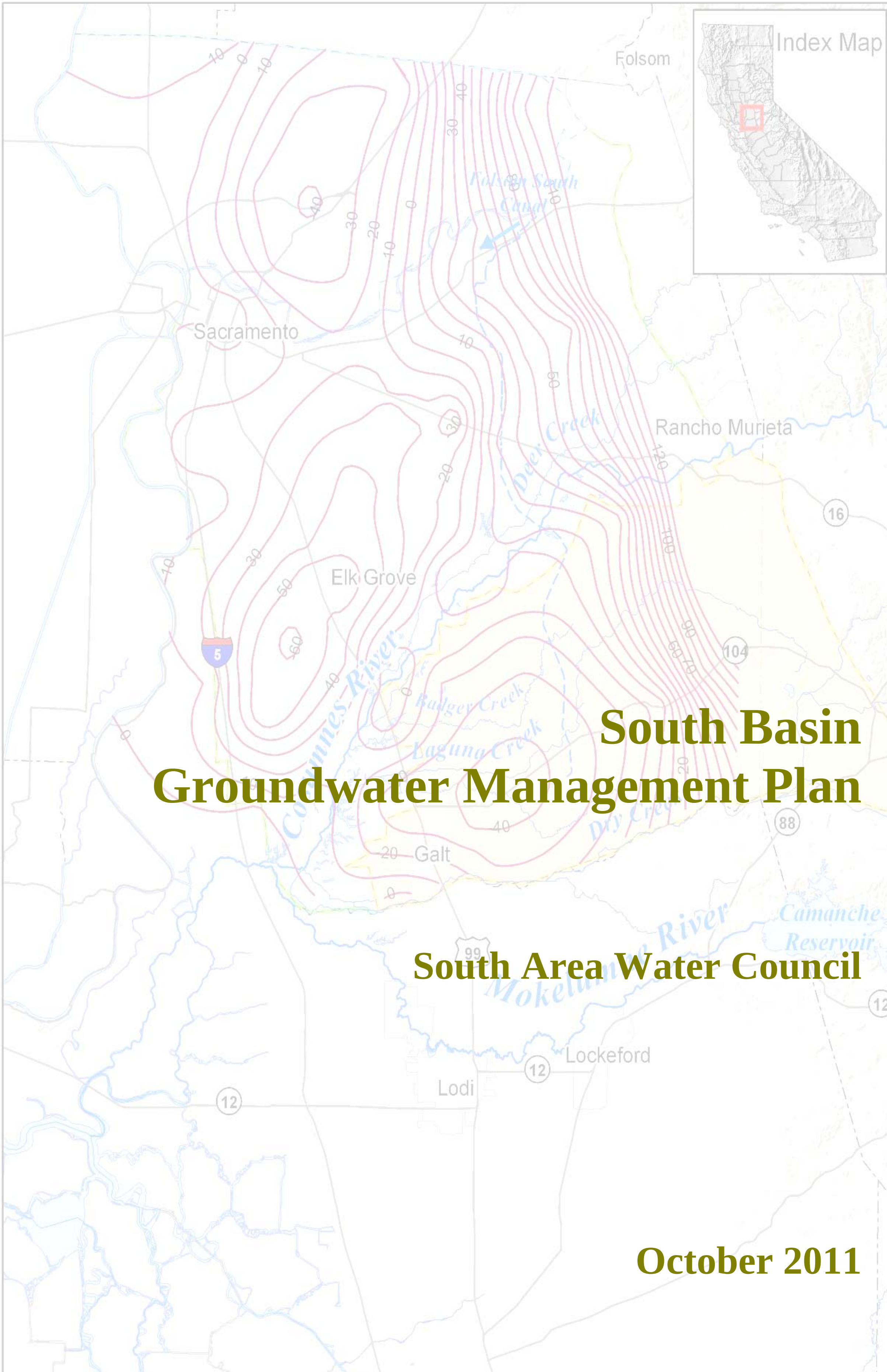

South Basin Groundwater Management Plan

South Area Water Council

October 2011

South Basin
Groundwater Management Plan

Prepared for:

South Area Water Council

October 2011

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Abbreviations and Acronyms

BI	Boundary Inflow
BMO	Basin Management Objectives
cfs	cubic feet per second
CWC	California Water Code
CVP	Central Valley Project
DP	deep percolation
DHS	Department of Health Services
DMS	data management system
DWR	California Department of Water Resources
GID	Galt Irrigation District
GMP	Groundwater Management Plan
JPA	Joint Powers Agreement
MSL	mean sea level
NGS	National Geodetic Survey
OHWD	Omochumne-Hartnell Water District
RMCSD	Rancho Murieta Community Services District
S	seepage from rivers
Se	baseflow to rivers
SacIGSM	Sacramento County Integrated Groundwater and Surface Water Model
SAWC	South Area Water Council
SCWA	Sacramento County Water Agency
SMUD	Sacramento Municipal Utility District
South Basin	South Sacramento County Groundwater Basin
TDS	total dissolved solids
TNC	The Nature Conservancy
Tp	pumping from groundwater
USGS	United States Geological Survey
Water Forum	Sacramento Area Water Forum
WWTP	Waste Water Treatment Plant

Executive Summary

Groundwater supports nearly 95 percent of all water demands in the South Sacramento County Groundwater Basin (South Basin). Interested stakeholders formed the South Area Water Council (SAWC), which initiated the effort to develop a Groundwater Management Plan (GMP) for the south area of Sacramento County to protect the health and viability of this vital resource. A plenary committee of the SAWC recommended developing a Joint Powers Authority to implement the GMP.

The South Basin GMP provides a framework under which all users of the aquifer can move toward a commonly held set of goals and objectives concerning groundwater use and protection. The plan includes specific goals and 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 South Basin GMP that brings forth the essence of the plan 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 body of the South Basin GMP document for more detail.

This GMP consists of five main sections: Land and Water Resources Setting, Basin Management Objectives, Monitoring Program, Implementation Plan, and Management Strategies Scenarios. A short description of each section is included in this executive summary.

Land and Water Resources Setting

This section provides stakeholders with a basic understanding of the groundwater conditions in the South Basin and the water demands and the sources that supply those demands. Information on water uses and supply sources is compared to groundwater and surface water available in the region.

Groundwater Conditions

In the last four decades, groundwater levels in wells outside the influence of the Cosumnes River have generally declined between 10 and 50 feet. The average annual decline in water levels in wells away from the Cosumnes River is approximately 1 foot; however, the more recent trend indicates less of a decline. Historical contour maps of the South Basin show the cone of depression at the center of the basin deepened as a result of groundwater pumping.

Water Demand and Supply

Because of the scarcity of measured data, estimates of water demand rely on water demand duties applied to land use distribution surveys in the South Basin. There are approximately 158,000 acres in the South Basin. Agriculture occupies roughly 43,000 acres, grasslands and riparian areas occupy roughly 108,000 acres, and the remaining 7,000 acres is occupied by urban land uses. The water demands for these areas from 2000 to 2004 are summarized below. Data from this period represent the most current land use, crop patterns, and water demand in the basin.

Summary of water demands and supply sources for the South Basin in acre-feet, 2000–2004.

Category	Water Demand	Water Supply Sources			
		Groundwater	Reclaimed Water	Surface Water	**Total Supply**
Agricultural					
Irrigated Agriculture	132,100	125,300	2,700	4,100	132,100
Semi-Agriculture	11,700	11,700			11,700
Urban					
Galt	4,900	4,900			4,900
Rancho Murieta	2,000			2,000	2,000
Rural Residential	3,700	3,700			3,700
SMUD	1,600			1,600	1,600
Total:	156,000	145,600	2,700	7,700	156,000

Groundwater Balance

The 25-year period of 1980–2004 is representative of a longer term average hydrology with dry and wet periods. While the ending dry years of 2000–2004 indicates that the South Basin aquifer storage lost an average of 11,900 acre-feet of water annually due to drought conditions. But when we look into water demand for the longer period—which contains both dry and wet years—the basin water balance shows that the South Basin aquifer storage gained an average of 2,500 acre-feet of water annually during this period.

Basin Management Objectives

This section discusses four goals and related Basin Management Objectives (BMOs) proposed for the South Basin based on feedback from basin stakeholders. The goals and objectives focus on managing and monitoring the basin to benefit all groundwater users in the basin. BMOs are used to help achieve groundwater basin goals.

The Stakeholders Plenary Group developed the following BMOs to meet the groundwater management plan goals listed below.

GOAL 1: Maintain Long-term Reliable Groundwater Supplies

BMO 1.1 – Understand the groundwater dynamics of the basin

BMO 1.2 – Maintain or enhance groundwater elevations to meet the long-term needs of groundwater users within the Groundwater Management Area

GOAL 2: Maintain or Improve Groundwater Quality

BMO 2.1 – Protect against adverse impacts to groundwater quality from man-made contaminants

BMO 2.2 – Protect against migration of contaminated groundwater

BMO 2.3 – Monitor and control saline water intrusion

BMO 2.4 – Facilitate implementation of policies and programs for wellhead protection, well abandonment and construction, by regulatory agencies

GOAL 3: Maintain and Enhance Related Natural Resource Features of the South Basin.

BMO 3.1 – Enhance the understanding of groundwater-surface water interaction along the Cosumnes River and creeks in the Basin to protect against adverse impacts to surface water resources

BMO 3.2 – Protect against inelastic land surface subsidence

GOAL 4: Maintain Local Control of Groundwater management

BMO 4.1 – Coordinate development and optimize operation of, or implement as appropriate future water management projects

BMO 4.2 – Actively develop and partner in conjunctive use projects of groundwater, surface water, and recycled water

BMO 4.3 – Examine public agency's land use plans to identify potential impact on groundwater

BMO 4.4 – Establish a procedure for sharing information with the public, appropriate resources management and regulation agencies on local, state, and federal levels

Monitoring Program

This section describes a monitoring program capable of assessing the current status of the basin. The program includes:

- Monitoring groundwater elevations,
- Monitoring groundwater quality,
- Monitoring and assessing the potential for land surface subsidence resulting from groundwater extraction, and
- Monitoring Surface water-groundwater interaction, which will lead to a better understanding of the relationship between surface water and groundwater along the rivers.

It is important to establish monitoring protocols that ensure the accuracy and consistency of data collected. Finally, the monitoring program includes a tool (Data Management System) for assembling and assessing groundwater-related data.

Implementation Plan

This section describes the structure and the method for implementing the Groundwater Management Plan after its adoption. The purposes of this implementation plan are to guide groundwater management efforts and carry out the proposed activities outlined in the BMOs section of this GMP.

The implementation plan components include:

Basinwide Management Actions

These actions facilitate achievement of the BMOs described in the GMP.

Governing Structure

The plenary committee recommended that a new Implementation Authority be formed through a Joint Powers Authority to represent all the interests in the basin to carry out the implementation plan. The final structure of the governing body is still being negotiated by the stakeholders in the basin.

The primary roles of the implementation authority would include:

- Establishing the legal entity with authority to implement the plan.
- Securing and providing funds for implementation of the GMP.
- Issuing and managing contracts necessary for implementation of the GMP.

- Overseeing the accuracy and quality of all reports associated with GMP implementation.
- Advancing and facilitating the goals and objectives identified in this GMP in a timely manner.
- Directing future updates to the GMP every 5 years, or more frequently if needed, to reflect changes in state laws or in local conditions/programs.
- Act as liaison between GMP implementation activities and agencies, individuals, and agencies represented by the group members.

Annual Review and Report

The Implementation Authority would be responsible for reporting on the progress of implementing the Southeast Sacramento County Groundwater Management Plan in an annual State of the Basin report. Prior to accepting the report, the Implementation Authority will consider comments from the general public.

Financing Mechanisms

Operational funding for Implementation Authority activities can be through annual member/participant contributions, county funding or state grants. The projects, policies, and programs that encompass the many groundwater-related management activities, can be funded through a variety of sources, which include, but are not limited to:

- Member/participant contributions
- Funding from other interested entities
- In-kind services by other entities within the Basin
- State or Federal grant programs

It is important to note that state grant programs or other sources of outside funding often require local financial support or contributions; therefore, local contributions aid in the acquisition of outside funding to implement the plan.

Implementation Schedule

The Implementation Authority must initiate certain activities within the first year to fulfill statutory requirements for its formation. These activities include:

- Establish an authority board, its strategies, and structure.
- Monitor groundwater status.
- Develop a Data Management System (DMS).
- Prioritize activities that can be undertaken immediately, taking into consideration public inputs.
- Acquire funding for first year activities.

The schedule for implementing the GMP must remain flexible to account for many factors that influence the implementation.

First year program start-up costs are estimated at $150,000 and the annual cost of plan operation is estimated at $75,000. The Implementation Authority will annually evaluate future programs.

Future Re-evaluation of GMP

The GMP and documents developed as part of the implementation are part of an on-going and evolving groundwater management program. The Implementation Authority will review the GMP and decide on updates based on new issues, changed conditions, and future technological advancements that will occur over time. Comprehensive review of the GMP will be scheduled every 5 years, unless the Authority decides it should be more frequently.

Management Strategies Scenarios

The Plenary Committee developed and evaluated alternatives for groundwater management that will facilitate achieving some of the BMOs, primarily conjunctive use and groundwater recharge. Alternatives are projects that could be reasonably implemented solely by the Implementation Authority or in conjunction with other stakeholders in the study area.

The SacIGSM Model was used to simulate a baseline (No Action condition) and three alternative groundwater management strategies. The focus of these simulations was a comparative analysis. The results of these simulations showed groundwater elevation changes at several observation wells, changes in groundwater contours, and changes to the groundwater budget of the basin as a result of the alternatives.

Comparison of simulations, relative to the baseline case, showed potential benefits of pursuing a particular management strategy. The model simulated 35 years of hydrology (1970 to 2004) with initial conditions of December 2004. The model delineated three aquifer layers based on DWR Bulletin 118-3, U.S. Geological Survey reports, numerous well logs, and California Division of Oil and Gas geographical logs. The top two aquifer layers—Upper Aquifer and Lower Aquifer—are fresh-water bearing aquifers.

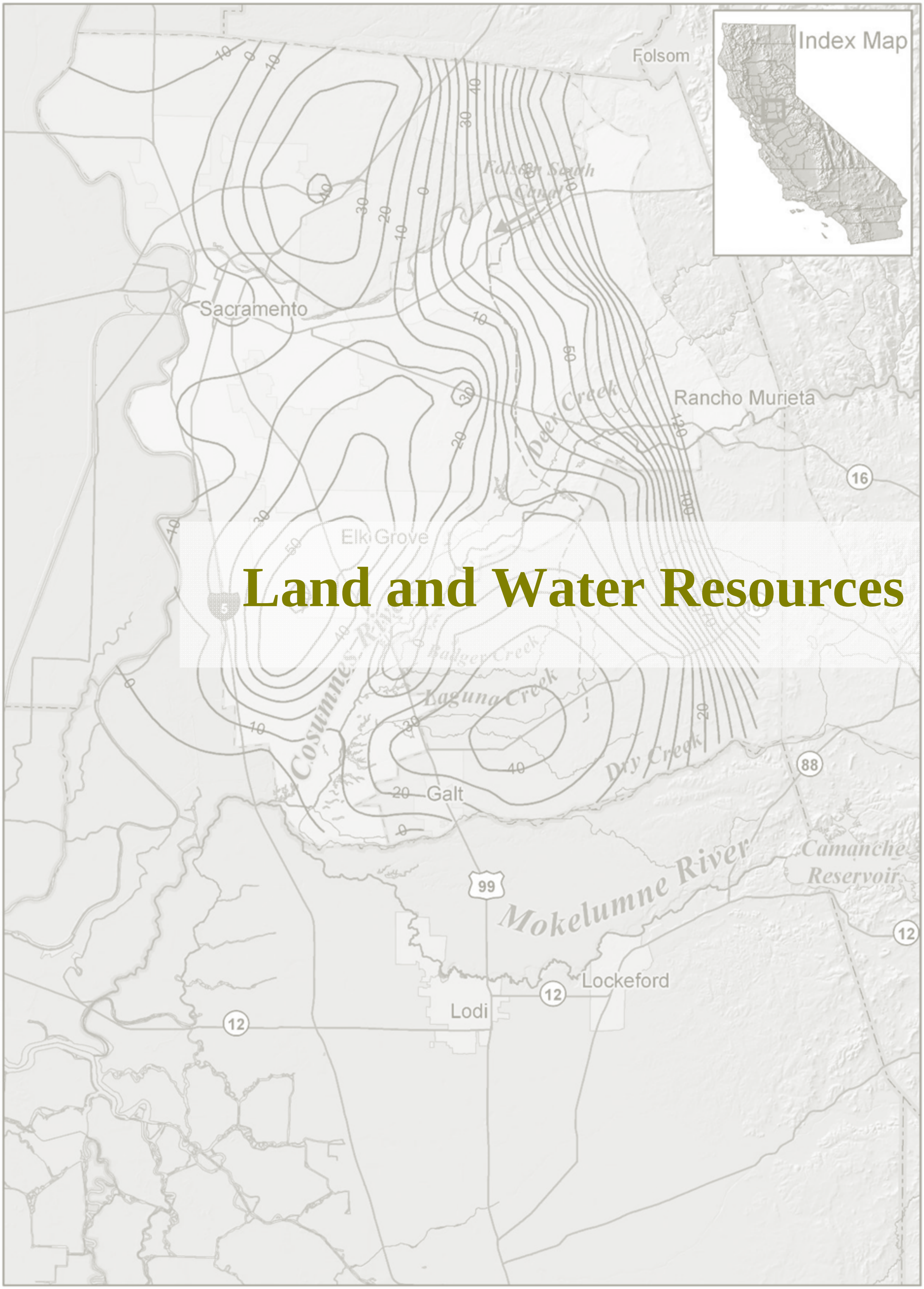
Four simulations covered a range of potential management scenarios or options:

1. Continuation of existing conditions with no projects (baseline).
2. Conjunctive use - utilize available surface water supplies in lieu of pumping.
3. Direct Groundwater Recharge - spread available surface water supplies onto percolation basins and existing channels to directly recharge groundwater.
4. Combination of In-lieu Recharge and Direct Recharge - utilize available surface water supplies in lieu of pumping groundwater and directly recharge groundwater.

The results of the four scenarios showed:

- The baseline condition shows stable-to-slightly increasing water levels.
- Higher groundwater elevations and increased average annual groundwater storage in the three management scenarios when compared to the baseline scenario.
- The scenario that included a combination of conjunctive use and direct recharge resulted in the greatest increase to groundwater storage and the spatial distribution of water elevations when compared to the other management scenarios.
- Each of the alternatives would almost equally benefit neighboring areas as it benefits the targeted Planning and Jurisdictional areas by reducing the long-term subsurface boundary flow into the basin.

