basin governance body (note that this action may take place several months after completion of the GMP because the governance body will not be formally established until the fall of 2006. Within six months of adoption, the basin governance body, with the assistance of an advisory committee, will develop a Public Outreach

Plan (POP). The POP will include strategies for communicating with both internal and external audiences during implementation of the CSCGMP.

The Water Forum has posted on its web site (http://www.waterforum.org) a copy of the CSCGMP. The Water Forum will continue to use its web site to distribute information on CSCGMP implementation activities to the public until the basin governance body's web site is operational. The basin governance body will create a public outreach web site within one year of the adoption of the CSCGMP. Copies of the CSCGMP and the POP will be posted on this site.

Actions. The basin governance body will take the following actions:

- Continue efforts to encourage public participation in the implementation process as opportunities arise.
- Provide public notice and public comment periods on formal revisions to the CSCGMP.
- Develop a POP and periodically review the POP and take actions as appropriate while implementing the CSCGMP.
- Provide briefings to the Water Forum Successor Effort on CSCGMP implementation progress.
- Maximize outreach on CSCGMP activities including the use of the Water Forum web site and in the future a web site sponsored by the basin governance body.

3.2.1.2 Involving Other Agencies Within and Adjacent to the Central Basin

As was mentioned previously, development of the CSCGMP involved the participation of a number of different stakeholders. A list of the stakeholder groups can be found in **Section 3.2.1.3**. This list of participants does not cover all interests both within and adjacent to the basin that may be affected by implementation of the CSCGMP. Once implementation of the CSCGMP begins, the basin governance body will be responsible for informing and involving agencies and stakeholders in the activities conducted under the plan.

One interest inside the Central Basin is the Air Force Real Property Agency (AFRPA), which oversees remediation efforts of contaminated soil and groundwater at Mather Field. As a stakeholder and water purveyor at Mather Field, SCWA has had ongoing dialog both with the County of Sacramento Department of Economic Development and the AFRPA to discuss issues related to land use, wellhead protection, groundwater management, and remediation efforts at Mather Field.

Outside interests include SGA which adopted a groundwater management plan that covers the organized municipal water purveyors in north Sacramento County in December 2003. Other adjacent interested agencies and stakeholders include SSCAWA and TNC, which owns and maintains wetlands and agricultural lands along the Cosumnes River corridor. Representatives from SSCAWA and TNC participate as stakeholders in the CSCGF negotiations and in preparation of the CSCGMP.

Actions. The basin governance body will take the following actions:

- Maintain a high level of involvement by stakeholders in implementing the CSCGMP by continued participation with the various stakeholder groups described above.
- Provide copies of the adopted CSCGMP and subsequent annual reports to representatives of SGA, SSCAWA, TNC, CSCGF, San Joaquin County, and the Water Forum Successor Effort.
- Meet with representatives from SGA, SSCAWA, TNC, CSCGF, and the Water Forum Successor Effort, as needed.
- Coordinate meetings outside the CSCGF with agricultural and agricultural-residential self-supplied pumpers within the basin
- Coordinate meetings with self-supplied pumpers within the basin to inform them of the management responsibilities and activities relative to this plan.
- Coordinate CSCGMP activities and work to the extent practicable with adjacent groundwater management entities, water interest groups, and state and federal regulatory agencies that have jurisdiction in areas related to CSCGMP activities.

3.2.1.3 Using Advisory Committees

The CSCGF and the basin governance body will use advisory committees in developing and implementing the CSCGMP.

Prior to beginning development of the CSCGMP, a task force made up of stakeholders in the CSCGF was named as the Advisory Committee to guide development of the CSCGMP. The Advisory Committee formed a Project Management Team (PMT) to develop the CSCGMP and to present and solicit comments from the Advisory Committee on a monthly basis. The Advisory Committee updated the CSCGF on a quarterly basis during development of the CSCGMP.

The groups represented on the CSCGMP Advisory Committee included:

- Agricultural residential users
- Building Industry Association
- Cal-Am Water Company
- California Department of Water Resources
- City of Elk Grove
- City of Folsom
- City of Rancho Cordova
- City of Sacramento
- Elk Grove, Sacramento Metropolitan, and Rancho Cordova Chambers of Commerce
- Elk Grove Water Service
- Golden State Water Company
- League of Women Voters
- The Nature Conservancy
- Omochumne-Hartnell Water District
- Sacramento County
- Sacramento County Farm Bureau
- Sacramento County Water Agency
- Sacramento Regional County Sanitation District
- Southgate Recreation and Parks District
- Water Forum

Action. The basin governance body will take the following action:

- Following adoption of the CSCGMP, the basin governance body will discuss the continuation and composition of advisory committees that will provide guidance in the implementation of the plan.

3.2.1.4 Developing Relationships with State and Federal Agencies

Working relationships between the basin governance body and local, state, and federal regulatory agencies are critical in developing and implementing the various groundwater management strategies and actions detailed in the CSCGMP.

The PMT has established working relationships with local, state, and federal regulatory agencies (e.g., EMD, DHS, EPA, etc.) in the process of developing the CSCGMP.

Action. The basin governance body will take the following action:

- Continue to develop and establish working relationships with local, state, and federal regulatory agencies, as appropriate.

3.2.1.5 Pursuing Partnership Opportunities

The basin governance body is committed to facilitating partnership arrangements at the local, state, and federal levels. Over the past decade, the Sacramento area water community and other local leaders have made great strides in regional planning and collaboration on water issues. The WFA, which involved over 40 stakeholders and seven years of facilitated discussions, resulted in a regional framework to balance the competing demands for increased use of surface and groundwater with the environmental needs of the lower American River through 2030. Several important partnerships have been formed to implement the WFA as well as to provide benefits to water agencies, their customers, and other groundwater users. For example, SCWA, TNC, and SSCAWA are working cooperatively to enhance stream flows in the Cosumnes River.

While facilities necessary to implement and expand conjunctive use programs in the Central Basin have been identified in **Section 2**, the potential exists to expand these facilities on a basin-wide level to achieve broader regional and statewide benefits. These facilities, however, would require substantial resources. To investigate any further opportunities would require resources provided through partnerships with potential beneficiaries.

Actions. The basin governance body will take the following actions:

- Continue to promote partnerships that accomplish both local supply reliability and broader regional and statewide benefits.
- Continue to track grant opportunities to fund groundwater management activities and local water infrastructure projects.

3.2.2 Component No. 2: MONITORING PROGRAM

This section describes a monitoring program that is capable of assessing the current status of the basin, and predicting responses in the basin as a result of future management actions. The program includes monitoring groundwater elevations, monitoring groundwater quality, monitoring and assessing the potential for land surface subsidence resulting from groundwater extraction, and developing a better understanding of the relationship between surface water and groundwater along the American, Cosumnes, and Sacramento rivers. Also important is establishing monitoring protocols to ensure the accuracy and consistency of data collected. Finally, the monitoring program includes a tool (DMS, a.k.a. SHEDTOOL) for assembling and assessing groundwater-related data.

3.2.2.1 Groundwater Elevation Monitoring

The PMT has compiled a significant amount of historical groundwater level data measurements, extending from prior to 1950 through 2003, for the basin. Sources of this data include the following:

- DWR/SCWA
- USGS
- SMUD

DWR and SCWA have a program that collects biannual (spring and fall) groundwater level data from more than 150 wells throughout Sacramento County. SCWA uses these data to generate biannual groundwater contour maps for the county. However, because wells have been added and dropped from the program over time, it is difficult to compare a historic contour map with a recent one. For this reason, SGA, SCWA, and the basin governance body are establishing a standardized network of wells that combines those monitored by DWR, SCWA, SGA member water purveyors, and other sources. It is the intent of these parties that the wells comprising this program be maintained as a consistent long-term network that represents overall groundwater elevation conditions in the basin. **Appendix B** shows the wells currently proposed for this network. The wells were selected to provide uniform geographic coverage and are located in a series of polygons that cover the entire Central Basin.

The resulting grid, shown in **Appendix B**, includes approximately 90 polygons roughly about five square miles each. The proposed set of monitoring wells was selected from the DMS to represent water levels for as many polygons as possible. Individual wells were selected by the following methods:

- Giving preference to wells currently in DWR's and SCWA's monitoring program. These wells were selected because (1) they have long records of historic groundwater level data and are useful in assessing trends within the groundwater basins, (2) uniform protocols were used in measuring and recording the water level data, and (3) these are typically non-producing wells, so water level readings represent relatively static levels.
- Identifying other municipal and private wells with well construction information and long records of groundwater level data and giving preference to those wells with the lowest recent extraction volumes.

Actions. Additional actions by the basin governance body will include:

- Coordinate with DWR and others to identify an appropriate group of wells for monitoring for a spring 2007 set of groundwater elevation measurements.
- Coordinate with DWR and others to ensure that the selected wells are maintained as part of a long-term monitoring network.
- Coordinate with DWR to ensure that the timing of water level data collection by other agencies coincides within one month of DWR and SCWA data collection (currently DWR and SCWA collect water level data in the spring and fall).
- Coordinate with other agencies to ensure that needed water level elevations are collected and verify that uniform data collection protocols are used among the agencies.
- Coordinate with USGS to determine the potential for integrating USGS monitoring wells constructed for the NAWQA program into the SCWA and SGA monitoring network.
- Consider ways to fill gaps in the monitoring well network by identifying suitable existing wells or identifying opportunities for constructing new monitoring wells.
- Assess annually groundwater elevation trends and conditions based on the monitoring well network.
- Assess annually the adequacy of the groundwater elevation monitoring well network.
- Identify a subset of monitoring wells that will be monitored more frequently than twice annually to improve understanding of aquifer responses to pumping throughout the year.

3.2.2.2 Groundwater Quality Monitoring

Because many of the wells in the basin are used for public water supply, an extensive record of water quality data is available for most wells. Water purveyors have compiled available historic water quality data for constituents monitored as required by DHS under CCR Title 22. Sources of water quality data include the following:

- DWR
- Central Basin water purveyors
- USGS

This level of monitoring is sufficient under existing regulatory guidelines to ensure that the public is provided with a safe and reliable drinking water supply. Ultimately, it may be advisable to have in place a network of shallow (less than 200 feet deep) sentry wells to serve as an early warning system for contaminants that could make their way to greater depths in the basin where groundwater purveyors primarily extract groundwater. SCWA has been working with AFRPA to identify a subset of the sentry wells located in and around the Mather Field for integration into this monitoring effort. The basin governance body along with SCWA will also coordinate with EPA and the RWQCB, which oversees Aerojet and Boeing's remediation efforts and with EMD for the LUST cleanup efforts, to identify existing dedicated monitoring wells in the basin.

CCR Title 22 water quality reporting is required by DHS for each public drinking water source within the Central Basin. The Central Basin monitoring network includes these wells. The water quality monitoring well network may be expanded to include additional DWR, USGS, Mather Field, Aerojet, Boeing, RWQCB, and privately owned wells based on the outcome of coordination meetings with these agencies, businesses and various land owners.

Actions. The following actions will be taken by the basin governance body:

- Coordinate with cooperating agencies to verify that uniform protocols are used when collecting water quality data.
- Coordinate with USGS to obtain historic water quality data for NAWQA wells, determine timing and frequency of monitoring under USGS program, and discuss the potential for integrating USGS monitoring resources with other portions of the Central Basin monitoring network.
- Coordinate with local, state, and federal agencies to identify where wells may exist in areas with sparse groundwater quality data. Identify opportunities for collecting and analyzing water quality samples from those wells.
- Assess annually the adequacy of the groundwater quality monitoring well network..
- Coordinate with DWR on the groundwater quality data they collect.

3.2.2.3 Land Surface Elevation Monitoring

Subsidence of the land surface resulting from compaction of underlying formations affected by head (groundwater level) decline is a well-documented concern throughout much of the Central Valley. During a typical pumping season, changes in land surface elevation can be observed as a result of both elastic and inelastic subsidence in the underlying basin. Elastic subsidence results from the reduction of pore fluid pressures in the aquifer, and typically rebounds when pumping ceases or when groundwater is otherwise recharged resulting in increased pore fluid pressure. Inelastic subsidence occurs when pore fluid pressures decline to the point that fine-grained sediments such as clays consolidate, resulting in permanent compaction and reduced ability to store water in that portion of the aquifer. Other side effects may include damaged levees, canals, or pipes.

While some land surface subsidence is known to have occurred as a result of groundwater extraction west of the Sacramento River, the extent of subsidence east of the Sacramento River has been minimal. DWR maintains three subsidence monitoring stations in the Sacramento Valley.

Historical benchmark elevation data for the period from 1912 through the late 1960s obtained from the National Geodetic Survey (NGS) were used to evaluate land subsidence in north Sacramento County. From 1947 to 1969, the magnitude of land subsidence measured at benchmarks north of the American River ranged from 0.13 feet to 0.32 feet, with a general decrease in subsidence in a northeastward direction. This decrease is consistent with the geology of the area: formations along the eastern side of the Sacramento Valley are older than those on the western side and are subject to a greater degree of pre-consolidation, making them less susceptible to subsidence. The maximum documented land subsidence of 0.32 feet was measured at both benchmark L846, located approximately two miles northeast of the former McClellan AFB, and benchmark G846, located approximately one mile northeast of the intersection of Greenback Lane and Elkhorn Boulevard. Another land subsidence evaluation was performed in the Arden-Arcade area of Sacramento County from 1981 to 1991. Elevations of nine wells in the Arden-Arcade area were surveyed in 1981, 1986, and 1991. The 1986 results were consistently higher than the 1981 results; this was attributed to extremely high rainfall totals in early 1986 that recharged the aquifer and caused a rise in actual land surface elevations. The 1991 results were consistently lower than the 1986 results; this was attributed to five years of drought immediately preceding the 1991 measurements which caused depletion of the aquifer and resulting land surface subsidence. Comparison of eight of the locations indicates that seven benchmarks had lower elevations in 1991 than in 1981 and one benchmark had a higher elevation in 1991. Of the seven benchmarks with lower elevations in 1991, the maximum difference is 0.073 feet (less than one inch).

Whether this is inelastic subsidence is indeterminate from the data, but it is clear that the magnitude of the potential subsidence in the benchmarks between 1981 and 1991 was negligible.

Actions. While available data and reports indicate that land surface subsidence is not a problem in the Sacramento County area, the basin governance body is interested in pursuing additional possible actions to continue to monitor potential land surface subsidence especially in the Central Basin. Actions may include the following:

- Investigate the feasibility and costs of resurveying the wells in the Arden-Arcade area, which were last measured in 1991.
- Coordinate with USGS to ascertain the suitability of the use of Interferometric Synthetic Aperture Radar (InSAR) images of the Central Basin and the surrounding area. If the technology appears suitable, identify the costs of determining ground surface elevations and identify potential cost-sharing partners.
- Coordinate with other agencies, particularly the City and County of Sacramento and the NGS to determine if there are other suitable benchmark locations exist in the area to aid in analysis of potential land surface subsidence.

3.2.2.4 Surface Water Groundwater Interaction Monitoring

The interaction between groundwater and surface water has not been extensively evaluated in the Central Basin area. This is what is known:

- A recent draft decision by the SWRCB (2003) regarding the American River concluded that from Nimbus Dam to about 6,000 feet below the dam, groundwater elevations and surface water elevations were similar enough to each other that groundwater could be tributary to the American River. Beyond 6,000 feet down river from the dam, groundwater elevations are sufficiently lower than the river channel to conclude that the American River is a "losing" stream down to its confluence with the Sacramento River.
- Groundwater modeling has been used to estimate flow volumes between surface water and groundwater for various hydrologic conditions. California State University, Sacramento (CSUS) in cooperation with DWR has recently installed several monitoring wells in and adjacent to the American River to investigate groundwater interaction with the American River and how recent United States Army Corp of Engineers (USACE) levee reinforcement projects might have changed the surface water-groundwater flow relationships.
- In 1991, SRCSD, Sacramento County, and the City established the Sacramento Coordinated Water Quality Monitoring Program (CMP). Since that time, the CMP has monitored surface water quality for a variety of constituents, including trace elements at several locations on the American and Sacramento rivers. The CMP monitors the Sacramento River at the Freeport Bridge and the American River at Nimbus Dam.
- SCWA has completed an Memorandum of Agreement (MOA) with TNC and SSCAWA for the Management of Water and Environmental Resources associated with the lower Cosumnes River. This MOA reflects a desire to work together to actively investigate opportunities for flow restoration, conjunctive use management, and enhanced recharge within the Cosumnes River corridor.

Actions. The basin governance body will pursue actions to better understand the relationship between surface and groundwater in the Central Basin area, including the following:

- Work cooperatively with SGA, TNC, and OHWD to compile available stream gage data and information on tributary inflows and diversions from the American, Cosumnes, and Sacramento rivers to quantify net groundwater recharge or discharge between gages in the Central Basin area.
- Coordinate with local, state, and federal agencies to identify available surface water quality data from the American, Cosumnes, and Sacramento rivers proximate to the Central Basin area.

- Correlate groundwater level data from wells in the vicinity of river stage data to further establish whether the river and groundwater are in direct hydraulic connection, and if surface water is gaining or losing at those points.
- Continue to coordinate with local, state, and federal agencies and develop partnerships to investigate cost-effective methods that could be applied to better understand surface water-groundwater interaction along the American, Cosumnes and Sacramento rivers.
- Coordinate with CSUS, to analyze data obtained from recently constructed monitoring wells on the CSUS campus to better understand the relationship between groundwater basin and surface water flows at that location.

3.2.2.5 Protocols for Collection of Groundwater Data

Through the work completed as part of SGA's groundwater management plan, MWH has evaluated the accuracy and reliability of groundwater data collected by cooperating agencies within the Sacramento region (MWH, 2002). The evaluation indicated a significant range of techniques, frequencies and documentation methods for collection of groundwater level and groundwater quality data.

Although the groundwater data collection protocol may be adequate to meet the needs of individual agencies, the lack of consistency yields an incomplete picture of basinwide groundwater conditions. Other types of groundwater data collection protocols are included in **Sections 3.2.2.1** and **3.2.2.2** above.

<u>Actions</u>. To improve the comparability, reliability, and accuracy of groundwater data, the basin governance body will take the following actions:

- The governance body will develop within one year a standard operating procedure (SOP) for collection of water level data.
- Provide cooperating agencies with guidelines developed by DHS for the collection, pretreatment, storage, and transportation of water quality samples (DHS, 1995).
- Provide training on implementing the SOPs.

3.2.2.6 Data Management System

For the basin governance body to achieve its primary objective of sustaining the groundwater resource within the Central Basin, it was essential to develop a data storage and analysis tool, or DMS. The DMS was developed by MWH under contract with USACE. Other local sponsors included SGA and its member agencies, DWR, and SCWA.

The DMS is a public domain application developed in a Microsoft Visual Basic environment and is linked to a database containing Central Basin purveyor data. The DMS provides the end-user with ready access to both enter and retrieve data in either tabular or graphical formats. Security features in the DMS allow for access restrictions based on a variety of user permission levels.

Data in the DMS include the following:

- Well construction details
- Known locations of groundwater contamination and potentially contaminating activities (PCA)
- Long-term monitoring data on the following:
  - Monthly extraction volumes
  - Water elevations
  - Water quality
- Aquifer characteristics based on well completion reports and the Sacramento County IGSM.

The DMS allows viewing of regional trends in groundwater level and quality not previously available to stakeholders in the basin. The DMS has the capability of quickly generating well hydrographs and groundwater elevation contour maps using historic groundwater level data. The DMS allows the user to view water quality data for CCR Title 22 required constituents as a temporal concentration graph at a single well, or any constituent can be plotted with respect to concentration throughout the Central Basin area. Presentation of groundwater elevation and groundwater quality data in these ways will be useful for making groundwater basin management decisions.

SGA and the basin governance body will be establishing data transfer protocols so that groundwater data in the North and Central Basins (by cooperating agencies, DWR, AFRPA, USGS, etc.) can be readily appended to the database and analyzed through the DMS. Annual summaries of groundwater monitoring data will be prepared using the analysis tools in the DMS and presented in an annual State of the Basin report (see **Section 4**). Once the DMS is fully populated and quality-control checked, a summary of existing basin conditions will be prepared. These initial summary analyses will be performed on at least an annual basis to assess the impacts of current and future management actions on the groundwater system.

Actions. To maintain and improve the usability of the DMS, the basin governance body will take the following actions:

- Continue to update the DMS with current water purveyor data.
- Make recommendations to MWH (or assigned DMS developer) on utilities to add to the DMS to increase its functionality.

3.2.3 Component No. 3: GROUNDWATER RESOURCE PROTECTION

The basin governance body considers groundwater resource protection a critical component in maintaining a sustainable groundwater resource. There are two aspects of groundwater resource protection, 1) preventing contamination from entering the groundwater, and 2) remediation of known contaminant plumes. Prevention measures include proper well construction and destruction practices, development of wellhead protection measures, and protection of recharge areas. Prevention also includes measures that prevent human activities and deleterious natural substances, such as saline water, from entering the groundwater system. Remediation includes any activity that removes and treats man made contaminants from the soil and the groundwater system.

3.2.3.1 Well Construction Policies

The Sacramento County Environmental Management Department (EMD) administers the well permitting program for Sacramento County. Standards for well construction are identified in Sacramento County Code No. SCC-1217 (County Well Ordinance), as amended on April 9, 2002. In addition to general well construction standards, Sacramento County has a policy of special review by appropriate regulatory agencies before granting a well permit within 2,000 feet of a known contaminant plume (referred to as Consultation Zones). Prohibitions have been established by various State regulatory agencies for drilling new public supply wells at Mather Field or near the Aerojet or Boeing facilities. As part of the development of the DMS, the extent of contaminant plumes associated with Mather Field, Aerojet, and Boeing were delineated for SGA and SCWA (see **Figure 2-19**).

Actions. The basin governance body will take the following actions:

- Ensure that appropriate Sacramento County and Central Basin implementation staff and consultants are provided a copy of the County Well Ordinance and understand proper well construction procedures.
- Adhere to Sacramento County's Consultation Zone and provide a copy of the boundary of the prohibition zones to appropriate agencies within the Central Basin.
- Provide a copy of the most recently delineated plume extents at Mather Field and Aerojet/Boeing to EMD and appropriate staff for their review and possible use.
- Coordinate with other groundwater users in the Central Basin to provide guidance, as appropriate, on well construction.
- Where feasible and appropriate, use subsurface geophysical tools prior to construction of the well to assist in well design.

3.2.3.2 Well Abandonment and Destruction Policies

EMD administers the well destruction program for Sacramento County. The standards for well destruction are identified in the County Well Ordinance. A concern of the basin governance body and EMD is that many abandoned supply wells have not been properly destroyed. As part of development of the DMS for SGA, DWR well records for all known wells in the North Basin were reviewed for reported destruction. Based on the information provided each well was then rated based on the level of confidence that the well in question was actually destroyed properly. This information was then entered into the DMS.

Actions. The basin governance body will take the following actions:

- Complete a similar survey of abandoned and/or destroyed wells in the Central Basin and populate DMS with data.
- Ensure that all public and private agencies in the Central Basin are provided a copy of the County Well Ordinance and that they understand proper well destruction procedures, and support implementation of these procedures.
- Follow up with cooperating agencies and EMD on reported abandoned and/or destroyed wells to confirm the information collected from DWR.
- Obtain copies of any information on abandoned and/or destroyed wells in the Central Basin from EMD or other regulatory agencies to fill any gaps in the governance body's records.
- Meet with EMD to discuss ways to ensure that wells in the Central Basin are properly abandoned or destroyed.
- Obtain and review a copy of a "wildcat map" from California Division of Oil and Gas to ascertain the extent of historic gas well drilling operations in the area as these wells could function as conduits of contamination if not properly destroyed. It should be noted that EMD has no jurisdiction over gas wells.

3.2.3.3 Wellhead Protection Measures

Identification of wellhead protection areas is an element of the Drinking Water Source Assessment and Protection (DWSAP) program administered by DHS. DHS set a goal for all water systems statewide to complete Drinking Water Source Assessments by mid-2003. Most water purveyors in the basin have completed their required assessments by performing the three major elements required by DHS:

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

Delineation of capture zones includes using groundwater gradient and hydraulic conductivity data to calculate the surface area overlying the portion of the aquifer that contributes water to a well within specified time-of-travel periods. Typically, areas are delineated representing 2-, 5-, and 10-year time-of-travel periods. These protection areas must be managed to protect the drinking water supply from viral, microbial, and direct chemical contamination.

Inventories of PCAs include identifying potential origins of contamination to the drinking water source and protection areas. PCAs may consist of commercial, industrial, agricultural, and residential sites, or infrastructure sources such as utilities and roads. Depending on the type of source, each PCA is assigned a risk ranking, ranging from "very high" for such sources as gas stations, dry cleaners, and landfills, to "low" for such sources as schools, lakes, and non-irrigated cropland. Vulnerability analysis includes determining the most significant threats to the quality of the water supply by evaluating PCAs in terms of risk rankings, proximity to wells, and physical barrier effectiveness (PBE). PBE takes into account factors that could limit infiltration of contaminants including type of aquifer, aquifer material (for unconfined aquifers), pathways of contamination, static water conditions, hydraulic head (for confined aquifers), well operation, and well construction. The vulnerability analysis scoring system assigns point values for PCA risk rankings, PCA locations within wellhead protection areas, and well area PBE; the PCAs to which drinking water wells are most vulnerable are apparent once vulnerability scoring is complete.

PCA and capture zone information from the DWSAP will need to be added into the DMS. The DMS includes a feature that will automatically calculate wellhead protection areas if no data are available or if new well locations are proposed.

Actions. The basin governance body will take the following actions:

- Request that public water purveyor agencies within the Central Basin provide vulnerability summaries from the DWSAP to the basin governance body to be used for guiding management decisions in the basin.

- Contact groundwater basin managers in other areas of the state for technical advice, effective management practices, and “lessons learned” regarding establishing wellhead protection areas.

3.2.3.4 Protection of Recharge Areas

Surface geology within and directly adjacent to the Central Basin’s boundary was investigated as part of the 1993 Sacramento County General Plan for the purpose of delineating areas of potentially high recharge (as shown in Figure 7 of the Conservation Element of the 1993 Sacramento County General Plan). Much of the surface area considered to have the highest potential for recharge along the American River is developed. Other recharge areas identified in the Sacramento County General Plan include areas around and adjacent to the streams that flow along and across the Central Basin such as the Cosumnes River and Morrison stream group. Previous studies have also indicated that the abandoned aggregate mining pits north and south of Jackson Highway could be possible recharge locations. These pits typically extend 20 to 30 feet below ground surface and are mined to the clay layer that separates the Laguna Formation from the Mehrten Formation. Water introduced to these pits could deep percolate vertically through the interbedded clay lenses and horizontally through the pit walls into the Laguna formation. Flood waters, raw surface water, and perhaps treated recycled water can be discharged into these pits for year-round recharge. The RWQCB will need to provide regulatory approval prior to any use of these pits for recharge.

Another recharge location is along the Cosumnes River. The Cosumnes River overlies very transmissive soils, evidenced by the lack of river flow during certain times of year. Enhancing this recharge is already being considered through a pilot program (coordinated through the Water Forum, SCWA, TNC, and SSCAWA) that conveys American River water through the Folsom South Canal and then discharges it to the Cosumnes River at the canal crossing. It is hoped that this program will demonstrate an improvement in the fishery and riparian habitat along the Cosumnes River as well as provide enhanced recharge.

Action. The basin governance body will take the following action:

- Continue to work with mining companies, TNC, and SSCAWA to explore the possibilities for enhancing recharge into the Central Basin.

3.2.3.5 Control of the Migration and Remediation of Contaminated Groundwater

Major sources of contamination within the Central Basin are primarily from Mather Field, Aerojet, Boeing, and various active and inactive landfill sites. The extent of the groundwater contaminant plumes emanating from these sources are shown in **Figure 2-19**. Also of concern is localized contamination by industrial/commercial point sources such as dry cleaning facilities and numerous fuel stations throughout the basin.

While the basin governance body does not have the authority or responsibility for remediation of this contamination, it is committed to coordinating with responsible parties and regulatory agencies to stay informed on the status and disposition of known contamination in the basin. For example, information on known LUST sites has been collected from the EMD, the SWRCB, and the RWQCB and entered into the DMS. Also, SCWA has been in communication with AFRPA, which is overseeing remediation efforts at Mather AFB (see **Section 3.2.2.2**).

Actions. The basin governance body will take the following actions:

- Coordinate with appropriate regulatory agencies (EMD, DTSC, EPA, and DHS) and known responsible parties to develop a network of monitoring wells to act as sentry wells for public supply wells.
- If detections occur in these monitoring wells, meet with the appropriate regulatory agencies and responsible parties to develop strategies to minimize the further spread of contaminants.
- Use the information on mapped contaminant plumes and LUST sites in developing groundwater extraction patterns and in locating future production or monitoring wells.
- Meet with representatives of EMD and RWQCB to establish a mutual understanding about the basin governance body's groundwater management responsibilities. Identify ways to have open and expedited communication with EMD regarding any new occurrences of LUSTs, particularly when contamination is believed to have reached the groundwater.

3.2.3.6 Control of Saline Water Intrusion

Saline water intrusion from the Sacramento/San Joaquin Delta (Delta) is not currently a problem in the Central Basin, and is not expected to become a problem in the future. Higher groundwater elevations associated with recharge from the American and Sacramento rivers have maintained a historical positive gradient, preventing significant migration of any saline water from the Delta into the Sacramento County region. These groundwater gradients will continue to serve to prevent any localized pumping depressions in the basin from inducing flow from the Delta into the Central Basin.

Actions. The basin governance body will take the following actions:

- Track the progression, if any, of saline water bodies moving toward the east from the Delta. Because this is a highly unlikely scenario, this action will be limited to communicating with DWR's Central District Office on a biennial basis to check for significant changes in TDS concentrations in wells. DWR has a regular program of sampling water quality in select production wells throughout the adjacent Solano, San Joaquin, and Yolo counties. This program will serve as an early warning system for potential saline water intrusion from the Delta.
- Observe TDS concentrations in municipal wells that are routinely sampled under CCR Title 22. These data will be readily available as part of the DMS and will be reported on in the annual State of the Basin report.
- Inform all stakeholders of the presence of the salinity interface and the approximate depth to the interface for their reference when locating potential wells. EMD, which issues well permits, is aware of the interface. SCWA will provide a map to EMD indicating the contour of the elevation of the base of fresh water in Sacramento County for its reference when issuing well permits.