Land and Water Resources



1 Land and Water Resources

1.1 Introduction

Groundwater is one of California's most valuable resources and requires protection and proper management to maintain its beneficial uses. The South Area Water Council (SAWC) initiated an effort to develop a Groundwater Management Plan (GMP) for the south area of Sacramento County. Groundwater supports nearly 95 percent of all water demands in the South Sacramento County Groundwater Basin (South Basin). Therefore, to protect the health and viability of this vital resource, interested stakeholders came together to develop a GMP.

This Land and Water Resources section provides stakeholders with a basic understanding of the groundwater conditions in the South Basin and the water demands and the sources that supply those demands. Information on water uses and supply sources is then compared to groundwater and surface water available in the region. This comparison allows a determination of the balance between demand and available supply.

1.1.1 Groundwater Conditions

In general, wells near the Cosumnes River showed a stable groundwater level trend, while wells away from the river showed a declining trend.

In the last four decades, groundwater levels in wells outside the influence of the Cosumnes River have generally declined between 10 and 50 feet. The average annual decline in water levels in wells away from the Cosumnes River is approximately 1 foot. Historical groundwater contour maps of the South Basin, developed by different agencies, showed an increase in the size of the cone of depression at the center of the basin as a result of increased pumping.

1.1.2 Water Demand and Supply

Water demand data is scarce in the South Basin because most water uses are supplied from private wells without water meters that serve this predominately rural agricultural area. Therefore, estimates of water demand are based primarily on water demand duties applied to land use distributions surveys in the South Basin. There are approximately 158,000 acres in the South Basin and agriculture occupies roughly 43,000 acres, grasslands and riparian areas occupy roughly 108,000 acres, and the remaining 7,000 acres is occupied by urban land uses. The water demands for these areas for the period from 2000 to 2004 are summarized in **Table 1-1**. Data from this period represent the most current land use, crop patterns, and water demand in the basin.

Table 1-1. Summary of water demands and supply sources for the South Basin (Planning Area) 2000–2004.					
Category	Water Demand (acre-feet)	Water Supply Sources			
		Groundwater (acre-feet)	Reclaimed Water (acre-feet)	Surface Water (acre-feet)	Total Supply
Agricultural					
Irrigated Agriculture	132,100	125,300	2,700	4,100	132,100
Semi-Agriculture	11,700	11,700			11,700
Urban					
Galt	4,900	4,900			4,900
Rancho Murieta	2,000			2,000	2,000
Rural Residential	3,700	3,700			3,700
SMUD	1,600			1,600	1,600
Total:	156,000	145,600	2,700	7,700	156,000

A groundwater and surface water balance can be performed based on estimated water demands and available water supply sources in the South Basin. The water balance will allow local planners and stakeholders to determine the long-term viability of the resource.

1.1.3 Groundwater Balance

The information for the groundwater balance is derived from the data presented in Table 1-1 and from data extracted from a regional groundwater model. The groundwater balance components are expressed in acre-feet in **Table 1-2**.

This balance shows the inflows and withdrawals from the regional groundwater aquifer based on water demand data from 2000–2004. This information indicates that the South Basin aquifer storage lost an average of 11,900 acre-feet of water annually during this period due to drought conditions. But when we look into water demand for the longer 1980–2004 period, which contains both dry and wet years, the basin water balance indicates that the South Basin aquifer storage gained an average of 2,500 acre-feet of water annually during this period.

Table 1-2. Summary of modeled groundwater balance in the South Basin.				
Inflow (acre-feet)	**1980–2004**		**2000–2004**	
Infiltration (rainfall & irrigation)	+59,500		+48,400	
Seepage from streams	+60,200		+52,300	
Sub surface inflow from adjacent basins	+37,300		+33,000	
Subtotal		157,000		+133,700
Outflow (acre-feet)				
Groundwater withdrawals	-154,500		-145,600	
Subtotal		-154,400		-145,600
Change in groundwater storage		+2,600		-11,900

Table 1-3. Summary of modeled surface water balance in the South Basin.		
Inflow (acre-feet)		
Inflow to local Rivers & creeks	+537,000	
Local runoff to creeks	+65,000	
Locally generated discharge	+15,000	
Subtotal		+617,000
Outflow (acre-feet)		
Seepage to aquifer	-52,300	
Irrigation and urban	-9,700	
Outflow to the Delta	-555,000	
Subtotal		- 617,000
Balance		0

1.1.4 Surface Water Balance

A similar, simplified, balance can be performed for surface water resources. The surface water balance of the South Basin is summarized in **Table 1-3.**

This surface water balance provides an average estimate of the available water from local streams, rainfall, and local discharges. Because there is limited data on many of the creeks in the basin, it is difficult to develop an accurate balance. However, this simplified balance shows that very little surface water is used to meet irrigation and urban demands compared to the amount of surface water flowing through the area. Currently, the most significant benefit of surface water is recharge to the local aquifer.

Streamflow is seasonal in the South Basin, that is, most of the flow in the local rivers and creeks occurs during the winter when there is no demand for irrigation water. During the summer, with the exception of locally generated discharges, the rivers and creeks that cross the basin are typically dry and therefore do not support irrigation demands.

1.2 Study Area Boundaries

The study area for this GMP includes several regionally important planning boundaries that define the area covered by this GMP. **Figure 1-1** depicts the overlap of the various planning areas related to this GMP.

Throughout this document reference will be made to Jurisdiction and Planning areas. Information on land use, water demand, and other physical characteristics will often be shown for both areas. Segregation of this information will help in developing appropriate basin management objectives in the South Basin, and provide a basis for developing a cooperative management strategy for the water resources of the area.

As Figure 1-1 shows, the GMP Planning Area for this effort is the area of the Cosumnes subbasin (as defined by California Department of Water Resources (DWR)) within Sacramento County. This area includes all of the South Basin and a portion of the Central Basin, as defined by the Water Forum Agreement. Outside of the South Basin, the Planning Area includes the Cosumnes River corridor, which encompasses Rancho Murieta, Omochumne-Hartnell Water District (OHWD), and the Cosumnes River Preserve—all of which lie within the Central Basin. This overlapping area is of joint interest to both the Central and South basins and will be cooperatively managed in the future.

The GMP Jurisdiction Area is that portion of the South Basin entirely within Sacramento County (**Figure 1-2**). The Jurisdiction Area is so named because it is the area over which the GMP will have management jurisdiction. The portion of the Planning Area within the Central Basin is managed by the Sacramento Central Groundwater Authority, which has developed and adopted a GMP for the Central Basin.

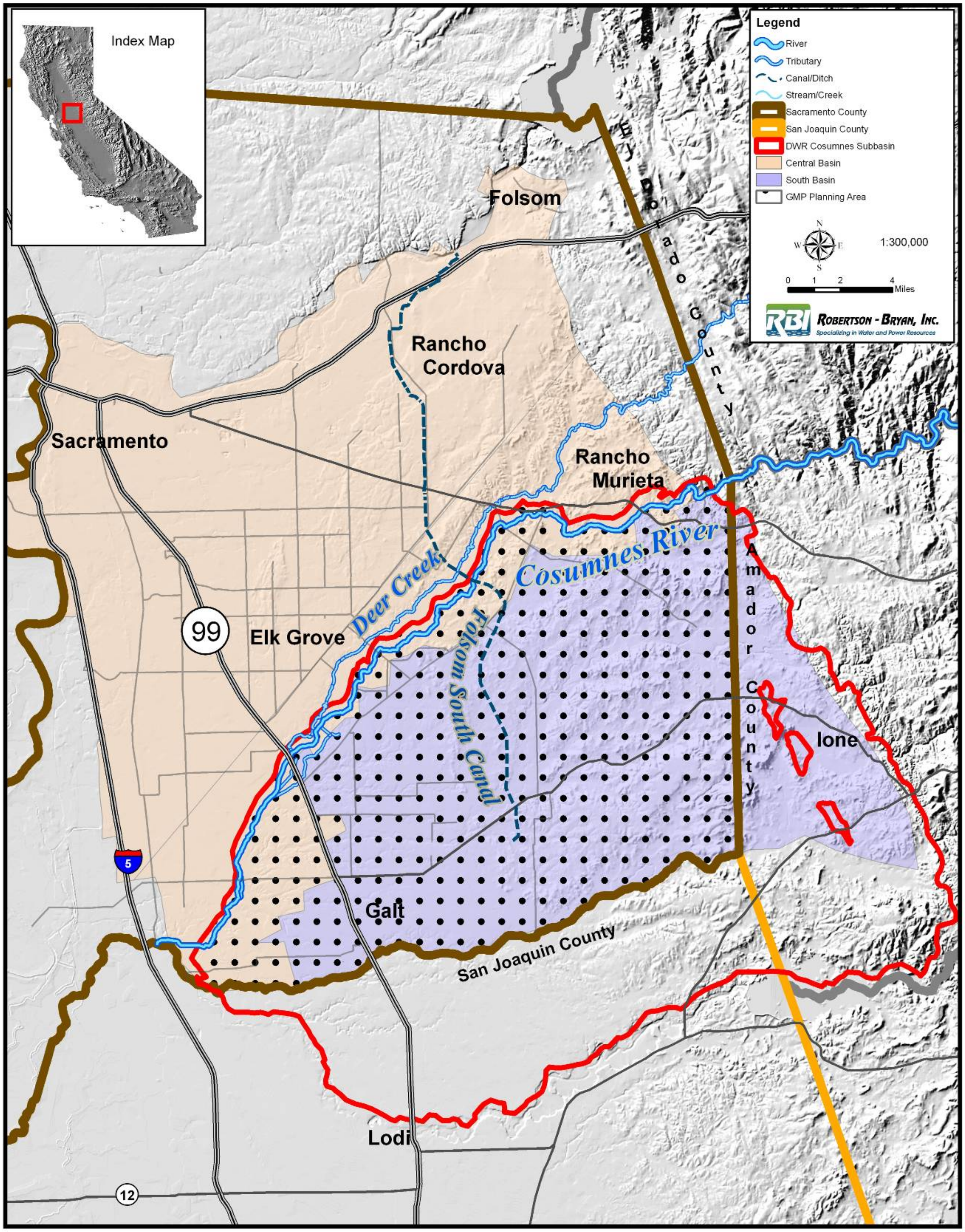


Figure 1-1. Planning Area for the South Sacramento County GMP.

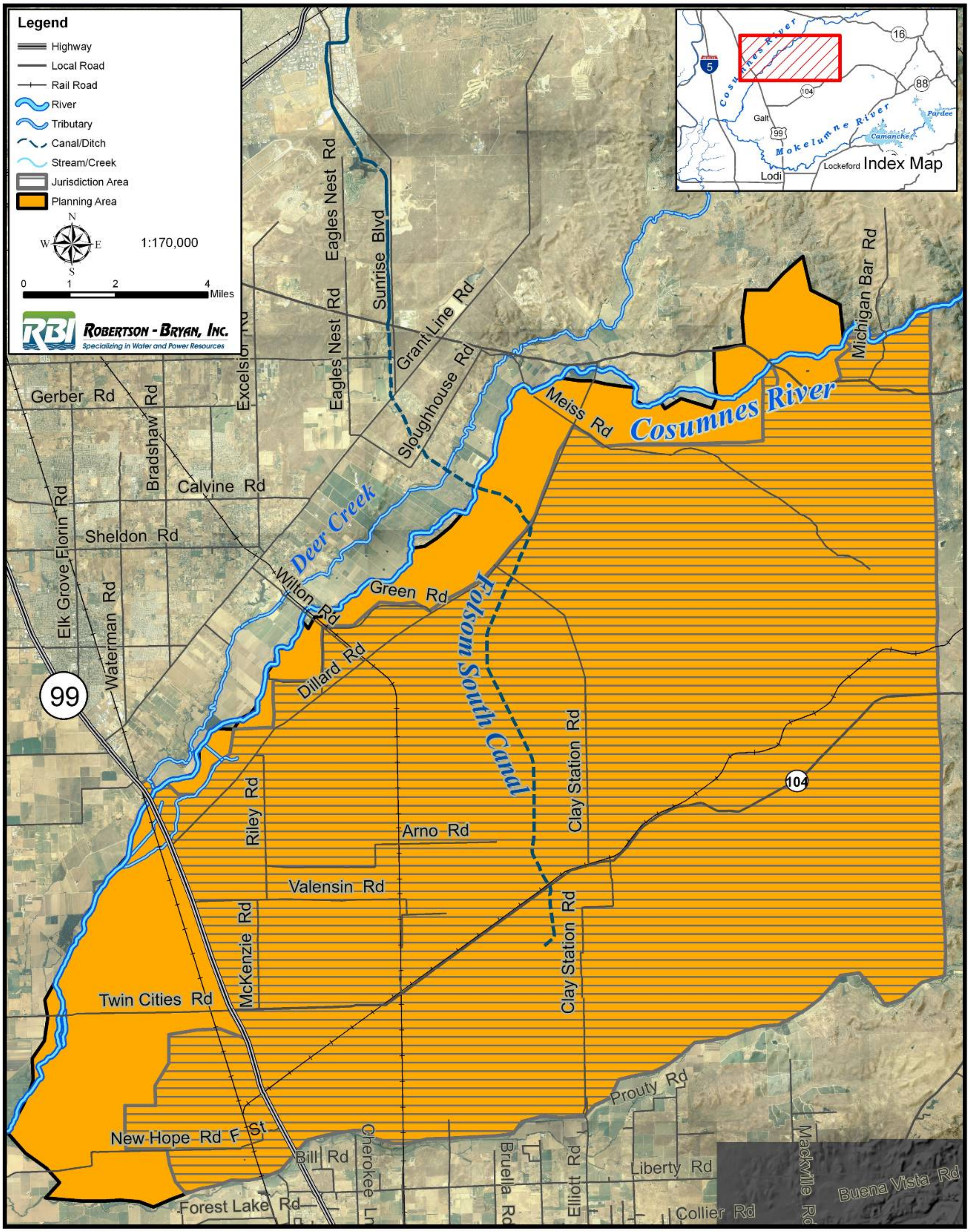


Figure 1-2. Planning and Jurisdiction areas of the South Sacramento GMP.

1.3 Hydrologic Characterization of the South Basin

The hydrologic setting section describes the current understanding of surface and subsurface hydrologic conditions in the south area. This section provides an overview of the surface water and groundwater resources available in the area.

Groundwater is the major supply source for nearly all agricultural, residential, and municipal users in southern Sacramento County. Characteristics of the local hydrogeology and groundwater-level trend in the area are described to provide readers an understanding of impacts of past, current, and future demands on this resource.

1.3.1 Hydrology

The South Basin is bounded by the Cosumnes River on the north and west and Dry Creek on the south. The Amador County line is the eastern boundary of the South Basin. Several small creeks—Deer, Badger and Laguna—drain portions of the basin westward (**Figure 1-3**). No flow monitoring stations exist on either Badger Creek or Laguna Creek; therefore, no historical flow data is available.

Annual precipitation in the South Basin ranges from approximately 15 inches at the western edge to about 22 inches in the east (DWR 2003). Winter storms between November and March account for about 80 percent of the annual precipitation in the basin. As Table 1-3 shows, local runoff generated by precipitation (65,000 acre-feet), inflow from rivers, streams, and creeks (537,000 acre-feet), and locally generated discharge from irrigation and other manmade activities (15,000 acre-feet) generate an average annual surface flow from the South Basin of 617,000 acre-feet. The Cosumnes River is the major source of surface flow to the south area with an average annual flow of 312,000 acre-feet per year, and is a major source of groundwater recharge for the Central and South basins. Other creeks in the basin—Deer, Badger, Laguna, and Dry—contribute the balance (225,000 acre-feet) at the estimated annual stream flow in the South Basin (537,000 acre-feet).

Flows on the Cosumnes River are unregulated and result primarily from winter storms and seasonal snowmelt. Approximately 16 percent of the watershed lies above the typical snow-level elevation of 5,000 feet. Consequently, only a small portion of the upper reaches of the watershed receives significant snowfall; and the flow regime of the river is influenced primarily by rainfall.

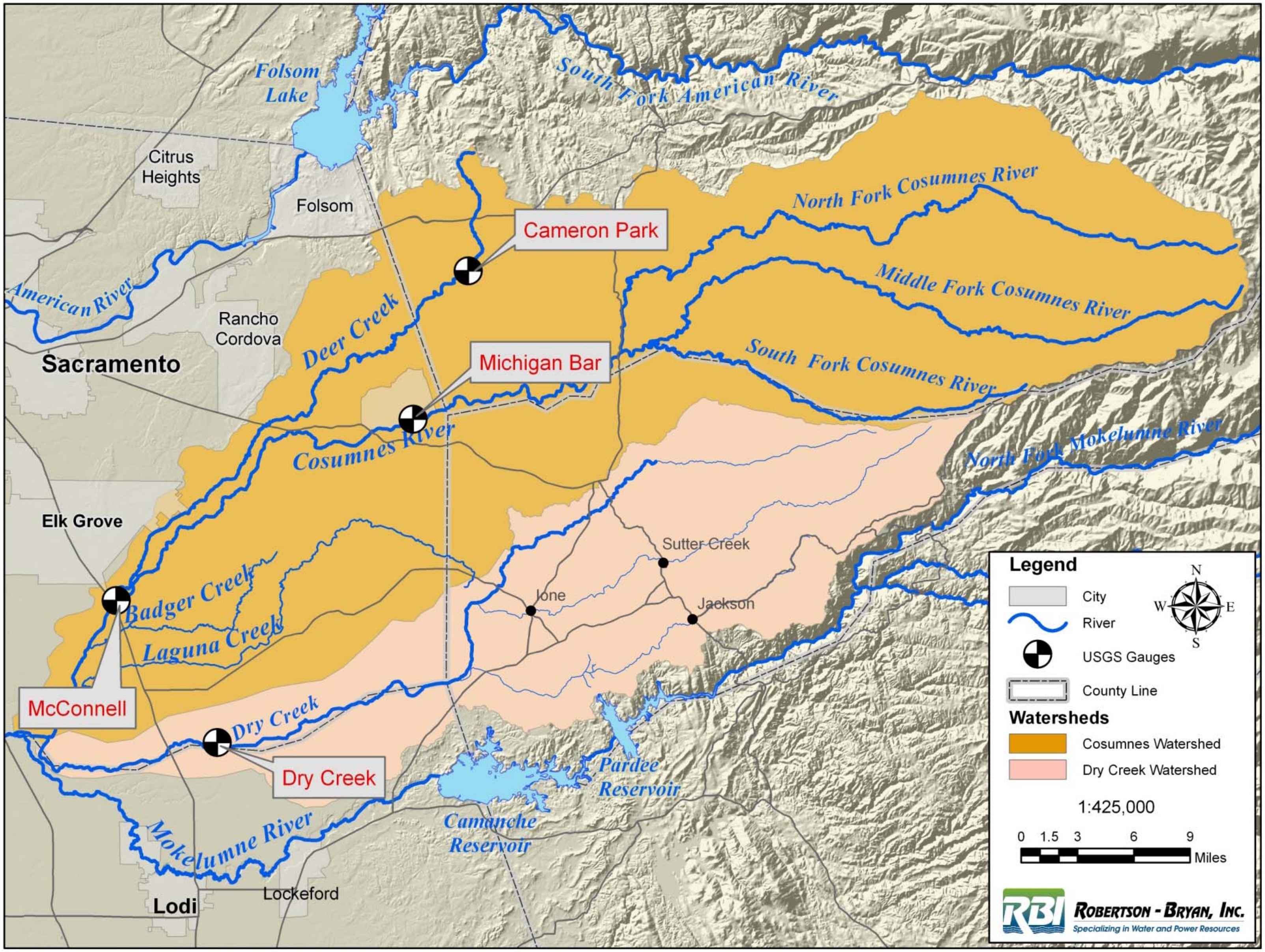


Figure 1-3. Cosumnes River and Dry Creek Watershed.

The historical average daily flow of the Cosumnes River at the U.S. Geological Survey (USGS) gauge at Michigan Bar is shown in **Figure 1-4** for water years 1907 to 2008, and the average monthly flow pattern is shown in **Figure 1-5**. **Table 1-4** provides the average monthly flow by water year type for the 1907 to 2008 period of record. The Cosumnes River exceedance diagram in **Figure 1-6** indicates a highly variable flow pattern for each season, with flow primarily occurring in the winter and spring and minimal flow in the summer and fall. The flow record for Michigan Bar includes all upstream operations, including releases from Sly Park Reservoir for agricultural use along the lower reaches of the Cosumnes River.

A comparison of historical flows in the Cosumnes River between the USGS gauges at Michigan Bar and McConnell (Figure 1-3) illustrates that the river loses flow in its lower reaches. This loss is attributable to seepage to the groundwater aquifer, evaporation, and evapotranspiration. These two gauges can be compared between October 1, 1941, and September 30, 1982, when the McConnell gauge was in operation. During this period, flow at Michigan Bar is compared to flow at McConnell for days when flow at Michigan Bar is less than or equal to 100 cubic feet per second (cfs) and the flow difference between two consecutive days is less than 10 cfs, to avoid periods when flows were increasing due to precipitation. It was assumed that for flows less than 100 cfs, it would take two days for the flow at Michigan Bar to reach McConnell and hence a lag of two days was used for the comparison. Comparison of average daily flow at Michigan Bar and McConnell is shown in **Figure 1-7**, which illustrates that the river loses flow between the two gauges. For instance, an average daily flow of 40 cfs at Michigan Bar typically results in only 10 cfs at McConnell. The data also show that when flow at Michigan Bar is less than or equal to 30 cfs, 85 percent of the time there is no flow at McConnell.

Deer Creek

Deer Creek drains an area of low foothills approximately 9 miles northeast of Highway 16. Historically, Deer Creek and the Cosumnes River were part of the same connected floodplain downstream of Dillard Road, but are now separated by a system of levees. Historical flow data for Deer Creek is limited. Sacramento County maintains a stage gauge on Deer Creek at Wilton Road and Scott Road. The purpose of these gauges is to provide flood level warnings; they do not provide flow values. In 2004 the USGS installed a flow monitoring station on Deer Creek near Cameron Park. **Figure 1-8** shows the average monthly flow for Deer Creek for the data available since April 2004.

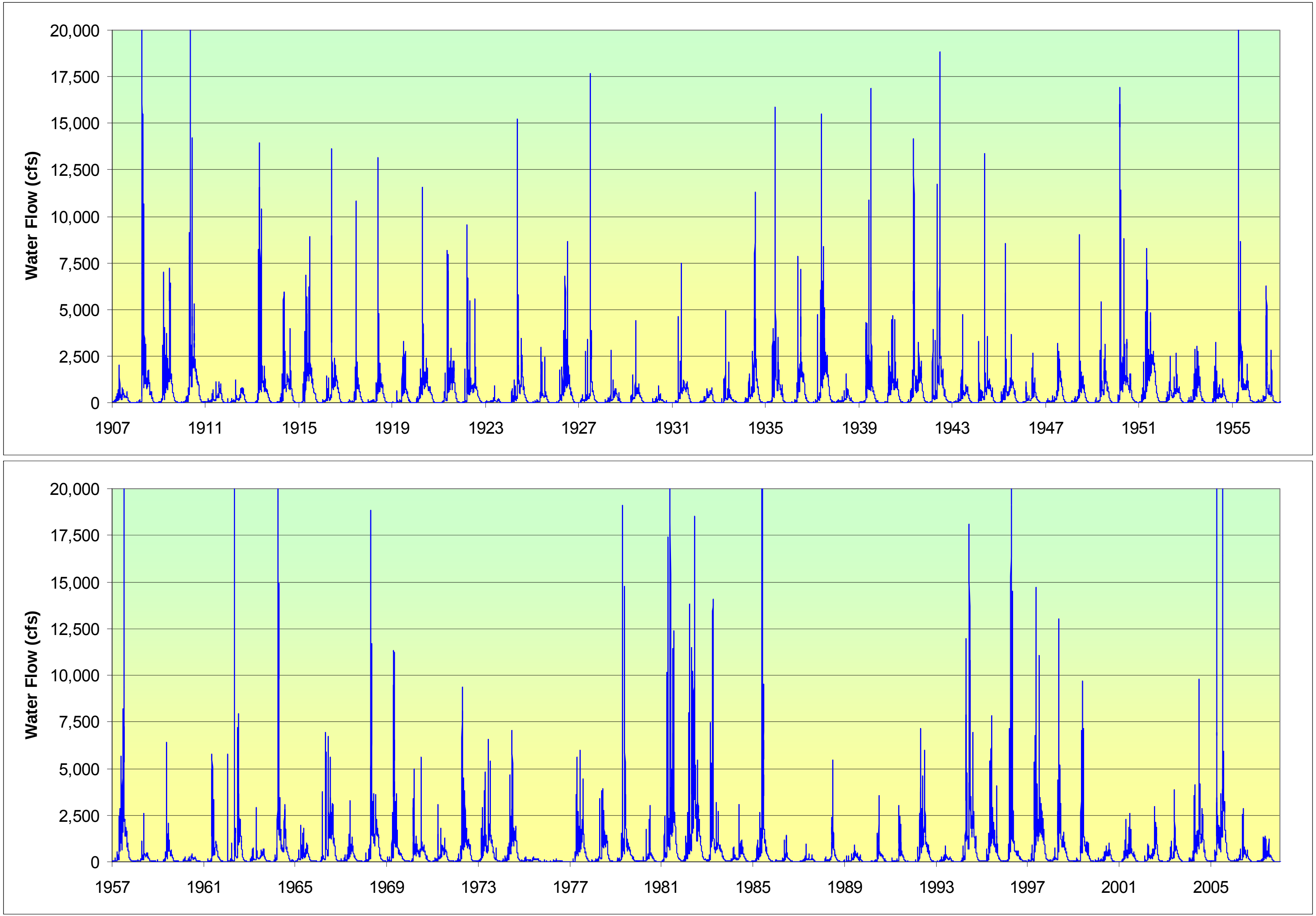


Figure 1-4. Average daily streamflow for Cosumnes River Water Years 1907 to 2008.

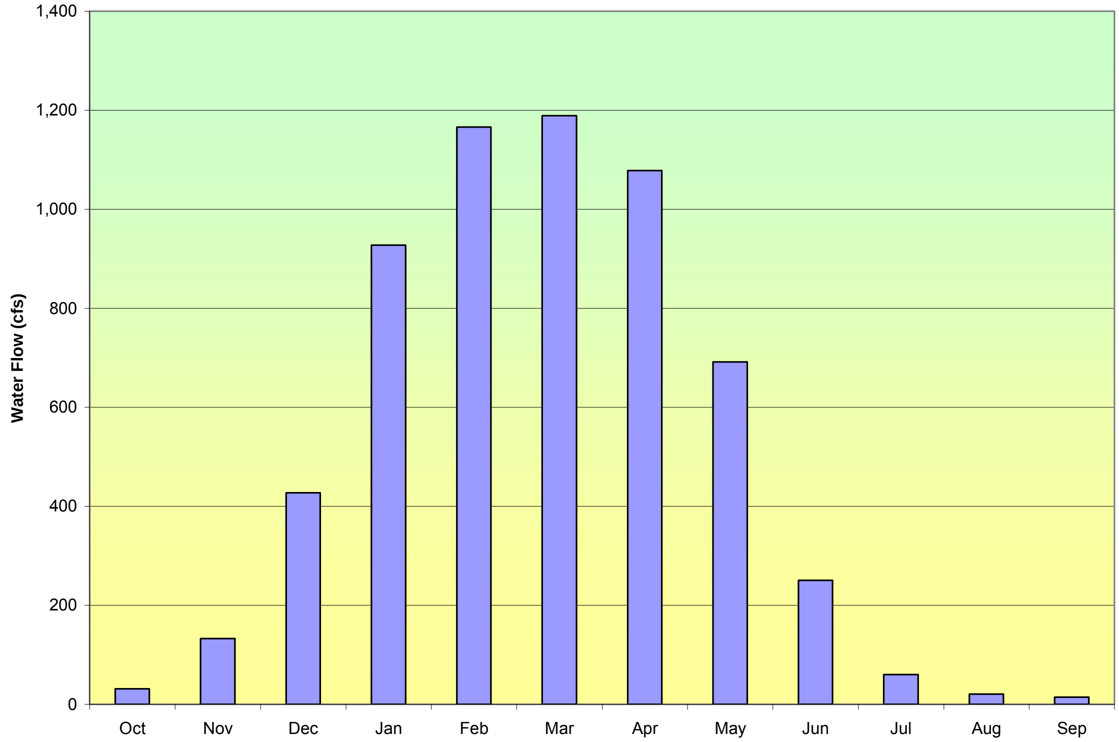


Figure 1-5. Average monthly streamflow for Cosumnes River Water Years 1907 to 2008.

Table 1-4. Average monthly streamflow for Cosumnes River by Water Year Type for Water Years 1907 to 2008.

Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual Flow
	cubic feet per second												acre-feet
Period Average	32	134	378	748	1,020	1,042	959	602	213	50	18	13	312,070
Wet	29	121	698	1,946	1,989	2,032	1,764	1,213	470	117	38	27	626,260
Above Normal	49	344	773	1,108	1,700	1,261	1,246	695	230	54	21	15	448,128
Below Normal	24	79	185	274	665	954	994	636	214	42	13	11	245,419
Dry	33	87	162	266	457	532	483	284	90	24	13	7	146,021
Critical	23	40	71	148	290	431	308	184	59	14	5	4	94,520

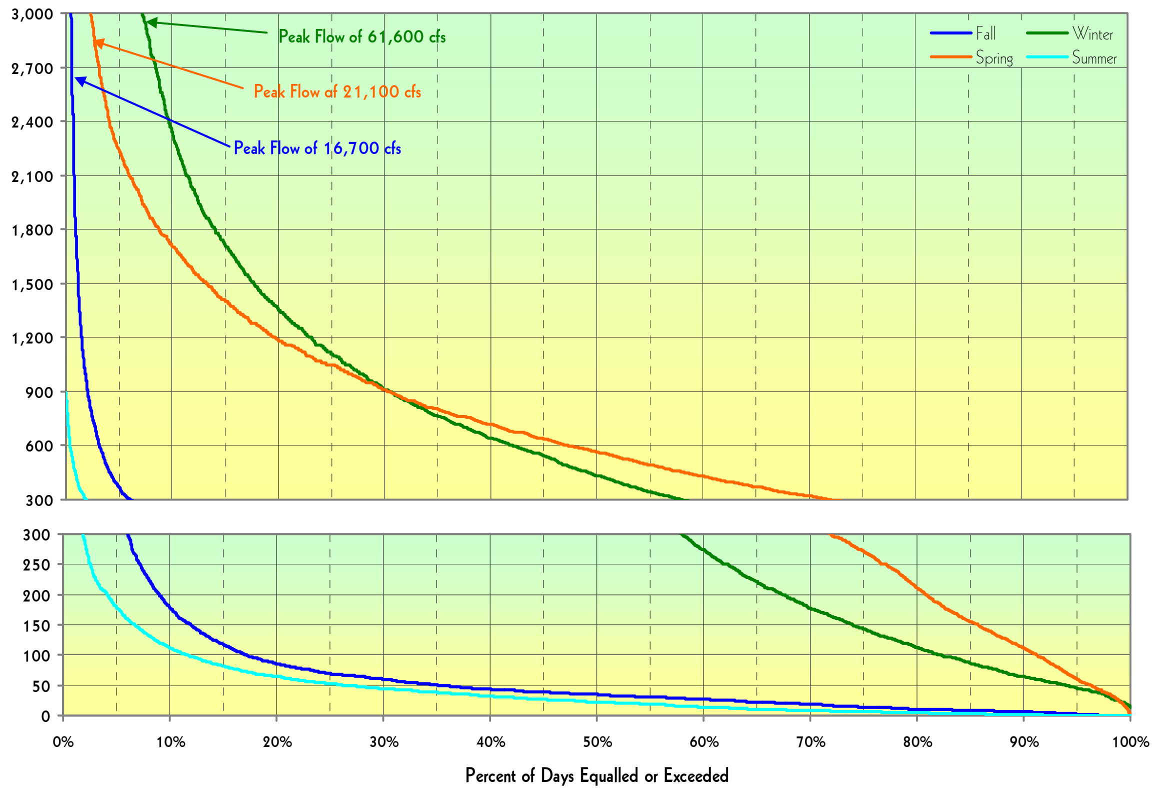


Figure 1-6. Seasonal exceedance of Cosumnes River at Michigan Bar.

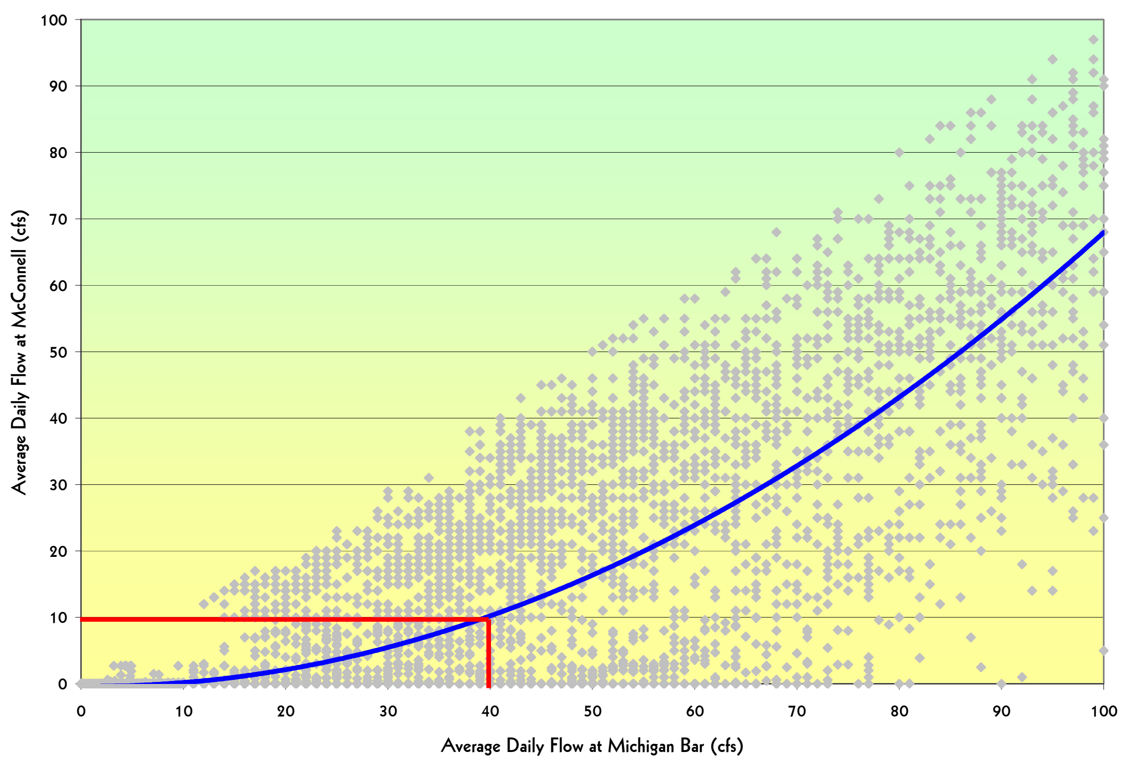


Figure 1-7. Comparison of flow between Cosumnes River at Michigan Bar and McConnell.

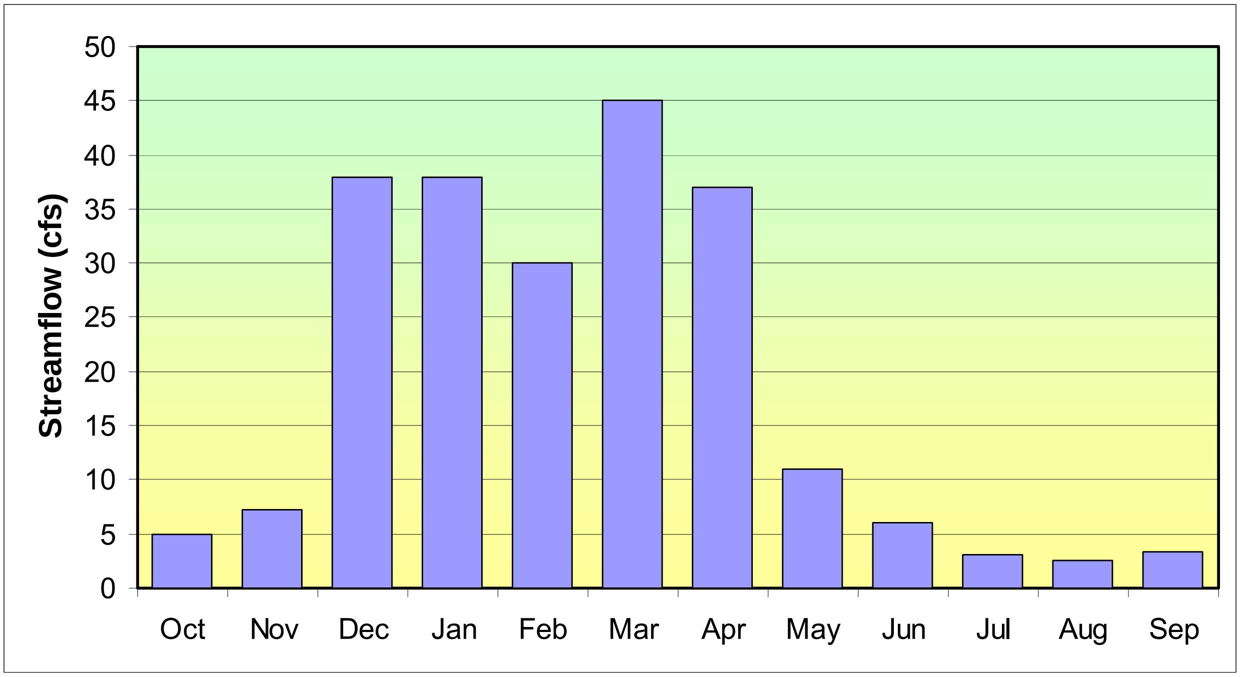


Figure 1-8. Average monthly streamflows on Deer Creek near Cameron Park for 2004 to present (USGS data).