3.2.4 Component No. 4: GROUNDWATER SUSTAINABILITY

To ensure a long-term viable supply of groundwater, the basin governance body seeks to maintain or increase the amount of groundwater stored in the basin over the long term. The WFA's groundwater management element provides a framework by which the groundwater resource in the Sacramento County-wide basin can be protected and used in a sustainable manner. As mentioned previously, the WFA estimated a long-term average annual pumping limit within the Central Basin of 273,000 AF/year. As discussed in **Section 2**, historic groundwater extractions have resulted in a net depletion of groundwater stored under the Central Basin area. To ensure a sustainable resource, SCWA continues to move forward with its conjunctive use program in Zone 40, including pursuit of additional surface water supplies, increased use of recycled water, and implementation of the WFA water conservation element. Current conjunctive use activities include the City/SCWA Franklin Intertie and continued development of the FRWA project that will bring additional surface water supplies into Zone 40. The

City also is considering optimizing the use of American River water within the POU boundaries. Lastly, SRCSD is looking at opportunities for use and possible in-lieu recharge of groundwater through use of recycled water for non-potable uses.

Conjunctive management is a program that includes both conjunctive use and the development of banking and exchange opportunities with local in-basin partners after local needs are met. Banking and exchange partnerships will result in increased surface water and perhaps revenue to pay for some of the necessary capital improvements to help sustain the resource. The basin governance body and SCWA are also interested in direct recharge and propose to investigate a variety of ways to recharge water into available storage space in the basin. Opportunities for direct recharge exist through the use of recharge basins (e.g., abandoned aggregate mining pits) or through a aquifer storage and recovery (ASR) program. The City of Roseville is currently implementing an ASR program where treated surface water is injected into the groundwater and then recovered in the summer months and dry years through groundwater wells. The success of this program will be monitored closely by the governance body.

Another recharge opportunity would provide raw or treated surface water to municipal and agricultural users in lieu of extracting groundwater. During the early phases of Zone 40's conjunctive use program, there is expected to be excess capacity in both the raw water pipeline from the FRWA project and the Central WTP that could be delivered through some type of conveyance to groundwater users.

Actions. The basin governance body will take the following actions:

- Continue to investigate conjunctive use opportunities within the Central Basin area. Groundwater users within the Central Basin will coordinate any recharge efforts.
- Continue to investigate opportunities for development of direct recharge facilities in addition to in-lieu recharge (e.g., injection wells or surface spreading facilities, through constructed recharge basins or in riverbeds or streambeds).

3.2.4.1 Demand Reduction

An important factor in maintaining the sustainable yield of the basin is by reducing demand for potable water supplies through conservation and the use of recycled water for landscape irrigation.

Water Conservation. RWA's efforts in developing and implementing a regional Water Efficiency Program (WEP) are well recognized by CSCGF. The WEP assists participants in meeting their water conservation agreements with the Water Forum, the California Urban Water Conservation Council, and CVPIA. The goal of the WFA is to achieve system-wide conservation of slightly more than 25 percent by 2030.

The basin governance body will work closely with the Water Forum Successor Effort and RWA to ensure that all applicable cost-effective BMPs are implemented in the Central Basin urban areas. The basin governance body shall develop BMPs for self-served agricultural and agricultural-residential water users. These BMPs will be based on applicable Reclamation and DWR data and recommendations.

Water Recycling. The SRCSD is developing a countywide Water Recycling Master Plan to provide up to 40 MGD of recycled water. SRCSD treats wastewater at its Sacramento Regional WWTP and is looking for ways to increase demand for tertiary treated or recycled water. Currently, SRCSD is treating approximately 5 mgd of recycled water and delivering it to nearby landscape irrigation users within the Laguna West, Lakeside and Laguna Stonelakes portion of Zone 40. SRCSD expects the capacity of that facility to increase to 10 mgd over the next few years to serve areas within the City of Elk Grove known at the East Franklin and Laguna Ridge development areas within Zone 40.

Actions. The basin governance body will take the following actions:

- Participate in RWA's WEP to ensure that Central Basin purveyor conservation efforts are focused and effective. For those who receive wholesale water supplies, the governance body of the Central Basin will ensure that they are informed of the benefits and regional importance of participating in the WEP.

- The basin governance body shall develop BMPs for self-served agricultural and agricultural-residential water users.
- Coordinate with SRCSD to investigate further opportunities for expanded use of recycled water throughout the Central Basin.

3.2.5 Component No. 5: PLANNING INTEGRATION

With the large number of water purveyors that serve the greater Sacramento area, the need to integrate water management planning on a regional scale is a high priority. Individual purveyors derive their supplies from the American River, Sacramento River, the groundwater basin, or some mix of these sources. Individual purveyor infrastructure systems are mostly independent; where interconnections do exist they are typically for emergency purposes only.

The WFA provides a regional conjunctive use framework with commitments from individual purveyors concerning groundwater and surface water operations, including limitations on surface water diversions from the lower American River during dry years. SCWA and others planning efforts seek to better integrate the individual plans of various entities to implement various elements of the WFA in keeping with the 2030 regional framework. Such integration also promotes operational efficiency, cost savings, and in some cases generates larger statewide-system benefits.

Some of the municipal groundwater purveyors that provide water service within the Central Basin have opted out of the Water Forum Process and the development of the CSCGMP. If these purveyors choose to participate in the future, then information relative to their water system will be added to the CSCGMP.

3.2.5.1 Existing Integrated Planning Efforts

Stakeholders in the Central Basin, such as SCWA, have already implemented integrated management in the region through cooperation with the City in treating and wheeling surface water (see **Section 2.2.3.2**), participation in the WEP (see **Section 3.2.4.1**), and the SRCSD recycled water program (see **Section 2.4**).

3.2.5.1.1 Urban Water Management Planning

Most urban purveyors in the Central Basin are required to prepare an Urban Water Management Plan. These plans, as defined by CWC § 10610 et seq., require public water suppliers with more than 3,000 customers, or who deliver more than 3,000 AF of water annually, to identify conservation and efficient water use practices to help ensure a long-term, reliable water supply. The basin governance body will encourage that all retail purveyors to submit plans to DWR.

3.2.5.1.2 DWSAP Program

The DWSAP Program is administered by DHS. The first step in completing a source protection program is to conduct a preliminary assessment. The assessment includes "delineation of the area around a drinking water source through which contaminants might move and reach the drinking water supply; an inventory of PCAs that might lead to the release of microbiological or chemical contaminants within the delineated area; and a determination of the PCAs to which the drinking water source is most vulnerable." Refer to the following DHS web site for more details

on the DWSAP program: (http://www.dhs.ca.gov/ps/ddwem/dwsap/overview.htm).

These assessments only apply to agencies that deliver groundwater for public drinking water supply. Data from the assessments have or will be incorporated into the DMS.

3.2.5.1.3 Land Use Planning

Effective January 1, 2002, State Water Code Sections 10910-10915 (inclusive) (commonly known as SB 610) required that a water supplier take certain actions to confirm sufficiency of water supply as a condition to approval of new development projects. These actions involve the development of Water Supply Assessments and Written Verifications at the request of the land use authority. These documents provide an assurance that adequate water supplies are available before a project moves forward in gaining entitlements for development. The governance body will coordinate with and exchange information with all land use agencies within the area on a continuing basis to provide the latest information pertaining to activities taking place for the protection and availability of groundwater resources; however, the governance body will not be placed in a role of responding to SB 610 requests.

3.2.5.1.4 Integrated Groundwater and Surface Water Modeling

The basin governance body is interested in using and building on existing groundwater models for the Sacramento area. In the late 1990s, a range of groundwater extraction and recharge scenarios were simulated using the North American River and Sacramento County Combined IGSM. This model was originally developed for the American River Water Resources Investigation (ARWRI), conducted by Reclamation, and was later used for the Draft Water Forum Solution Model developed for the Water Forum. The Water Forum used the model in the development of a conjunctive use strategy for the groundwater basin underlying Sacramento County and southern Placer County. SGA recently updated the calibration model to run with the latest version of IGSM. Historical water budgets from 1970 to 1995 were developed and a comparison was provided of model results and actual measured values for groundwater elevations and streamflows over the calibration period. SCWA and SGA are pursuing having the hydrologic period extended from 1995 to 2000 and extending the planning model hydrologic period that is used for measuring effects of conjunctive use practices. Currently the hydrologic period extends from 1922 to 1995.

The reason for maintaining and updating the IGSM is because it forms the basis for the WFA and the Zone 40 WSMP environmental analyses. The basin governance body should be the custodian of the IGSM model because the model is used for regional planning by Reclamation and DWR for projects such as ARWRI, CVPIA, and the CALFED process and is a tool that is supported by the DMS. In addition, the model is a suitable tool to analize the effects of local projects on regional groundwater conditions.

Actions. The basin governance body will take the following actions:

- Prepare and adopt a formal integrated water management plan in accordance with CWC § 10540 et seq. The plan will include, but not be limited to, the elements listed above. The Central Basin governance body will seek to form an ad hoc committee with SCWA, RWA, SSCAWA, and TNC to determine which agency would be most appropriate to prepare that plan and to update and make use of the IGSM model.
- Review the Water Forum Land Use procedures and make recommendations on the type of role, if any, the basin governance body should take with respect to land use decisions within the basin.

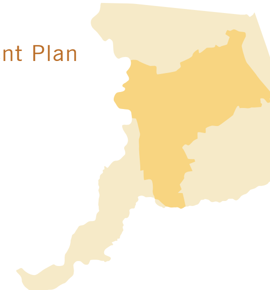
3.3 SUMMARY OF SECTION 3

Table 3-1 below provides a summary of **Section 3** for quick reference and for use in further sections. The table correlates which activities are related to one or more BMOs.

Table 3-1. Summary of Action Items and How Each Applies to the BMOs

Action Items Related to BMO	BMO No. 1 Maintain the long-term average groundwater extraction rate at or below 273,000 AF/year	BMO No. 2 Maintain specific groundwater elevations within all areas of the basin consistent with the Water Forum "solution"	BMO No. 3 Protect against any potential inelastic land surface subsidence by limiting subsidence to no more than 0.007 feet per 1 foot of drawdown in the groundwater basin	BMO No. 4 Protect against any adverse impacts to surface water flows in the American, Cosumnes, and Sacramento rivers	BMO No. 5 Water quality objectives
Component No. 1 Stakeholder Involvement					
Involving the Public		✓		✓	✓
Involving Other Agencies Within & Adjacent to the Central Basin		✓	✓	✓	✓
Using Advisory Committees	✓	✓	✓	✓	✓
Developing Relationships with State and Federal Agencies	✓	✓	✓	✓	✓
Pursuing Partnership Opportunities			✓	✓	✓
Component No. 2 Monitoring Program					
Groundwater Elevation Monitoring		✓			
Groundwater Quality Monitoring					✓
Land Surface Elevation Monitoring			✓		
Surface Water Groundwater Interaction Monitoring				✓	
Protocols for Collection of Groundwater Data		✓			
Data Management System	✓	✓	✓	✓	✓
Component No. 3 Groundwater Resource Protection					
Well Construction Policies					✓
Well Abandonment and Destruction Policies					✓
Wellhead Protection Measures					✓
Protection of Recharge Areas					✓
Control of the Migration and Remediation of Contaminated Groundwater					✓
Control of Saline Water Intrusion					✓
Component No. 4 Groundwater Sustainability					
Demand Reduction (Water Conservation and Water Recycling	✓	✓	✓	✓	✓
Component No. 5 Planning Integration					
Existing Integrated Planning Efforts (Urban Water Management Planning, DWSAP Program, Land Use Planning, and Groundwater Modeling)	✓	✓	✓	✓	✓

Plan Implementation



Section 4

Plan Implementation

This section identifies needed monitoring, trigger points, and recommended steps necessary to fully implement the BMOs and action items presented in **Section 3**. Many of these steps involve coordination by the future basin governance body with other local, state and federal agencies. This coordination can take place within 6 months of the adoption of this CSCGMP by the governance body. Monitoring, assessing data trends, and reporting the state of the basin for the purpose of determining the adequacy of the management activities is a key process in this plan. Assessments in the value of monitoring and reporting activities will be made as new monitoring data become available for review by the Central Basin governance body. All results of the monitoring program and actions/decisions made by the governance body will be documented in an annual State of the Basin report. This section also considers the schedule and budget necessary to implement the CSCGMP.

4.1 BACKGROUND

Section 3 identified BMOs, plan components, and management actions (see **Table 3-1**) to implement the groundwater management plan. However, it did not define or identify specific actions that would be taken in the event the objectives of the BMOs were not being met. **Section 4** defines these specific actions by providing a set of "trigger points" in conjunction with recommended actions for each BMO. Associated steps based on exceeding a trigger point's established threshold are the next level of management activity to be undertaken by the governance body.

As mentioned in previous sections, determining and maintaining the health of the Central Basin is the governance body's foremost concern and is accomplished through data collection and evaluation, remedial and/or restorative actions if necessary, and reporting. Findings and the success or failure of steps taken to remedy a problem will comprise a good portion of the content of the annual State of the Basin report published by the basin governance body.

4.2 SPECIFIC ACTIONS BASED ON MONITORING RESULTS

The term "trigger point" as used in this section is defined as a condition in which a BMO has been breached at a defined level. Each trigger point has a corresponding recommended action that is linked to each level. The recommended action is dependent on the measurement taken and the BMO in question. Individual trigger points are tied to monitoring actions such as groundwater level measurements, groundwater extraction calculations, water quality determinations, etc.

Once a trigger point has been reached, the basin governance body must decide on its course of action. For example, if groundwater levels begin to fall in basin polygon areas (discussed in **Section 3.1.2** and **Appendix B**) that had previously been identified as an area of concern, what action(s) should be taken by the basin governance body? In this case, the basin governance body would go to the trigger points that address potential lowering of groundwater levels in areas being impacted by groundwater pumping or by hydrologic conditions.

The actions that a trigger point might require for the "groundwater elevation" BMO (BMO No. 2) are described as follows:

Trigger Point 1. This initial alert stage informs the basin governance body and the overlying groundwater extractor(s) that a specific polygon area is being compromised. Activation of this trigger will only take place after conducting a thorough investigation into the cause of the condition.

Trigger Point 2. This stage assumes that the area has already gone through Trigger Point 1 actions and is at the next level of alert. This stage may require a reduction in pumping in predefined area(s) to bring the affected area back into compliance. Groundwater extractors within the affected area may not be the actual cause of decline.

Trigger Point 3. This stage indicates continuously declining groundwater levels in an area even during wet and normal hydrologic cycles. This would indicate that excessive pumping is the probable cause. Well owners with operating wells in the affected area(s) will be identified and notified of the basin condition in their area. An assessment will be levied against those owners who continue to pump at the higher level.

Trigger Point 4. If the recommended actions from the first three trigger points do not result in an improvement to the affected area(s), the basin governance body will need to consider what action it will take. In this example there appears to be two alternatives. The first is to consider whether a lower groundwater level in the area is acceptable. If lower groundwater levels are deemed acceptable, then the basin governance body has the ability to adapt to the real monitoring data and change the model-based thresholds for management in the area. If lower groundwater levels are deemed unacceptable, the second alternative would require finding supplemental water supplies and building the necessary infrastructure to deliver these supplies, for the area(s) and reduce pumping to allow groundwater levels to recover to acceptable levels. The cost of this last action will be exacted upon well owners with operating wells in the area that are contributing to the decline in groundwater levels.

This same process can be extrapolated for the average groundwater extraction rate, water quality, land subsidence, and aquifer stream interaction BMOs. The only difference in each trigger point is the measurement parameters and the set of actions and penalties. These are listed by BMO in **Table 4-1**. A full description of the BMOs, the methods of monitoring and management actions are provided in **Section 3**. **Table 4-1** provides the set of conditions that initiate change in how the basin is being managed and lays down the initial framework for penalties in the event trigger points are continuously exceeded.

Table 4-1. Monitoring Actions and Trigger Points

Monitoring Action	Trigger Points	Recommended Action
BMO No. 1. Maintain the long-term average groundwater extraction rate at or below 273,000 AF/year		
The term "long-term average" means averaging data over a long period of time. This will begin with completion of an accurate estimate of the current total groundwater extraction from the basin. Once completed, estimates will be made at least every five years. Five-year estimates will consist of agricultural and agricultural-residential data available through the DWR Land Use Survey, and data collected by the various purveyors (collected monthly and available on an annual basis). The collective data will then be used to compare estimated groundwater extractions and the BMO requirement of 273,000 AF/year. More frequent estimates can be made by assuming agriculture and agricultural-residential data remain relatively constant.	Trigger Point 1. Groundwater extractions for the basin have exceeded 273,000 AF for the previous year.	Evaluate and confirm the data. Look for opportunities to reduce pumping either through conservation, or education in water use and irrigation practices for urban, agricultural, and agriculture-residential.
	Trigger Point 2. Groundwater extractions for the basin have exceeded 273,000 AF for the previous two (2) years	Evaluate and confirm the data and include formal notification of the signatory governing bodies, local water purveyors and the agricultural community. Reduce pumping through importation of surface water where conveyance systems exist. In cases where infrastructure is not in place to convey alternative water supplies, reductions in pumping may be necessary until said facilities are in-place.
	Trigger Point 3. Groundwater extractions for the basin have exceeded 273,000 AF for the previous five (5) consecutive years	Evaluate and confirm data and include formal notification of the signatory governing bodies, local water purveyors and the agricultural community. Reduce pumping, acquire surface water entitlements to replace lost groundwater supplies, and construct conveyance facilities for surface water. Look for agreements with third parties and financing mechanisms to assist in infrastructure requirements. Initiate an extraction-rate-based funding mechanism over the entire basin.
	Trigger Point 4. Groundwater extractions for the basin have exceeded 273,000 AF for more than five (5) years.	Evaluate and confirm data and include formal notification of the signatory governing bodies, local water purveyors and the agricultural community. Conduct a mandatory examination of adequacy of long-term sustainable yield criteria and the actual effects on the basin with the higher groundwater yield. This may require a reassessment of the sustainable yield criteria, and possibly an increase, in accordance with basin governance body procedures. Consultation with the Water Forum Successor Effort will be required prior to taking this action.

Table 4-1. Monitoring Actions and Trigger Points (continued)

Monitoring Action	Trigger Points	Recommended Action
BMO No. 2. Maintain specific groundwater elevations within all areas of the basin consistent with the Water Forum "solution."		
A monitoring methodology to meet specific objectives in managing groundwater levels requires a systematic, repeatable, and scientific approach. The objective of this monitoring program is to take measurements from selected monitoring wells that have sufficient construction and hydrogeologic data. Wells will be assigned to represent the polygon areas defined in **Appendix B**, and may be grouped within the basin in areas that are sufficiently distinct in the makeup of hydrogeology and land use. Monitored groundwater levels for a well will be compared with the designated upper and lower groundwater level threshold for each polygon that is assigned to the well. The upper and lower thresholds are termed the "bandwidth" of the polygon.	Trigger Point 1. A 25 to 50 percent encroachment into the designated bandwidth of a polygon.	Alert stage that informs the basin governance body and the overlying groundwater extractor(s) that a specific polygon area is being compromised. Activation of this trigger will take place only after the cause of the condition is thoroughly investigated.
	Trigger Point 2. A 50 to 75 percent encroachment into the designated bandwidth of a polygon.	In the event groundwater level measurements hit Trigger Point 2 without first initiating Trigger Point 1, the recommended actions of Trigger Point 1 still apply. Additionally, this stage initiates a requirement to collect a fee to secure supplemental water supplies or to reduce pumping in a predefined area(s).
	Trigger Point 3. A 75 to 100 percent encroachment into the designated bandwidth of a polygon. This indicates continuously declining groundwater levels in an area even during wet and normal hydrologic cycles, indicating that excessive pumping is the probable cause.	Well owners with operating wells in the affected area(s) will be identified and notified of the basin's condition in their area. An assessment will be levied against those owners who continue to pump at the higher level. Every attempt will be made by the governance body to ameliorate the impact assessments to private domestic groundwater pumpers.
	Trigger Point 4. Over 100 percent encroachment into the designated bandwidth of a polygon.	If the recommended actions from the first three trigger points do not result in an improvement to the affected area(s), the basin governance body will need to consider which of two actions it will take. The first is to consider whether a lower groundwater level in the area is acceptable. If so, the basin governance body has the ability to adapt to the actual monitoring data and change the model-based thresholds for management in the area. If lower groundwater levels are deemed unacceptable, the second action would require finding supplemental water supplies and construct infrastructure for the area(s) and reduce pumping to allow groundwater levels to recover to acceptable levels. Fees in addition to Trigger Point 3 fees will be assessed to cover costs associated with this action.

Table 4-1. Monitoring Actions and Trigger Points (continued)

Monitoring Action	Trigger Points	Recommended Action
BMO No. 3. Protect against any potential inelastic land surface subsidence by limiting subsidence to no more than 0.007 feet per 1 foot of drawdown in the groundwater basin.		
If inelastic subsidence is documented in conjunction with declining groundwater levels, the basin governance body will investigate and take appropriate actions to avoid or mitigate adverse impacts. Subsidence should be measured and thought of as a long-term process. While some measurements have been made to determine the level of subsidence in the Sacramento area, some concern exists regarding the accuracy of the measurements and sufficiency of the data. The North and Central basins should collaborate to gain a better understanding of subsidence.	Trigger Point 1. Subsidence measured at less than 0.007 feet per foot of groundwater decline.	If subsidence is measured either in the North or Central basins, further study should be initiated to rule out any error in survey or survey markers. A measure of impacts, if any, should also be noted and weighed as to whether the impact is acceptable.
	Trigger Point 2. Subsidence measured at or above 0.007 feet per foot of groundwater decline.	Subsidence greater than the set limit is cause for concern and needs to be addressed by first assessing Trigger Point 1 data and then determining if the amount of subsidence can occur with acceptable impacts. If so, the criteria of 0.007 feet per foot of groundwater decline may be increased according to the data collected.
	Trigger Point 3. Data collected for ground subsidence has a high correlation with declines in groundwater elevations or if any structural damage is identified as being caused by subsidence.	The basin governance body needs to develop and implement a plan to reduce pumping, or by some other means, prevent dewatering of the aquifer in areas where inelastic subsidence is occurring. This may mean providing surface water or other supplemental water supplies to these areas or injection of surface water (or off-site groundwater) to replace groundwater that has been removed through extraction or in some manner has been prohibited from recharging the area of concern.
BMO No. 4. Protect against any adverse impacts to surface water flows in the American, Cosumnes, and Sacramento rivers.		
It is the intent of this plan that controllable operations of the groundwater system do not negatively impact the area's rivers and streams. The basin governance body will seek to gain a better understanding, in cooperation with SGA and others, of potential impacts of the discharge of local area groundwater to major rivers adjacent to the Central Basin. Water quality issues related to this type of discharge will be reported in the Annual State of the Basin Report. No Trigger Points are assigned to water quality issues as a result of groundwater discharges at this time.	Trigger Point 1. Monitoring of losses of river water to groundwater shows a 5 percent increase over the current loss rate based on total flow in the river.	Use the calibrated Sacramento County IGSM to identify where losses are likely occurring in the river(s). Identify and provide quantity of loss in the State of the Basin Report. Coordinate and consult any efforts with State DWR, SGA, TNC, and SSCAWA.
	Trigger Point 2. Monitoring of losses of river water to groundwater shows a 25 percent increase over the current loss rate based on total flow in the river.	Complete the same analysis as for Trigger Point 1 and begin to develop alternative management strategies that reduce the hydraulic gradient (or slope) of the groundwater piezometric surface that is in contact with the river(s). Seek stakeholder approval and funding to implement a preferred alternative to begin managing the losses of surface water to the groundwater system.

Table 4-1. Monitoring Actions and Trigger Points (continued)

Monitoring Action	Trigger Points	Recommended Action
BMO No. 5. Water quality objectives		
Water quality objectives will include analyzing for total dissolved solids (TDS) (typically a measure of salinity), volatile organic compounds (VOC), and nitrates. Any violation exceeding the management criteria will require an action by the basin governance body.	Total Dissolved Solids	
	Trigger Point 1. Monitoring results of TDS exceed the secondary drinking water standard MCL of 1,000 mg/L.	Report the exceedance in the State of the Basin Report. If a health concern exists, the affected stakeholder(s) would be notified and arrangements made to remedy the problem.
	Trigger Point 2. High TDS levels believed to be coming from the deeper aquifer system.	A study will be conducted to determine if the increase in TDS is a result of groundwater well construction and extraction activities. Well construction may be a concern if high TDS water moves upward into the shallow aquifer due to the high piezometric surface of the deep aquifer. This condition “pushes” water into the shallow aquifer zone through a well or along the outside of a well. This condition also may occur through an improperly abandoned well that is screened in the deep aquifer.
	Volatile Organic Compounds	
	Trigger Point 1. Monitoring results of VOCs meet or exceed established maximum contaminant levels.	Report the exceedance in the State of the Basin Report. The affected stakeholder(s) and appropriate regulatory agencies would be notified and arrangements made to remedy the problem.
	Trigger Point 2. VOC monitoring results believed to be a result of normal basin pumping activities.	A study, in conjunction with appropriate regulatory agencies, will be conducted to determine the source of the contamination. If specific pumping activities are found to be the cause of contaminant migration, the appropriate regulatory agency will take the necessary steps to have the designated responsible party replace lost capacity and to protect other private and public wells from being contaminated.
	Nitrates	
	Trigger Point 1. Monitoring results of nitrates meet or exceed established the Primary Drinking Water Standard of 40 mg/l.	Report the exceedance in the State of the Basin Report. If a health concern exists, the affected stakeholder(s) would be notified and arrangements made to remedy the problem.
	Trigger Point 2. Source of nitrates believed to be a result of activities related to on-site wastewater disposal system management.	A study, in conjunction with the appropriate regulatory agencies, will be conducted to determine the source of the contamination. If on-site wastewater disposal systems are found to be the cause, a larger study of the impacted area may be warranted. Recommendations from these studies may necessitate an evaluation of design standards for on-site wastewater disposal systems county-wide.

4.3 CENTRAL BASIN WELL PROTECTION PROGRAM

The Central Basin Well Protection Program (WPP) is a result of negotiations that took place in the CSCGF. A copy of the negotiated Trial Balloon on Well Protection is included in **Appendix D**. Any differences between the Trial Balloon and this section are a result of the need to provide supplemental information and clarification for full implementation of the WPP. The basin governance body will be responsible for implementing this program.

4.3.1 Background

The WFA set the long-term average annual extraction of groundwater (i.e., sustainable yield) from the Central Basin at 273,000 acre-feet. When the Water Forum stakeholders negotiated this extraction volume for the basin, it was anticipated that this volume would result in a further decline in groundwater levels (approximately 50 feet in the deepest part of the cone of depression as measured in 1990). It was expected that such a decline would affect some existing domestic and agricultural wells. An update of the Impact Analysis (**Appendix E**) was recently completed. This update is based on groundwater model improvements and the Zone 40 WSMP. Results of this analysis show that the decline is not as severe as originally expected.

Protection of the Central Basin's groundwater resource and the domestic and agricultural wells located within the basin is of fundamental importance to the stakeholders of the CSCGF. Regarding the basin's long-term sustainable yield, the CSCGF was concerned that the continued decline in groundwater levels could result in the "dewatering" of some wells, particularly agricultural and agricultural-residential wells. Agricultural and agricultural-residential users have no alternative source of supply if their wells are dewatered, and current groundwater users should not have to subsidize future growth in the basin by paying the cost of deepening or replacing existing wells. To address this concern, it was proposed that a WPP be included as part of the groundwater management plan for the Central Basin.

4.3.2 Trust Fund Proposal

It is the responsibility of the basin governance body to develop specific details on operation of the well protection trust fund (trust fund). These details include, but are not limited to, the amount of a well protection fee, how the well protection fee will be collected, criteria for submitting a claim, claim verification, maximum amount paid per verified claimant, timeline between submission of claim and date of decision, etc.

All details related to the trust fund should be developed, and the WPP fully operational, within one year of the creation of the basin governance body. (NOTE: Development and implementation of the Central Basin WPP is not intended to modify or change any provisions of the North Vineyard Well Protection Program Agreement, or to relieve any party of their obligations as set forth in that agreement.) Some of the specific details of the trust fund are defined in the following subsections.

4.3.2.1 Creation of the Trust Fund

The purpose of the trust fund is to cover the cost of deepening or replacing existing agricultural or agricultural-residential wells that may be impacted by future development in the Central Basin area. As mentioned previously, funding for the trust fund will be provided through collection of a well protection fee. Well protection fees can be collected as part of the building permit process for new construction or as part of the well drilling permit process for a new well. The amount of the fee, how it will be collected, and how the trust fund should be administered will be determined by the basin governance body. The specifics of the fees, how much the fee should be, and who gets assessed will be determined within 6 months of adoption of the CSCGMP.

4.3.3 Fee Exemptions

Any property that is exclusively served by surface water is exempt from paying the well protection fee. Any well drilling permit application for a remediation well required by a regulatory compliance order and all monitoring wells are exempt from paying the well protection fee. If an individual is obtaining both a building permit and applying to drill a new well on the same property, only one assessment should be made. For example, if a purveyor has paid the impact fee for a new well and is required to also get a building permit for appurtenant structures, the fee would only be assessed once.

4.3.4 Update to Fee Program

Once the well protection fee has been established by the governance body, a public notice and comment period will be conducted. The fee shall be indexed to the average of the Engineering News-Record (ENR) construction cost index for 20 U.S. cities and San Francisco when the WPP is adopted. Increases shall be determined by calculating an adjustment factor based on the index when the WPP is adopted, and the current index. Adjustments shall be made on an annual basis.

Throughout the life of the trust fund, the basin governance body should have the power to change the amount of the assessment by conducting a nexus study, including an impact analysis. This study would be initiated as a result of the findings of actuarial studies. An impact analysis was completed in December 2005 (see **Appendix E**).

4.3.5 Authority to Collect Fees

The basin governance body is responsible for collecting the well protection fee and administering the trust fund. Details of this authority will be determined as part of the process of establishing the basin governance body. The basin governance body should work cooperatively with permit-issuing authorities to see that fees are collected in an efficient manner.

4.3.6 Eligibility to Participate in Program

To establish eligibility for coverage under the program, existing wells must be registered with the basin governance body by the well owners. The basin governance body shall establish the terms and conditions under which a well shall be registered, and will develop a schedule and set a reasonable time limit by which to complete the registration process. The governance body shall make every reasonable attempt to inform all residents who may be eligible to participate in the WPP to register their well(s).

Once a well has been registered, coverage by the trust fund shall continue for as long as the fund remains active. Coverage of a well can be transferred for a particular property if ownership changes. Once a well has been registered, coverage by the trust fund shall continue for as long as the fund remains active. Coverage of well can be transferred on a particular property when there is a change in ownership.

4.3.7 Eligibility for Claims

The basin governance body will establish eligibility criteria for claims against the trust fund that are clearly defined and strictly related to a decline in groundwater level. Wells that have failed for reasons other than a decline in groundwater level, such as a structural failure or faulty motors or pumps, etc., will not be covered by the fund.