Dry Creek

Dry Creek, a tributary to the Cosumnes River, drains about 348 square miles of the Sierra Nevada and Central Valley between the Cosumnes and Mokelumne watershed. The upper Dry Creek watershed has a peak elevation of approximately 3,300 feet in an area characterized by relatively steep slopes. Dry Creek historically connected to the Mokelumne River, but was routed through Grizzly Slough to the Cosumnes River before 1910, when levees along the lower Cosumnes and Mokelumne rivers were constructed to convert sloughs and wetlands to arable land (PWA 2004). The USGS maintained a streamflow gauging station on Dry Creek near Galt from 1926 to 1997, where the gauge recorded approximately 50 years of data. The USGS abandoned the gauge after it was damaged by flooding in 1997. Based on data available from the USGS, the average monthly flow for Dry Creek is shown in **Figure 1-9**.

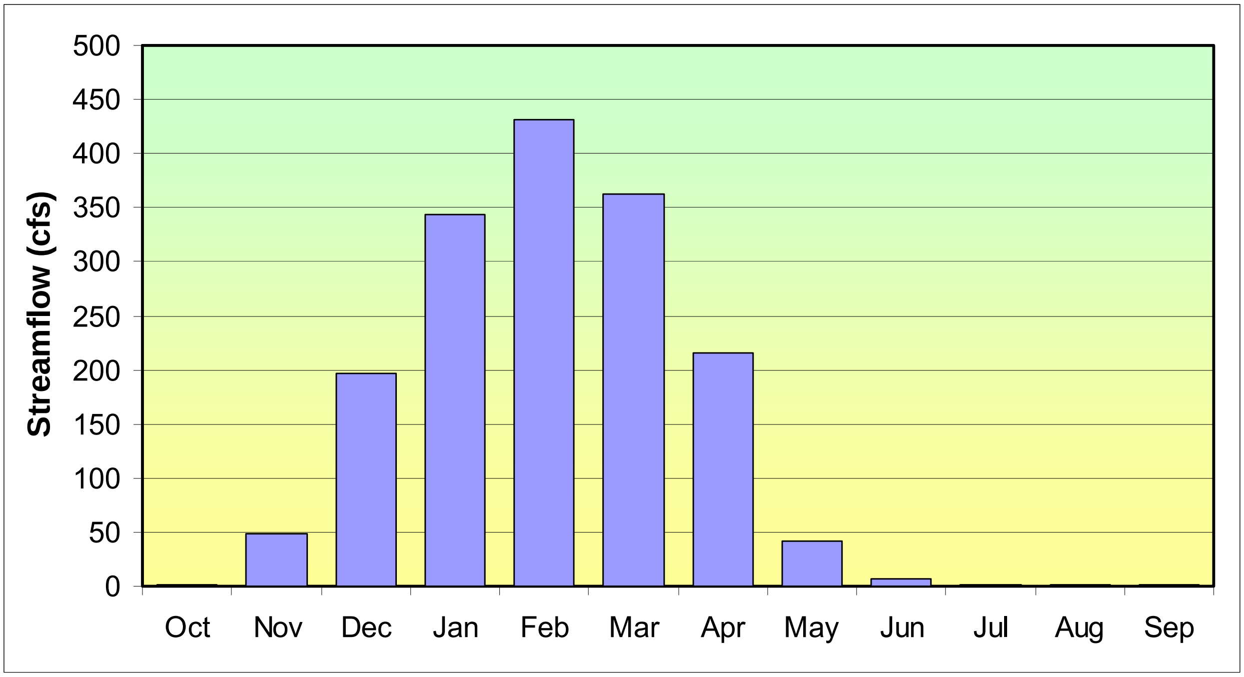


Figure 1-9. Average monthly streamflow on Dry Creek near Galt for 1926 to 1997 (USGS data).

1.3.2 Hydrogeology of the South Basin

The South Basin is within the Cosumnes subbasin (DWR Basin Number 5-22.16). DWR estimates that the total groundwater storage capacity of the entire Cosumnes subbasin is 6 million acre-feet based on 1967 and 1974 data (DWR 2003). This estimate is based on a surface area of 281,000 acres, an aquifer thickness above the Mehrten formation of 290 feet (20- to 310-foot depths), and an average specific yield of 7.4 percent.

> **Specific Yield**
> The ratio of the volume of water draining out of a volume of material to the total volume of material drained; used to calculate the quantity of water recoverable from underground storage.

The geologic formations that contain groundwater in the South Basin are described below and their distribution is shown in **Figure 1-10.**

- **Floodplain Formations:** A younger alluvium layer that includes recent sediments deposited along the channels of active streams along the Cosumnes River, Deer Creek, and Dry Creek. The young alluvium layer consists primarily of unconsolidated silt, fine-to-medium grained sand, and gravel. The maximum thickness of this layer is 100 feet with a specific yield ranging from 6 percent to 12 percent. The sand and gravel zones in this layer are highly permeable and yields significant quantities of water to wells.

- **Laguna and Riverbank Formations:** Older alluvium layers that make up the unconfined aquifer of the area (formerly known as Victor). These layers consist of loosely to moderately compacted sand, silt and gravel deposits with discontinuous interbedded lenses of clay. The thickness of this layer ranges between 100 feet and 650 feet and has a specific yield ranging from 6 percent to 7 percent (Olmstead and Davis 1961). Wells tapping sand layers in the Laguna Formation yield high amounts of groundwater.

- **The Mehrten Formation**: This layer is of volcanic origin, underlying the Laguna formation and makes up the second aquifer in the area. It consists of black volcanic sand, silt, and clay interbedded with intervals of dense tuff breccia. The sand intervals in this formation are highly permeable and wells in them can have moderate to high yield. The tuff breccia intervals act as confining layers. Thickness of the layer is between 200 and 1,200 feet. Specific yields for this layer range from 6 percent to 12 percent (Olmstead and Davis 1961).

Tuff Breccia

A pyroclastic rock consisting of more or less equal amounts of ash, cinder, and larger fragments.

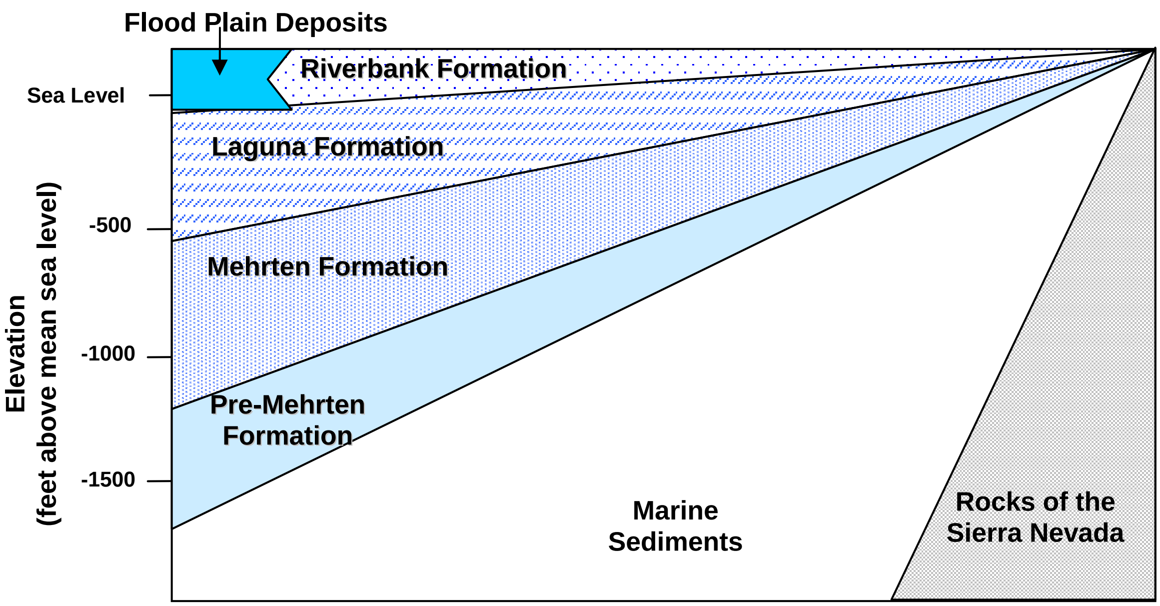


Figure 1-10. Generalized depiction of South Basin geologic formations. Modified from Central Sacramento County Groundwater Management Plan.

Historical and Current Groundwater Levels

The condition of a groundwater basin can be evaluated by reviewing historical groundwater level data collected from active wells or from dedicated monitoring wells. Historical well data can be viewed as hydrographs, which describe groundwater levels over time for a single well. Well data can also provide the basis of groundwater contour maps, which provides a regional picture of groundwater levels at a specific point in time. This section reviews the historical well data to show the overall trend of groundwater conditions in the South Basin.

Current and historical groundwater levels in the South Basin are available from data collected by DWR, Sacramento County, and other agencies. DWR provides data for more than 100 wells in the South Basin (DWR Water Data Library: http://wdl.water.ca.gov/). However, the data for many of these wells is sporadic because of inconsistency in data collection, access to wells, and well abandonment. About 30 wells within the basin have continuous data records for at least 25 years. In general, wells near the Cosumnes River showed a stable groundwater trend, while wells further away from the river show a declining trend. Four wells that are particularly illustrative of groundwater trends of the aquifer away from major recharge sources, such as the Cosumnes River, were selected to provide a characterization of the historical trend in groundwater elevation in these areas. The hydrographs of these wells, and their locations, are shown in **Figure 1-11**. These wells show the reaction of the groundwater basin to groundwater pumping over the past 50 years.

In spite of the partial seasonal recovery of groundwater levels during the non-irrigation season, the groundwater levels in wells outside the influence of the Cosumnes River have generally declined between 10 and 50 feet from 1963 to 2007 as shown in Figure 1-11. No groundwater levels record was available for wells in the South Basin before the 1960s. Water levels declined from the mid-1960s to early 1980s and recovered slightly through 1986. During the 1987 through 1992 drought, water levels once again declined and continued to decline through 1995. From 1996 through 2000, much of the basin has recovered to water levels near those in the mid-1980s (DWR 2003). Groundwater levels declined again in recent years between 2000 and 2007.

> **Groundwater Contour Maps**
>
> Groundwater level contours are lines on 2-dimensional maps representing points of equal groundwater elevations. The contour map provides a snapshot of groundwater elevation over a region. When a map is made with equal interval contour lines (every 1 foot, 2 feet, or 5 feet, etc.), the spacing of contour lines provides a visual clue to the change in water level slopes (hydraulic gradients). Closely spaced contour lines represent steep slopes; widely spaced contour lines represent gentle slopes.

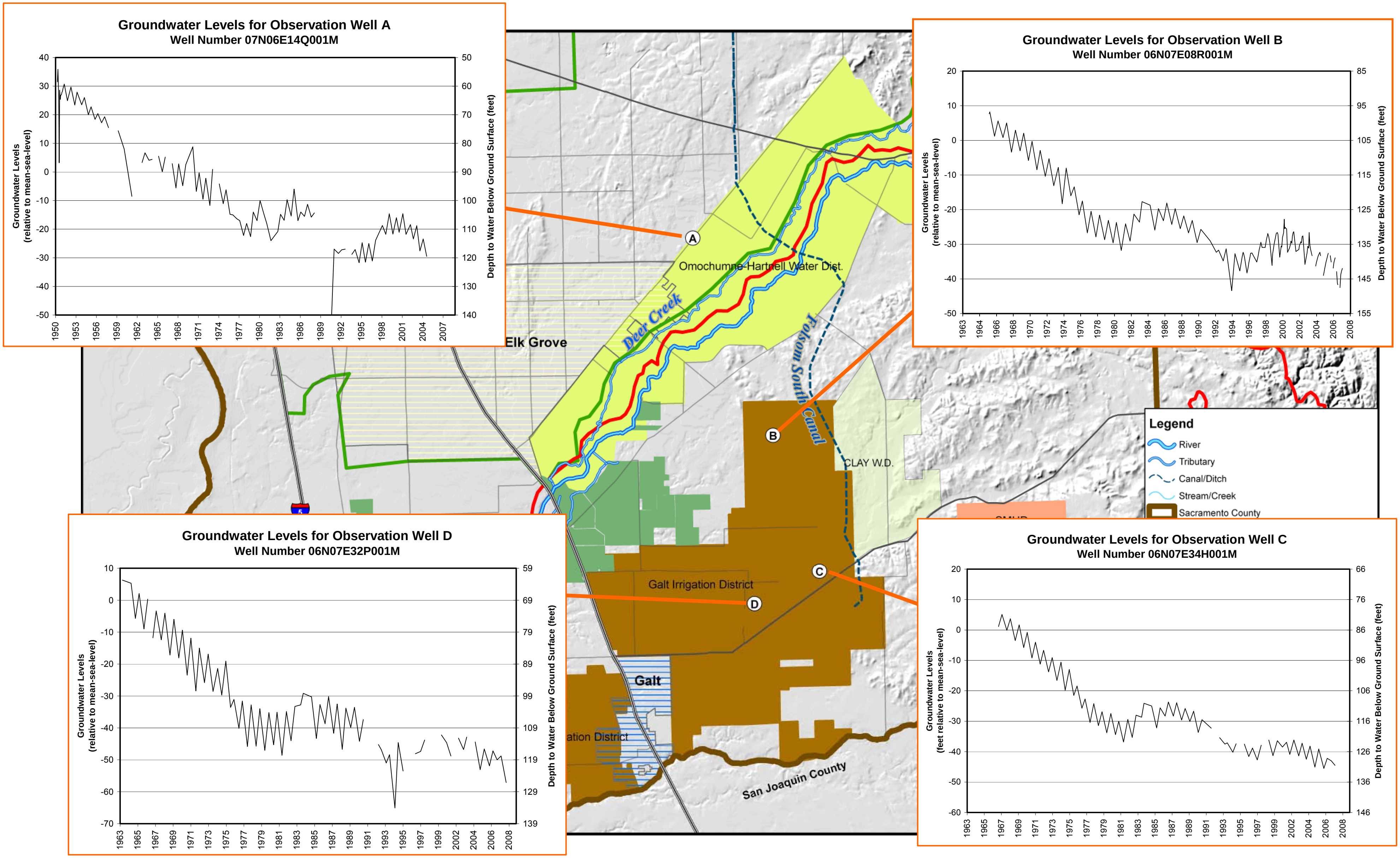


Figure 1-11. South Sacramento Basin well hydrographs – wells outside the influence of the Cosumnes River.

Using data from many wells, Sacramento County generates periodic groundwater contour maps to show groundwater elevation on a regional scale for a specific point in time. **Figure 1-12** shows groundwater contours for the fall of 1969. This figure shows a relatively small regional cone of depression in the central western portion of the South Basin where water levels were 40 feet below mean sea level (MSL). **Figure 1-13** shows a contour map for the spring of 2000. This figure shows that the location of the regional cone of depression has shifted toward the center of the basin and has increased in size. These two contour maps—separated by 31 years—show that groundwater levels in the South Basin have generally declined throughout the basin with more severe depressions occurring near the communities of Galt and Elk Grove.

An interesting aspect of the contour maps shown in Figures 1-12 and 1-13 is that groundwater levels near the Cosumnes River have not fallen to the degree that groundwater levels have fallen away from the river. Because the Cosumnes River is a major source of recharge for the regional aquifer, groundwater levels in close proximity to the river benefit from the consistent source of recharge from the river. Hydrographs of wells near the river verify the relative stability and recovery in this area of recharge. **Figure 1-14** shows two hydrographs for wells located near the Cosumnes River.

Water Quality

Groundwater in the water-bearing deposits underlying most of Sacramento County is of excellent mineral quality for irrigation and domestic use. Calcium-magnesium and calcium-sodium bicarbonate water types are most common within the South Basin. Based on analyses of several water supply wells in the area, total dissolved solids (TDS) range from 140 to 438 mg/L and averages about 218 mg/L. No sites with significant impairments have been identified within the Cosumnes subbasin (Bulletin 118, DWR 2003).

The quality of groundwater in the South Basin is generally acceptable to all users and there are no known areas of contaminated groundwater within the South Basin. However, there are a limited number of wells with a record of historical water quality data because only a few wells in the basin are used for public water supply; these wells are:

- City of Galt water system,
- Elk Grove Unified School District wells in Wilton, and
- Arcohe Elementary School in Herald.

Based on these available data, there are no significant water quality changes over time. Specifically, there are no major contamination problems.

As efforts continue to develop a better understanding of the local groundwater basin and its water quality, additional data should be collected from ag-residential and agricultural wells.

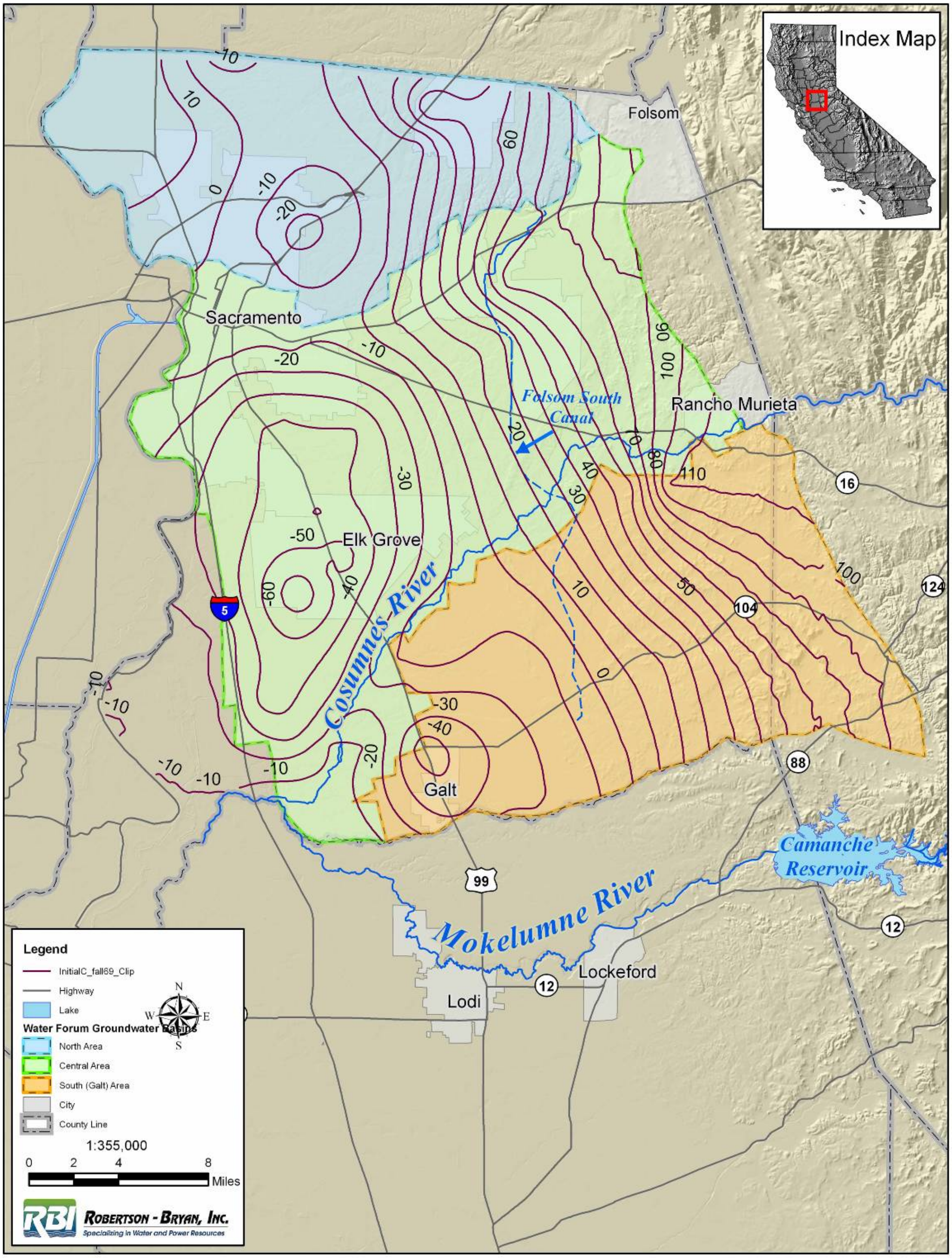


Figure 1-12. Fall 1969 groundwater elevation contour map (Sacramento County Water Agency).

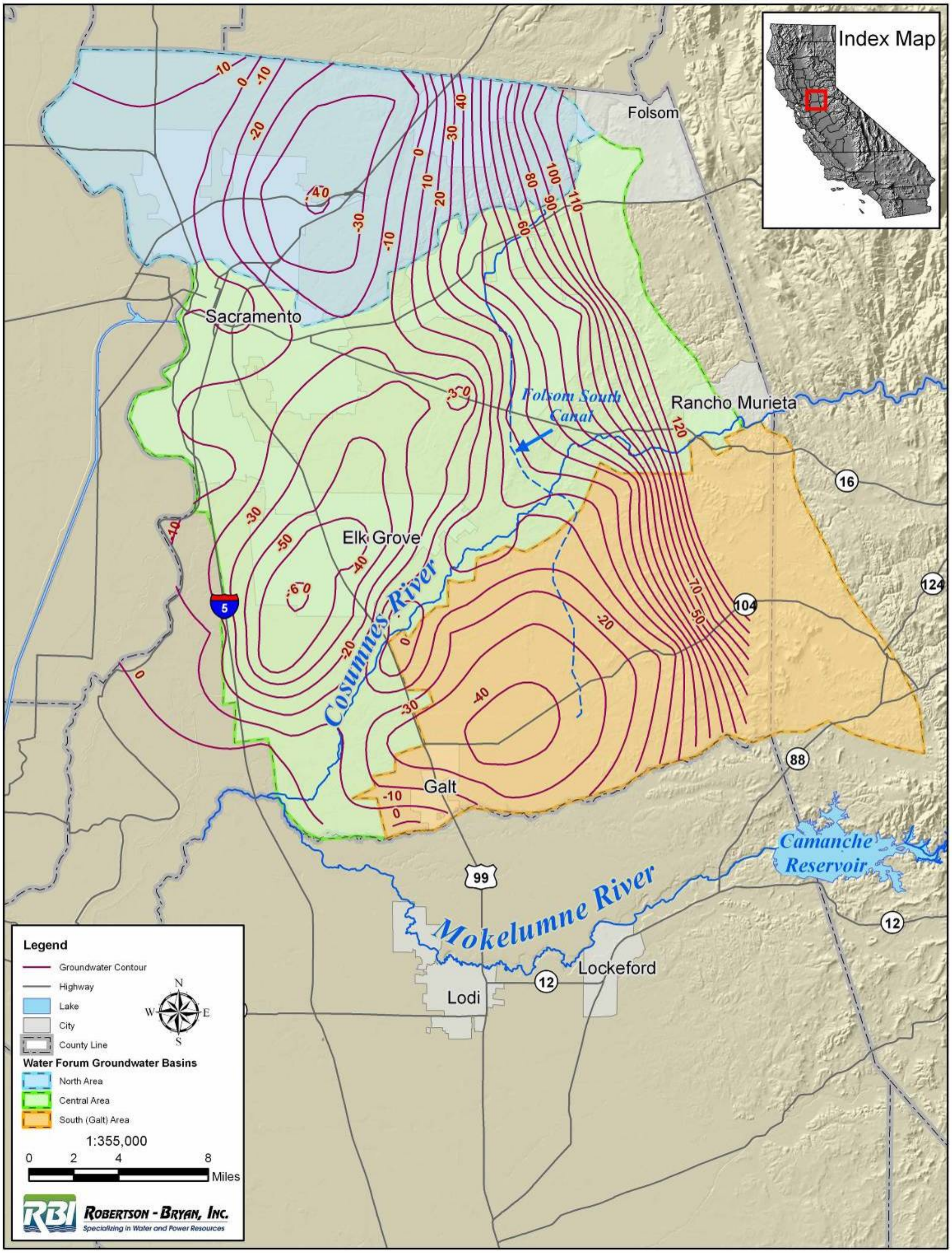


Figure 1-13. Spring 2000 groundwater elevation contour map (Sacramento County Water Agency).

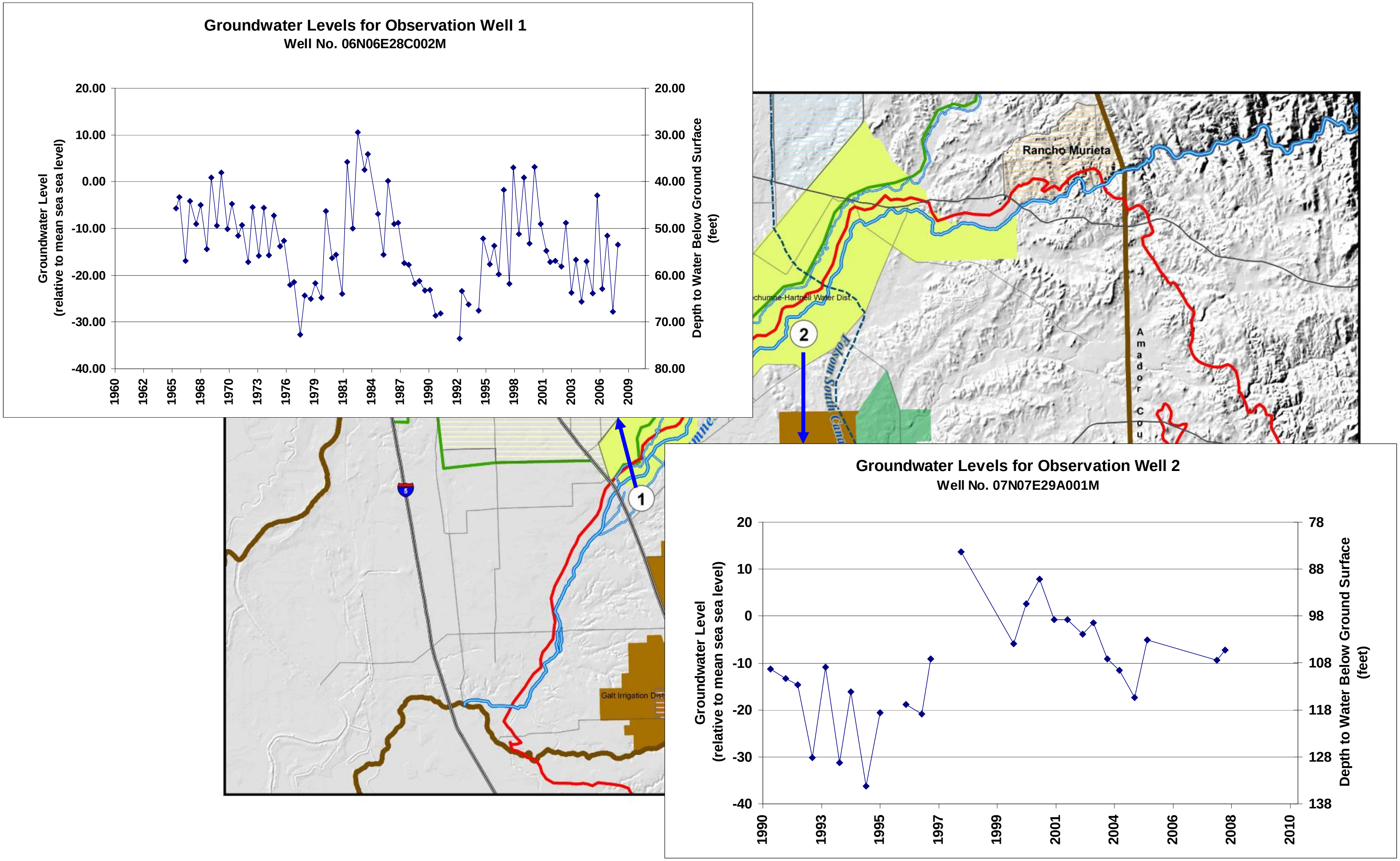


Figure 1-14. Hydrographs of wells near the Cosumnes River.

1.4 Basin Land Use

The California Department of Water Resources (DWR) performs land use surveys for most of California, including Sacramento County, to quantify acreage of irrigated land and planted crop types. DWR develops the base data for land use surveys from aerial photography or satellite imagery superimposed on a cartographic base and verified as needed with site visits to identify or verify crop types. The latest available land use survey data for Sacramento County was collected by DWR in 2000. DWR's data was augmented with Sacramento County land use planning data from 2004 by WRIME to develop a more current land use picture. The land use data is summarized below and provides the basis of developing water use values for the South Basin.

DWR classified land uses within the South Basin into **five** land use classes:

- **Irrigated agricultural land** consists of areas irrigated and used for agricultural crop production. Irrigated agriculture in the Planning Area includes citrus and subtropical; deciduous fruits; field crops; grain and hay crops, truck, nursery, and berry crops; and vineyards.

- **Semi-agricultural land** is land occupied by agricultural activities other than crop production. Semi-agricultural includes farmsteads, dairies, poultry farms, livestock feedlots, and fish farms. Fish farms were added to the class of semi-agriculture because it is a significant water-consuming activity in south Sacramento County.
  [Note: DWR classifies existing fish farms as "urban high water use."]

- **Urban land** uses within the Planning Area occur mainly in Galt and Rancho Murieta. This category also includes ag-residential land in the basin, such as in the communities of Wilton and Herald.

- **Grassland** classification includes non-irrigated grass lands and areas that have not been developed. Land in the classification includes non-irrigated or dry land pasture.
  [Note: DWR classifies this land use as "Native Vegetation Land."]

- **Riparian vegetation land** consists of areas along waterways covered with riparian vegetation. Most of the riparian vegetation in the Planning Area is associated with the Cosumnes River and its floodplain.

1.4.1 Land Use Patterns

GMP Planning Area Land Use Patterns

Land use patterns of 2004 are the basis for estimated consumptive use. The Planning Area covers a total of 158,068 acres that include Clay Water District, Galt Irrigation District, The Nature Conservancy, City of Galt, Rancho Murieta community, a portion of Omochumne-Hartnell Water District, and other unincorporated areas. **Figure 1-15** shows the distribution of land uses in the Planning Area.

Table 1-5. Land use classification in Planning Area.

Land use	Area (acres)	Percentage
Irrigated Agriculture	40,514	26
Semi-Agriculture	2,467	1
Riparian Vegetation	2,528	2
Grassland	105,508	66
Urban	7,051	5
Total Area	158,068	100

Table 1-5 shows the acreages and percent distribution of the five major land use classes found in the Planning Area. **Figure 1-16** provides a graphic representation of the percentage distribution of land uses. Grassland is the primary land use classification in the Planning Area, occupying 66 percent of the total area, followed by irrigated agriculture, which occupies 26 percent of the total area (Table 1-5). **Table 1-6** shows the distribution of crop types in irrigated agriculture classification for the Planning Area.

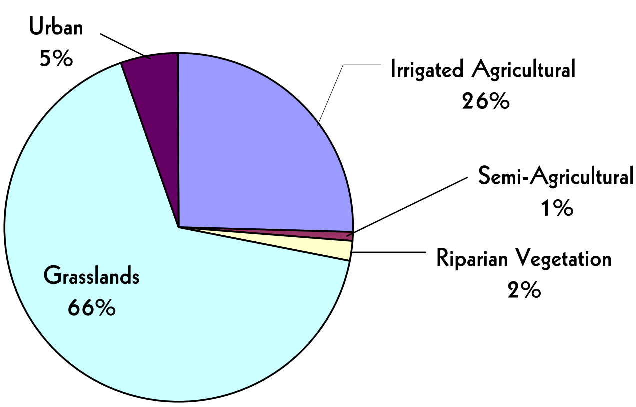


Figure 1-16. Graphic representation of land use distribution in the Planning Area.

Table 1-6. Distribution of irrigated agriculture lands in the Planning Area.

Irrigated Agriculture Sub-category	Area (acres)	Percentage
Citrus and Subtropical	22	<1
Deciduous Fruits	1,035	3
Field Crops	10,256	25
Grain and Hay Crops	2,232	6
Pasture Crops	13,376	33
Truck, Nursery, and Berry	908	2
Vineyards	12,685	31
Total	40,514	100

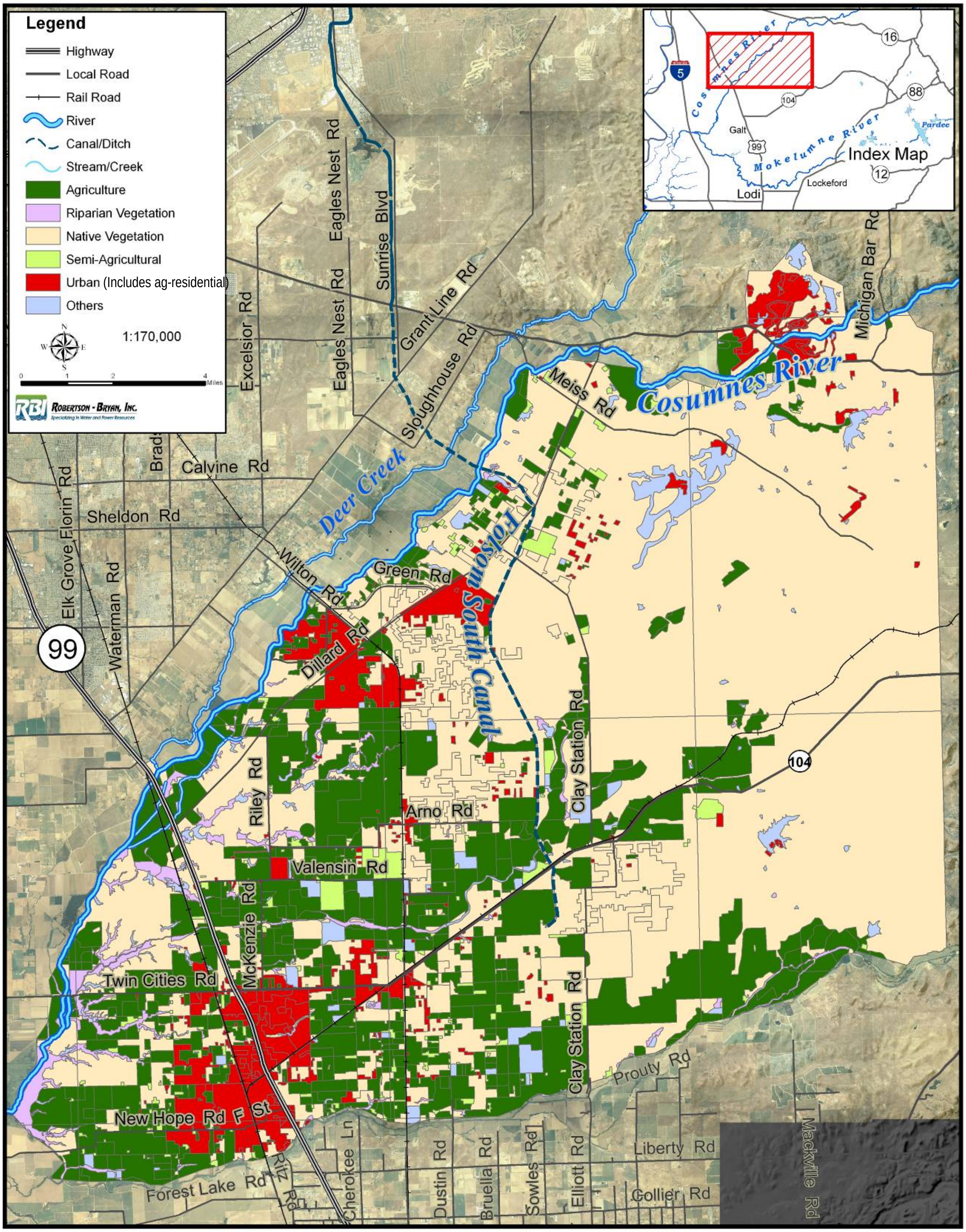


Figure 1-15. Distribution of land use in the Planning Area.

Jurisdiction Area Land Use Patterns

The Jurisdiction Area is comprised of Clay Water District, Galt Irrigation District, a portion of the Cosumnes River Preserve, the City of Galt, and unincorporated areas of the county (Figure 1-2). The Jurisdiction Area covers a total area of 131,321 acres. **Figure 1-17** shows the distribution of land uses in the Jurisdiction Area. **Table 1-7** shows the acreages and percent distribution of the five major land use classifications found in the Jurisdiction Area.

Table 1-7. Land use classification in the Jurisdiction Area.

Land use	Area (acres)	Percentage
Agricultural	31,343	24
Semi-Agricultural	2,106	2
Riparian Vegetation	1,494	1
Grassland	90,637	69
Urban	5,741	4
Total Area	131,321	100

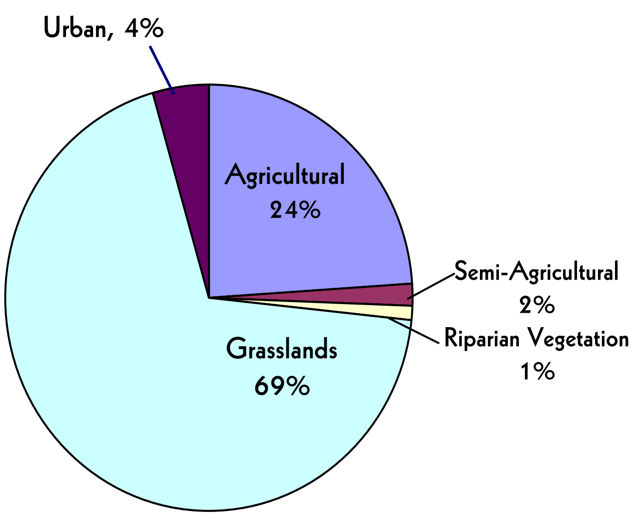


Figure 1-17. Distribution of percentage of land use in the Jurisdiction Area.