Any claim against the trust fund must be submitted to the basin governance body for review and verified by an independent source (e.g., hydrogeolologist, well service company, etc.) to be compensated by the fund. The verification cost will be funded by the trust fund.

4.3.8 Sunset Provision

No earlier than five years after implementing this program, nor later than the beginning of the eleventh year after surface water from the FRWA project is delivered to the Central Basin area, the basin management body shall conduct a comprehensive evaluation to determine whether a continuing need exists to maintain the trust fund. In conducting this evaluation, the basin management body shall consider the following factors:

- Groundwater levels
- Number of claims made against the trust fund
- Rate of claims filed over time (i.e., is the rate of claims increasing or decreasing)
- Status of urbanization (i.e., is further growth/development anticipated and, if yes, how will it affect water supply)

A decision on whether or not to continue the trust fund shall be reserved to the basin governance body.

If the basin governance body decides to terminate the program, any undisbursed money should be used for other activities consistent with the purposes of the CSCGMP (e.g., conservation, habitat mitigation, enhancement of groundwater recharge, etc.). For this to occur, the language establishing the trust fund must be consistent with the requirements set forth in Government Code, Section 1600.

4.4 GROUNDWATER CONTAMINATION MONITORING AND COLLABORATION PROGRAM

The Central Basin Groundwater Contamination Monitoring and Collaboration Program is a result of negotiations that took place in the CSCGF. A copy of the negotiated Trial Balloon is included in **Appendix F**. Any differences between the Trial Balloon and this section are a result of the need to provide supplemental information and clarification for full implementation of the program. The basin governance body will be responsible for implementing this program.

4.4.1 Background

Groundwater contamination and remediation of contaminated groundwater in the Central Basin must be addressed proactively. Water purveyors, regulatory agencies, responsible parties, and the Water Forum Successor Effort should meet on a regular basis to share information and develop strategies to collaborate on potential threats to drinking water sources and on cleanup activities.

These collaborative strategies should be designed to avoid negative impacts on all other water resources and water users.

4.4.2 Program Components

The components of the program focus on maintaining a policy of keeping remediated groundwater within the Central Basin through non-potable uses within newly developing areas and to maintain consistent outreach programs to private well owners to inform and collect data on groundwater cleanup efforts taking place within the region.

Program Component 1. Use of Remediated Groundwater in Urbanized Areas

The Water Forum Successor Effort and the basin governance body should commence a high-priority effort to convince Sacramento County and the cities of Elk Grove, Rancho Cordova, and Sacramento to adopt policies that encourage the use of remediated groundwater for non-potable purposes.

Program Component 2. Survey Private Wells for Potential Contamination

The Water Forum Successor Effort and the basin governance body should request that the RWQCB require responsible parties (i.e., parties who caused contamination) to survey private wells within 2,000 feet of any identified contaminant plume, and also require development of an appropriate monitoring plan for said wells. The monitoring plan shall be subject to review by the basin governance body and shall include the use of “sentinel” wells. The plan also should include information on frequency of sampling, reporting requirements, etc.

Program Component 3. Assistance of the Sacramento County Environmental Management Department

Sacramento County EMD is responsible for issuing well drilling permits and ensuring that the provisions of Sacramento County’s well drilling ordinance are enforced. If the requirements of the ordinance are not met, EMD should undertake whatever rigorous enforcement actions are available and effective in the given circumstances.

The basin governance body will work with EMD to establish and maintain an information clearing house to assist individual well owners in addressing contamination concerns (e.g., sources for well testing services, substances to be tested for, cost, options if contamination is found, etc.). As part of its responsibility for this information clearinghouse, the basin governance body should collaborate with the RWQCB to maintain up-to-date information on contamination sources in the Central Basin. Also, EMD should undertake a concerted effort to inform individual well owners of the importance of testing/monitoring water quality in their wells through a variety of public education tools, including (but not limited to) a brochure provided to all applicants as part of the well permitting procedure.

4.5 CENTRAL BASIN REPORTING METHODS

The basin governance body is responsible for reporting on the progress of implementing the CSCGMP in an annual State of the Basin report. At a minimum, the annual State of the Basin report will summarize groundwater conditions within the basin, and document groundwater management activities from the previous year. Much of the data used in developing the annual State of the Basin report will come from the monitoring data stored in the basin's DMS. The report also will detail the progress made on implementing the various action items described in **Section 3**.

4.5.1 State of the Basin Report

The annual State of the Basin report is an essential document that will provide detailed information to stakeholders and the general public on the current state of the Central Basin. This report will include the following:

- Reports on trigger points that were reached (if any) and actions that were taken to evaluate/mitigate the problem.
- An evaluation supported by monitoring results on whether management actions and trigger point actions are meeting the BMOs.
- Improved characterization of the basin through interpretation of new and historical data included in the DMS.
- Summary and interpretation of groundwater elevation data based on the polygon method outlined in **Appendix B**.
- Summary and interpretation of basin water quality, including a graphical presentation of how the sampling data compare with thresholds set in **Section 3.1.5** for the various water quality constituents.
- Update on implementation of the WPP and identification of fund reserves and any monies spent, including specific information on which wells were impacted and how the determination was made to expend program funds.
- Update on the Groundwater Contamination Monitoring and Collaboration Program, including actions taken throughout the year, and how those actions lead toward the stated goals of the CSCGMP.
- Summary of any component changes, including the addition or modification of BMOs (e.g., polygon thresholds for maximum and minimum groundwater elevations or thresholds for water quality concentrations) during the period covered by the report.

The annual State of the Basin report will be completed between April 1 and June 1 of each year and will cover conditions and activities completed through December 31 of the prior year.

4.6 FUTURE REVIEW OF THE GMP

The CSCGMP is intended to serve as a framework for the first regionally coordinated management effort in the Central Basin area. Updates by the basin governance body will be identified in the annual State of the Basin report described above. The CSCGMP is therefore intended to be a living document, and it will be important to evaluate all of the actions and objectives over time to determine how well they are meeting the overall specific goals. The basin governance body will reevaluate the entire CSCGMP within five years of adoption.

4.7 FINANCING AND SCHEDULE

The basin governance body is responsible for implementing the various programs as follows:

- Monitoring for groundwater quality or elevations in wells located outside participating water purveyor boundaries.

- Customization of the DMS interface.
- Preparation of annual reports.
- Adaptive updates of the CSCGMP.
- Update of data sets and recalibration/improvement of existing groundwater model (IGSM).
- Collection of additional subsidence data.
- Construction of monitoring wells where critical data gaps exist.
- Stream-aquifer interaction studies.
- Implementation of the CSCGMP action items in **Section 3**, including, but not limited to the following:
  - Ad-Hoc Advisory Committee coordination, as required.
  - Project management.
  - Implementation of broader regional conjunctive use program, including agriculture.
  - Development of Public Outreach Plan.
  - BMO monitoring procedures.
  - Survey of abandoned wells.
  - Obtain DWSAP dates.
  - Update DMS data.
- Develop details of administering WPP including outreach.
- Registering wells for the WPP.
- Implementation of the WPP.
- Implementation of the Groundwater Contamination Monitoring and Collaboration Program.
- Reevaluate CSCGMP every five years.

Table 4-2 provides an estimate of annual costs to operate the monitoring and reporting program according to the recommended trigger point actions described in **Section 3** and **Table 4-1** above. Other costs include implementation of remedies to problems, the WPP, and additional costs associated with the start-up of the first year of plan implementation. Table 4-3 shows an implementation schedule for the first two years.

4.7.1 Plan Implementation Costs

First year program startup costs are estimated at $280,000. This is essentially 1.2 full time people working throughout the year on setting up monitoring programs, taking measurements, compiling data, reporting data. Future program costs will be evaluated on an annual basis by the basin governance body.

Table 4-2. Estimate in Implementation of the GMP

Action Items Related to the adopted CSCGMP	Total Cost
Component No. 1 Stakeholder Involvement	
Involving the Public (Development of Public Outreach Plan)	$5,590
Involving Other Agencies Adjacent to the Central Basin	$7,405
Utilizing Advisory Committees	$9,605
Developing Relationships with State and Federal Agencies	$9,605
Pursuing Partnership Opportunities	$5,545
Subtotal	$37,750
Component No. 2 Monitoring Program	
Groundwater Elevation Monitoring	$20,974
Groundwater Quality Monitoring	$44,886
Land Surface Elevation Monitoring	$3,420
Surface Water Groundwater Interaction Monitoring	$5,310
Protocols for the Collection of Groundwater Data	$8,886
Data Management System	$23,418
Subtotal	$106,894
Component No. 3 Groundwater Resource Protection	
Well Construction Policies	$3,500
Well Abandonment and Destruction Policies	$3,500
Wellhead Protection Measures	$3,500
Protection of Recharge Areas	$3,500
Control of the Migration and Remediation of Contaminated Groundwater	$3,500
Control of Saline Water Intrusion	$1,062
Subtotal	$18,560
Component No. 4 Groundwater Sustainability	
Demand Reduction (Water Conservation and Water Recycling)	$2,148
Subtotal	$2,148
Component No. 5 Planning Integration	
Existing Integrated Planning Efforts (Urban Water Management Planning, DWSAP Program, Land Use Planning, and Groundwater Modeling)	$30,414
Subtotal	$30,414
Reporting	
Well Protection Program	$4,015
Water Quality Collaboration Program	$14,015
Completion of Annual State of the Basin Report	$50,684
Subtotal	$68,714
Subtotal	
Associated Project Costs (5%)	$13,224
Estimated Annual Total	**$277,704**

Table 4-3. Implementation Schedule

TASKS	2006			2007												2008											
	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Monitoring for groundwater quality or elevations in wells located outside participating water purveyor boundaries						✓						✓						✓						✓			
Customization of the DMS interface	✓	✓	✓												✓												✓
Preparation of annual reports							✓	✓											✓	✓							
Adaptive updates of the CSCGMP									✓	✓											✓	✓					
Update of data sets and recalibration/improvement of existing groundwater model (IGSM)																									✓	✓	✓
Collection of additional subsidence data	Every Five Years																										
Apply for state/federal grant funding	✓	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→
Construction of monitoring wells where critical data gaps exist																✓	→	→	→	→	→	→	→	→	→	→	→
Stream-aquifer interaction studies																		✓	✓	✓							
Implementation of the CSC-GMP, including:																											
▪ Ad-Hoc Committee coordination, as required	✓	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→
▪ Project management	✓	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→
▪ Implementation of broader regional conjunctive use program, including agriculture	✓	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→
▪ Development of Public Outreach Plan	✓	✓	✓																								
▪ BMO monitoring procedures			✓	✓	✓																						
▪ Survey of abandoned wells			✓	✓	✓																						
▪ Obtain DWSAP dates				✓	✓											✓	✓										
▪ Update DMS data							✓	✓					✓	✓					✓	✓					✓	✓	
Develop details of administering WPP	✓	✓	✓																								
Registering wells for the WPP	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓												
Implementation of the Groundwater Contamination Monitoring and Collaboration Program			✓	✓	✓																						
Revaluate CSCGMP	Every Five Years																										

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Section 5

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CENTRAL SACRAMENTO COUNTY

GROUNDWATER MANAGEMENT PLAN

FEBRUARY 2006

MWH

WATER FORUM

SACRAMENTO COUNTY WATER AGENCY

Appendix A

Summary of the process used for arriving at the long-term average annual sustainable yield of 273,000 AF/year that was negotiated by the Central Basin.

Appendix A – Summary of the process used for arriving at the long-term annual average sustainable yield of 273,000 AF/year that was negotiated for the Central Basin

This appendix describes how the Groundwater Negotiation Team (GWNT) developed the long-term annual average sustainable yield for the Central Basin.

The first step taken was development of the baseline models. The buildup of water demands for each model is shown in **Figure A-1.** Groundwater extractions range from approximately 250,000 AF/year in 1990 to 350,000 AF/year in 2030. One additional demand condition was evaluated to consider if 1990 levels of water demand were sustained with 25 percent levels of water conservation applied. This demand condition is not represented in **Figure A-1** to avoid confusion, but is represented in each of the model result graphs that follow.

Figure A-1. Baseline Groundwater Demand Build-up in Central Basin

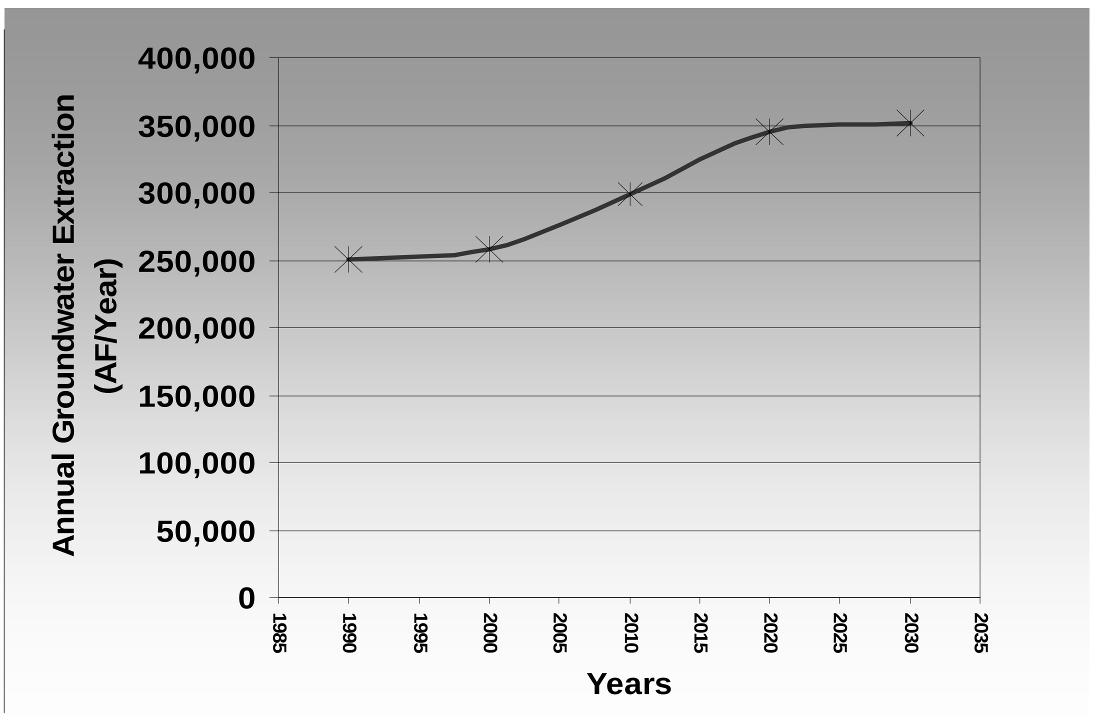
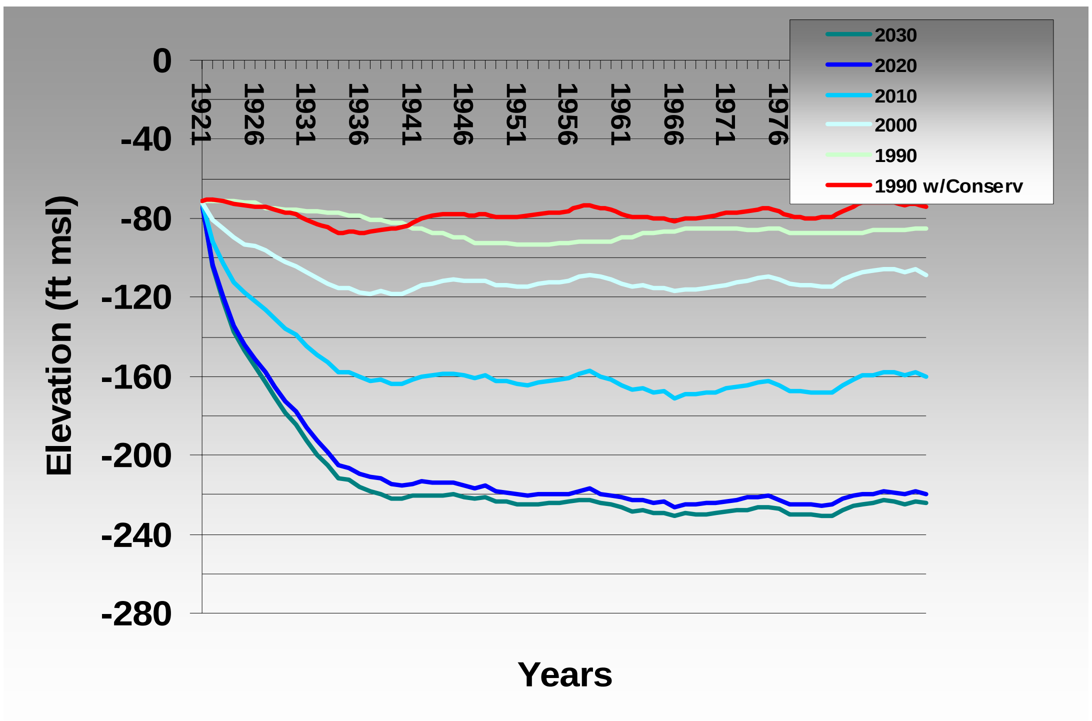


Figure A-2 illustrates the response of groundwater elevations to the simulated demands from the computer model using 70-years of historical hydrology for each 10-year growth increment. This collection of model runs comprises the baseline runs used for negotiation of the sustainable yield.

Each baseline model run begins at the same initial condition of approximately 73 feet below sea level (**Figure A-2)**. This initial condition simply represents a starting point and should not be construed as a measured groundwater elevation. It is only after 15 to 20 years in the model run that the model begins to reflect what the groundwater elevation pattern might look like under the varying hydrologic period. From the initial condition, the direction and severity of the groundwater elevation curve as it moves forward in time through the historical hydrologic years depends on the use of groundwater and the imposed land use conditions.

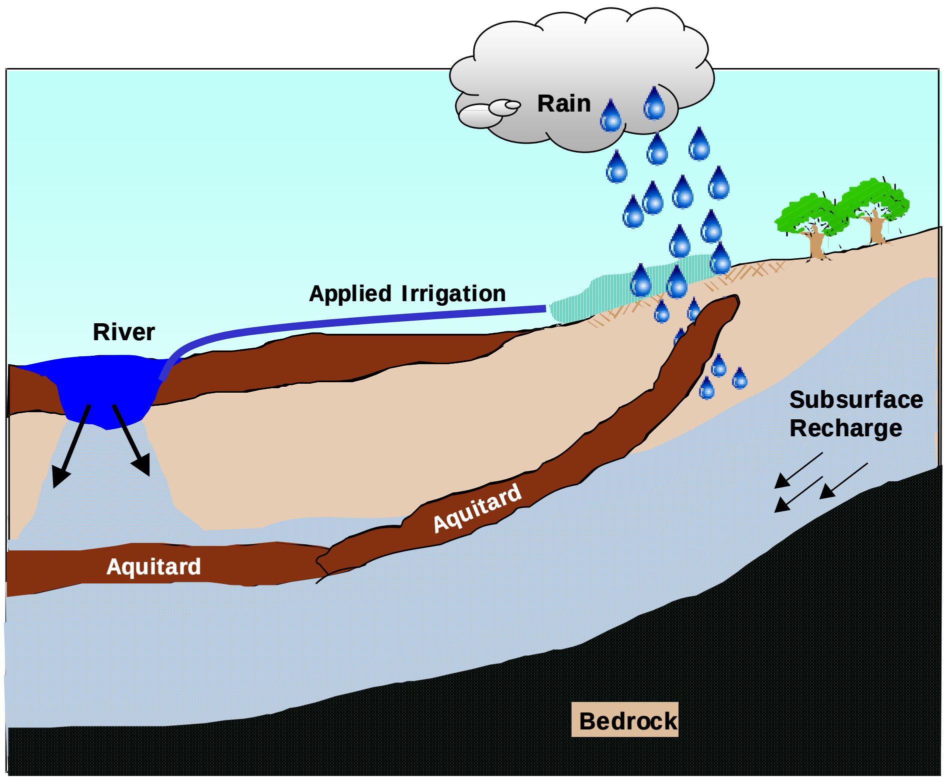
Figure A-2. Groundwater Elevation Trends for 10-Year Growth Increments



For instance, using the 2030 baseline run, the curve begins at initial conditions and quickly descends in about 15 years to approximately 220 feet below sea level and then stabilizes around this elevation for the remainder of the simulation. It is during the rapid drawdown period that the basin is said to be "out of balance" (i.e., pumping is greater than recharge). It is not until the curve flattens that natural recharge catches up with the higher rate of pumping. Higher rates of natural recharge occur predominantly through rivers that are hydraulically connected to the aquifer, such as the American and Sacramento Rivers. Recharge rates from the Cosumnes River do not increase significantly because it is not hydraulically connected over large reaches of the river bordering the Central Basin.

An illustration of a hydraulically connected river is shown in **Figure A-3** along with other sources of recharge. The slope of the groundwater surface from the river to the aquifer dictates how much recharge is occurring. The steep decline and then stabilization in **Figure A-2** is the result of river recharge going through this transition until the rate of recharge equals the rate of extraction (or pumping). Fluctuation in groundwater elevation after stabilization is the result of wet and dry year hydrology.

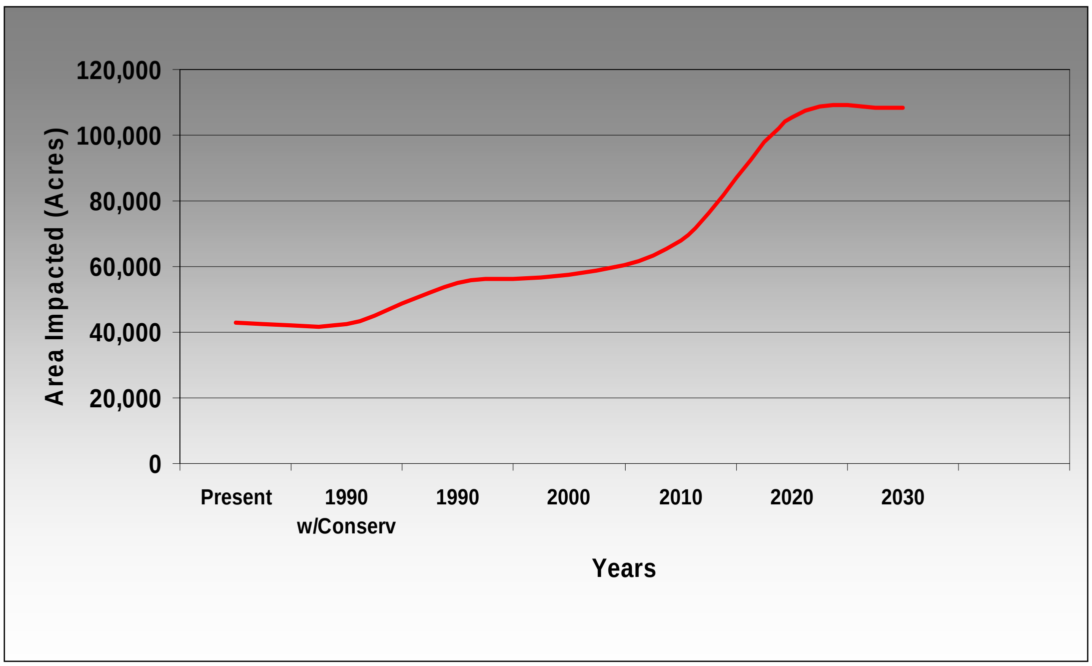
Figure A-3. Sources of Groundwater Recharge



Even though an extraction rate is sustainable, the impacts associated with it may not be acceptable to the overlying community. These impacts include water quality degradation, de-watering of wells, increased pumping costs, and ground subsidence. To address these issues, the GWNT statistically quantified these impacts for each of the baseline model runs.

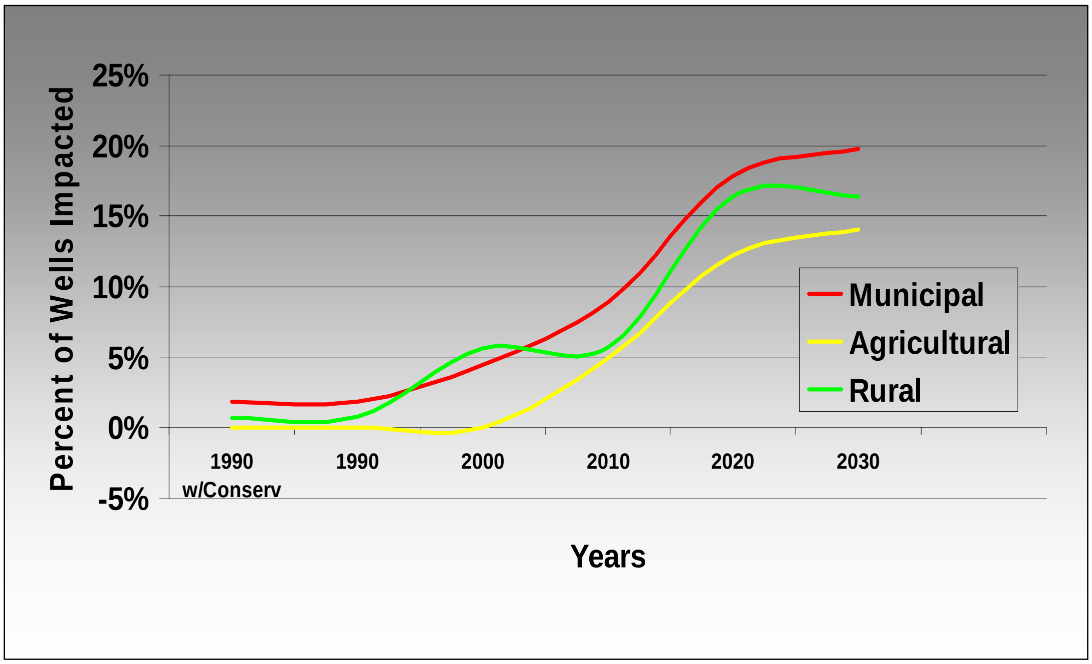
Water Quality Degradation – The amount of water quality degradation is measured by determining the land area that may currently be using water from the higher quality upper aquifer that could be impacted by lesser quality groundwater in the deeper aquifer. This occurs when groundwater levels in the upper aquifer decrease sufficiently to allow an upwelling of lower quality water from the lower aquifer. This could result in the need for private well owners to provide treatment for iron, manganese, total dissolved solids (or salinity), and possibly arsenic. **Figure A-4** shows the relationship between the baseline model runs and the amount of land area where water quality degradation "may" occur. Between 2000 and 2005 the curve remains relatively flat, after 2010 the amount of area potentially impacted increases significantly.

Figure A-4. Water Quality Degradation due to Pumping



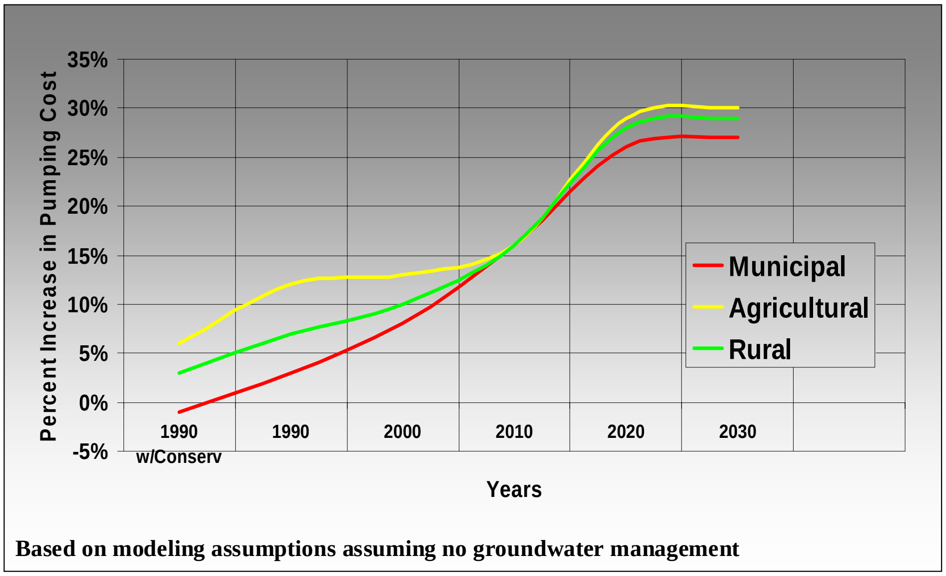
De-Watering of Wells – De-watering of a well occurs when groundwater levels drop below the depth of the well casing or screens. When this happens the well either needs to be deepened, the pump lowered, new screens constructed in the casing, or the well replaced. A sampling of wells was taken of each of the major groundwater users within 1-mile quadrants throughout the basin. For each well, the depth and location of the well was noted and then transferred to a groundwater level contour map for each baseline model run to determine if groundwater levels fell below the bottom of the well casing or screens. **Figure A-5** shows the percentage of wells impacted for each user category based on the baseline model runs. The rural and agricultural categories are of the highest interest given the shear quantity of wells and the expense a homeowner or farmer would bear to replace a well. Similar to water quality (**Figure A-4**) impacts, it is not until after 2010 that more than five percent of the rural and agricultural wells are impacted. The slight decrease in impacted rural wells between 2000 and 2010 is an artifact of the graphing utility and should be considered as little to no change in the percentage of wells impacted.

Figure A-5. Percent of Wells De-Watered by Lowering Groundwater Elevations



Increased Cost in Pumping - As groundwater levels fall, the energy it takes to pump the water to the ground surface with sufficient pressure to meet household and irrigation needs increases. In some cases, the water level may fall to the point where the pump is unable to lift water out of the well. In this circumstance, a new pump and motor may be required. Using the same sampling of wells as was used for the proceeding analysis, an accounting of the percent increase in the cost to pump was done for each user group. The result of this analysis is displayed in **Figure A-6** The agricultural line is relatively flat until 2010 and then it experiences a sharp increase. The other user groups steadily increase indicating a more uniform impact of lowered groundwater elevations across both municipal and rural users.

Figure A-6. Percent Increase in Pumping Cost by Lowering Groundwater Elevations



Land Subsidence - Land subsidence occurs when soils consolidate as water is removed from the soil matrix. The soil types underlying the Central Basin are not prone to subsidence. Benchmark studies over a 50+ year period indicate that the ratio of land subsidence to groundwater decline in the Central Basin is approximately 0.007 feet per foot of draw down. Based on the minimal amount of potential land subsidence, further evaluation was considered not necessary.

Appendix B

Summary of the development of Basin Management Objective #2 (Maintain specific groundwater elevations within all areas of the Central Basin consistent with the Water Forum solution).

Appendix B – Summary of the development of Basin Management Objective #2 (Maintain specific groundwater elevations within all areas of the Central Basin consistent with the Water Forum solution).

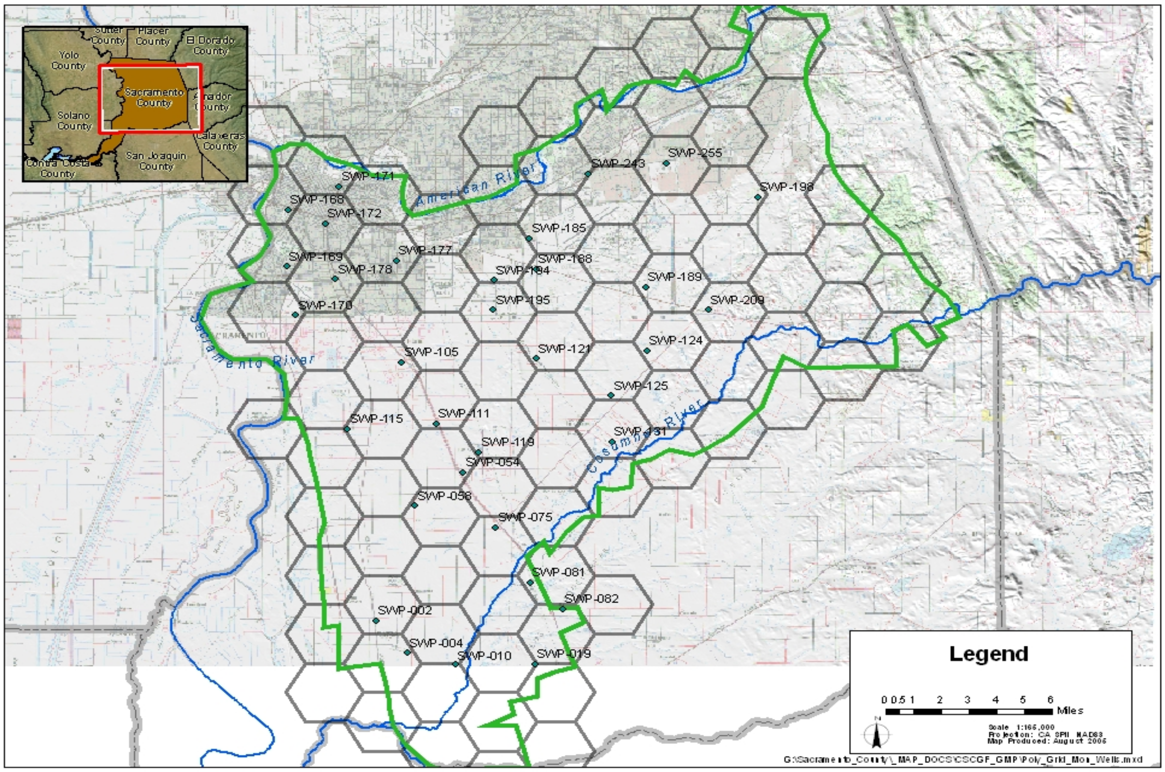
The following is a step-by-step description of how to the Central Basin will develop and/or update groundwater elevation thresholds. Thresholds will be established for upper and lower groundwater elevations throughout the Central Basin. Specific thresholds are summarized in **Section 3.1.1.1** of the CSCGMP.

Step 1. Define a polygon grid over the Central Basin that can be used as surrogate areas for possible management regions. This is done first to assist in understanding the basin's behavior at a relatively high level of resolution prior to possible aggregation of the areas based on meeting the objectives above.

The polygon grid used for the Central Basin is an extension of a similar grid used in the SGA GMP. This was done intentionally to allow for combining the monitoring results for both north and south of the American River knowing that each has the same level of resolution. The polygon grid is shown in **Figure B-1**. Each polygon represents an area of 3200 acres or 5 square miles.

Step 2. Locate a State Monitoring Well to represent each grid area based on the period of measurement record and the quality of the data. The period of record should include 1977 to 2003. Gaps in data should not exceed 1 year in time with monitoring at least twice a year, spring and fall. If no well meets this criterion, the location and/or perhaps the construction of a monitoring well will be necessary in the future. The location of selected wells is shown in **Figure B-1**.

Figure B-1. Polygons and Existing Monitoring Well Assignments



Step 3. Using the Water Forum Solution dataset in the Integrated Groundwater Surface Water Model[1] (IGSM) for 2030 conditions (Water Forum build-out), extract from the model, the hydrograph at the center of each polygon area. This is done to determine the ultimate behavior of the aquifer and then to compare the ultimate condition relative to existing groundwater elevations.

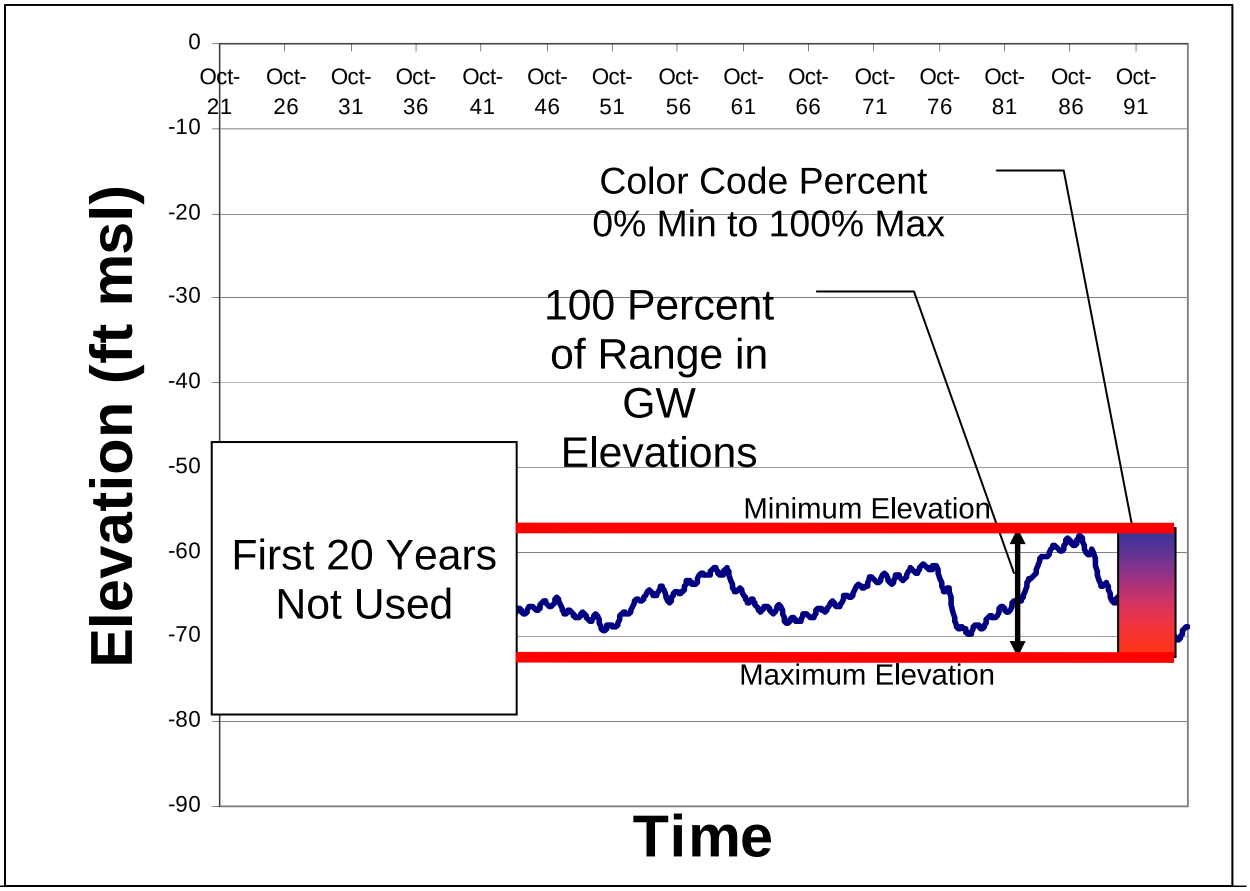
Step 4. Each of the real monitoring data hydrographs and model hydrographs will have a trace that shows groundwater elevations increasing in the wet months and decreasing in the dry months. The hydrographs also show the cumulative effect of multiple dry or wet years.

[1] The IGSM is a finite element, quasi three-dimensional, multi-layered model that integrates surface water and groundwater on a monthly time step. The IGSM was developed for use as a regional planning tool for large areas influenced by both surface water and groundwater. The tool is well-equipped to accommodate input and output of land use and water use data over large areas. Data input includes hydrogeologic parameters, land use, water demand, precipitation and other hydrologic parameters, boundary inflows, and historical water supply. For purposes of parameter definition and developing water budgets around physical and/or political boundaries, the IGSM divides Sacramento, Placer, Sutter, and San Joaquin counties into subregions. Each subregion is further divided into unique numbered elements varying from 200 to 800 acres in size. Overlying this grid is a coarse parametric grid utilized for specifying aquifer and other parameters.

For the model hydrographs, the maximum and minimum elevations are extracted from these hydrographs proceeding the first 20 years of model simulation to allow the groundwater basin to stabilize from initial conditions. The maximum and minimum values of model groundwater elevations are selected from each hydrograph. For instance, the lowest elevation may occur in the 1977 drought period and the maximum elevation may occur in the 1986 wet hydrology.

To normalize the data for the model data, the maximum and minimum elevation of each hydrograph are assumed to be equivalent to 100 percent of the operational range of the basin at that specific location within that polygon. This normalization is necessary to account for the fact that each polygon area has differing elevations due to the nature of the groundwater basin and the surface topography (i.e. the depth to groundwater in the eastern portion of the basin is less than the depth to groundwater in the southern Elk Grove portion of the basin). **Figure B-2** illustrates this process of defining the bandwidth of the model data and the percent rating using the high and low values. Five percent is added to the high elevation and subtracted from the low elevation to provide a small buffer that may show up in real-time monitoring but not in the model (e.g. monitoring wells located next to high producing wells that are running will be influenced by the localized cone of depression of the high producing wells showing a slight deviation from the actual regional groundwater elevation that is being measured).

Figure B-2. Methodology of Bandwidth based on Model Hydrograph



Importance of Bandwidth in Describing BMO Objectives

The bandwidth concept is important from the standpoint of judging whether the aquifer is within a management range; understanding that groundwater elevations fluctuate from month to month and from year to year depending on groundwater use and hydrologic conditions. The percentage indicator within the bandwidth becomes the index of performance and in setting management goals. Within the bandwidth itself, there can be various levels of warning and actions that take place based on each increasing level of warning. This concept is explained in step 6 where a framework for the BMO is defined.

Step 5. Three periods in the historical record are selected to represent a worst, best, and average case of groundwater conditions; these are 1977 (critical dry year), 1983 (very wet year), and 1979 (average year following 2 years after the 1977 drought period), respectively. The significance of 1977 is the combined behavior of increased groundwater extractions, reduced recharge from rivers and deep percolation, and cumulative effects of back to back dry years.

Underlying this information is the time element of how quickly does the groundwater elevation change in one polygon area versus another. For example, a polygon close to the river is influenced significantly by the river's recharge and will be affected almost immediately based on high or low flow river stages. In the dry years, polygons closest to the rivers experience the highest percentage of groundwater decline relative to the total bandwidth. Whereas, an area removed from the major recharge sources will not feel the full impact due to the time that it takes for river recharge to migrate to these areas. Groundwater movement is typically not more than 700 feet a year in the unconfined aquifer.

If the information described above is translated into a figure in terms of percent of the maximum and minimum or "bandwidth" values (e.g., a value from 0 to 100 percent), it becomes apparent that there are areas of similar aquifer behavior as shown in **Figure B-3** for 1977 conditions. One preferred representation of what is termed, "management zones" is shown in **Figure B-4** by the green boundary lines. The delineation of management zones takes into consideration not only the aquifer behavior but also the land use and surface water and groundwater use taking place within the basin. Additional thought in developing the zones was given based on **Figures B-5** and **Figure B-6** (described more fully below).

Aggregation of similar areas to form management zones is for purposes of monitoring and maintaining a net benefit to groundwater users over time as use of groundwater and surface water change, and land uses change over time. Aggregation is also necessary to avoid creating a management program that is cumbersome, costly, and perhaps not fully understood by the future governance body.

Figure B-3. Percentage of Groundwater Model Elevation Depth for 1977 Hydrology

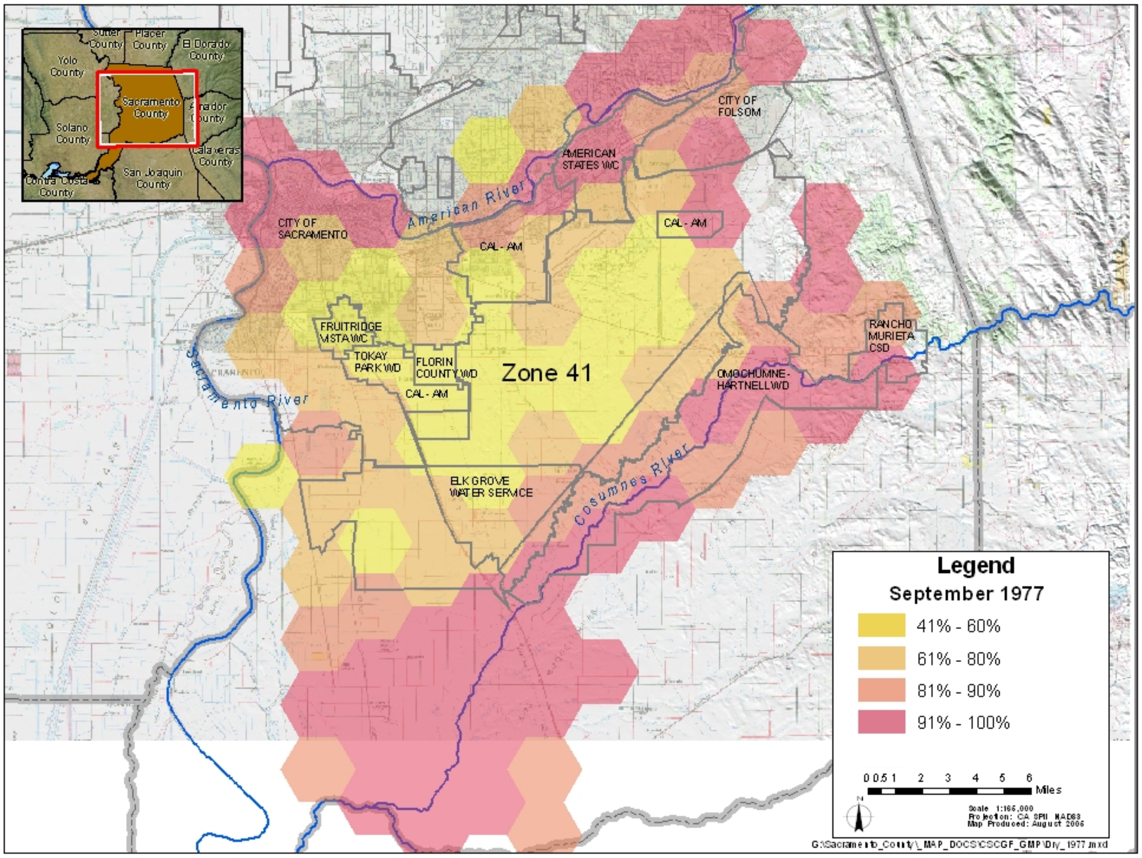
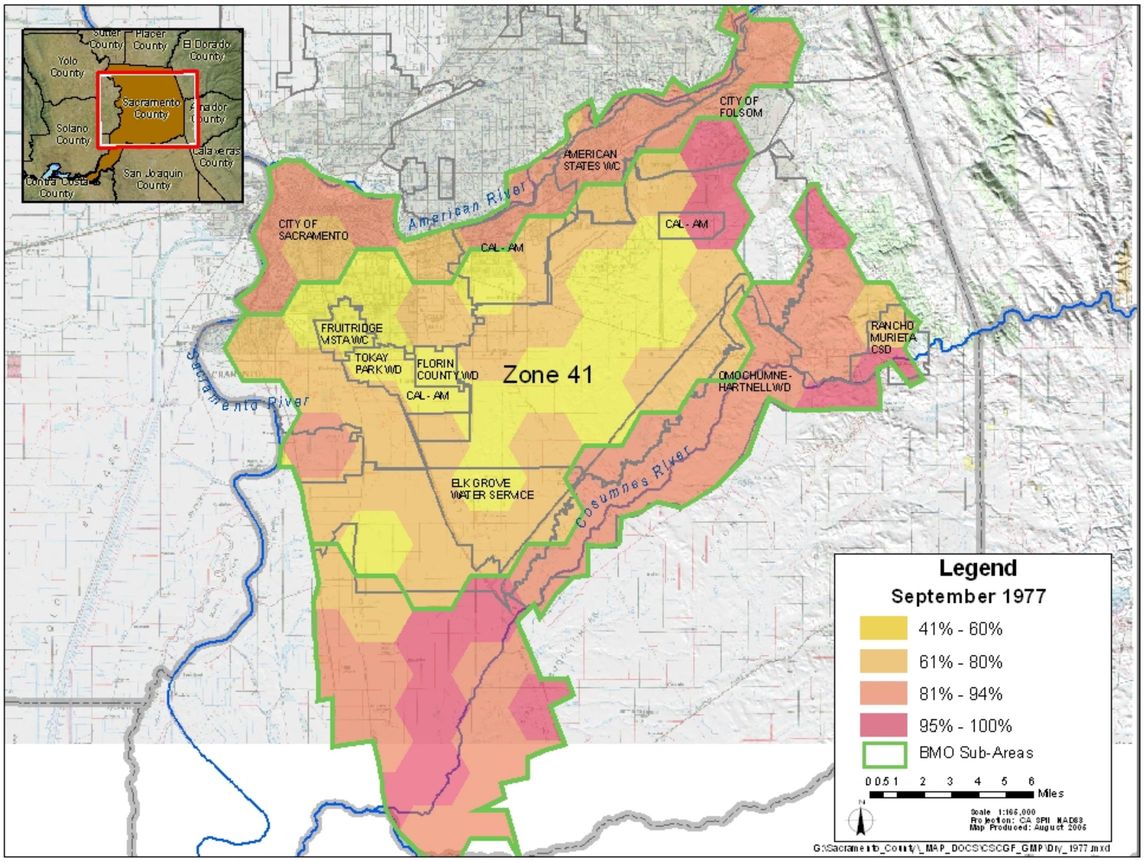


Figure B-4 suggests that within the Central Basin there be a north, central, and south management zone. The north and south zones are due to the obvious red polygons indicating areas with more sensitivity to drought conditions. The north zone is predominantly made up by the City of Sacramento, Cal-Am, and Golden State Water Company with both surface water and groundwater being used. Cal-Am is still dependent on groundwater and therefore is most affected by drought conditions.

The south zone is predominantly groundwater with agricultural and agricultural residential land uses with private wells and is deserving of being a focal point on groundwater management. Since this zone is also significantly affected by drought conditions, monitoring in this area is going to be extremely important to understand the full affect of changing conditions both in hydrology in the river recharge sources and land use changes both within the south zone and in the central zone.

Figure B-4. Groundwater Management Zone Delineation based on 1977 Hydrology



If **Figure B-4** (1977 critical year**)** is compared to **Figure B-5** (1983 wet year**)**, a similar pattern of recharge is evident along the rivers except that now there is an increase in the percent of bandwidth. The darker blue in **Figure B-5** (1983 wet year) represents percentages closest to the upper elevation of bandwidth for each polygon. The same aggregation is represented in **Figure B-5** to illustrate the logical separation of management zones.

The central zone is perhaps the most interesting in terms of how it behaves. **Figure B-6** (normal year) represents 1979 average hydrologic conditions two years after the 1977 extended drought condition and just before the wet period into 1983. This figure combines the time element of how long it takes for the effect of drought conditions to fully establish itself at the cone and how long it takes to recover. The central zone maintains a residual effect of the drought by the darker yellow polygons not changing significantly from 1977 to 1979 indicating 50 percent of the bandwidth, and from 1979 to 1983 with a similar pattern near the cone of depression. This implies that the central zone takes more time to react and recover; whereas, the north and south zones react quickly to hydrologic conditions where the polygons reduce from 90 percent in 1977 to 60 to 80 percent in 1979 and 10 percent in 1983.

Figure B-5. Percentage of Model Groundwater Elevation Depths for 1983 Hydrology

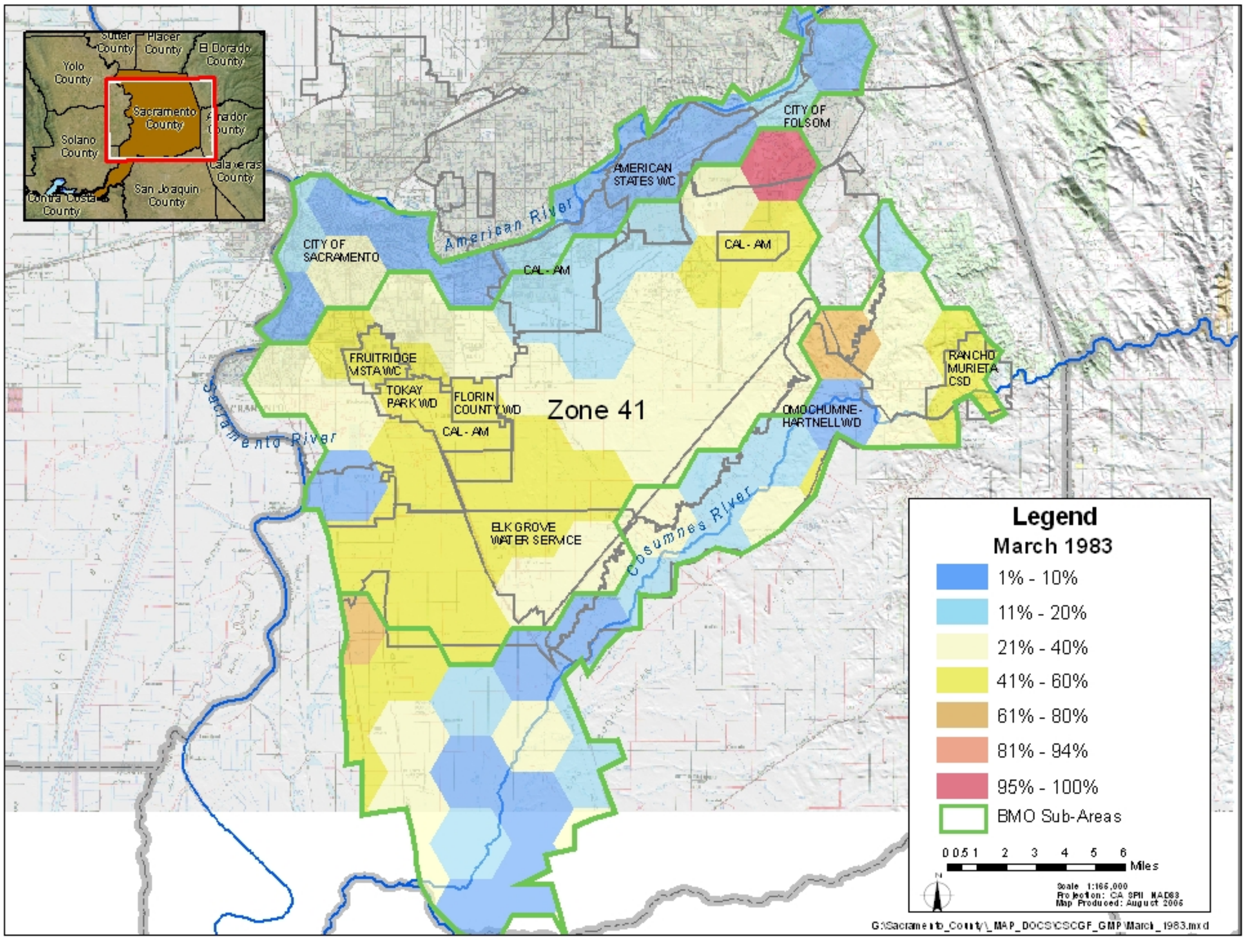
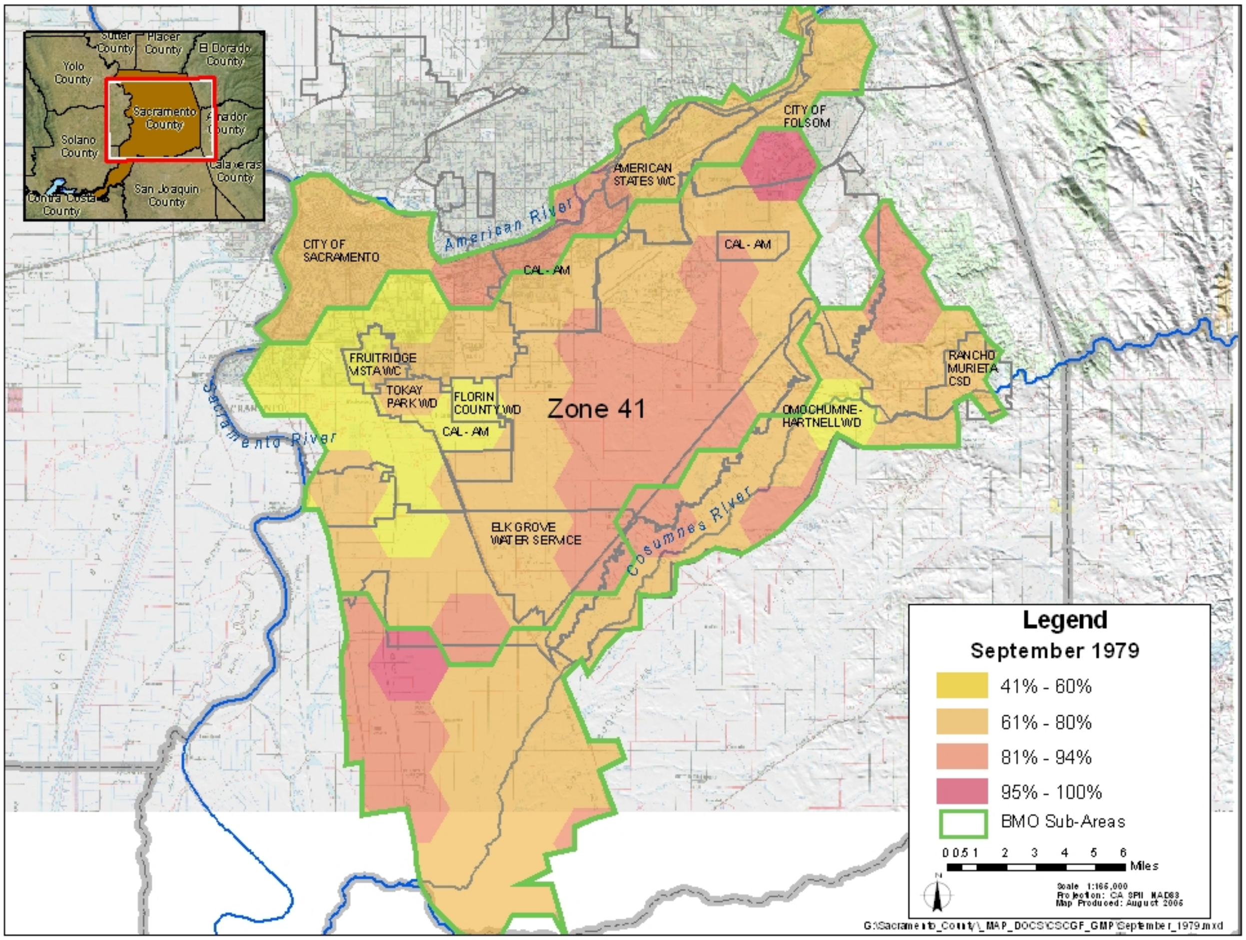


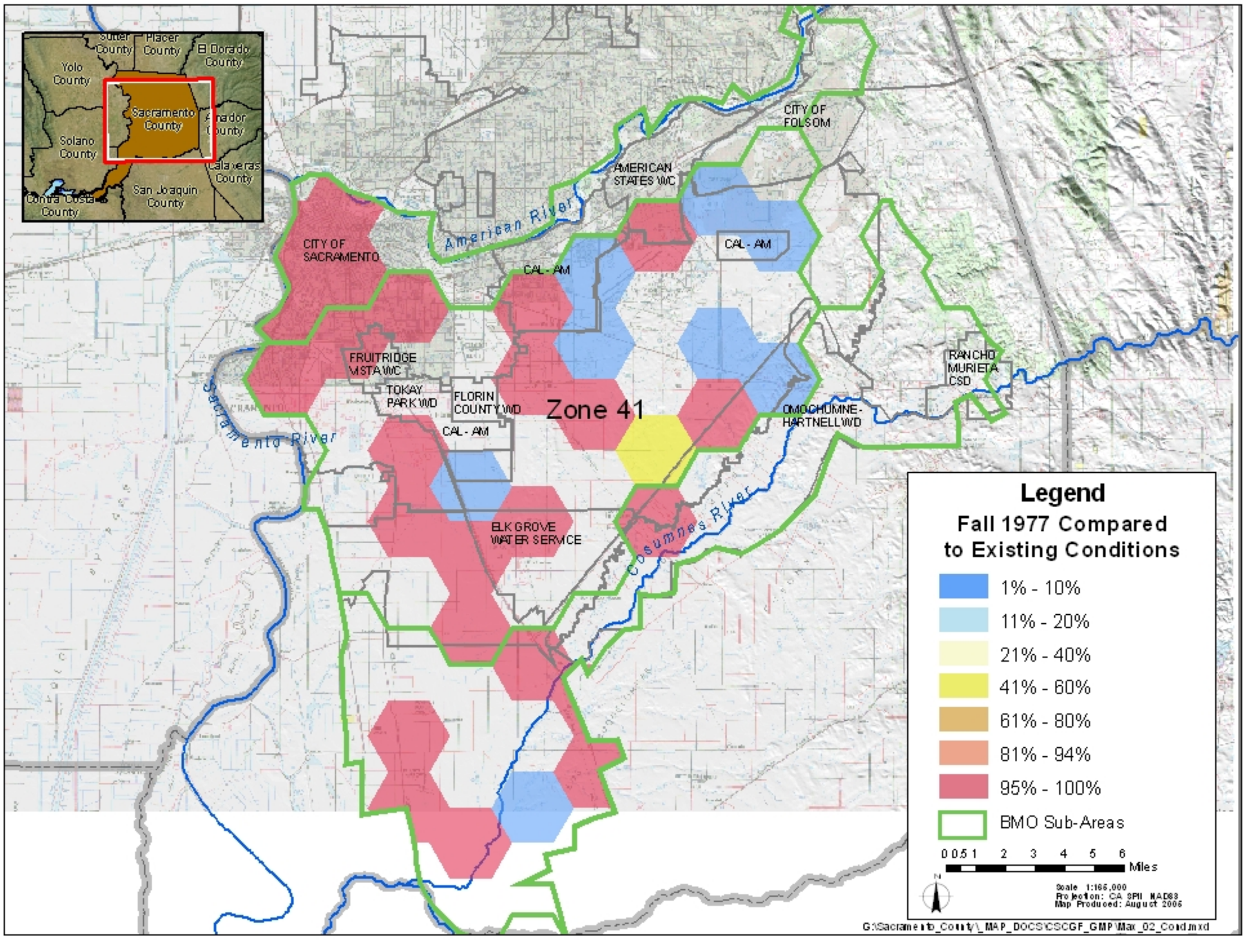
Figure B-6. Percentage of Model Groundwater Elevation Depths for 1979 Hydrology



Step 6. Ground-truthing the model data versus real data is necessary from the perspective of private well owners who currently realize a certain level of reliability in groundwater elevations and understand that during drought conditions there will be periods when groundwater elevations reach their lowest point with possible increase in energy costs and dewatering of wells. To achieve a sense of relative difference between the management objectives and current groundwater conditions, the bandwidth concept is applied to real monitoring data for the most recent measurement value as explained in Step 4 above.