Figure 1-18 is a graphic presentation of the percentage distribution of land uses in the GMP Jurisdiction Area. Grasslands, the primary land use category in the area, occupy 69% of the total area; followed by irrigated agriculture, which occupies 24% of the total area. Vineyards, pasture crops, and field crops occupy about 91% of the total irrigated agricultural land in the Jurisdiction Area (**Table 1-8**). This crop mix percentage is different from those of the mid-1970s, when pasture crops, field crops and grains occupied about 94% of the total irrigated agricultural land and vineyards occupied only 1%. The comparison between the crop mix in 2004 and 1976 is shown in **Figure 1-19**.

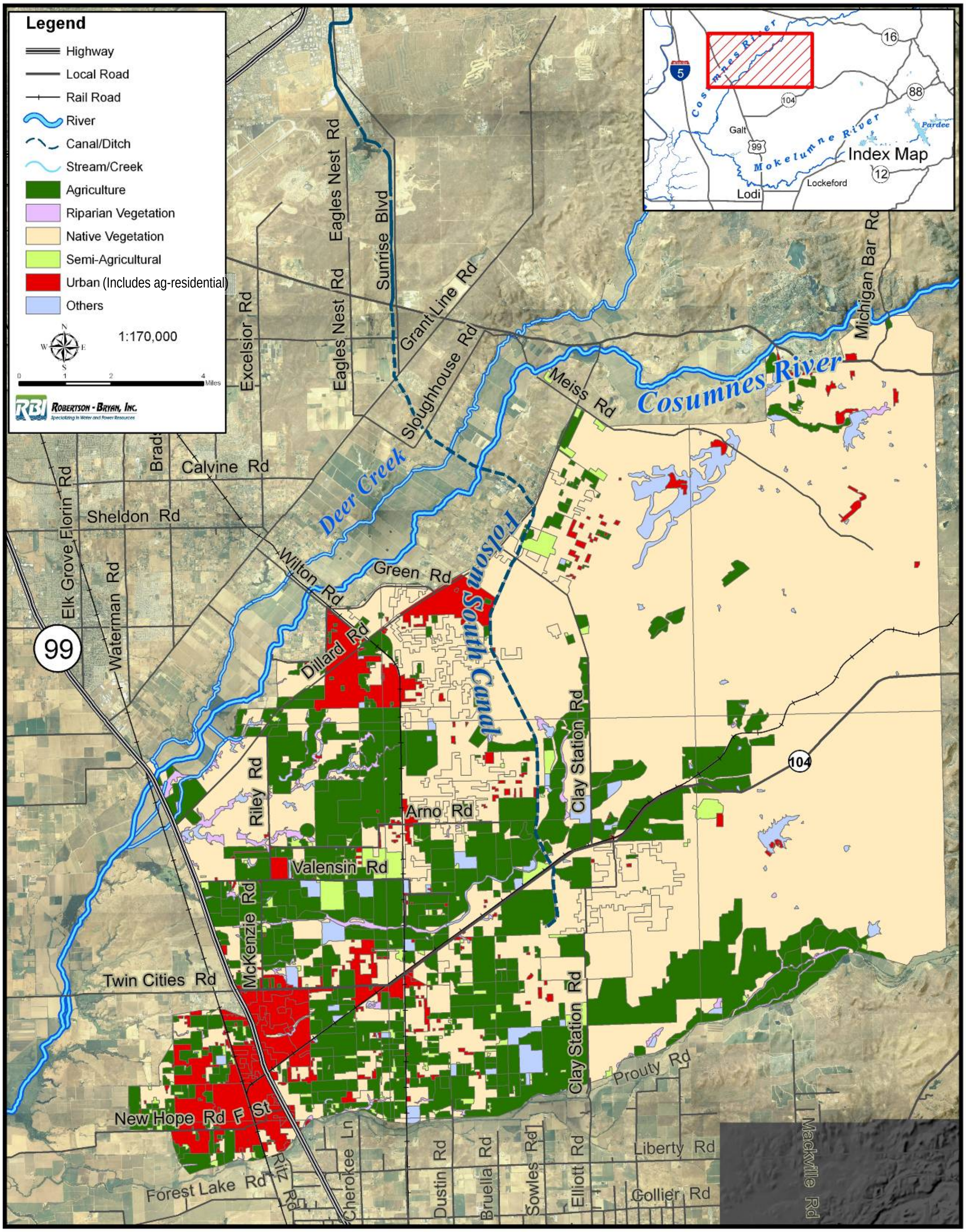


Figure 1-18. Distribution of land use in the Jurisdiction Area.

Table 1-8. Distribution of irrigated agriculture lands in the Jurisdiction Area.

Irrigated Agriculture Sub-Category	Area (acres)	Percentage
Citrus and Subtropical	22	0
Deciduous Fruits	959	3
Field Crops	7,851	25
Grain and Hay Crops	1,273	4
Pasture Crops	9,985	32
Truck, Nursery, and Berry	489	2
Vineyards	10,764	34
Total	31,343	100%

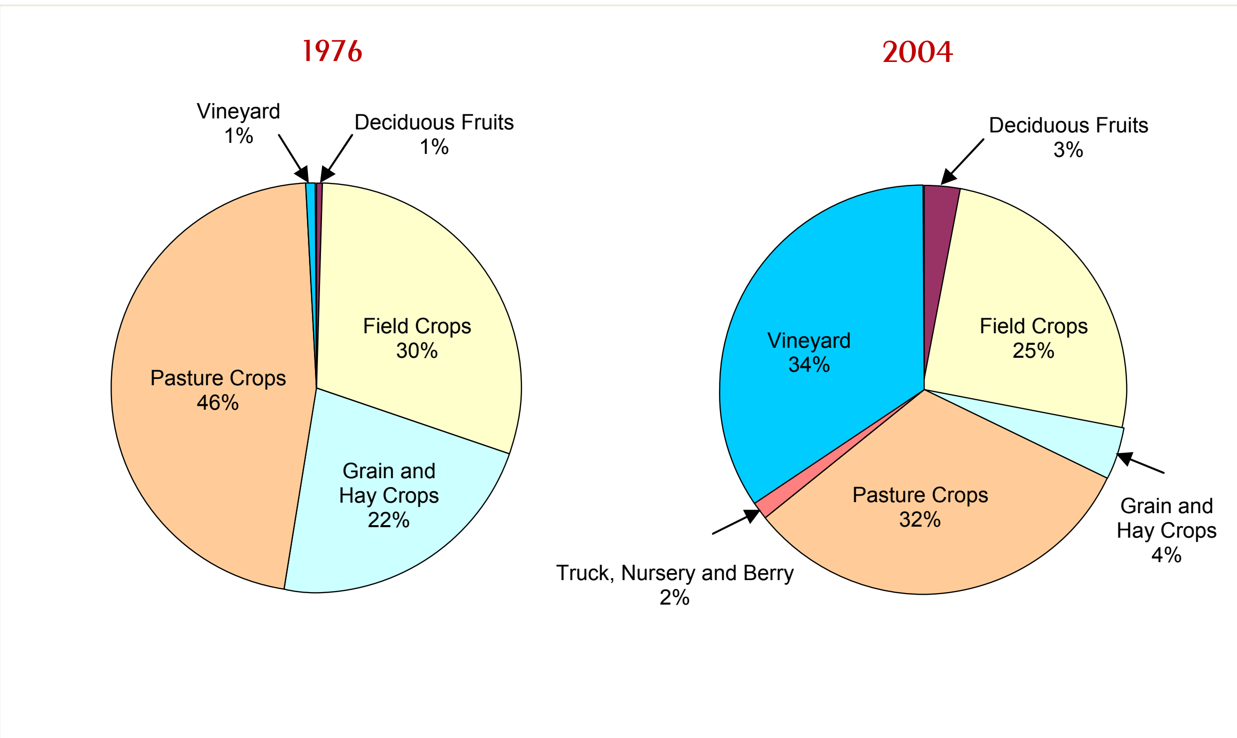


Figure 1-19. Irrigated agriculture land use classification crop mix in 1976 and 2004, South Basin Jurisdiction Area.

1.5 Basin Water Demand

Water demand estimates are based on updated 2004 land use data described in the previous section, DWR 2000 water use survey data for Sacramento County and the Sacramento County Integrated Groundwater and Surface water Model (SacIGSM).

Water demand estimates are calculated separately for Planning and Jurisdiction areas and are presented in two main groups:

- **Developed water: includes surface water or groundwater pumped or diverted for agricultural, semi-agricultural, or urban uses.**
- **Undeveloped water: includes the consumptive use of surface flow by vegetation in open space and riparian areas.**

A summary of the total water demand in the Planning and Jurisdiction areas is presented in **Table 1-9**. These demands are described in greater detail in the remainder of this section.

Table 1-9. Summary of total water demand for Planning and Jurisdiction areas of the South Basin – 2000–2004.

Water Demand Category	Planning Area Water Demand (acre-feet per year)	Jurisdiction Area Water Demand (acre-feet per year)
Developed	156,000	122,200
Undeveloped	112,700	96,400
Total	268,700	218,600

1.5.1 Developed Water Demand

The total estimated annual developed water demand 156,000 and 122,200 acre-feet per year for the Planning and Jurisdiction areas, respectively. **Table 1-10** summarizes demands for these areas. The agricultural demand represents about 92 percent of the total water demand in the South Basin.

Table 1-10. Developed water demand for Planning and Jurisdiction areas of the South Basin, 2000–2004

Water demand Category	Planning Area Water Demand (acre-feet per year)	Jurisdiction Area Water Demand (acre-feet per year)
Irrigated Agricultural	132,100	102,000
Semi-Agriculture	11,700	10,500
Urban	12,200	9,700
Total	156,000	122,200

Irrigated Agricultural

The South Basin does not have complete records of irrigated agricultural water demand; however, DWR estimates that existing agricultural demands (i.e., the total volume of water applied to a crop) using values for precipitation, crop acreage, evapotranspiration, and irrigation efficiency (**Appendix A**). In this study, these DWR values were used as an input to the SacIGSM model along with land use to derive water use and supply information. The model refined these DWR values through model calibration to achieve final estimates for irrigated agricultural water demand in South Basin.

Total annual irrigated agricultural water demand is estimated to be 132,100 and 102,000 acre-feet per year for the Planning and Jurisdiction areas, respectively (Table 1-10).

Semi-Agriculture

The average semi-agriculture water demand is about 11,700 and 10,500 acre-feet per year for the Planning and Jurisdiction areas, respectively. Dairies and fish farms are included in this land use classification. Actual water demand data, number of farms, and information on dairy and fish farm practices were used to develop a better estimate of water demand. This was done by interviewing farm owners in the basin. About 90 percent of the total water demand by semi-agriculture is used by fish farms in the Planning Area, or approximately 11,000 acre-feet. It is important to note that during the irrigation season, some fish farms make their tailwater available to adjacent agricultural users. This amount is approximately 20 percent of the total water pumped for the fish farm activity, or approximately 2,000 acre-feet per year that is available for re-use by agriculture.

Urban

According to 2004 census data, the total population in South Basin is 39,540. The City of Galt has a population of 22,965; Rancho Murieta has a population of 6,750, and about 9,800 people live in the ag-residential communities in the basin.

The average annual urban water demand for 2000–2004 in the South Basin was about 12,200 and 9,700 acre-feet per year for the Planning and Jurisdiction areas, respectively. On average, Galt uses about 4,900 acre-feet per year of groundwater, Rancho Murieta diverts about 2,000 acre-feet of Cosumnes River flow per year. The remainder of the urban water demand is consumed by ag-residential in the rural communities in the basin almost exclusively from groundwater.

Water demand records from the City of Galt (1990–2007), Rancho Murieta diversion record (2000–2007), and the 2000–2004 water data are used for this effort. No records are available for ag-residential water demands. A water duty of 0.5 acre-feet per acre was used in this study to develop the annual water demand for ag-residential areas in the South Basin. This value was based on estimates of water demand for ag-residential areas developed by WRIME in the Central Sacramento County Basin Groundwater Planning effort.

1.5.2 Undeveloped Water

Undeveloped water is the consumptive use of water by vegetation in grasslands and riparian areas. Grasslands are non-irrigated grassland, brush, and oak woodland where the consumptive use of water for plants is met from precipitation that infiltrates into the plant root zone. Much of the grassland in the basin is also grazed by cattle.

Water use by riparian vegetation includes the consumptive use of water by vegetation along streams and water courses and marsh lands. The source of water for the riparian vegetation is stream water that infiltrates into the plant root zone.

Table 1-11 summarizes the annual volume of water consumptively used by vegetation in grassland and riparian areas for the Planning and Jurisdiction areas. This consumptive water use is met from precipitation and river flow seepage that is stored in the root zone of plants.

Table 1-11. Grassland and riparian vegetation consumptive use for Planning and Jurisdiction areas of the South Basin, 2000–2004.

Water Use Category	Planning Area Consumptive Use (acre-feet per year)	Jurisdiction Area Consumptive Use (acre-feet per year)
Grassland	109,000	93,300
Riparian Vegetation	3,700	3,100
Total	112,700	96,400

1.6 Basin Supply Sources

The water supply in the South Basin depends mainly on groundwater. Groundwater pumping supplies about 93 percent of the total agricultural and urban demand in the South Basin. Only 5 percent of total demand is met by surface water in the South Basin. Reclaimed wastewater provides 2 percent of the area's total demand.

Apart from the City of Galt—whose public water system is supplied completely by groundwater—commercial agricultural, semi-agricultural operations, and residential homeowners are all self-supplied pumpers. Surface water supply in the basin is used by Rancho Murieta, some riparian diverters, SMUD, and a limited number of customers in Galt Irrigation District and Clay Water District. In addition, reclaimed water is supplied from fish farm discharges and the wastewater treatment plant for the City of Galt. Reclaimed water is supplied to a limited number of farmers in the basin. The following are the main water purveyors in the South Basin.

- City of Galt

The city public water system is supplied completely by groundwater. City of Galt pumps water from its municipal wells to meet an average annual demand of 4,900 acre-feet. The current water system is comprised of two three-million gallon storage tanks with pump stations, seven wells, 62 miles of water piping and valves, and 5,800 lateral connections.

- Galt Irrigation District

The Galt Irrigation District purchases surface water from SMUD, via the Rancho Seco power facility. This water is conveyed through Laguna Creek to local diversions. Away from the Laguna Creek corridor, agricultural water demands are met from groundwater. The Galt Irrigation District contains 34,000 acres.

- Clay Irrigation District

Although the Clay Irrigation District historically purchased water from SMUD for delivery to irrigators along Laguna Creek, it now relies on groundwater. The District contains 6,500 acres.

- Omochumne-Hartnell Water District

Omochumne-Hartnell Water District (OHWD) historically purchased and managed supplemental water from the Central Valley Project (CVP) for the benefit of District agricultural users adjacent to the Cosumnes River and Deer Creek. In recent years, however, the number of riparian diverters has decreased because of the unavailability of CVP water, declining flows in the Cosumnes River during the irrigation season, and the increasing use of drip irrigation for orchard and vineyards in the Cosumnes River and Deer Creek floodplain.

Typical drip irrigation operators prefer groundwater because it is a cleaner, more reliable source. **Table 1-12** shows the volume of water purchased by OHWD from 1959 to 1986. This surface water importation improved the groundwater levels in the district by reducing groundwater pumping.

Four flashboard dams that historically supported diversions are now maintained and operated by the District to increase the wetted perimeter of the river to affect greater groundwater recharge.

Table 1-12. Volume of water purchased by OHWD from 1959 to 1986

	Year	Acre-Feet
Sly Park Reservoir released to the Cosumnes River	1959	2,610
	1960	3,150
	1961	3,474
	1962	0
	1963	1,116
	1964	2,027
	1965	0
	1966	5,300
	1967	0
	1968	4,000
	1969	0
	1970	3,271
	1971	0
	1972	4,006
	1973	2,737
	1974	790
Folsom South Canal releases to Deer Creek	1975	500
	1976	8,697
	1977	0
	1978	785
	1979	371
	1980	72
	1981	2,950
	1982	107
	1983	40
	1984	86
	1985	2,008
	1986	638
	1987	44
	Total	48,779
	Average per year	1,680

- Rancho Murieta Community Services District

Rancho Murieta Community Services District (RMCSD) relies on Cosumnes River water as its sole water supply source. RMCSD has appropriative water rights on the Cosumnes River for up to 6,368 acre-feet per year for municipal, agricultural, industrial, environmental, and recreational uses. Water is diverted from the Cosumnes River at Granlee's Dam and pumped into three off-stream lakes—Calero, Chesbro, and Clementia—from November 1 until May 31 of each year. The minimum flows in the Cosumnes River must be 76 cfs at Michigan Bar before water can be diverted.

RMCSD diverted on average about 2,000 acre-feet per year from 1992–2001 to meet its water demand (**Figure 1-20**). Surface water supplied by the Cosumnes River is counted for the Planning Area only and not the Jurisdiction Area because the Cosumnes River is outside the Jurisdiction Area.

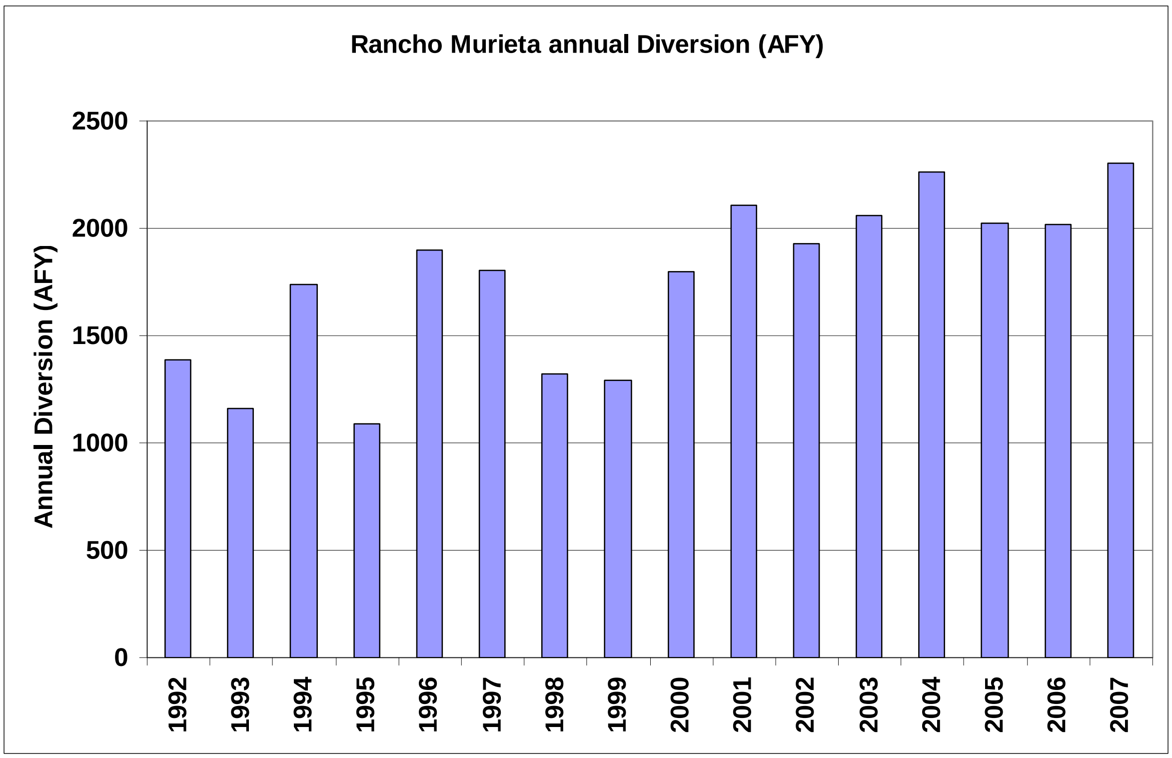


Figure 1-20. Rancho Murieta annual diversions from the Cosumnes River, 1992–2007.

- Sacramento Municipal Utilities District

SMUD imports CVP water from the American River, via the Folsom South Canal, for use in the Rancho Seco facility. SMUD utilizes approximately 1,700 acre-feet per year, either in the power facility or in Rancho Seco Lake.

SMUD also discharges approximately 800–1,000 acre-feet monthly into Hadselville Creek, a tributary of Laguna Creek, from Rancho Seco. During the irrigation season, water released to the creek is diverted by farmers in Galt Irrigation District and Clay Water District. This source of surface water provides about 4,000 acre-feet annually to meet a portion of the agricultural water demand in the Jurisdiction Area and about 3,600 acre-feet recharge to the aquifer through the Laguna Creek streambed.

The total estimated developed water demand is 156,000 and 122,200 acre-feet per year for Planning and Jurisdiction areas, respectively. **Table 1-13** summarizes the water supplies that meet this developed water use for 2000–2004. The details of these estimates are provided in the following discussion.

Table 1-13. Water supply for Planning and Jurisdiction areas of the South Basin, 2004

Water Supply Source	Planning Area Water Supply (acre-feet per year)	Jurisdiction Area Water Supply (acre-feet per year)
Surface Water (Cosumnes River and SMUD)	7,700	5,400
Reclaimed Water (Galt WWTP & fish farm tailwater)	2,700	2,000
Groundwater	145,600	114,800
Total	156,000	122,200

1.6.1 Surface Water Sources

Surface water supplies a small portion—only 5 percent of the total water supply—of the South Basin's annual water demand. There are two sources of surface water in the area—the Cosumnes River and SMUD's imported water through the Folsom South Canal. Due to the strong seasonality of Cosumnes River flows, only a smaller volume of water is available for use during the irrigation season. As discussed in Section 2, flows in the Cosumnes River typically cease in the lower reaches of the river from July through November.

Landowners along the Cosumnes River have riparian water rights and historically riparian users have received imported water from the Central Valley Project, purchased by Omochumne-Hartnell Water District. Current riparian diversions within the Planning Area are estimated to be 100 acre-feet annually.

1.6.2 Reclaimed Water Sources

The City of Galt's wastewater treatment plant (WWTP) discharges effluent to Laguna Creek, a portion of which is used for irrigating fields adjacent to the WWTP (**Figure 1-21**). An average of 700 acre-feet per year of reclaimed water is used for agricultural irrigation. Effluent not used for irrigation is discharged to Laguna Creek during the winter when the WWTP is permitted to release effluent to surface waters.

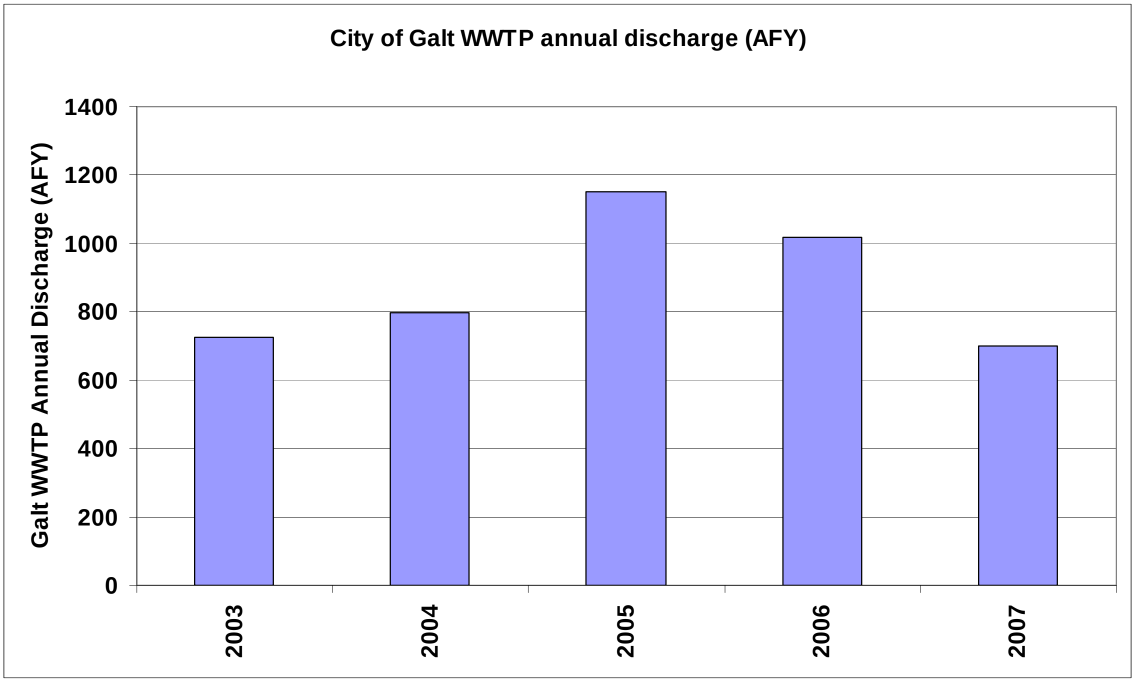


Figure 1-21. City of Galt WWTP discharges from 2003–2007.

Fish farms in the Planning Area withdraw about 11,000 acre-feet of groundwater annually. These operations typically recycle water several times within the farm before it is discharged. During the irrigation season, agricultural farms adjacent to the fish farms use about 2,000 acre-feet of the discharge water for irrigation. During the winter months, discharge water not used for irrigation flows into local creeks.

The reclaimed water supply from the WWTP is available only in the Planning Area and not in the Jurisdiction Area because all the fields that receive reclaimed water from the WWTP are outside the Jurisdiction Area boundary.

1.6.3 Groundwater Sources

Groundwater supplies about 93 percent of the total agricultural and urban demand and 100 percent of the semi-agriculture demand in the South Basin. Water is extracted mainly from the shallow aquifer underlying the South Basin, with some wells penetrating the deeper confined aquifer. In 1990, there were an estimated 12 municipal wells, 200 agricultural wells, and 1,400 ag-residential wells in the South Basin (Sacramento County Water Agency 1990).

Studies concluded that there is a hydraulic disconnection between the regional aquifer and the streams in the South Basin (Fleckenstein et al., 2004) classifying the river as a "losing stream"—meaning the river serves as a source of recharge to the underlying groundwater aquifer.

Recharge to the groundwater aquifer is derived from four major components:

- deep percolation of precipitation
- deep percolation of the non-consumptive use portion of applied irrigation water
- seepage from streams
- Subsurface inflow from surrounding areas

The only records for groundwater pumping in the South Basin are for the City of Galt, whose public water system is supplied completely by groundwater pumping from its municipal wells. However, groundwater pumping for agricultural and semi-agriculture operations and residential homeowners was estimated using SacIGSM. [1] The model shows that in the period 2000–2004, 145,600 was pumped from the aquifer underlying the Planning Area and 114,800 acre-feet from the Jurisdiction Area. Groundwater model estimates for the Jurisdiction Area (114,800 acre-feet per year) concurs with the estimated sustainable yield (115,000 acre-feet per year) recommended in the Water Forum Agreement for the basin. The distribution of groundwater pumping among the different users in the South Basin is summarized in **Table 1-14**.

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[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 SGSM 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 (SCWA 2004).

Table 1-14. Summary of groundwater pumping in the South Basin, 2000–2004.

Category	Groundwater Pumping acre-feet Planning Area	Groundwater Pumping acre-feet Jurisdiction Area
Irrigated Agriculture	125,300	96,000
Semi Agriculture	11,700	10,500
Galt	4,900	4,900
Rural Residential	3,700	3,200
Total	145,600	114,600

1.7 Basin Water Balance

In the preceding sections, water supplies and demands were discussed based on information collected from DWR, information provided by stakeholders, and SacIGSM results. The SacIGSM refines annual water use estimates in the South Basin from 1970 to 2004. SacIGSM was developed in the early 1990s and has been used over the past 15 years by local and state agencies in numerous projects across Sacramento County.

For development of this Land and Water Resources settings section, updated land and water use data was entered into the SacIGSM to refine water use estimates for the Planning and Jurisdiction areas. The update and calibration of the SacIGSM model readied it for use in developing water balance components, baseline conditions, and analyzing alternative water management scenarios in the South Basin. The model calculated an overall water balance for the South Basin, which is reported in the resources setting section for the South Basin. **Appendix B** provides additional information about the SacIGSM model. This information is now used to develop a water balance for the South Basin.

1.7.1 Water Supply Demand Balance

Water supplies for the South Basin come from groundwater, surface water, and reclaimed water. Groundwater supplies about 93 percent of the total agricultural and urban demand in the South Basin, making it the main source of water in the basin. Reclaimed wastewater is used to meet 2 percent of the total demand. Although surface water supplies are abundant in the South Basin, only about 5 percent of that source is utilized in the South Basin (estimated total annual surface flow is 537,000 acre-feet per year). Stream flow patterns, lack of infrastructure, and other constraints make it difficult to utilize more surface water in the South Basin. Surface water supplies an estimated 7,700 and 5,400 acre-feet per year for the Planning and Jurisdiction areas, respectively.

Tables 15 and 16 provide the average water supply and demand balance for the Planning and Jurisdiction areas for 2000–2004. The 2000–2004 period represents the most recent land use, demand and supply in the basin.

Table 1-15. Planning Area water demand and supply balance, 2000–2004.

Total Area	158,000	acres
Total Water Demand	156,000	acre-feet
Supply Sources		
Groundwater pumping	145,600	acre-feet
Surface water	7,700	acre-feet
Reclaimed water	2,700	acre-feet
Total Supply	156,000	acre-feet

Table 1-16. Jurisdiction Area water demand and supply balance, 2000–2004.

Total Area	131,300	acres
Total Water Demand	122,200	acre-feet
Supply Sources		
Groundwater pumping	114,800	acre-feet
Surface water	5,400	acre-feet
Reclaimed water	2,000	acre-feet
Total Supply	122,200	acre-feet

1.7.2 Groundwater Balance

Groundwater balance quantifies all individual inflows, outflows, and changes in groundwater storage over a given time period. **Figure 1-22** depicts the main groundwater inflow and outflow components in the South Basin. The basic concept of water balance is:

CHANGE IN STORAGE = SYSTEM INFLOWS – SYSTEM OUTFLOWS

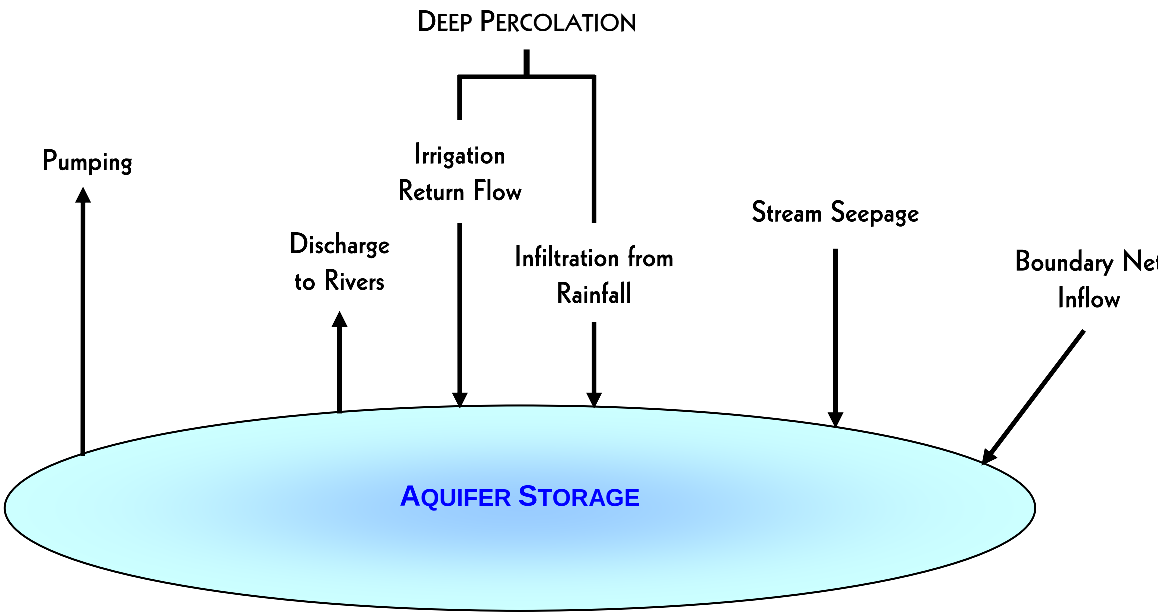


Figure 1-22. Groundwater balance components, South Basin.

Groundwater recharge (**inflow**) into South Basin includes the following components:

1. Deep Percolation consisting of:
    a. Irrigation return Flow: From land application of water, including agriculture fields (seepage losses from unlined canals can be part of this component), semi-agriculture parcels, and urban areas.
    b. Infiltration from rainfall that falls on the basin floor.
2. Stream Seepage: Seepage from surface water bodies, predominantly from Cosumnes River, Deer Creek, Dry Creek, and Badger creek.
3. Subsurface Boundary Inflow: Groundwater inflow to the South Basin along the eastern boundary with Amador County, northern and western boundaries with Central Basin, and southern boundaries with San Joaquin County.

Discharge (**outflow**) components from the groundwater basin include:

1. Groundwater pumping for agriculture, semi-agriculture, and urban.
2. Discharge to rivers and creeks (base flow). Previous studies concluded that there is a hydraulic disconnection between the regional aquifer and the streams in the area; therefore, it is reasonable to assume that base flow from the aquifer to streams is zero.

Considering the various inflow and outflow components in the basin, the groundwater balance equation can be written as:

$$\Delta S = DP + S + IB - Tp - Se$$

Where,

DP = deep percolation – infiltration from rainfall and return flow from agriculture, semi-Agriculture, and urban

S = seepage from rivers

IB = boundary inflow – eastern, northern, western and southern boundaries

Tp = pumping from groundwater

Se = base flow to rivers

S = change in groundwater storage

The groundwater balance for the Planning Area for 2000–2004 and 1980–2004 can be expressed as shown in the following table.

Table 1-17. Groundwater balance in the South Basin Planning Area.

Inflow (acre-feet)		1980–2004		2000–2004	
DP	Deep Percolation (rainfall & irrigation)	+59,500		+48,400	
S	Seepage from rivers	+60,200		+52,300	
IB	Subsurface boundary inflows	+37,300		+33,000	
Subtotal			+157,000		+133,700
Outflow (acre-feet)					
Tp	Pumping from groundwater	-154,500		-145,600	
Se	Baseflow to rivers	0		0	
Subtotal			-154,500		-145,600
Change in groundwater storage			+2,500		-11,900

The groundwater balance for the Jurisdiction Area for 2000–2004 and 1980–2004 can be similarly expressed.

Table 1-18. Groundwater balance in the South Basin Jurisdiction Area.

Inflow (acre-feet)		1980–2004		2000–2004	
DP	Deep Percolation (rainfall & irrigation)	+45,000		+35,900	
S	Seepage from rivers	+19,400		+13,900	
IB	Subsurface boundary inflows	+50,400		+49,800	
Subtotal			+114,800		+99,600
Outflow (acre-feet)					
Tp	Pumping from groundwater	-118,300		-114,800	
Se	Baseflow to rivers	0		0	
Subtotal			-118,300		-114,800
Change in groundwater storage			-3,500		-15,200

1.7.3 Discussion

Updated and refined land and water use data for the South Basin was input into the SacIGSM and the model recalibrated to simulate surface water and groundwater interaction in Sacramento County. Water budgets resulting from the model calibration were used to develop the South Basin groundwater balance analysis (Sacramento County Integrated Ground and Surface water Model (SacIGSM) Model Refinement - Central and South Area, 2008).

In the Planning Area, the main source of recharge to the aquifer is stream seepage from the Cosumnes River and deep percolation from agriculture and precipitation, which provides 75 percent of the total recharge to the Planning Area (including the Jurisdiction Area). The remaining 25 percent is from subsurface boundary inflow, primarily along the eastern boundary of the Basin.

Within the Jurisdiction Area boundary, subsurface inflow and deep percolation are the main sources of recharge, contributing about 86 percent of the total recharge to the area. Seepage from streams in the Jurisdiction Area contributes only 14 percent of the total recharge since the Cosumnes River is not included in this area.

Model results show that every year for the 5-year period between 2000 and 2004, the aquifer storage was reduced by an average of 11,900 acre-feet in the Planning Area and 15,200 acre-feet in the Jurisdiction Area because groundwater outflow exceeds recharge in the basin. This rate of storage reduction in the Jurisdiction Area corresponds to groundwater levels declining by an average of 1.4 feet per year due to drought conditions during these years.

However, when we analyze the period from 1980–2004, which includes wet and dry years, the aquifer storage was increased by an average of 2,500 acre-feet in the Planning Area and reduced by an average of 3,500 acre-feet in the Jurisdiction Area. This long-term water balance shows that the overall aquifer status was stable and fluctuated following the hydrologic cycle.

Figure 1-23 shows the change of groundwater storage in the Planning Area for the period 1970 to 2004.

From 1970 to 1980—a relatively dry cycle—groundwater storage declined about 380,000 acre-feet, or approximately 35,000 acre-feet per year, and recovered slightly through 1986 due to wet hydrologic conditions and getting approximately 24,000 acre-feet of surface water from Sly Park Reservoir and Folsom South Canal. During the 1987 through 1992 drought, groundwater storage declined and continued declining through 1994. Due to wet conditions from 1995 through 2000, the Basin recovered to the same storage levels as in the mid-1980s. The groundwater storage declined again in recent years between 2000 and 2004. This graph confirms that the aquifer is in a state of relative equilibrium since the 1980s and groundwater storage fluctuates following the hydrologic cycle.