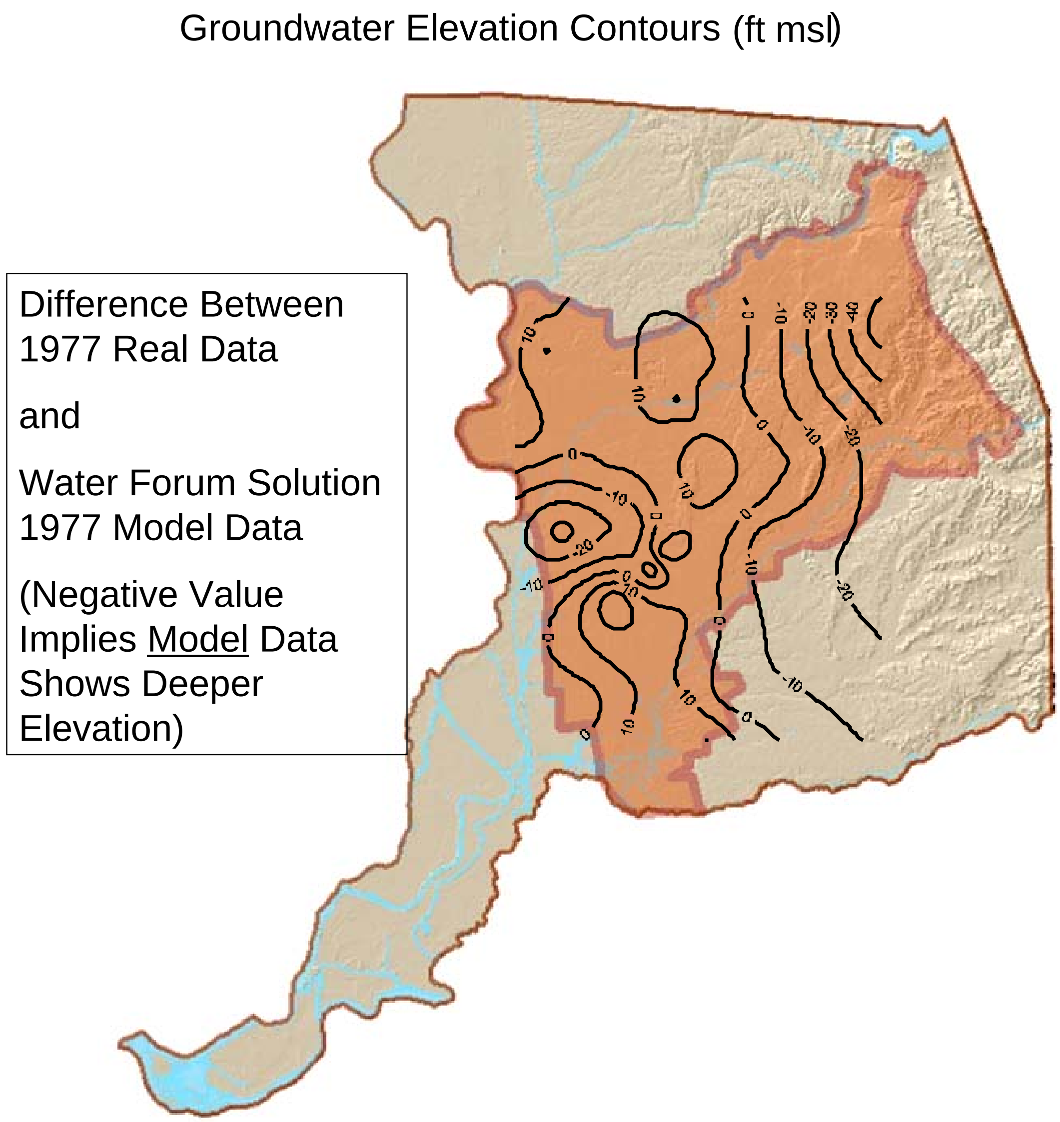
Figure B-7 provides a similar graph for 1977 conditions using real data to evaluate the lowest groundwater elevation relative to today's bandwidth and **Figure B-8** positions the 1977 real data on the model data and contours the difference. The expectation is that under the Water Forum Solution groundwater elevations do not exceed what actually occurred in 1977. If accidence does occur, **Figure B-7** provides, at a glance, the areas where accidence may occur which then provides the basin governance body to begin to understand future programs to mitigate for this event.

Figure B-7. Percentage of Real Groundwater Elevation Depths for 1977 Hydrology



Lastly, to look at the difference between the 1993 real data and the 1993 model data in a more absolute manner, a difference contour map is generated that indicates the probable increase or decrease that might be expected from the 2030 Water Forum Solution in the three management zones. Positive values in **Figure B-8** indicate a positive effect or higher groundwater elevation and a negative contour represents an area that may be impacted by the Water Forum Solution.

Figure B-8. Groundwater Elevation Difference Contours between Model and Real Data for 1977 Hydrology



<u>Step 7.</u> The next step is the development of a framework for monitoring and management of groundwater elevations for each management zone. The fundamental requirements of the framework are listed as follows:

- Provides for simple implementation;
- Allows for adaptive changes based on monitored data;
- Keeps the presentation of the data in a form that can be understood by all stakeholders;
- Allows for differing stages of attention requiring specific actions;
- The details of this framework are provided in **Section 4** (Plan Implementation) of the CSCGMP.

Appendix C
Public Notices

NO085 PUBLIC NOTICE

RESOLUTION NO. WA-2590

RESOLUTION OF INTENTION TO PREPARE A GROUNDWATER MANAGEMENT PLAN FOR THE CENTRAL GROUNDWATER BASIN OF SACRAMENTO COUNTY AND ADOPT A STATEMENT OF PUBLIC PARTICIPATION

WHEREAS, the stakeholders in the Central Sacramento County Groundwater Forum (hereinafter referred to as "Groundwater Forum") desire to develop a Groundwater Management Plan (hereinafter referred to as "GMP") in accordance with Section 10753 - 10753.10 of the California State Water Code (hereinafter referred to as "Water Code") and a groundwater management governance mechanism for the Central Sacramento County Groundwater Basin (hereinafter referred to as "Central Basin"); and

WHEREAS, development of a GMP would provide for the effective management of the groundwater resource; and

WHEREAS, the State Water Code requires that before a GMP can be prepared a local public agency with statutory authority adopt a Resolution of Intention; and

WHEREAS, the Groundwater Forum lacks the statutory authority to adopt a Resolution of Intention; and

WHEREAS, the Sacramento County Water Agency (hereinafter referred to as "Agency") was formed in 1952 by a special legislative act of the State of California (the Sacramento County Water Agency Act .hereinafter referred to as "Agency Act") and is a stakeholder in the Groundwater Forum; and

WHEREAS, under the Agency Act the Agency is to provide for the protection, preservation, and enhancement, for current and future beneficial uses, the groundwater resources in Sacramento County; and

WHEREAS, under the Agency Act the Agency is empowered to develop, adopt and implement a plan for the management of groundwater resources.

NOW, THEREFORE, the Board of Directors of the Sacramento County Water Agency resolves and determines as follows:

Section 1. The foregoing recitals are true and correct and this Board so finds and determines.

Section 2. The Agency will develop the groundwater management plan for the Central Basin. Upon completion of the GMP, the groundwater management governance mechanism developed by the stakeholders of the Groundwater Forum will adopt and implement the GMP. Among other components, the Central Basin groundwater management plan shall include the following components:

a. Basin Management Objectives;

b. Components relating to the monitoring and management of groundwater levels, groundwater banking, groundwater quality, inelastic land surface subsidence, and changes in surface flow and surface water quality that directly affect groundwater levels or quality or are caused by groundwater pumping;

c. Monitoring protocols to track changes in conditions related to the components in paragraph (b) and to generate information for the purpose of meeting Basin Management Objectives and establishing effective management of groundwater;

d. A plan to involve other local agencies, water purveyors, and private well owners in the Central Basin in the development of the groundwater management plan;

e. A map depicting the Central Basin, as defined by California Department of Water Resources Bulletin No. 118 and the Groundwater Forum, other local agencies, and water purveyors in the Central Basin; and,

f. Rules related to implementation of the groundwater management plan.

Section 3. The Groundwater Forum will provide for public involvement in the development of the groundwater management plan. The Groundwater Forum's plan for public involvement shall include the following:

a. The formation of a Technical Review Committee and Policy Committee to guide development of the groundwater management plan;

b. Coordination and participation from the Water Forum;

c. Preparation of a Public Outreach Plan; and,

d. Public review and comment period and public hearings.

On a motion by Director Collin, and seconded by Director Nottoli, the foregoing resolution was passed and adopted by the Board of Directors of the Sacramento County Water Agency, State of California, this 19th day of April, 2005 with the following vote, to wit:

AYES: Directors, None
NOES: Directors, None
ABSENT: Directors, None
ABSTAIN: Directors, None

Roger Dickinson
Chair of the Board of Directors of the
Sacramento County Water Agency,
a district organized under the laws of the
State of California

ATTEST:
Clerk of the Board of Supervisors of Sacramento
County, California, and ex officio Secretary of the Board of Directors
of Sacramento County
Water Agency

2Ti April 27 & May 4, 2005

Appendix D

Trial Balloon on Well Protection Program

CENTRAL SACRAMENTO COUNTY GROUNDWATER FORUM

Trial Balloon on a Well Protection Program: Final recommendations negotiated by the CSCGF

BACKGROUND

The Water Forum Agreement sets the long-term average annual extraction of groundwater (i.e., sustainable yield) in the Central Area at 273,000 acre-feet. At the time this figure was negotiated, it was anticipated that this sustainable yield would likely lead to a further decline in the groundwater level of approximately 50 feet in the deepest part of the existing cone of depression. Such a decline would undoubtedly affect some existing domestic and agricultural wells.

The protection of domestic and agricultural irrigation wells is of fundamental importance to the Agriculture and Agricultural/Residential Groundwater Users Interest Groups. Agriculturists and "ag/res" users have no alternative source of supply and they should not be required to subsidize future development by having to pay the cost of either deepening or replacing their existing wells. In order to address this concern, we propose that the following be included as part of the "solution package" concerning groundwater management in the Central Area.

RECOMMENDATIONS

The Central Sacramento County Groundwater Forum recommends:

1. The creation of a "well protection" trust fund.

2. The purpose of this fund shall be to cover the costs of deepening or replacing any *existing* well that provides water for agricultural or domestic use that may be impacted by future development in the Central Area. (The Central Area of the groundwater basin is bounded on the north by the American River, on the east by the Sierra foothills, on the south by the southern boundary of the Omochumne-Hartnell Water District and on the west by the Sacramento River and Interstate 5.)

3. This fund should be administered by whatever entity or authority is charged with the responsibility for managing groundwater in the Central Area.

4. The trust fund should be financed through:

- A fee assessed on every new building permit issued following a specified date (e.g., 30 days after establishment of an entity/authority to manage groundwater in the Central Area) ; and
- A fee assessed on any permit to drill a *new* well for any purpose, including agriculture, agricultural/residential, business, M & I supply, etc. However, an application to drill a remediation well required by a regulatory compliance order and all monitoring wells should be exempted from paying a fee.

5. Any property within the City of Sacramento that is served by surface water should be exempted from paying a fee on building permits to support the well protection trust fund.

6. The amount of the fee to be assessed on both building permits (for new construction) and new well applications should be determined by the groundwater management entity/authority. The well assessment should be based upon the diameter of the well. If an individual is obtaining both a building permit and applying to drill a new well on the same property, there should be one assessment only

7. Once an initial or interim fee has been determined and the well registration process has been completed (described in paragraph 10), the groundwater management entity/authority should undertake a nexus study including an impacts analysis and may subsequently revise the amount of the fee in light of the impacts analysis and the number of wells that have been registered.

8. Throughout the life of the trust fund, the groundwater management entity/authority should have the power to change the amount of the assessment, based upon then current actuarial studies.

9. Ultimate responsibility for the collection of these assessments should be vested in the groundwater management entity/authority. The authority should see that fees are collected in whatever manner it deems most efficient.

10. In order to be eligible for coverage by the fund, existing wells must be registered by the well-owner in a manner to be determined by the groundwater management entity/authority and within a schedule or time-limit to be established by the authority. The authority shall make every reasonable attempt to inform all residents who may be eligible to participate in the well protection program of the need to register their well.

11. Once a well has been registered, coverage by the well protection trust fund shall continue for as long as the fund is operational. Coverage of the well is not affected by a change in ownership of the property on which it is located.

12. Eligibility criteria for claims against the fund must be clearly defined and strictly related to a decline in groundwater level. Sub-standard wells, faulty motors or pumps, etc. will not be covered by the fund or eligible for consideration.

13. Any claim against the trust fund must be submitted to the entity/authority and verified by an independent source (e.g., a hydrologist, a well service company, etc.) in order to be paid by the fund.

14. The groundwater management entity/authority shall be responsible for working out the details of how the trust fund shall operate including but not limited to the amount of the fee to be assessed, how assessment fees are collected, criteria for submission of a claim, how a claim will be verified, amount to be paid for a verified claim, timeline between submission of claim and date of decision, etc.

15. At the time that the trust fund becomes operational, the groundwater management entity/authority should, on its own initiative or in conjunction with other appropriate agencies/organizations, undertake a vigorous campaign to educate all water users on the importance of conservation and recommend specific practices that can be implemented by agriculture and agricultural/residential pumpers.

16. Not earlier than five years nor later than the beginning of the eleventh year after water from the Freeport project becomes available for conjunctive use in the Central Area, the groundwater management entity/authority shall conduct a comprehensive review to determine whether there exists a continuing need to maintain a well protection trust fund. In conducting this review, the management entity/authority shall consider the following factors:
    - Groundwater levels;
    - The number of claims made against the trust fund;
    - The rate of claims filed over time: i.e., is the rate of claims increasing or decreasing;
    - Status of urbanization: i.e., is further growth/development anticipated and, if yes, how will it impact water supply.

    A decision on whether or not to continue the fund shall be reserved to the governing board or authority responsible for groundwater management in the Central Area.

17. If as a result of this comprehensive review, a decision is made to terminate the well protection plan but money has accumulated in the trust fund and has not been paid out to meet prior claims, any un-disbursed money should be used for other activities consistent with the purposes of a groundwater management plan or groundwater management authority in the Central Area: e.g., conservation, habitat mitigation, enhancement of groundwater recharge, etc. (In order for this to occur, the language establishing the trust fund must be consistent with the requirements set forth in Government Code, Section 1600.)

18. All details related to the fund should be worked out and the well protection program should become operational within one year of the creation of a groundwater management entity/authority in the Central Area.

NOTE: Nothing in this proposal is intended to modify or change any provisions in the North Vineyard Protection Agreement or to relieve any party of obligations set forth in that Agreement.

Appendix E

Central Sacramento County Groundwater Management Plan – Impact Analysis for Well Protection Program

WRIME Water Resources & Information Management Engineering, Inc.
tel. 916.564.2236 1451 River Park Drive Suite 142, Sacramento, CA, 95815
fax 916.564.1639 http://www.wrime.com • info@wrime.com

TECHNICAL MEMORANDUM

To:	Jim McCormack, Water Forum Darrell Eck, SCWA	CC:	Eric Hong, DWR
From:	Reza Namvar Ali Taghavi	**Date:**	December 30, 2005
Subject:	**Central Sacramento County Groundwater Management Plan – Impact Analysis for Well Protection Program**		
Project Reference:	**310.T01.00**		

EXECUTIVE SUMMARY

The Central Basin Well Protection Program is a result of negotiations that took place as part of the Central Sacramento County Groundwater Forum. Water demands to meet the build-out level of development in future land use and water use conditions in Central Basin could potentially change groundwater levels in various parts of the Central Basin. These changes in groundwater levels may have potential impact on existing agricultural and rural domestic wells. The impacted wells may require lowering of the pump bowls, deepening of the well, or replacement of the well. The well protection program is being developed for the Central Basin to provide funding for mitigation of any wells that may be impacted by a lowering of groundwater levels. This Technical Memorandum (TM) provides an estimate of the cost of the well protection program under three future scenarios.

The number of irrigation and rural domestic wells in the Central Basin is not known. Based on the 2000 land use conditions and water demand information, it is estimated that 235 agricultural and 5,903 rural domestic wells exist in the Central Basin. Using the 2030 land use conditions, it is estimated that the irrigation wells will decrease to 194 wells, while the rural domestic wells will increase to 8,175 wells. The land use, water supply, and water demand information presented in this TM were obtained from the Hydrologic and Modeling Analysis for Zone 40 Water Supply Master Plan study (WRIME, 2004).

The water levels for the three future scenarios were obtained from the recent Hydrologic and Modeling Analysis for Zone 40 Water Supply Mater Plan (WRIME, 2004), and the modeling work performed as part of the Impact Analysis for Well Protection study. These future scenarios are:

- A – No Project (Baseline 2030),
- B – Proposed Project, and
- C – Reduced Surface Water Availability.

The "No Project" scenario represents the land and water use conditions based on the County's General Plan build-out level of development, and the corresponding firm water supply conditions.

The "Proposed Project" scenario represents the build-out conditions with the water supplies proposed under the Zone 40 WSMP. The Zone 40 WSMP was adopted in February 2005.

The "Reduced Surface Water Availability" scenario was simulated in this study to represent a 26,700 acre-feet/year (AFY) reduction in surface water diversion at Freeport to Zone 40 and increased groundwater pumping by 26,700 AFY in the Central Basin.

The simulated water levels were compared with the well bottom depth elevation data to obtain the number of impacted wells. The impact costs of changes in groundwater level include the cost of lowering the pump bowl, deepening the wells, or replacing the impacted wells.

The following table shows the impact cost of the three future scenarios.

Scenarios	Impacted Rural Domestic Wells	Impacted Agricultural Wells	Rural Domestic Wells Impact Cost	Agricultural Wells Impact Cost	Total Impact Cost
A - No Project	164	2	$560,000	$20,000	$580,000
B – Proposed Project	99	1	$423,000	$10,000	$433,000
C - Reduced Surface Water Availability	252	3	$1,097,000	$30,000	$1,127,000

The outline of the TM is presented below.

Executive Summary presents a summary of the TM findings.

1. Introduction provides some background on declining groundwater levels in the Central Basin, brief description of the alternatives, and the purpose of the TM.

2. Available Data provides details of available data that was used in this analysis.

3. Analysis of Well Inventory provides estimates of the number of agricultural and rural domestic wells in the Central Basin.

4. Impacted Wells provides estimates of the number of impacted agricultural and rural domestic wells in the Central Basin and the associated impact cost.

5. References lists the sources of information used in this analysis.

1. INTRODUCTION

Groundwater is a vital source of water for Central Sacramento County. In 2000, approximately 250,000 AF of groundwater was pumped in the Central Basin resulting in declining groundwater levels in some parts of the Central Basin.

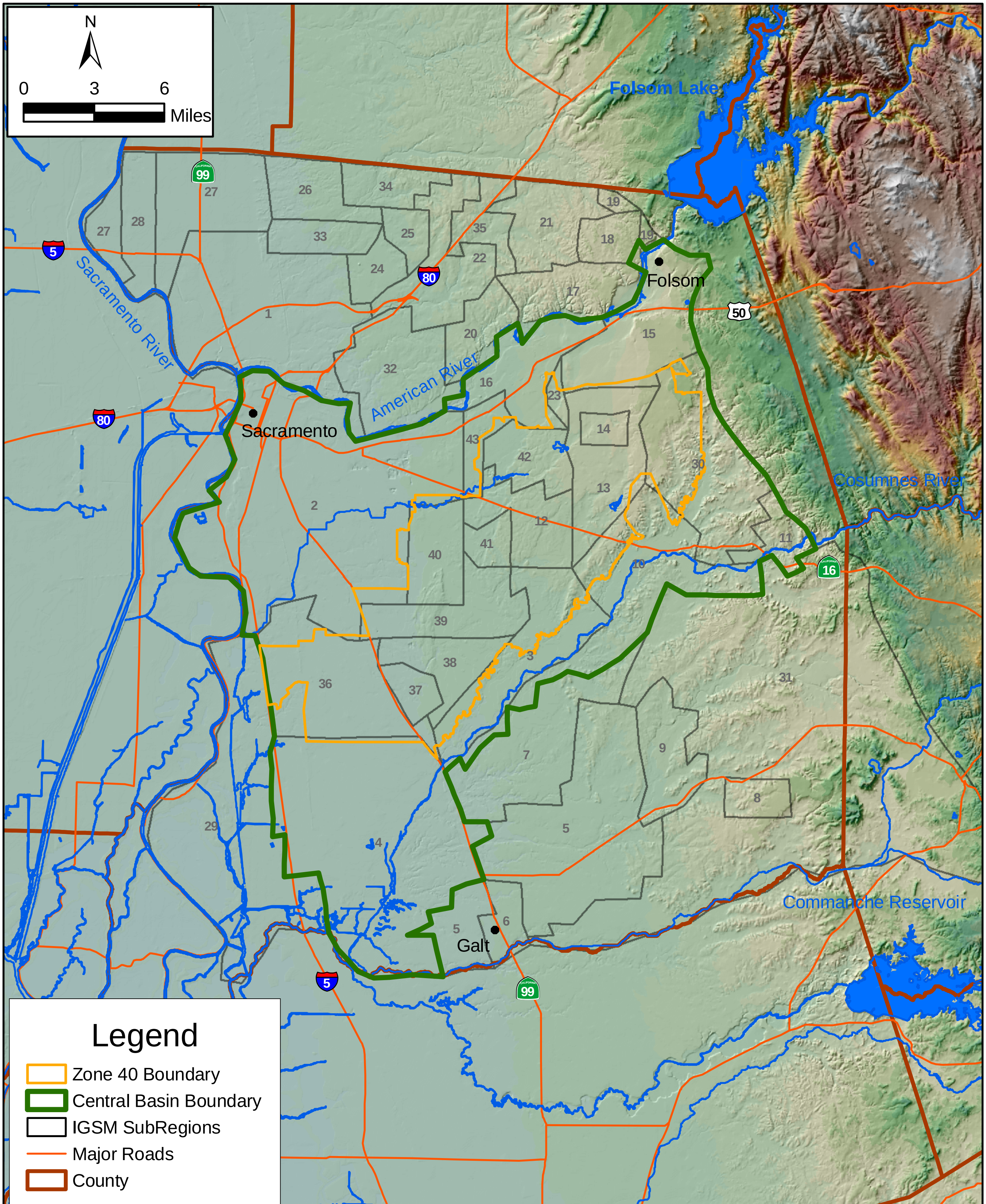
Anticipated urban water use is expected to increase the reliance on the groundwater aquifer and to lower groundwater levels. The Zone 40 Water Supply Master Plan (WSMP) project provides a conjunctive use program that consists of surface water, groundwater, and recycled water. As a result of the implementation of the WSMP groundwater levels in some parts of the Central Basin are expected to be lower than their current levels; however, higher than the future No Project conditions. Figure 1.1 shows the Zone 40 and the Central Basin.

Several water management scenarios including the Proposed Project were analyzed by WRIME (2004) using the Sacramento County Integrated Groundwater and Surface water Model (SACIGSM). A modified version of the Proposed Project scenario was also simulated as part of this study. The purpose of this scenario was to evaluate the worst-case scenario by analyzing the impact of reduced available surface water via the proposed Freeport diversion facilities, and maximum groundwater pumping in the Central Basin. The scenarios presented in this Technical Memorandum include:

- A – No Project (Baseline 2030),
- B – Proposed Project, and
- C - Reduced Surface Water Availability.

All of the simulations indicate that groundwater levels in some parts of the Central Basin will decline in the future. Declining groundwater levels may have an adverse impact on existing wells in Central Basin. Some wells may need to be deepened while some others may have to be replaced.

The Well Protection Program has been developed for the Central Basin to provide funding for deepening or replacement of impacted wells. This Technical Memorandum (TM) presents the results of an analysis of the expected impact cost to agricultural and rural domestic wells in the Central Basin.



WRIME

Central Sacramento Groundwater Basin
Well Impact Analysis

General Project Location

November 2005

Figure 1.1

2. AVAILABLE DATA

This study uses four categories of data for well impact analysis:

- Land Use Conditions,
- Water Demand,
- Well Depth, and
- Groundwater Levels.

The land use and water demand information are used to estimate the number of agricultural and rural domestic wells. The depth to groundwater at each well is compared to the depth to the bottom of the well to determine whether a well is impacted. The land use, water supply, and water demand information presented in this TM were obtained from the Hydrologic and Modeling Analysis for Zone 40 Water Supply Master Plan study (WRIME, 2004). The data sources and description of the available data is provided in the following subsections.

2.1 DATA SOURCES

The data for the well impact analysis was obtained from previous studies of Central Sacramento County, available databases, and interviews with local professionals. The data sources are presented below.

Sacramento County Groundwater Yield Analysis

A groundwater yield analysis including an evaluation of impacts and associated impact costs of increased groundwater withdrawals from the aquifer systems underlying the County of Sacramento was completed in 1997 for the SCWA (Montgomery Watson, 1997). The report consisted of two technical memorandums, TM1 Baseline Conditions and TM2 Impacts Analysis. The impacts and impact costs were based on the potential groundwater level changes for six Baseline Conditions. This study is commonly referred to as the 1997 Baseline Yield Analysis.

The 1997 Baseline Yield Analysis covers the northern, central, and southern areas of Sacramento County and investigates the impacts of lowering groundwater levels on groundwater quality, wells, land subsidence, and groundwater contamination. The replacement and additional pumping costs of the municipal, agricultural and rural domestic wells were evaluated on a reconnaissance level.

The numbers of agricultural and rural domestic wells in Central Sacramento County were estimated to be 324 and 4,955 wells, respectively. Depending on the simulated baseline condition, the number of agricultural wells impacted by additional groundwater level decline ranged from 0 to 54 wells. The number of impacted rural domestic wells ranged from 0 to 996 wells. The simulations with the highest groundwater pumping rates resulted in the highest number of impacted wells.

Distributions of agricultural and rural domestic well depth are provided in the technical memorandum of the 1997 Baseline Yield Analysis. However, the memorandum does not provide specific information about the location and depth of individual wells. The electronic files of the 1997 Baseline Yield Analysis provides well depth and location information for 964 wells in the Zone 40 area (Figure 2.1). No information was available in these electronic files for the wells outside the Zone 40 area.

DWR/USGS Well Log Database

The California Department of Water Resources (DWR), in cooperation with the United States Geological Survey (USGS), has developed a well log database for selected wells in the Central Sacramento County (DWR, 2005). This database has depth information for 92 wells in the Central Sacramento County. These wells are distributed over the entire central area (Figure 2.1).

Central Sacramento County Data Management System (DMS)

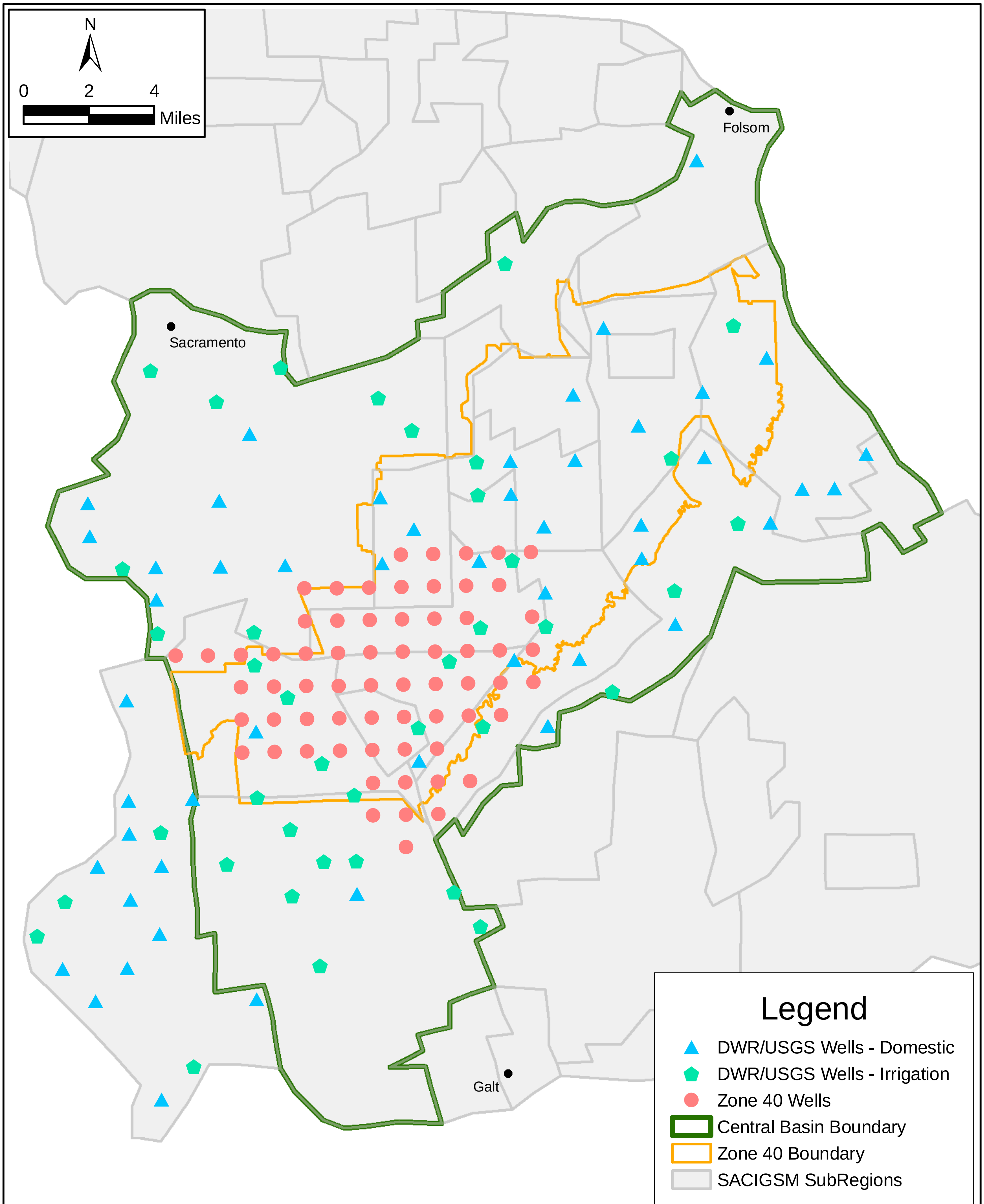
A database of 597 well logs in Central Sacramento County was obtained from MWH – Montgomery Watson Harza (MWH, 2005). However, this database contains only municipal and monitoring well information. Because this database does not provide information on irrigation and/or rural domestic wells, the database was not used in this study.

Hydrologic and Modeling Analysis for the Zone 40 Water Supply Master Plan

A hydrologic and modeling analysis was conducted for the Zone 40 WSMP (WRIME, 2004). Zone 40 was initially established in 1985 by the Sacramento County Water Agency to provide drinking water for the urbanizing unincorporated areas in the Laguna, Elk Grove, and Vineyard communities in Sacramento County.

The SACIGSM was used in the analysis of hydrologic effects of alternatives considered under the WSMP. The effects of water management alternatives were compared to two baseline conditions, 2000 and 2030 levels of development, reflecting existing conditions and ultimate buildout conditions. Table 2.1 presents the description of the alternatives. The Proposed Project represents the long-term effect of water demand and supply resulting from 2030 buildout conditions with additional surface water available and full reuse of remediated water. The Reduced Surface Water Availability scenario represents a 26,700 AFY reduction in available surface water from the FRWA diversion at Freeport and a 26,700 AFY increase in groundwater pumping in the Central Basin.

Water levels at selected irrigation and domestic wells were obtained from SACIGSM simulations for No Project, Project, and Reduced Surface Water Availability scenarios.



WRIME

Central Sacramento Groundwater Basin
Well Impact Analysis

Location of Sample Wells

November 2005

Figure 2.1

Table 2.1 Descriptions of Model Scenarios

	2000 Baseline	A - No Project (2030 Baseline)	B - Proposed Project	C - Reduced Surface Water Availability
Land Use	DWR 2000 Land Use Survey (Agricultural = 53,000 acres, Urban = 86,000 acres)	Projected 2030 Land Use (Agricultural = 45,000 acres, Urban = 137,000 acres)	Projected 2030 Land Use (Agricultural = 45,000 acres, Urban = 137,000 acres)	Projected 2030 Land Use (Agricultural = 45,000 acres, Urban = 137,000 acres)
Urban Water Demand	Based on DWR 2000 Land Use and a 12% level of conservation (205,000 AFY)	Based on projected 2030 Land Use and a 25.6% level of conservation (304,000 AFY)	Based on projected 2030 Land Use and a 25.6% level of conservation (304,000 AFY)	Based on projected 2030 Land Use and a 25.6% level of conservation (304,000 AFY)
Agricultural Demand	Based on crop type and the DWR 2000 crop acreages (171,600 AFY)	Based on crop type and estimated 2030 crop acreage (144,200 AFY)	Based on crop type and estimated 2030 crop acreage (144,200 AFY)	Based on crop type and estimated 2030 crop acreage (144,200 AFY)
Surface Water Supplies	Current supplies, estimated based on CALSIM II 2000 Baseline Condition simulation (128,100 AFY)	Increased to included 'firm water' supplies including 4,400 AFY of reclaimed water (194,800 AFY)	Increased to included 'firm water' supplies including 4,400 AFY of reclaimed water (194,300 AFY)	Reduced surface water diversion at Freeport to the Zone 40 area by 26,700 AFY (167,600 AFY)
Remediated Water	No Reuse	9,400 AFY is used in Zone 40, 5,000 AFY provided to augment Cosumnes River flow enhancement	100% Reuse (6,200 AFY reinjection, 5,000 AFY Cosumnes River flow enhancement, 18,800 AFY reuse)	100% Reuse (6,200 AFY reinjection, 5,000 AFY Cosumnes River flow enhancement, 18,800 AFY reuse)
Groundwater Pumping	Current Level of pumping (248,600 AFY)	Less pumping for agricultural demand, groundwater pumping to meet unsatisfied water demand (244,000 AFY)	Less pumping for agricultural demand, groundwater pumping to meet unsatisfied water demand (235,100 AFY)	Groundwater pumping in the Central area increased by 26,700 AFY (261,800 AFY)
Additional Supply Areas	None	None	North Vineyard, Zone 40 Uniform Pumping	North Vineyard, Zone 40 Uniform Pumping

2.2 IMPACT UNIT COSTS

The exact impact cost of each well will be different, however, representative average impact costs were used in this study to calculate the total impact cost. Current average costs for replacement of agricultural and rural domestic wells are $200,000 and $20,000, respectively (Ken Worster, 2005). The average replacement cost of agricultural and rural domestic wells in the 1997 Baseline Yield Analysis were $150,000 and $10,000, respectively. Assuming an annual inflation of 6%, the 2005 estimates for these costs are approximately $250,000 and $15,000. The impact unit cost estimates used in this study are presented in Table 2.2.

Table 2.2 – Impact unit cost estimates.

Impact	Cost Estimate	
	Agricultural Well	Rural Domestic Well
Pump Bowl Lowering	$10,000	$1,000
Well Deepening	$50,000	$5,000
Well Replacement	$220,000	$20,000

2.3 WELL DEPTH DATA

Well depth information for the agricultural and rural domestic wells in the Central Basin was obtained from the 1997 Baseline Yield Analysis and the DWR/USGS well log database. Table 2.3 presents the number of wells with bottom depth information that are available from these two sources. Figure 2.1 presents the location of the wells in Table 2.3.

Table 2.3 - Number of Wells in Central Basin With Bottom Depth Information.

Source	Well Type		Total
	Agricultural	Rural Domestic	
1997 Baseline Yield Analysis	189	775	964
DWR/USGS Databse	40	52	92
Total	**229**	**827**	**1056**

Agricultural wells are usually deeper than rural domestic wells. The distribution of depth of agricultural wells identified in Table 2.3 is illustrated in Figure 2.2. The agricultural wells are at least 80 feet deep and mostly range from 120 feet to 360 feet in depth. Eight wells are more than 600 feet in depth.

The distribution of depth of rural domestic wells identified in Table 2.3 is illustrated in Figure 2.3. The rural domestic wells are at least 60 feet deep and mostly range from 120 feet to 320 feet in depth.

Wells in the western part of the Central Basin pump from the upper aquifer (Layer 1 of SACIGSM), while wells in the eastern part pump from the lower aquifer (Layer 2 of SACIGSM). The location of the east-west SACIGSM cross-section and the locations of the wells are shown in Figure 2.4. Layer 1 thins out from west to east and occurs at lower depths in the eastern part of the Basin. The vertical distribution of pumping is illustrated in a SACIGSM cross-section (Figure 2.5).

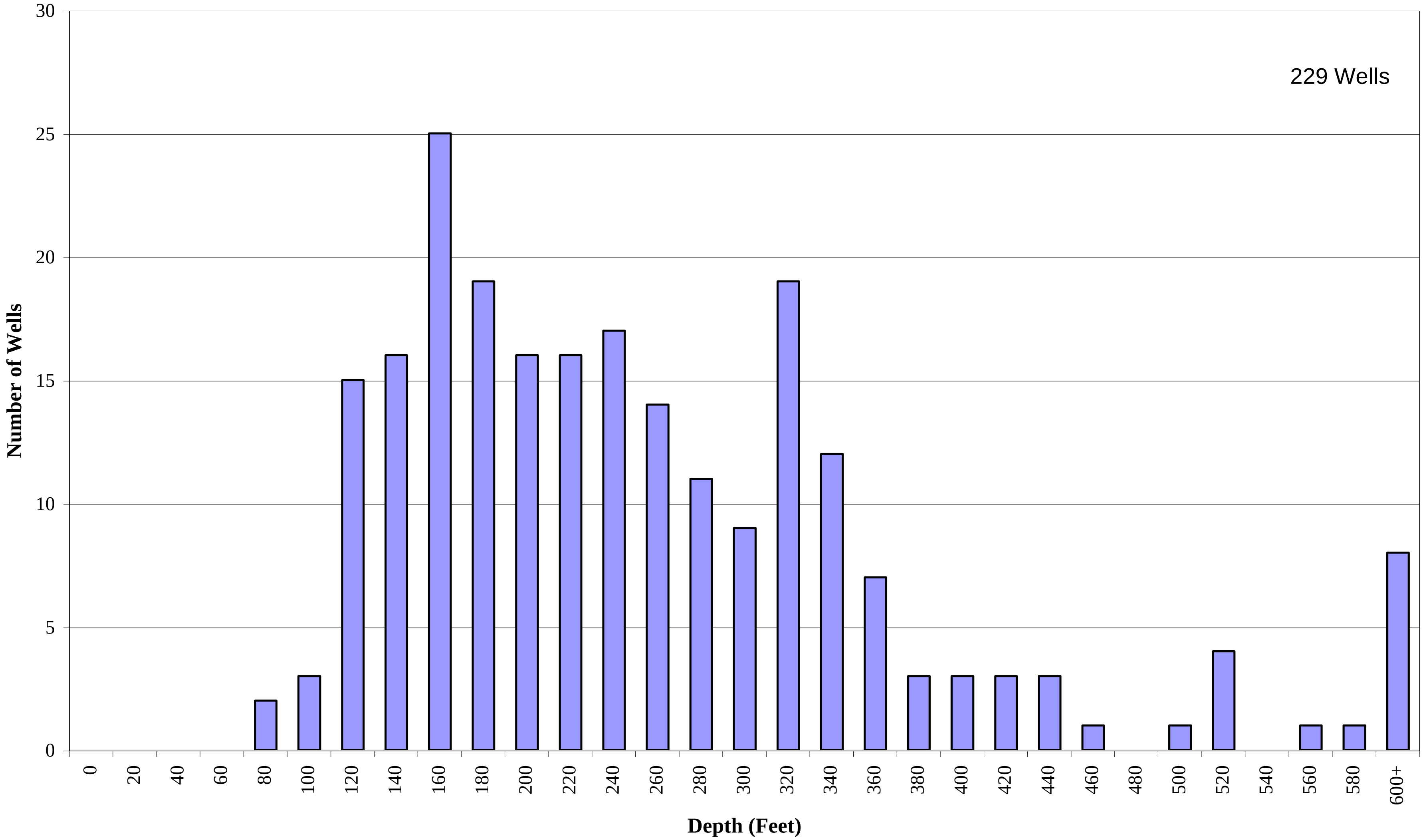
2.4 GROUNDWATER LEVELS

Groundwater levels at the location of the agricultural and rural domestic wells with available bottom depth data were obtained from WRIME's recent SACIGSM modeling analysis for Central Sacramento County (WRIME, 2004) and from a new SACIGSM simulation that was performed as part of this study for the Reduced Surface Water Availability scenario. Groundwater levels were compared with the well depth information to determine whether any well is impacted due to declining groundwater levels. The groundwater levels were obtained for the following scenarios:

- A – No Project (Baseline 2030),
- B – Proposed Project, and
- C - Reduced Surface Water Availability.

The Reduced Surface Water Availability scenario was developed as part of this study to obtain groundwater levels for a situation where 26,700 AFY of the planned surface water diversion at Freeport would not be available for Zone 40 and the water supply deficiency would be met by an additional 26,700 AFY of groundwater pumping in the Central Basin. This scenario represents the worst case conditions in which the groundwater pumping in the Central Basin is at maximum rate of 261,800 AFY.

Groundwater levels from layers 1 and 2 were used in this study. Layer 1 is thicker in the western half of the Central Basin and most of the wells in the western half pump from Layer 1. In contrast, Layer 1 thins out in the eastern half and most of the wells in this half pump from layer 2 (Figure 2.5).



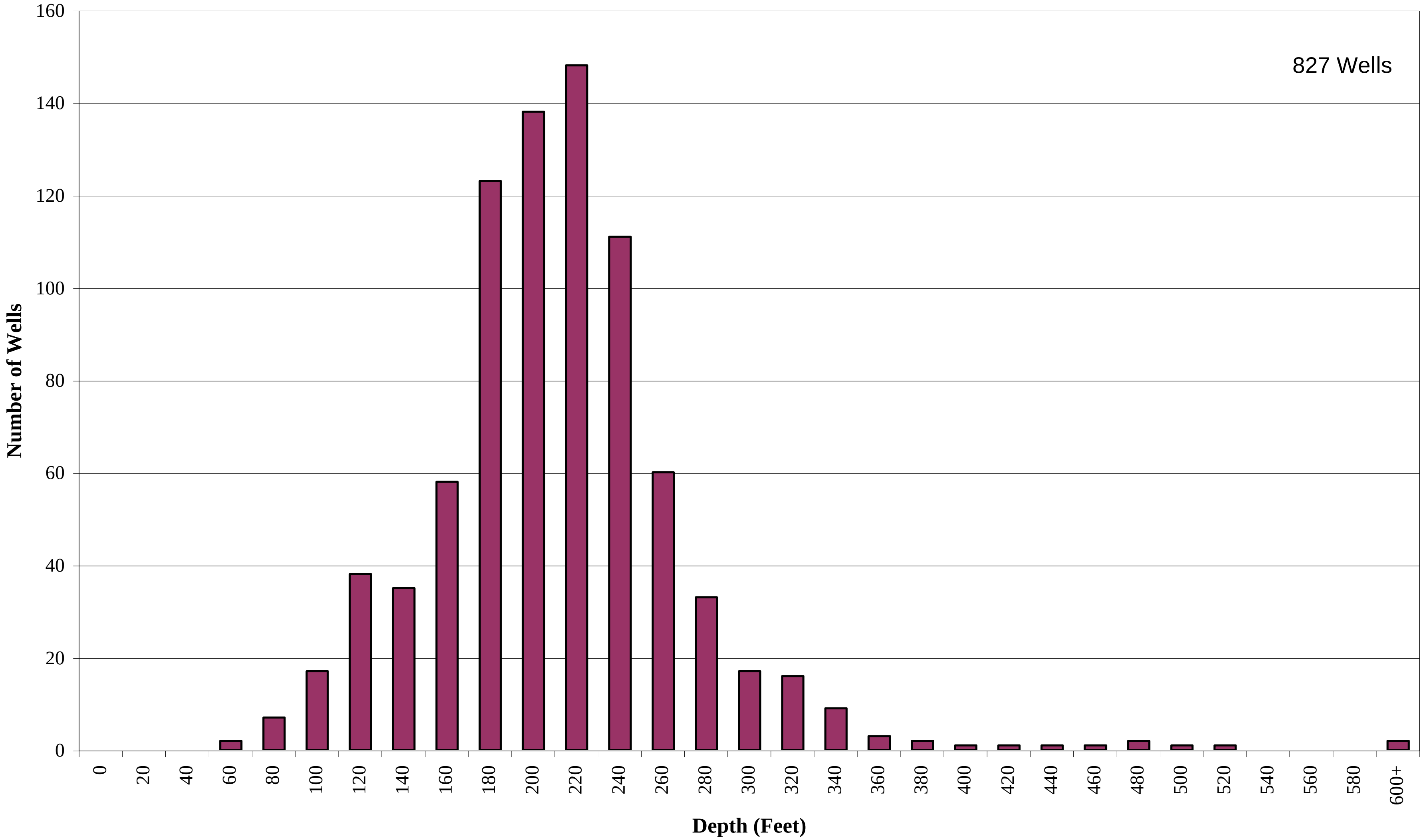
PRIME

Central Sacramento Groundwater Basin Well Impact Analysis

Agricultural Well Depth Distribution

November 2005

FIGURE 2.2



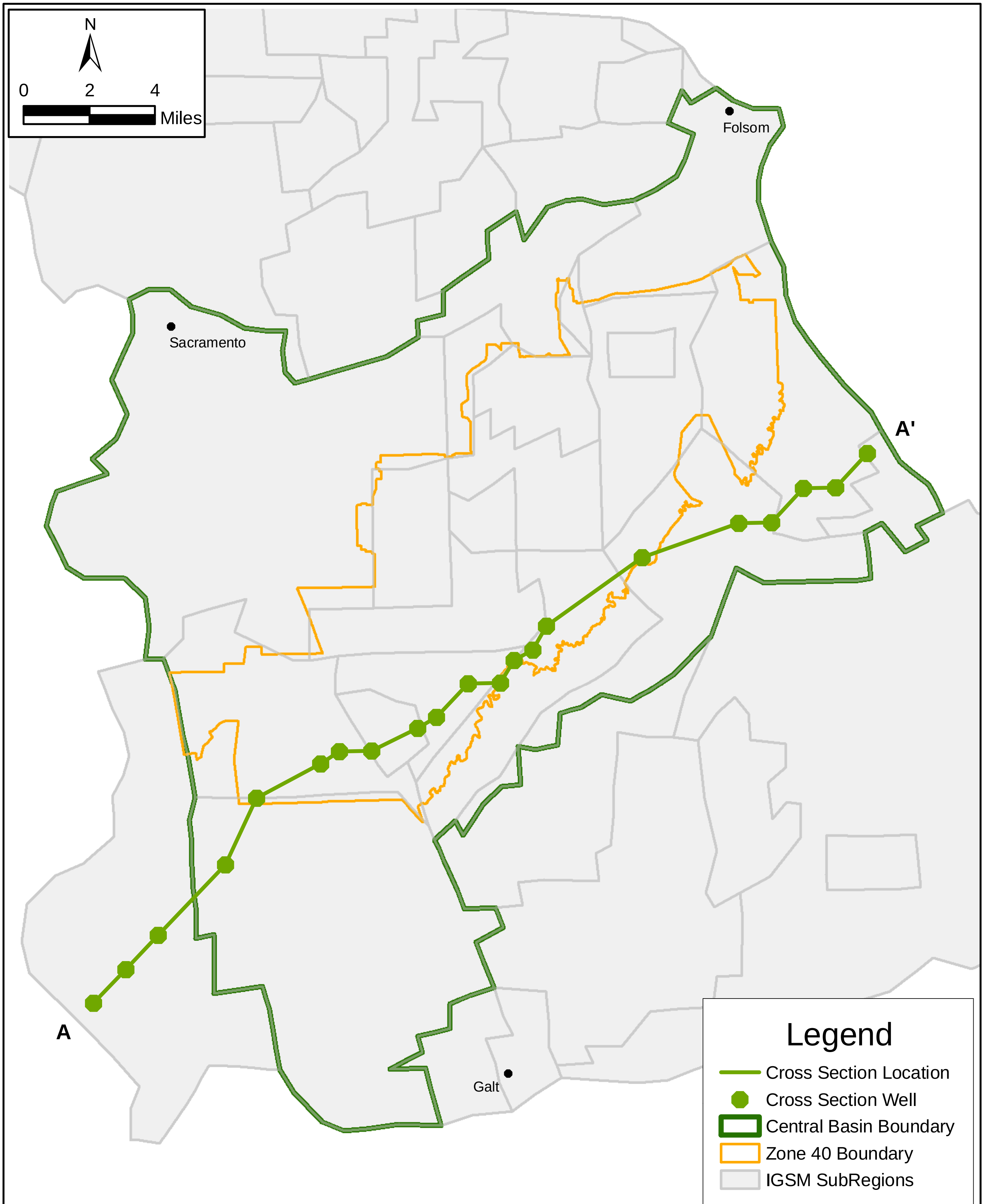
PRIME

Central Sacramento Groundwater Basin Well Impact Analysis

Rural Domestic Well Depth Distribution

November 2005

FIGURE 2.3



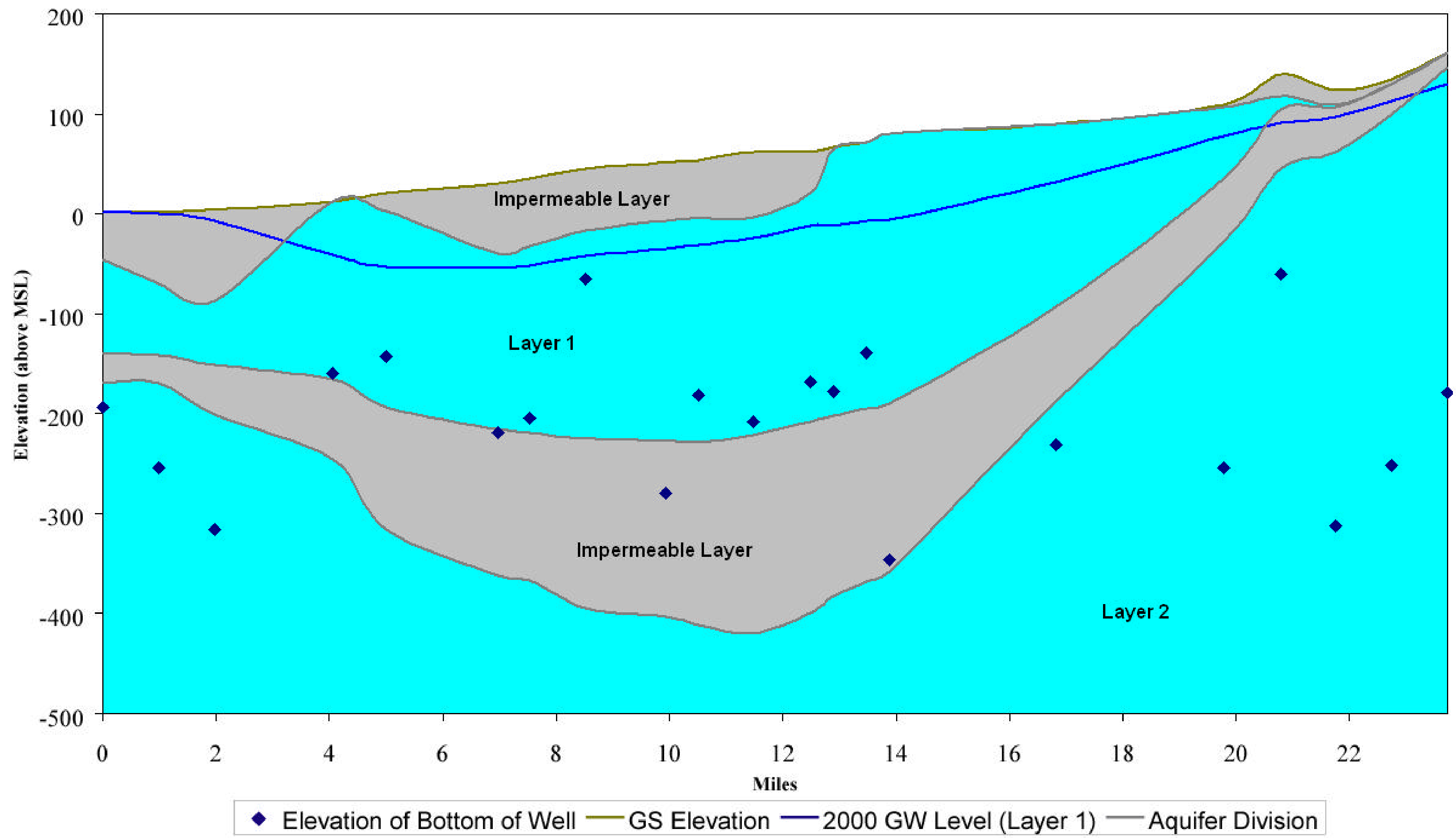
WRIME

Central Sacramento Groundwater Basin
Well Impact Analysis

Location of East-West Cross Section

November 2005

Figure 2.4



RIME

Central Sacramento Groundwater Basin Well Impact Analysis

Geologic Cross Section A - A'

November 2005

FIGURE 2.5

The No Project scenario represent groundwater levels at buildout (2030 level of development). The level of development represents a set of land use, water use, and water supply/demand conditions. The No Project scenario represent the long-term effect of buildout of the 2030 level of development with reduced agricultural demands and increased surface water supplies (Table 2.1). The No Project scenario provides a frame of reference for comparison of hydrologic impacts of various water management alternatives. The Proposed Project and the Reduced Surface Water Availability scenarios were analyzed under the 2030 level of development.

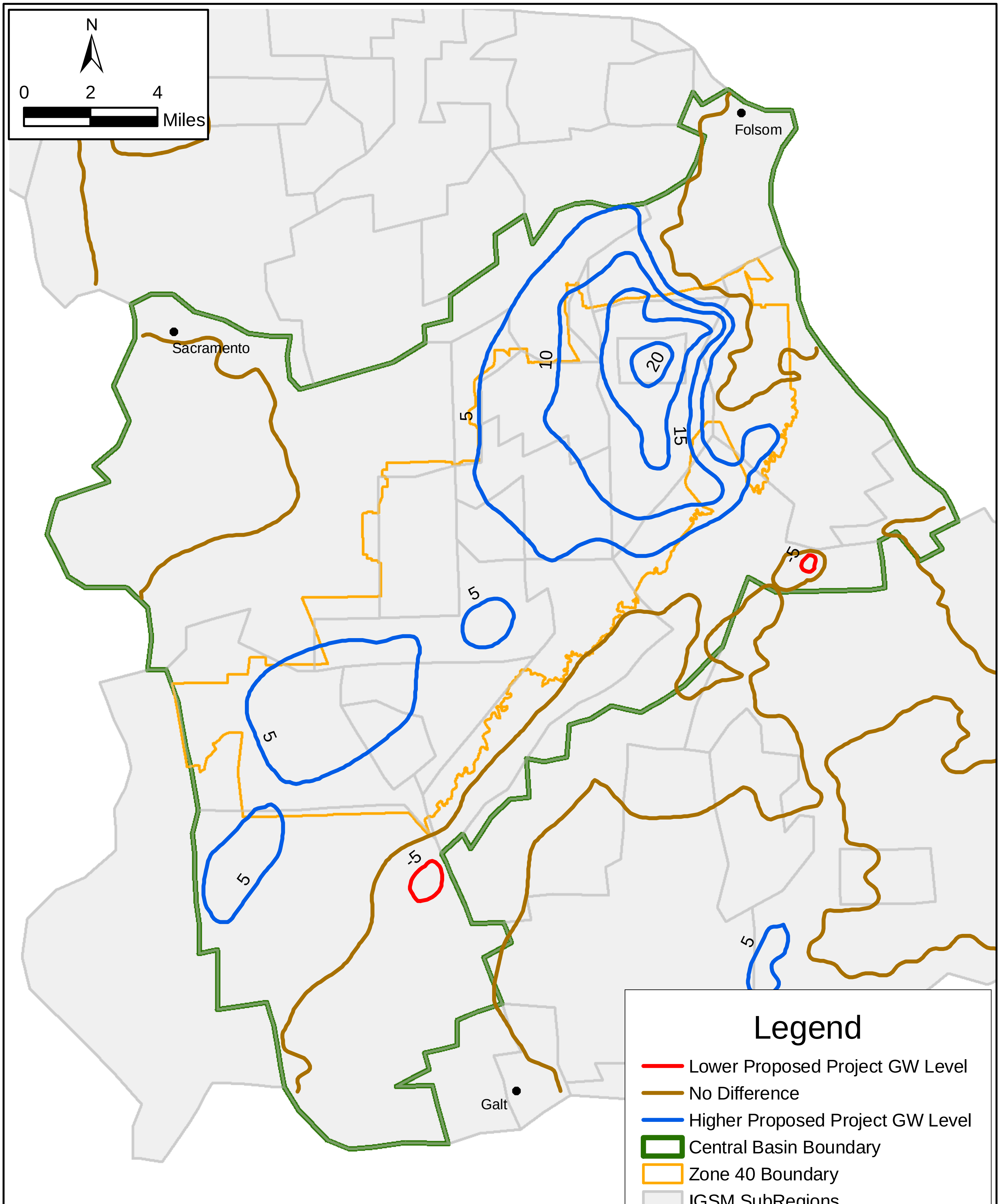
The groundwater levels of the Proposed Project scenario at the end of the simulation are compared to the groundwater levels of the No Project scenario (Figures 2.6 and 2.7). The blue contour lines represent areas with higher Proposed Project water levels than the No Project. The red contour lines indicate the Proposed Project water levels are lower than the No Project. The groundwater levels of the Reduced Surface Water Availability scenario at the end of the simulation are compared to the groundwater levels at the end of the No Project simulation (Figures 2.8 and 2.9). In the Reduced Surface Water Availability scenario water levels drop below the No Project water levels. The higher water level zone in the foothills is also limited to a smaller area. The comparison of the Reduced Surface Water Availability groundwater levels with the Proposed Project groundwater levels is presented in Figures 2.10 and 2.11. The groundwater levels of the Reduced Surface Water Availability scenario are lower than the Proposed Project water levels in all of the Central Basin. The maximum drop in water levels is observed in the western part of Zone 40 where less surface water is available for the Reduced Surface Water Availability scenario.

2.5 Land Use Conditions

The land use maps of the 2000 and projected 2030 conditions representing land use trends within the Sacramento County are presented in Figures 2.12 and 2.13 (WRIME, 2004). The land use data includes both the general land use and crop acreage to identify water use. The general land use conditions is divided into five classes of

- Agricultural land consisting of areas greater than 5 acres and used for agriculture;
- Agricultural-Residential consisting of 2- to 5-acre parcels zoned for agricultural and residential use;
- Urban consisting of municipal, commercial or industrial development;
- Native Vegetation/Undeveloped areas; and
- Riparian Vegetation consisting of areas along waterways.

The estimated acreage of general land use for the 2000 Baseline and 2030 Baseline are summarized in Table 2.4. The increase in urban and agriculture-residential acreages resulted from the conversion of agricultural land and the development of undeveloped land. The three



*Contours represent end of simulation change in groundwater levels

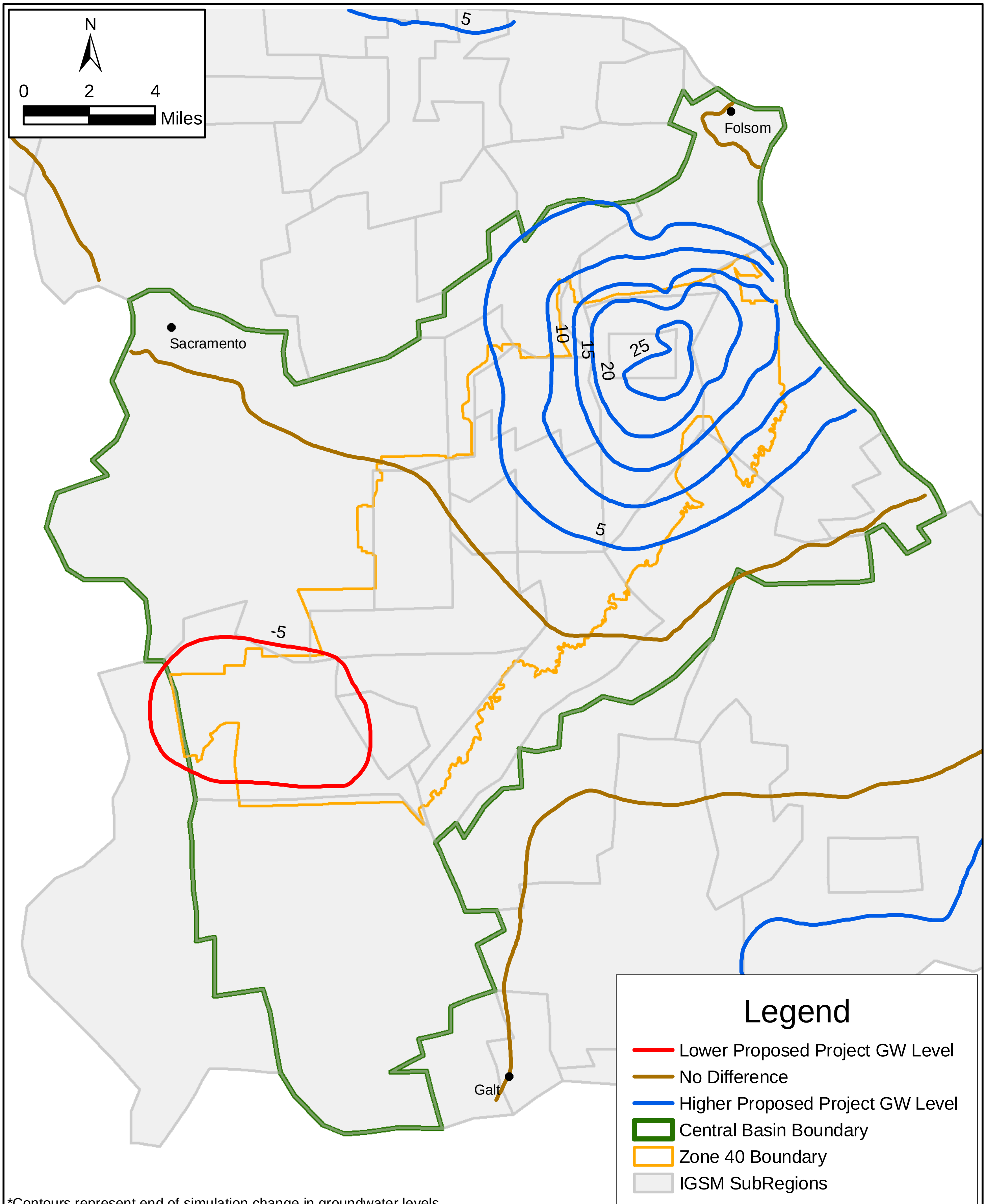
WRIME

Central Sacramento Groundwater Basin
Well Impact Analysis

Comparison of Proposed Project and No Project GW Levels - Layer 1

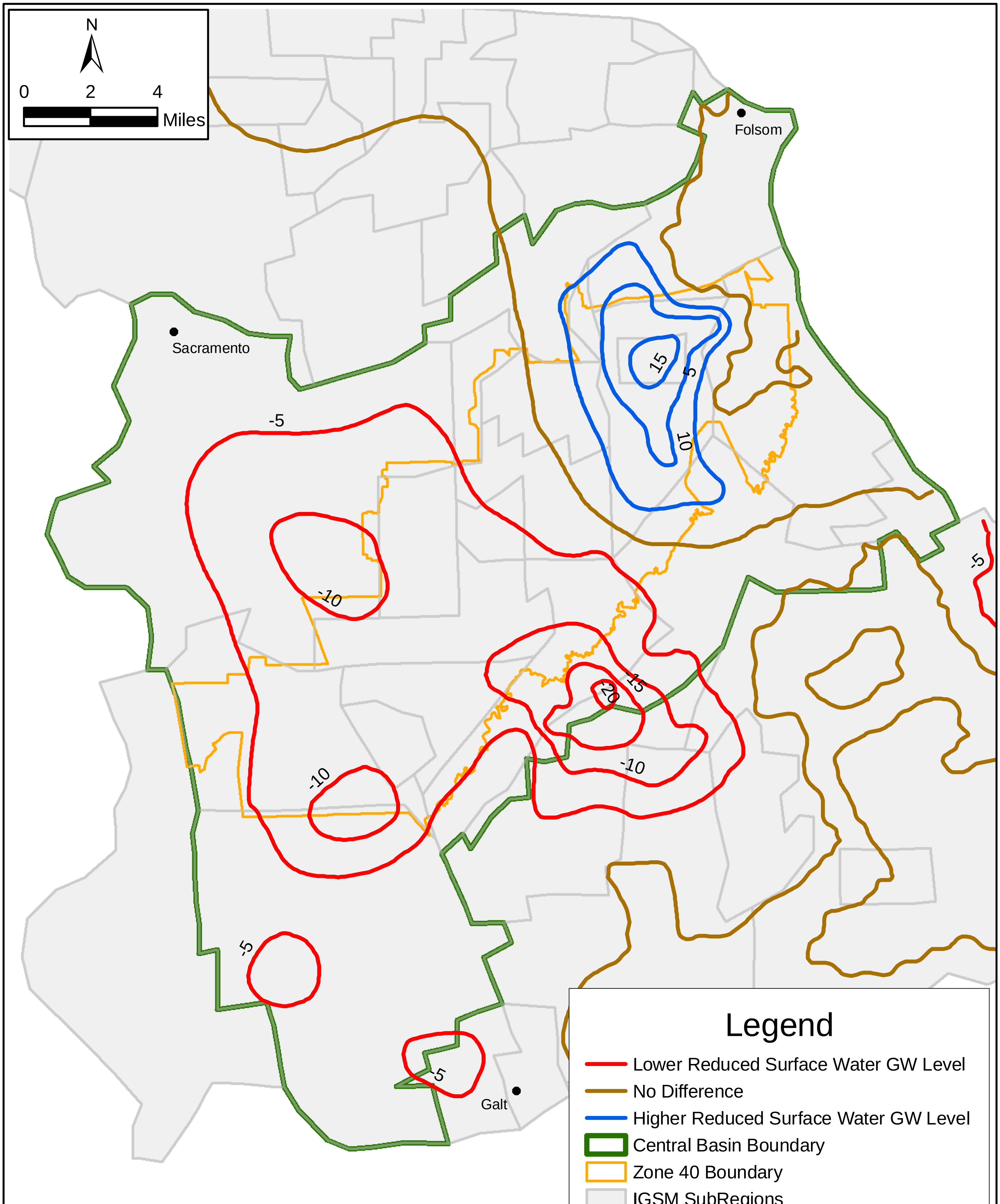
November 2005

Figure 2.6



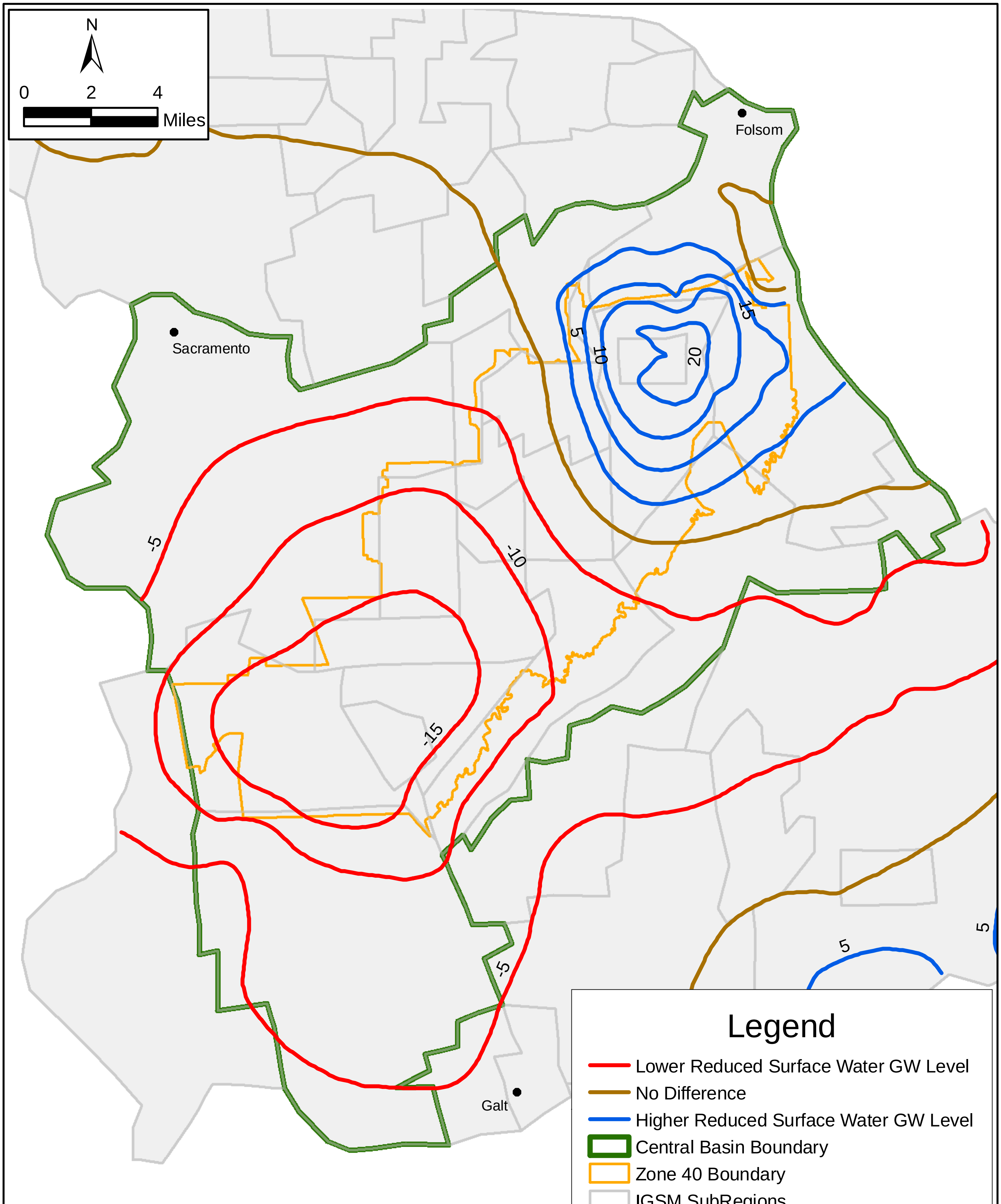
*Contours represent end of simulation change in groundwater levels

RIME	Central Sacramento Groundwater Basin Well Impact Analysis **Comparison of Proposed Project and No Project GW Levels - Layer 2**	November 2005 Figure 2.7



*Contours represent end of simulation change in groundwater levels

WRIME	Central Sacramento Groundwater Basin Well Impact Analysis **Comparison of Reduced Surface Water Availability and No Project GW Levels Layer 1**	November 2005 Figure 2.8



*Contours represent end of simulation change in groundwater levels

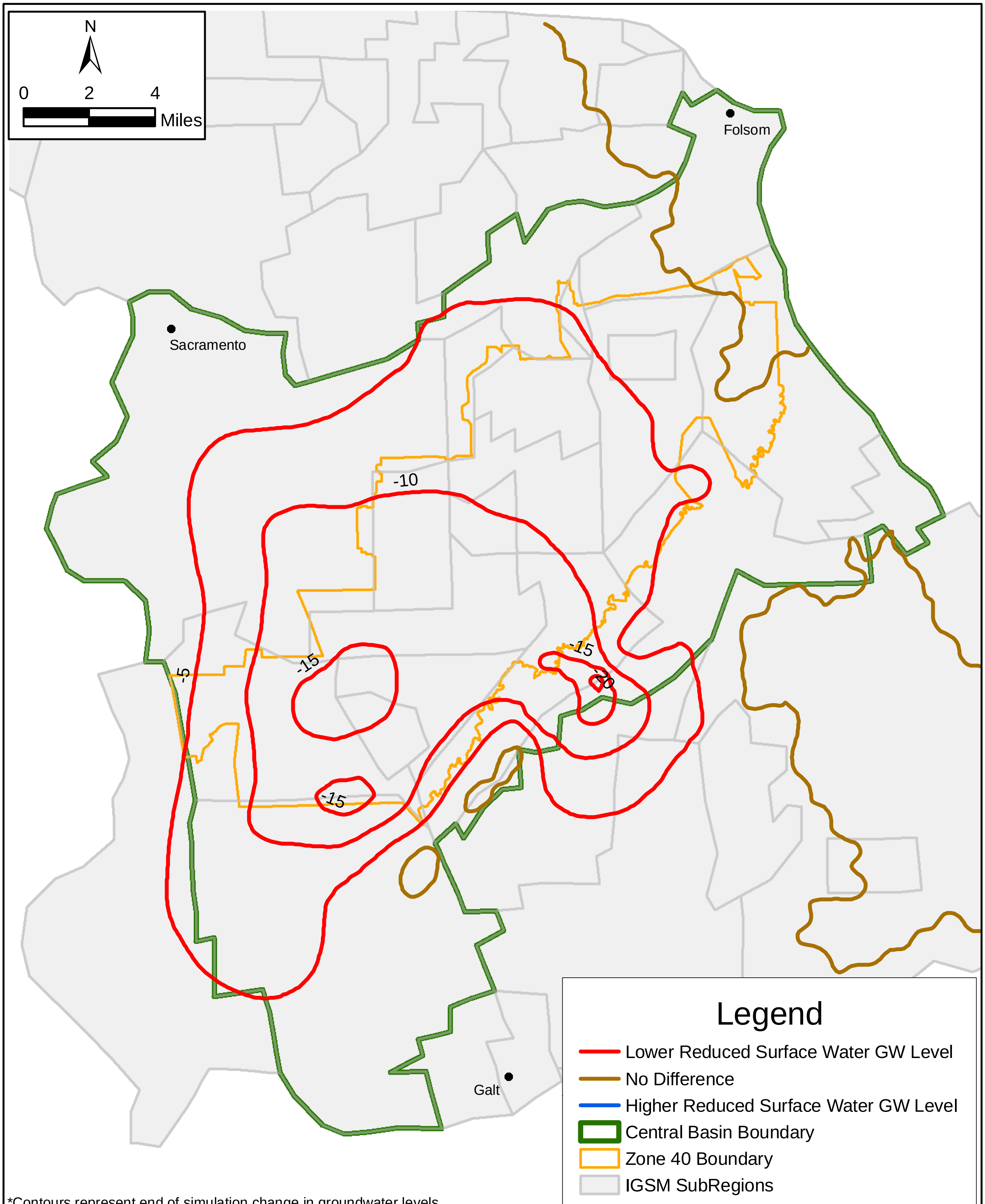
RIME

Central Sacramento Groundwater Basin
Well Impact Analysis

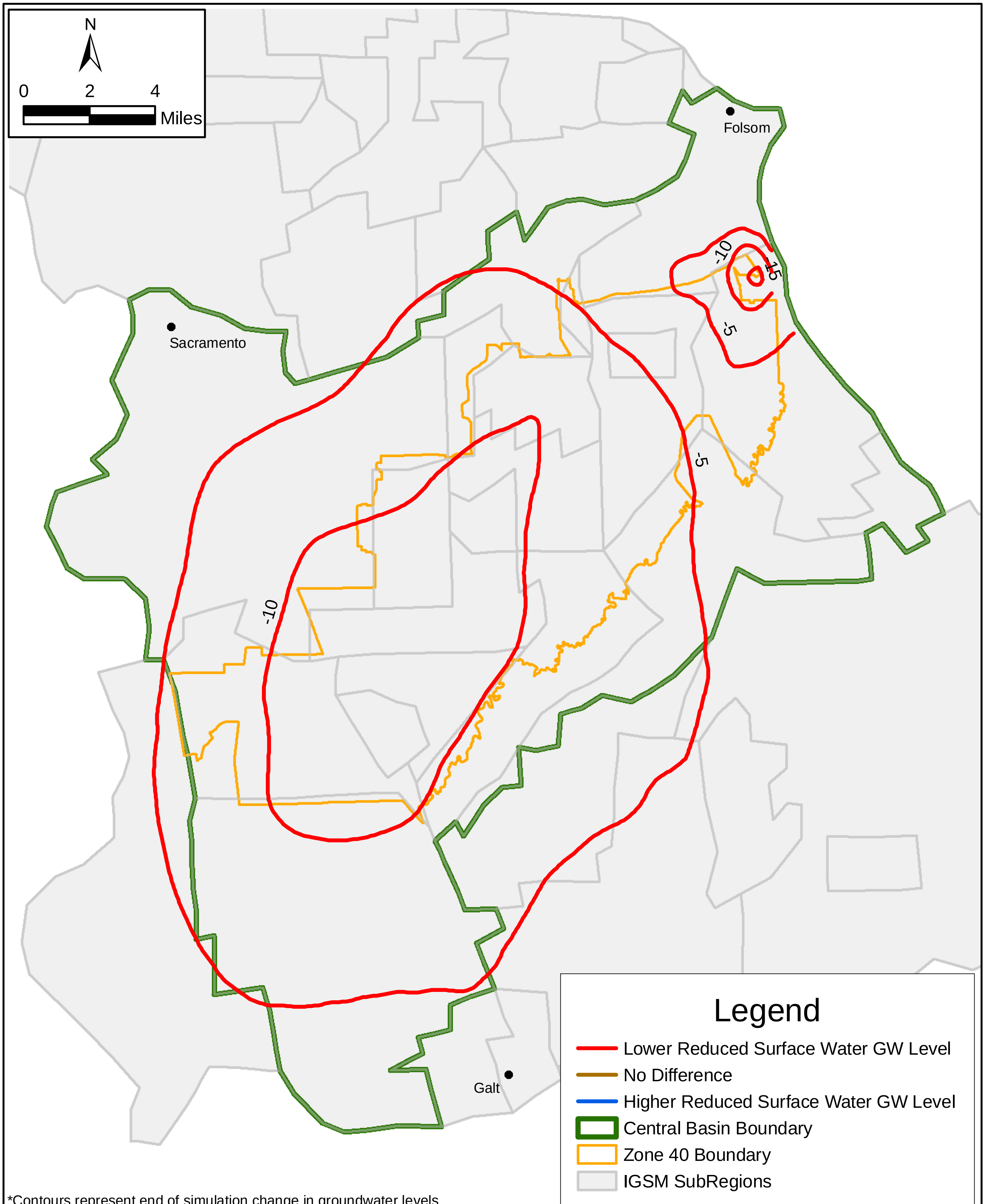
Comparison of Reduced Surface Water Availability and No Project GW Levels Layer 2

November 2005

Figure 2.9



RIME	**Central Sacramento Groundwater Basin Well Impact Analysis** **Comparison of Reduced Surface Water Availability and Proposed Project GW Levels - Layer 1**	November 2005 Figure 2.10



*Contours represent end of simulation change in groundwater levels

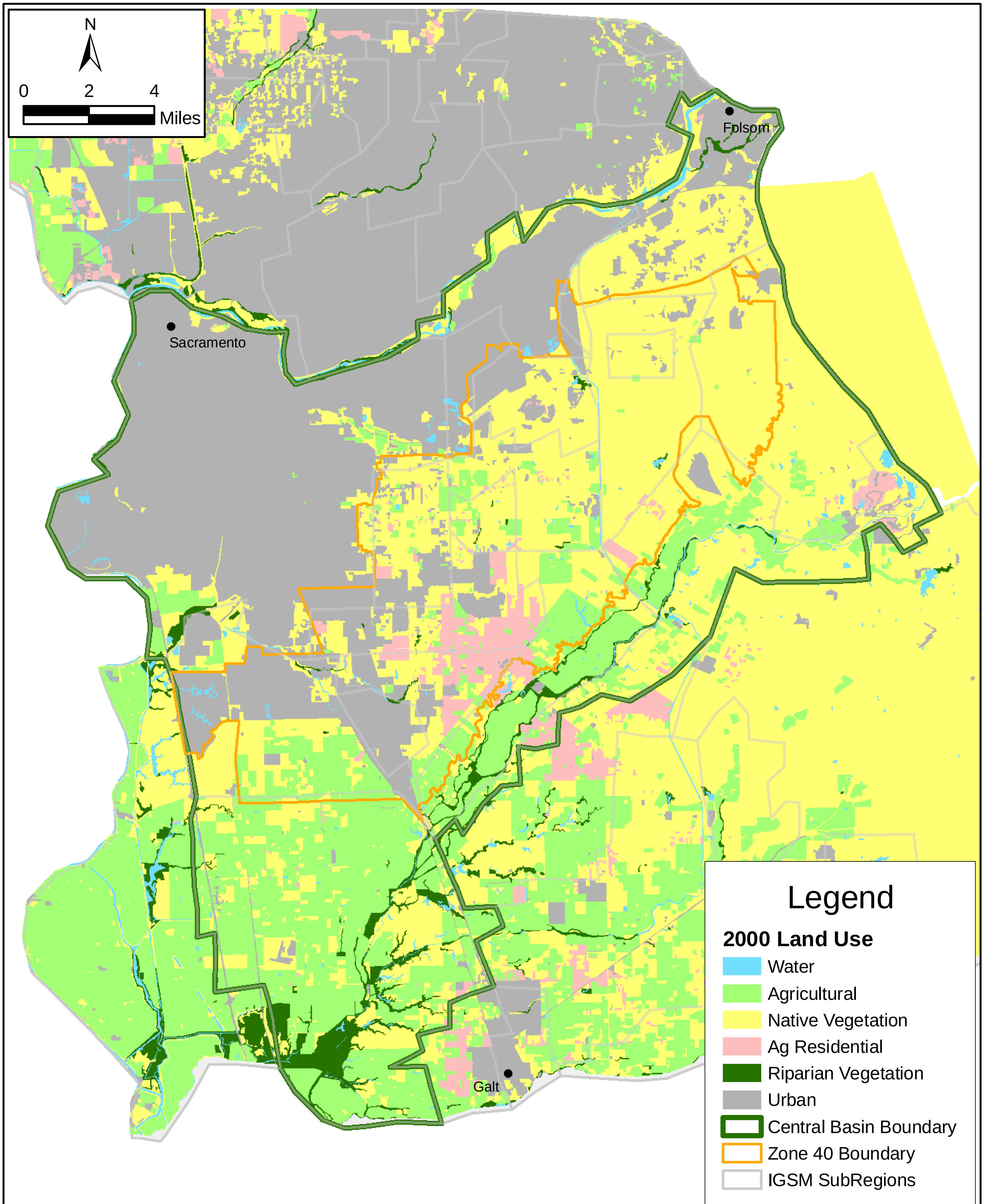
RIME

Central Sacramento Groundwater Basin
Well Impact Analysis

Comparison of Reduced Surface Water Availability and Proposed Project GW Levels - Layer 2

November 2005

Figure 2.11



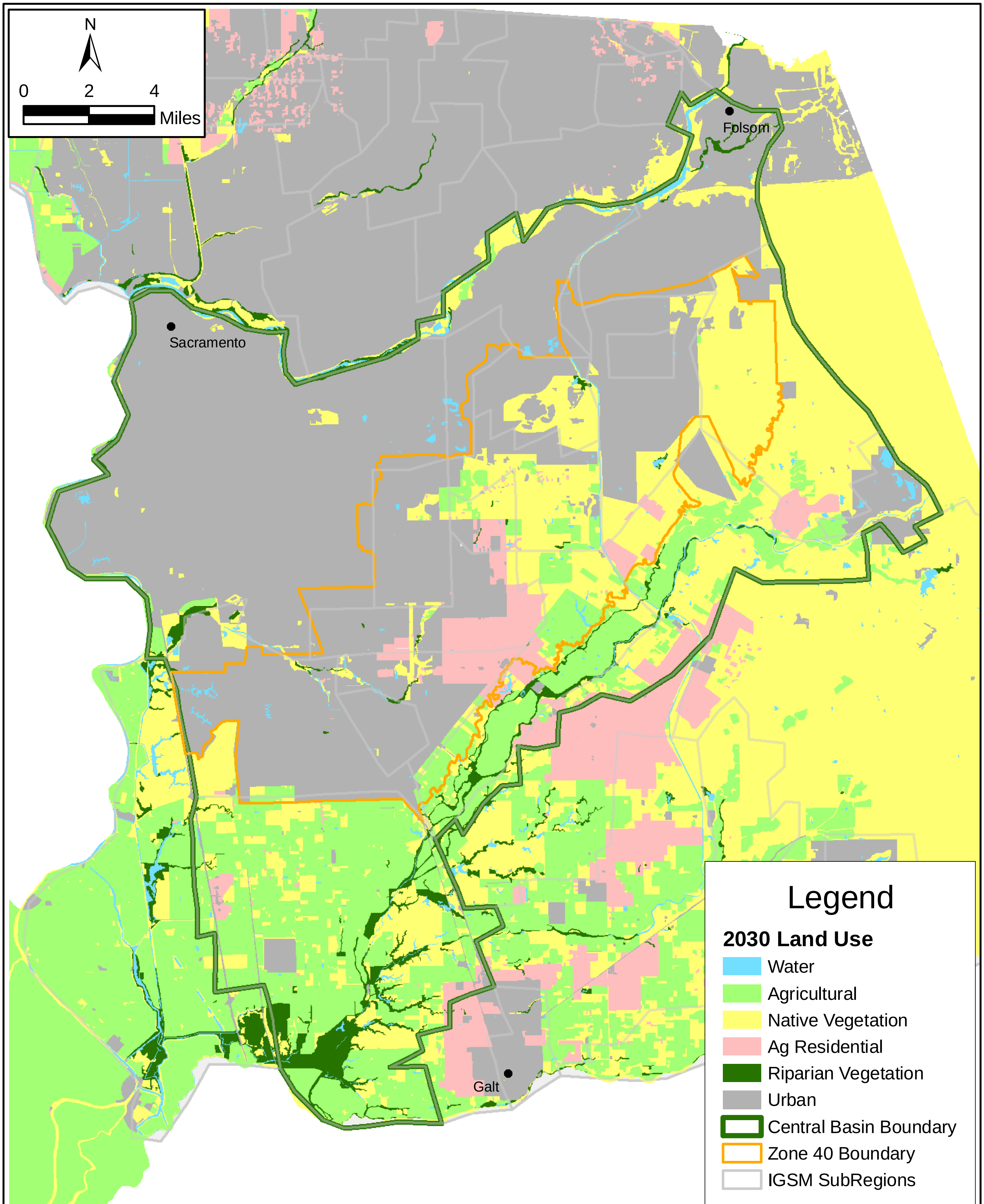
WRIME

Central Sacramento Groundwater Basin
Well Impact Analysis

Year 2000 General Land Use

November 2005

Figure 2.12



WRIME

Central Sacramento Groundwater Basin
Well Impact Analysis

Year 2030 General Land Use

November 2005

Figure 2.13

SACIGSM simulations (No Project, Proposed Project, and Reduced Surface Water Availability) are based on the estimated 2030 Baseline land use.

Table 2.4 Estimated Acreage of Land Use for the Central Basin (WRIME, 2004)

Class	Land Use, acres	
	2000	2030
Agriculture	51,126	39,492
Urban	80,387	132,263
Agriculture-Residential	7,572	10,486
Riparian Vegetation	6,409	6,363
Undeveloped / Native Vegetation	101,692	58,582
Total	**247,186**	**247,186**

2.6 Water Use

Water use estimates are based on the land use data briefly described in the previous section (WRIME, 2004). Water use is divided into two categories of urban and agricultural uses. The water demands for each model subregion for 2000 and 2030 Baseline conditions are presented in Table 2.5. The 2000 Baseline urban water demand includes a 12 percent level of conservation, however, a 25.6 percent level of conservation is included in the 2030 Baseline urban water demand. The average annual agricultural demand in Zone 40 reduces from 28,400 AFY for the 2000 Baseline to 5,000 AFY for the 2030 Baseline.

2.7 Water Supply Availability

The SACIGSM model scenarios are based on water supply availability from the following four sources:

- Surface Water Supplies;
- Recycled Water;
- Groundwater Supplies and;
- Groundwater Remediation and Reuse Options.

The surface water and groundwater supplies and remediation water reuse for each model subregion for No Project, Proposed Project, and Reduced Surface Water Availability scenarios are presented in Table 2.6. Groundwater pumping in Proposed Project is reduced by 9,400 AFY. The reduction in groundwater pumping is compensated by an additional 9,400 AFY of remediation water reuse. The surface water supply is reduced by 26,700 AFY for the Reduced Surface Water Availability simulation. The surface water reduction is accounted for by reducing the Freeport diversion by 26,700 AFY. Groundwater pumping is increased by 26,700 AFY to compensate for the surface water reduction.

Table 2.5 - 2000 and 2030 Baselines Water Demand (WRIME, 2004)

Subregion		2000 Baseline					2030 Baseline				
		Ag Acreage	Urban Acreage	AG Demand	Urban Demand	Total Water Demand	Ag Acreage	Urban Acreage	AG Demand	Urban Demand	Total Water Demand
Number	Name	(A)	(A)	(AF)	(AF)	(AF)	(A)	(AF)	(AF)	(AF)	(AF)
Central Area											
2	South Sacramento	1,440	46,525	3,912	116,296	120,208	386	50234	972	116006	116,978
3	Omochumne-Hartnell North	8,461	260	24,917	855	25,772	8388	137	24675	375	25,050
4	Southwest	27,132	1,048	84,623	1,201	85,824	26347	2284	82646	2181	84,827
10	Omochumne-Hartnell	6,132	720	20,260	1,215	21,475	6300	1277	21215	1796	23,011
11	Rancho Murieta	274	1,007	1,382	2,781	4,163	216	2178	1085	5011	6,096
12	Sunrise "A" – SCWA	1,341	721	5,715	927	6,642	1158	2482	4766	2659	7,425
15	City of Folsom	2	5,312	10	20,159	20,169	0	11697	0	32904	32,904
16	Arden Cordova	202	6,600	380	14,331	14,711	173	6929	303	12534	12,837
30	Fothills North	618	669	1,981	529	2,510	935	1825	3610	1202	4,812
37	EGWS	0	2,307	0	2,710	2,710	0	2590	0	2552	2,552
43	Rosemont – Cal Am	9	2,752	34	6,198	6,232	0	2990	0	5610	5,610
Total Central Area		**45,611**	**67,921**	**143,214**	**167,202**	**310,416**	**43,903**	**84,623**	**139,272**	**182,830**	**322,102**
Zone 40											
13	Sunrise Douglas – SCWA	96	230	145	115	259	713	8512	3012	17429	20,441
14	Security Park – Cal Am	1	86	5	381	384	11	1737	54	1455	1,509
23	Sunrise – SCWA	0	525	0	2,059	2,058	0	912	0	2059	2,059
36	Laguna/Franklin – SCWA	3,323	7,655	10,265	14,422	24,687	50	14228	154	35752	35,906
38	SCWA/EGWS Retail	1,558	1,760	7,209	6,185	13,394	53	5884	242	14308	14,550
39	Vineyard – SCWA	1,603	3,389	7,425	7,646	15,071	322	7533	1479	21988	23,467
40	N. Vineyard in POU - SCWA	540	1,978	1,644	4,444	6,088	0	5600	0	9929	9,929
41	N. Vineyard Out POU – SCWA	516	82	1,620	261	1,880	0	2351	0	7038	7,038
42	Mather	21	2,181	105	2,303	2,410	0	5755	0	11168	11,168
	Total Zone 40	**7,658**	**17,886**	**28,418**	**37,816**	**66,233**	**1,149**	**52,512**	**4,941**	**121,126**	**126,067**
	Grand Total	**53,269**	**85,807**	**171,632**	**205,018**	**376,649**	**45,052**	**137,135**	**144,213**	**303,956**	**448,169**

Table 2.6. Water Supplies for No Project, Proposed Project, and Reduced Surface Water Availability Scenarios

(RR=Remediation Reuse, GS=Groundwater, SW=Surface Water)

Subregion		A - No Project				B - Proposed Project				C - Reduced Surface Water Availability			
		GW	SW	RR	Total	GW	SW	RR	Total	GW	SW	RR	Total
Number	Name	(AF)	(AF)	(AF)	(AF)	(AF)	(AF)	(AF)	(AF)	(AF)	(AF)	(AF)	(AF)
Central Area													
2	South Sacramento	28,590	88,388		116,978	28,590	88,388		116,978	32,070	88,388		120,458
3	Omochumne-Hartnell North	20,710	4,340		25,050	20,703	4,347		25,050	23,211	4,347		27,558
4	Southwest	84,827	0		84,827	84,827	0		84,827	95,075	0		95,075
10	Omochumne-Hartnell	16,441	6,570		23,011	16,441	6,570		23,011	18,433	6,570		25,003
11	Rancho Murieta	181	5,915		6,096	181	5,915		6,096	205	5,915		6,120
12	Sunrise "A" – SCWA	7,434	-9		7,425	7,503	-78		7,425	8,403	-78		8,325
15	City of Folsom	0	32,904		32,904	0	32,904		32,904	0	32,904		32,904
16	Arden Cordova	7,637	5,200		12,837	7,637	5,200		12,837	8,561	5,200		13,761
30	Fothills North	4,812	0		4,812	4,812	0		4,812	5,388	0		5,388
37	EGWS	2,552	0		2,552	2,552	0		2,552	2,864	0		2,864
43	Rosemont – Cal Am	5,610	0		5,610	5,610	0		5,610	6,282	0		6,282
Total Central Area		178,794	143,308	0	322,102	178,856	143,246	0	322,102	200,492	143,246	0	343,738
Zone 40													
13	Sunrise Douglas – SCWA	12,418	6,486	1,537	20,441	3,012	14,356	3,073	20,441	3,012	9,961	3,073	16,046
14	Security Park – Cal Am	839	542	128	1,509	54	1,198	257	1,509	54	831	257	1,142
23	Sunrise – SCWA	1,109	768	182	2,059	0	1,696	363	2,059	0	1,177	363	1,540
36	Laguna / Franklin – SCWA	17,831	15,314	2,761	35,906	18,504	11,880	5,522	35,906	20,292	3,984	5,522	29,798
38	SCWA / EGWS Retail	8,161	5,128	1,261	14,550	8,301	3,726	2,523	14,550	9,117	118	2,523	11,758
39	Vineyard – SCWA	13,647	7,882	1,938	23,467	13,447	6,144	3,876	23,467	14,827	601	3,876	19,304
40	N. Vineyard in POU - SCWA	733	9,141	55	9,929	2,033	7,785	111	9,929	2,093	7,785	111	9,989
41	N. Vineyard Out POU – SCWA	4,233	2,252	553	7,038	4,222	1,710	1,106	7,038	4,654	129	1,106	5,889
42	Mather	6,181	4,002	985	11,168	6,631	2,568	1,969	11,168	7,243	-248	1,969	8,964
Total Zone 40		65,152	51,515	9,400	126,067	56,204	51,063	18,800	126,067	61,292	24,339	18,800	104,431
Grand Total		**243,946**	**194,823**	**9,400**	**448,169**	**235,060**	**194,309**	**18,800**	**448,169**	**261,784**	**167,585**	**18,800**	**448,169**

3. ANALYSIS OF WELL INVENTORY

The exact number of agricultural and rural domestic wells in the Central Sacramento County is not known. In order to determine the potential impacts of lowering groundwater levels on these wells an analysis was performed to estimate the total number of wells in each model subregion. The following subsections present the methodology and the results of this analysis.

3.1. AGRICULTURAL WELLS

Agricultural wells are those wells that are primarily utilized for crop and pasture irrigation. The number of agricultural wells in the Central Sacramento County was estimated based on land use, water demand, and average well capacity.

The average well capacity of agricultural wells for Central Sacramento County is approximately 971 gallons per minute (MW, 1997). Agricultural wells are assumed to pump at the average capacity rate for 6 months each year and produce 772 AFY of water.

Agricultural water demand in each subregion is dependent on the acreage of land used for agricultural purposes and the estimated agricultural water duty. WRIME (2004) provided estimates of agricultural water demands of the subregions in Central Sacramento County for 2000 Baseline and 2030 Baseline conditions (Table 3.1).

The number of agricultural wells in each subregion is obtained by dividing the agricultural water demand by 772 AFY per well. The estimated number of agricultural wells in Central Sacramento County is presented in Table 3.1. Majority of the agricultural wells are in Omochumne-Hartnell North (Subregion 3), Southwest (Subregion 4), and Omochumne-Hartnell (Subregion 10) subregions along the Cosumnes River. The estimated total number of agricultural wells in Central Sacramento County with 2000 Baseline conditions is 235 wells and reduces to 194 wells with 2030 Baseline conditions.

3.2. RURAL DOMESTIC WELLS

Rural domestic wells are those wells that produce water for utilization at agricultural residential areas. The number of rural domestic wells in Central Sacramento County was estimated based on agricultural residential land use and average well capacity.

Rural domestic wells are assumed to pump, on the average, enough water for residential use and irrigation of 1.25 acres of land (MW, 1997). WRIME (2004) provided estimates of agricultural residential land use in the subregions in Central Sacramento County for 2000 Baseline and 2030 Baseline conditions (Table 3.2).

Table 3.1 – Estimated Number of agricultural wells in Central Sacramento County

Subregion		2000 Ag Water Demand	2030 Ag Water Demand	2000 Agricultural Wells	2030 Agricultural Wells
Number	**Name**	**(AF)**	**(AF)**	**(well)**	**(wells)**
Central Area					
2	South Sacramento	3,912	972	6	2
3	Omochumne-Hartnell North	24,917	24,675	33	32
4	Southwest	84,623	82,646	110	108
10	Omochumne-Hartnell	20,260	21,215	27	28
11	Rancho Murieta	1,382	1,085	2	2
12	Sunrise "A" – SCWA	5,715	4,766	8	7
15	City of Folsom	10	0	1	0
16	Arden Cordova	380	303	1	1
30	Fothills North	1,981	3,610	3	5
37	EGWS	0	0	0	0
43	Rosemont – Cal Am	34	0	1	0
Zone 40					
13	Sunrise Douglas – SCWA	145	3,012	1	4
14	Security Park – Cal Am	5	54	1	1
23	Sunrise – SCWA	0	0	0	0
36	Laguna/Franklin – SCWA	10,265	154	14	1
38	SCWA/EGWS Retail	7,209	242	10	1
39	Vineyard – SCWA	7,425	1,479	10	2
40	N. Vineyard in POU - SCWA	1,644	0	3	0
41	N. Vineyard Out POU – SCWA	1,620	0	3	0
42	Mather	105	0	1	0
	Total	**171,632**	**144,213**	**235**	**194**

Table 3.2 – Estimated number of rural domestic wells in Central Sacramento County

Subregion		2000 Ag Residential Land Use	2030 Ag Residential + General Plan Ag Residential Land Use	2000 Rural Domestic Wells	2030 Rural Domestic Wells
Number	**Name**	**(Acres)**	**(AF)**	**(wells)**	**(wells)**
	Central Area				
2	South Sacramento	9	1	8	1
3	Omochumne-Hartnell North	897	1,240	718	992
4	Southwest	195	868	156	695
10	Omochumne-Hartnell	804	2,367	644	1,894
11	Rancho Murieta	580	0	464	0
12	Sunrise "A" – SCWA	74	69	60	56
15	City of Folsom	21	4	17	4
16	Arden Cordova	0	0	0	0
30	Fothills North	143	1,018	115	815
37	EGWS	0	0	0	0
43	Rosemont – Cal Am	0	0	0	0
	Zone 40				
13	Sunrise Douglas – SCWA	9	0	8	0
14	Security Park – Cal Am	2	1	2	1
23	Sunrise – SCWA	0	0	0	0
36	Laguna / Franklin – SCWA	50	12	40	10
38	SCWA / EGWS Retail	1,953	1,720	1,563	1,376
39	Vineyard – SCWA	2,225	2,400	1,780	1,920
40	N. Vineyard in POU - SCWA	301	8	241	7
41	N. Vineyard Out POU – SCWA	87	511	70	409
42	Mather	28	0	23	0
	Total	**7,378**	**10,219**	**5,909**	**8,180**

The number of rural domestic wells in each subregion is obtained by dividing the agricultural residential land use by the area covered by each well (1.25 acres). The estimated number of rural domestic wells in Central Sacramento County is presented in Table 3.2. The majority of the rural domestic wells are in Omochumne-Hartnell North (Subregion 3), Southwest (Subregion 4), and Omochumne-Hartnell (Subregion 10), Rancho Murrieta (Subregion 11), SCWA / EGWS Retail (Subregion 38), Vineyard-SCWA (Subregion 39) subregions along Cosumnes River and in the middle of Zone 40. The estimated total number of rural domestic wells in Central Sacramento County with 2000 Baseline conditions is 5,909 wells and increases to 8,180 wells with 2030 Baseline conditions. This is due to increased acreage of agricultural residential land use in the 2030 Baseline conditions.

4. IMPACTED WELLS

Impacts associated with groundwater level decline analyzed in this study include pump bowl lowering, well deepening, and well replacement. The location of water level in relation to the pump bowl and the bottom of the well indicates the level of impact on a well. If the declining water levels remain above the pump bowl, the well would remain in operation. If the water levels drop below the pump bowl, depending on the magnitude of decline, the following impact categories or thresholds may be used:

- Threshold 1 – Lowering the pump bowl,
- Threshold 2 – Deepening the well, or
- Threshold 3 – Replacing the well.

The groundwater levels during the 26-year hydrologic sequence were analyzed at each well location, under each scenario. The lowest groundwater level over time was selected for comparison with the available well depth data. The above impact criteria were used to determine if a well is impacted by the particular scenario.

4.1. IMPACT CRITERIA

Threshold 1 – Lowering the Pump Bowl

If the groundwater level drops below the pump bowl then the pump cannot operate and the pump bowl should be lowered. However, there is a limit on how much the pump bowl could be lowered. The pump cannot operate at the bottom of the well and has to be at least 10 feet above the bottom of the well. The pump bowls are typically installed 50 feet above the bottom of the wells. Thus, the pump lowering threshold is used when the lowest groundwater level at a well location is between 50 feet above the bottom of the well to 10 feet above the bottom of the well. In this situation, it is assumed that the well remains operable and should not be deepened, however, the pump bowl needs to be lowered.

Threshold 2 – Deepening the Well

A well is expected to be deepened if the distance between the bottom of the well and the groundwater levels above the bottom of the well is less than 10 feet. By deepening the well, the pump bowl can be lowered to a new operational depth. A well is considered a candidate for deepening if the lowest groundwater level at that well is between 10 feet above the bottom of the well and 30 feet below the bottom of the well. It is our understanding that most irrigation and domestic wells in Central Basin were drilled by cable-tool method. With cable-tool method the hole is usually drilled deeper than the casing to allow water to flow from bottom into the well. These wells could be deepened without significant technical difficulties.

Threshold 3 – Replacing the Well

If the lowest groundwater level at a well is 30 feet or more below the bottom of the well then, rather than deepening the well, it is economical to replace the well. The well replacement criterion is defined as the lowest groundwater levels to be more than 30 feet below the bottom of the well.

4.2. NUMBER OF IMPACTED WELLS

A well may be affected by multiple impacts. It may require pump bowl lowering at first, then require well deepening. If the water levels continue to drop then the well may need to be replaced. The analysis of this study assumes that only one type of impact will be applied to any well. The impact criteria will be evaluated for the lowest groundwater level at each well and the worst impact will be selected. The impact cost is based on the worst condition at each well and does not represent the sum of all possible impacts at the wells.

The wells with bottom depth elevations in each subregion of Central Sacramento County are the sample wells of each subregion (Figure 2.1 and Table 2.3). The estimated total numbers of agricultural and rural domestic wells are presented in Tables 3.1 and 3.2. These wells are the population wells of each subregion. The impact criteria are applied to the wells with bottom depth elevations (sample wells) of each subregion. The ratio of the impacted sample wells of each subregion to the total sample wells of that subregion is the subregion's impact ratio. The total number of impacted wells of any subregion is determined by multiplying the impact ratio of the subregion by the number of population wells of the subregion. The following equations were used to estimate the number of impacted wells:

$$\text{Impact Ratio } (IR_i) = (\text{Impacted Sample Wells})_i \ / \ (\text{Total Sample Wells})_i \text{, and}$$
$$\text{Impacted Wells}_i = IR_i * (\text{Total Population Wells})_i \text{,}$$

where

i = subregion index.

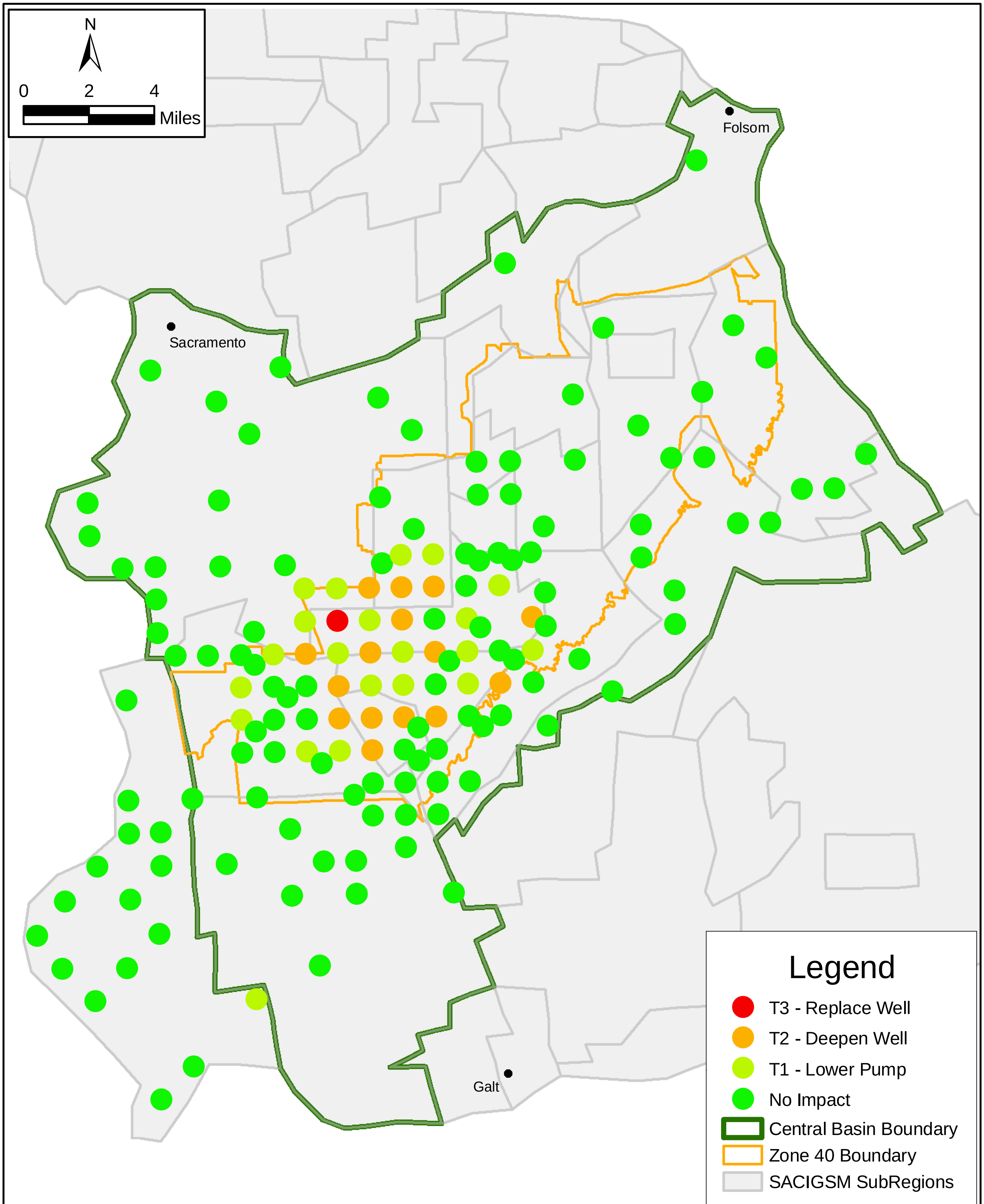
The numbers of impacted agricultural and rural domestic wells for each threshold are presented in Table 4.1. For subregions with sample wells less than 10% of the population wells, the average impact ratio of the subregion and the neighboring subregions is used. The impact analysis was performed for agricultural and rural domestic wells independently. The locations of the impacted sample wells for the three future scenarios are presented in Figures 4.1 to 4.3. Majority of the impacted sample wells occur in the southern parts of Zone 40.

Table 4.1 – Number of Impacted Wells

Impact Criteria	Agricultural Wells			Rural Domestic Wells		
	A-No Project	B–Proposed Project	C-Reduced Surface Water Availability	A-No Project	B-Proposed Project	C-Reduced Surface Water Availability
Lower Pump Bowl	2	1	3	95	48	142
Deepen Well	0	0	0	61	43	83
Replace Well	0	0	0	8	8	27
Total	**2**	**1**	**3**	**164**	**99**	**252**

4.3. IMPACT COST

The Well Protection Plan of Central Sacramento County covers the pump lowering, well deepening, and well replacement impact costs. The unit costs of the well deepening and well replacement are presented in Table 2.2. These unit costs are multiplied by the number of impacted wells from Table 4.1 to obtain the impact cost for the Central Sacramento County (Table 4.2). The Reduced Surface Water Availability scenario has the highest impact costs while the Proposed Project scenario result in the lowest impact cost. The reduced available surface water and increased groundwater pumping of the Reduced Surface Water Availability scenario result in $20,000 increase in impact cost of the agricultural wells and $674,000 increase in impact cost of the rural domestic wells.



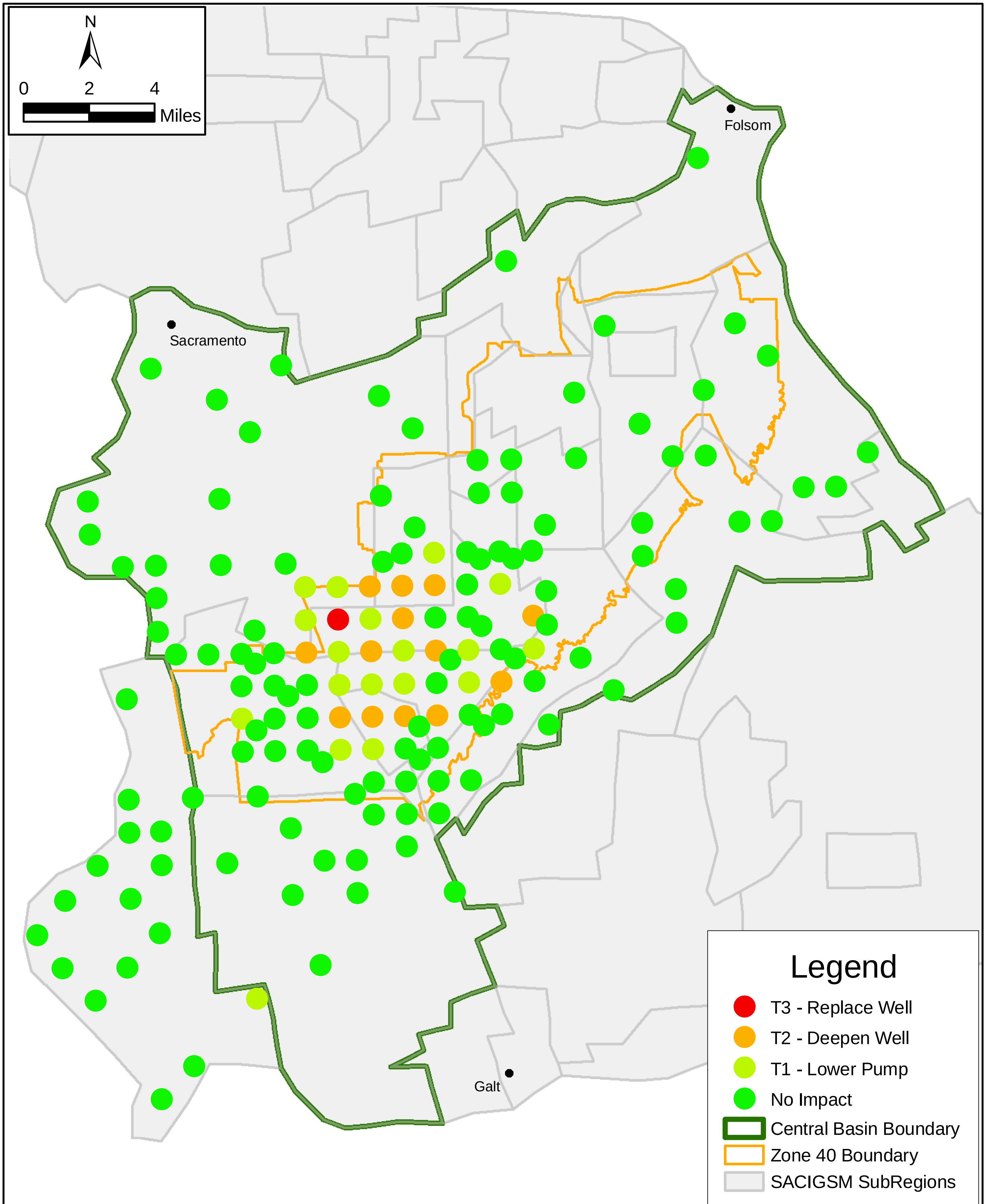
RIME

Central Sacramento Groundwater Basin
Well Impact Analysis

Location of Impacted Sample Wells Under No Project Scenario

November 2005

Figure 4.1



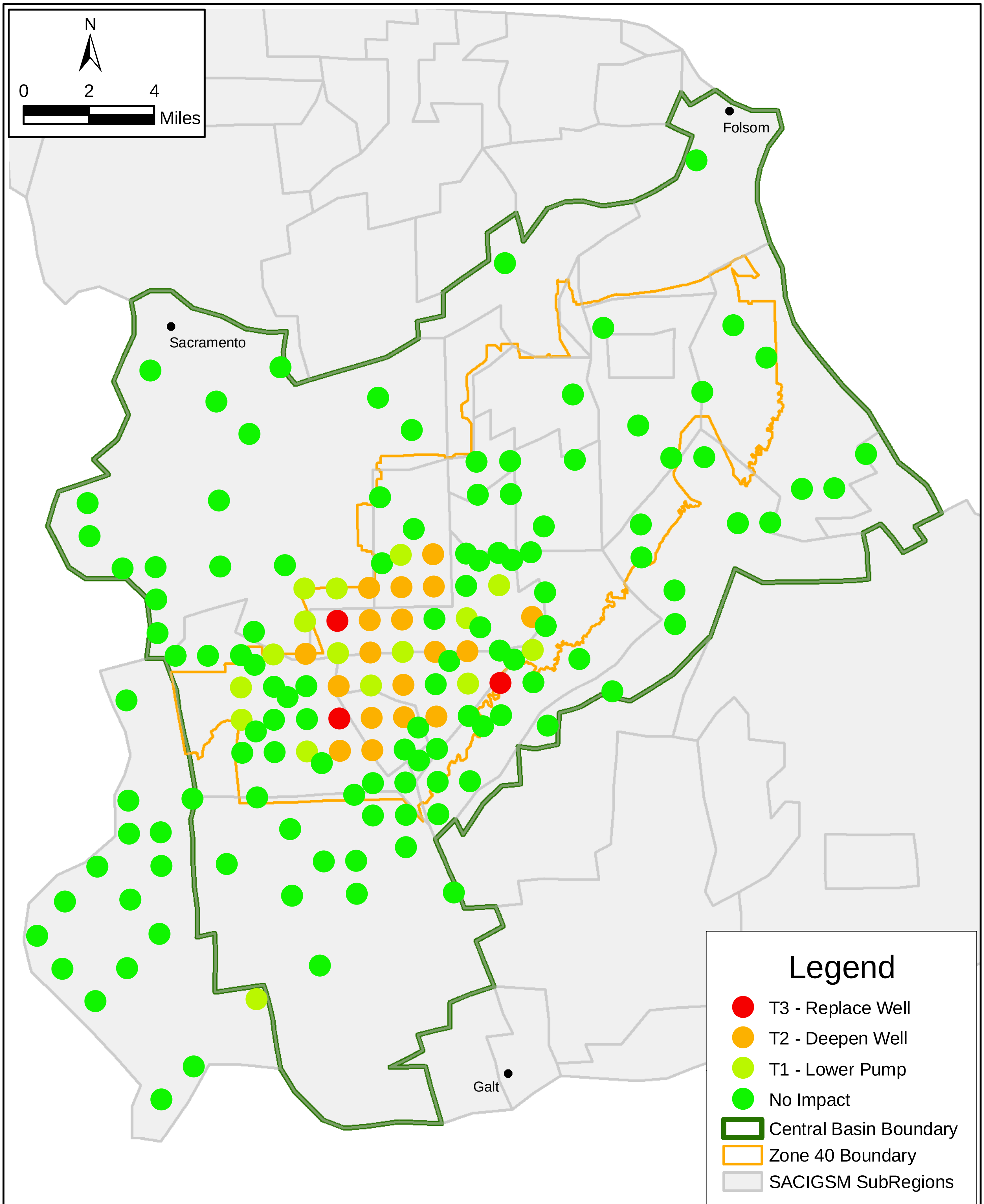
WRIME

Central Sacramento Groundwater Basin
Well Impact Analysis

Location of Impacted Sample Wells Under Proposed Project Scenario

November 2005

Figure 4.2



WRIME

Central Sacramento Groundwater Basin
Well Impact Analysis

Location of Impacted Sample Wells Under Reduced Surface Water Availability Scenario

November 2005

Figure 4.3

TABLE 4.2 – AGRICULTURAL AND DOMESTIC RURAL WELLS IMPACT COSTS FOR THE CENTRAL SACRAMENTO COUNTY

Impact	Agricultural Wells			Rural Domestic Wells		
	A-No Project	B-Proposed Project	C-Reduced Surface Water Availability	A-No Project	B-Proposed Project	C-Reduced Surface Water Availability
Lower Pump Bowl	$20,000	$10,000	$30,000	$95,000	$48,000	$142,000
Deepen Well	0	0	0	$305,000	$215,000	$415,000
Replace Well	0	0	0	$160,000	$160,000	$540,000
Subtotal	**$20,000**	**$10,000**	**$30,000**	**$560,000**	**$423,000**	**$1,097,000**
				A-No Project	B-Proposed Project	C-Reduced Surface Water Availability
Total Impact Costs for Ag and Rural Domestic Wells				**$580,000**	**$433,000**	**$1,127,000**

5. REFERENCES

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Appendix F
Trial Balloon on Water Quality Collaboration Program

CENTRAL SACRAMENTO COUNTY GROUNDWATER FORUM

Trial Balloon on Groundwater Contamination;
Final recommendations negotiated by the CSCGF

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1. Groundwater contamination and remediation of contaminated groundwater in the Central Basin must be addressed *proactively*. Water purveyors, regulatory agencies, Responsible Parties* and the Water Forum Successor Effort should meet on a regular basis to share information and develop strategies to collaborate on drinking water supplies and cleanup activities. These collaborative strategies should be designed to minimize negative impacts on other water resources and water users. (*Responsible Parties are defined in federal legislation: 42 U.S.C. Sec. 9607 (a)).

   NOTE: At such time as the management entity for the Central Sacramento County Groundwater Basin has been established, representatives of that entity should also be included in these discussions.

2. The Water Forum Successor Effort should undertake a high priority effort to persuade Sacramento County, the cities of Elk Grove, Rancho Cordova and Sacramento (as well as the cities of Citrus Heights, Folsom and Galt) to adopt policies that encourage the use of remediated water for non-potable purposes. .

3. The Central Valley Regional Water Quality Control Board requires Responsible Parties to identify all wells within 2000 feet of any known plume of contamination in the Central Basin. For those wells that the responsible lead agency* has determined are threatened by contamination, that agency should require the Responsible Parties to implement a sampling plan for the impacted well(s), including frequency of sampling, chemicals, reporting requirements, etc. (* The

lead agency is that agency which is responsible for directing the mitigation activities associated with a specific contamination release.)

4. The Sacramento County Environmental Management Department (EMD) should establish and maintain an information clearing house to assist individual well owners in addressing contamination concerns: e.g., how to get a well tested, by whom, for what, options if contamination is found, etc. This should include use of a web-page where information can be found with links to other organizations such as the Water Forum.

5. EMD should undertake a concerted effort to inform individual well owners of the importance of testing/monitoring water quality in their wells through a variety of public education tools including (but not limited to) a brochure provided to all applicants as part of the well permitting procedure.

6. EMD should collaborate with the Central Valley Regional Water Quality Control Board and other regulatory agencies to maintain up-to-date information on contamination sources in the Central Basin.

7. The Environmental Management Department, which is responsible for permitting wells, should exercise the strictest vigilance to ensure that all requirements of the well ordinance are enforced. If requirements are not met, EMD should undertake whatever rigorous enforcement actions are available and effective in the given circumstances.