The recent model-calculated decline in groundwater level is verified by comparing it to the observed groundwater levels in wells in the Jurisdiction Area, which show a similar declining trend, as presented in previous sections. The observed groundwater levels in the basin declined at an average rate of 1.2 feet per year for the same period.

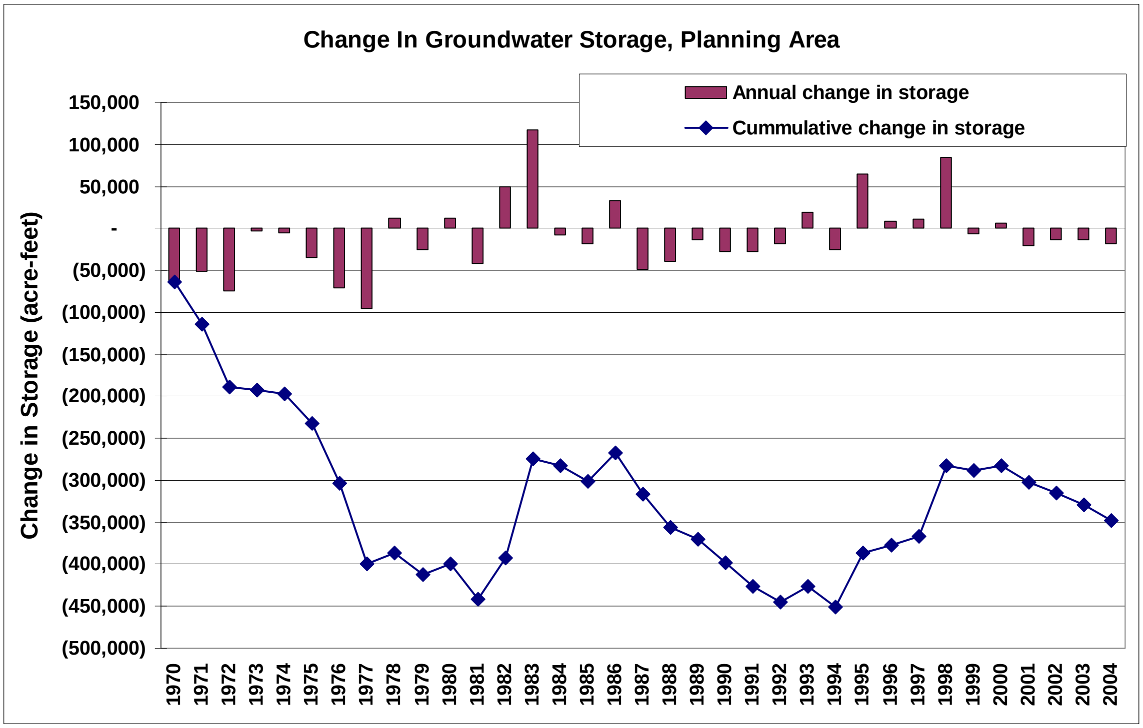


Figure 1-23. Change of groundwater storage in the Planning Area for the period 1970–2004.

1.8 Issues of Concern

This Land and Water Resources setting section provides stakeholders with a basic understanding of current groundwater conditions in south Sacramento County. This information was developed from the best available data. Additionally, several technical issues important to a comprehensive understanding of local groundwater conditions were identified. These issues are highlighted below.

1.8.1 Groundwater Recharge from Local Rivers and Streams

The rivers and stream that flow from the Sierra Nevada provide an important source of recharge water to groundwater aquifers of the Central Valley. As the development of groundwater resources increased to meet agricultural and municipal demands in the

Central Valley, the interaction between rivers and underlying aquifers changed. In many cases, this interaction between river and aquifer is poorly understood—and the Cosumnes River is no exception. What is known is that the Cosumnes River and other local waterways are critical sources of recharge water to the aquifer underlying south Sacramento County and the northern San Joaquin County.

Increasing use of groundwater resources since the 1950s lowered groundwater levels throughout south Sacramento County and levels are now 60 to 100 feet below the Cosumnes River channel. The result is a hydraulic disconnection between much of the river and the regional aquifer, causing the river to become a predominantly losing system—the river does not receive baseflow from the regional aquifer and generally contributes river flow to the aquifer through channel seepage. Investigations of river flow and groundwater interactions along the lower Cosumnes River (below Michigan Bar at river mile 36) show that the loss of baseflow contributions to the river, as a result of lowering groundwater levels, has partially decreased summer and fall flow in the lower reach of the river.

At this time, there is only a general understanding of surface water/groundwater interaction. Much of this information is based on research conducted by UC Davis. To develop a more comprehensive understanding of the groundwater basin, it is important that additional information be collected on the rate of groundwater recharge from the Cosumnes River and Dry Creek, as well as the lesser creeks.

There are efforts underway to collect such information along the Cosumnes River. UC Davis is currently conducting research along the river between Dillard Road and Twin Cities Road to identify river reaches with higher rates of recharge to the groundwater basin and to quantify those rates. This information will enhance our understanding of the Cosumnes' role in supplying water to the local aquifer.

1.8.2 Growth Projections

As the groundwater management planning efforts continue, stakeholders should prepare a projection of future water demands for the South Basin so that they can determine the long-term viability of groundwater resources. Future projections of water demands are typically based on projected growth in urban areas, as described in municipal and countywide land use plans. However, the South Basin is dominated by agricultural lands and the current Sacramento County General Plan (1993) does not project any changes to land use designation in the majority of the South Basin. The County's 1993 General Plan does report potential water demands for portions of South Basin for 2015, but the basis of these estimates is not completely understood and should be revisited prior to adopting these projections for this planning effort. The communities of Galt and Rancho Murieta provided current growth projections for incorporation into this planning process. These available projects were included in the baseline scenario model run that is included in the Management Strategies section of this plan.

After consulting local development agencies, it became clear that there are no comprehensive growth projections for the agricultural growth in the South Basin area; therefore, an alternative means of projecting growth in the area needs to be developed. Recently, the area has seen an increase in the subdivision of large agricultural parcels into ranchette-style parcels of 2–5 acres. It is important to capture the conversion of agricultural lands to ag-residential lands and the potential impacts to groundwater resources. Similarly, there has been a significant increase in the number of vineyards in the South Basin—replacing higher water using crops or converting previously non-irrigated lands to irrigated vineyards. A reasonable determination of whether this trend will continue in the future needs to made, as well as other potential crop type conversions, to facilitate an accurate estimate of future water demand in the South Basin.

Basin Management Objectives

2 Basin Management Objectives

This section discusses four goals and related Basin Management Objectives proposed for the South Basin based on feedback from basin stakeholders. The goals and objectives focus on managing and monitoring the basin to benefit all groundwater users in the Basin

Groundwater and surface waters within the Cosumnes Groundwater Basin are a vitally important resource that provides the foundation for maintaining current and future water needs. Preservation of these resources is essential to maintaining the economic viability and prosperity of the Basin area.

The South Basin GMP provides a framework under which all users of the aquifer can move towards a commonly held set of goals and objectives concerning groundwater use and protection. Groundwater management goals express the desired state of the groundwater basin in qualitative terms. These groundwater basin management goals provide the foundation for the more specific Basin Management Objectives (BMOs)—specific criteria defining the desired state of the basin. These objectives provide a mechanism for determining whether groundwater management goals are being achieved.

Senate Bill (SB) **1938**, created in 2002, requires that agencies:

"Prepare and implement a groundwater management plan that includes basin management objectives for the groundwater basin that is subject to the plan. The plan shall include components relating to the monitoring and management of groundwater levels within the groundwater basin, groundwater quality degradation, 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 in the basin."

Local agencies that fail to adopt or participate in a plan fulfilling the requirements of SB 1938 shall not be eligible for State funding intended for groundwater projects.

The Stakeholders Plenary Group developed the following BMOs to meet the groundwater management plan goals listed below.

GOAL 1: Maintain Long-term Reliable Groundwater Supplies.

The purpose of this goal is to maintain or enhance groundwater elevations to meet the long-term needs of groundwater users within the Groundwater Management Area. The plenary group developed the following BMOs to meet this goal.

BMO 1.1 – Understand the groundwater dynamics of the basin.

The complexity of flow within aquifers requires extensive data and detailed modeling to answer development questions. Even with this, accurate analysis of the water balance is often complicated by inflows and losses that are difficult to identify, monitor or interpret. However, relatively simple data, such as specific water levels in a carefully designed network of monitoring wells, can be combined with estimates of groundwater inflows and outflows to provide key indications of groundwater dynamics.

The governing body will pursue the following water management actions under this BMO.

Actions

1. Develop and maintain a consistent long-term monitoring network of an adequate number of wells that represent overall groundwater conditions in the basin.
2. Identify current and future groundwater needs for different users in the basin: Domestic, Agricultural, and Municipal based on information from users and other appropriate sources.
3. Identify areas that are contributing significant natural recharge in the basin.
4. Identify zones of critical groundwater conditions within the basin and evaluate interaction with surrounding areas.
5. Re-evaluate the Water Forum sustainable yield for the groundwater basin using data developed under this plan.

BMO 1.2 – Maintain or enhance groundwater elevations to meet the long-term needs of groundwater users within the Groundwater Management Area.

Long-term lowering groundwater levels can have adverse impacts on all groundwater users, ranging from increased energy costs and water quality degradation, to the need to deepen existing wells or even develop new wells. Therefore, it is important to maintain or enhance groundwater elevations in the basin so that groundwater will continue to be a reliable, safe, efficient, and cost-effective water supply.

Conjunctive use and recharge projects proved to be efficient means to achieve this objective in many parts of California. Conjunctive Use, as defined by the DWR 2003 Draft Bulletin 118, is:

"The coordinated and planned management of both surface and groundwater systems in order to maximize the efficient use of the resource; that is, the planned and managed operation of a groundwater basin and a surface water storage system combined through a coordinated conveyance infrastructure. Water is stored in the groundwater basin for later and planned use by intentionally recharging the basin during years of above-average water supply."

The governing body will pursue the following water management actions under this BMO.

Actions

1. Investigate and pursue conjunctive use opportunities within the South Basin area.
2. Seek and obtain permanent and/or temporary surface water supplies.
3. Identify recharge, and in-stream and off-stream storage sites.

GOAL 2: Maintain or Improve Groundwater Quality.

Although groundwater within the Basin generally has good quality and historically no persistent water quality problems were reported, it is economically important to maintain or improve groundwater quality in the Basin to meet the long-term needs of groundwater users within the Groundwater Management Area. The plenary group developed the following BMOs for the purpose of meeting this goal.

BMO 2.1 – Protect against adverse impacts to groundwater quality from man-made contaminants.

The stakeholders recognize that the long-term sustainability of the underlying basin cannot be accomplished without adequate groundwater quality protection and contamination prevention programs. Other than the City of Galt public supply wells, and other public entities such as school supply wells, there is little historical groundwater quality data available within the basin. The governing body will pursue the following water management actions under this BMO.

Actions

1. Develop and maintain basin groundwater quality database utilizing existing monitoring network of wells to collect water quality samples in addition to water quality data available from other agencies.
2. Develop the basin water quality baseline criteria (constituents and thresholds).
3. Assess annually the adequacy of the groundwater quality monitoring well network.
4. At least annually, compare baseline and future monitoring results to historical data and water quality standards for agriculture and drinking water to determine existence of water quality problems.

BMO 2.2 – Protect against migration of contaminated groundwater.

Historically, there are no known areas of contamination within the South Basin as are in neighboring basins. While the basin governance body does not have the authority or responsibility for remediation of contamination, it is committed to stay informed on the status and disposition of known contamination in neighboring basins or presence of any contaminant plumes in the South Basin. The governing body will pursue the following water management actions under this BMO.

Actions

1. Annually review data, regulations, and reports from regulatory agencies on contaminant plumes to provide warning of potential future problems.
2. If detections occur in monitoring wells within the basin or indicated in regulatory agencies reports, meet with the appropriate regulatory agencies and responsible parties to develop an action plan for warning water users and minimizing the further spread of contaminants.

BMO 2.3 – Monitor and control saline water intrusion.

Saline water intrusion from the Sacramento-San Joaquin Delta (Delta) is not currently a problem in the South Basin. Higher groundwater elevations associated with recharge from the American, Cosumnes, and Sacramento rivers have maintained a historical positive gradient, preventing significant migration of any saline water from the Delta into Sacramento County. But salinity intrusion into the shallow aquifer of the South Basin is a possible scenario if pumping depressions in the basin reverse the groundwater gradient. The governing body will pursue the following water management actions under this BMO.

Actions

1. Periodically observe TDS concentrations in monitoring wells throughout the South Basin that are routinely sampled.
2. Establish a threshold salinity level for alert or action by locals.
3. Inform all stakeholders of the presence of the salinity interface and the approximate depth to the interface for their reference when locating potential wells.

BMO 2.4 – Facilitate implementation of policies and programs for wellhead protection, well abandonment and construction, by regulatory agencies.

Contaminants from the surface can enter an improperly designed or constructed well along the outside edge of the well casing or directly through openings in the well head. Therefore, proper well design, construction, and site grading are essential to any wellhead protection program to prevent intrusion of contaminants into the well from surface sources. Furthermore, because wells can be a direct conduit to the aquifer, they must be properly destroyed or abandoned because they could provide an unimpaired route for pollutants to enter the groundwater, particularly if pumping equipment is removed from the well and the casing is left uncapped.

The Sacramento County Environmental Management Department (EMD) administers the well construction permitting and abandonment programs 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.

Identification of wellhead protection areas is an element of the Drinking Water Source Assessment and Protection (DWSAP) program administered by Department of Health Services (DHS). DHS set a goal for all water systems statewide to complete Drinking Water Source Assessments by mid-2003.

It is DHS's responsibility to maintain and enforce well-head standards; however, the governing body will pursue the following water management actions under this BMO.

Actions

1. Obtain vulnerability summaries from public water purveyor agencies within South Basin from the Drinking Water Source Assessment Program for SAWC governance body to use for guiding management decisions in the basin.
2. Coordinate with groundwater basin managers in other areas of the state to share technical advice, effective management practices regarding establishing Wellhead Protection Areas.
3. Working with California Department of Water Resources (DWR) and Sacramento County Environmental Management Department (EMD), to compile data regarding abandoned wells in the South Basin and create a Data Management System with the appropriate data.
4. Ensure that if requested, public and private agencies, and private groundwater users in the South Basin are provided a copy of the county well ordinance and understand the proper well construction and destruction procedures and support implementation of these procedures.

GOAL 3: MAINTAIN AND ENHANCE RELATED NATURAL RESOURCE FEATURES OF THE SOUTH BASIN.

The purpose of this goal is to minimize impacts resulting from continued groundwater pumping on related natural resources features such as surface water and land. The plenary group developed the following BMOs for the purpose of meeting this goal.

BMO 3.1 – Enhance the understanding of groundwater-surface water interaction along the Cosumnes River and creeks in the Basin to protect against adverse impacts to surface water resources.

The water agencies in South Basin and landowners understand the importance of preserving the fishery, wildlife, recreational, and aesthetic resources of the lower Cosumnes River. They also realize the significance to protect against adverse impacts to water quality resulting from interaction between groundwater in the basin and surface water flows in the Cosumnes River and other creeks in the Basin. The governing body will pursue the following water management actions under this BMO.

Actions

1. Work cooperatively with USGS, Sacramento County, TNC, GID, and OHWD to compile available information on stream flow, on tributary inflows, on surface water diversions from the Cosumnes River, and on groundwater pumping to quantify net groundwater recharge or discharge between gages along the waterways.
2. 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 Cosumnes River.
3. Review results from studies and develop an action plan as appropriate.

BMO 3.2 – Protect against inelastic land surface subsidence.

Land subsidence can cause significant damage to essential infrastructure. There is no evidence of historical land surface subsidence within the South Basin and no known impacts to existing infrastructure. Given historical trends, the potential for land surface subsidence from groundwater extraction in the South Basin appears to be remote. The governing body will pursue the following water management actions under this BMO.

Actions

1. Cooperate with adjacent groundwater management agencies to monitor for potential land surface subsidence.
2. 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.

GOAL 4: Maintain Local Control of Groundwater management.

The water agencies and stakeholders in the basin intend to retain local active control of groundwater resources management by ensuring on-going stakeholder involvement in appropriate management decisions. The plenary group developed the following BMOs for the purpose of meeting this goal.

BMO 4.1 – Coordinate development and optimize operation of, or implement as appropriate future water management projects.

Various water agencies in the South Basin share intents for development and operation of recharge, storage, conservation, water recycling, and extraction projects. The role of the governing body is to promote cooperation and sharing of information between the agencies sponsoring water management projects and other local water agencies and stakeholders. To the extent feasible, the governing body also will support measures to coordinate development and optimize operation of facilities to improve Basin-wide effectiveness and efficiency of water management. The governing body will pursue the following water management actions under this BMO.

Actions

1. Share information on project planning, design, and operation among local land owners and stakeholders.
2. Promote a coordinated approach toward project development and operation to optimize water management efforts.
3. Seek funding for projects and programs for future water conservation, recycling, public outreach, and education and groundwater recharge in the Basin.

BMO 4.2 – Actively develop and partner in conjunctive use projects of groundwater, surface water, and recycled water.

The region's assets of federal, state, and local water supplies, dewatered groundwater storage, and significant irrigation demand make it an ideal location to regulate surface supplies conjunctively. Some water agencies within south Sacramento County have existing/promised water rights and contracts that cannot be fully utilized for a variety of factors, including supply reliability and infrastructure limitations. It is very important for those agencies to maximize the utilization of existing/promised water rights.

The Basin should also be capable of absorbing wet-year water supplies in order to maintain a reliable and economical water supply. Wet-year water supplies, also known as flood-flows or unregulated flows, are defined as either releases made from upstream storage reservoirs to maintain adequate flood storage capacity or flows in excess of in-stream flow requirements. Developing cost-effective methods to capture and store flood water is a major challenge due to the intensity and infrequency of major storm/runoff events. Therefore, the local agencies intend to work cooperatively to increase the ability to absorb surface water when available. The governing body will pursue the following water management actions under this BMO.

Actions

1. Cooperate with other relevant agencies in projects that promote the area's conjunctive water management capabilities and enhance groundwater.
2. Investigate potential sources of water and funding opportunities for conjunctive use projects.
3. Identify potential recharge sites in South Basin; undertake and approve appropriate conjunctive use studies, plans, and project proposals that benefit stakeholders and land owners in the basin.

BMO 4.3 – Examine public agency's land use plans to identify potential impact on groundwater.

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 require developing 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 governing body will pursue the following water management actions under this BMO.

Actions

1. Undertake initial review of all proposed public agency's projects with potential to benefit or impact groundwater in the basin and provide comments as appropriate.
2. Coordinate with and exchange information with lead agencies regarding projects with the most significant risk to groundwater.
3. Submit formal comments on public agency's land use plans for the South Basin, when appropriate.
4. Coordinate with local planning agencies to develop land use strategies that protect groundwater recharge areas.

BMO 4.4 – Establish a procedure for sharing information with the public, appropriate resources management and regulatory agencies on local, state, and federal levels.

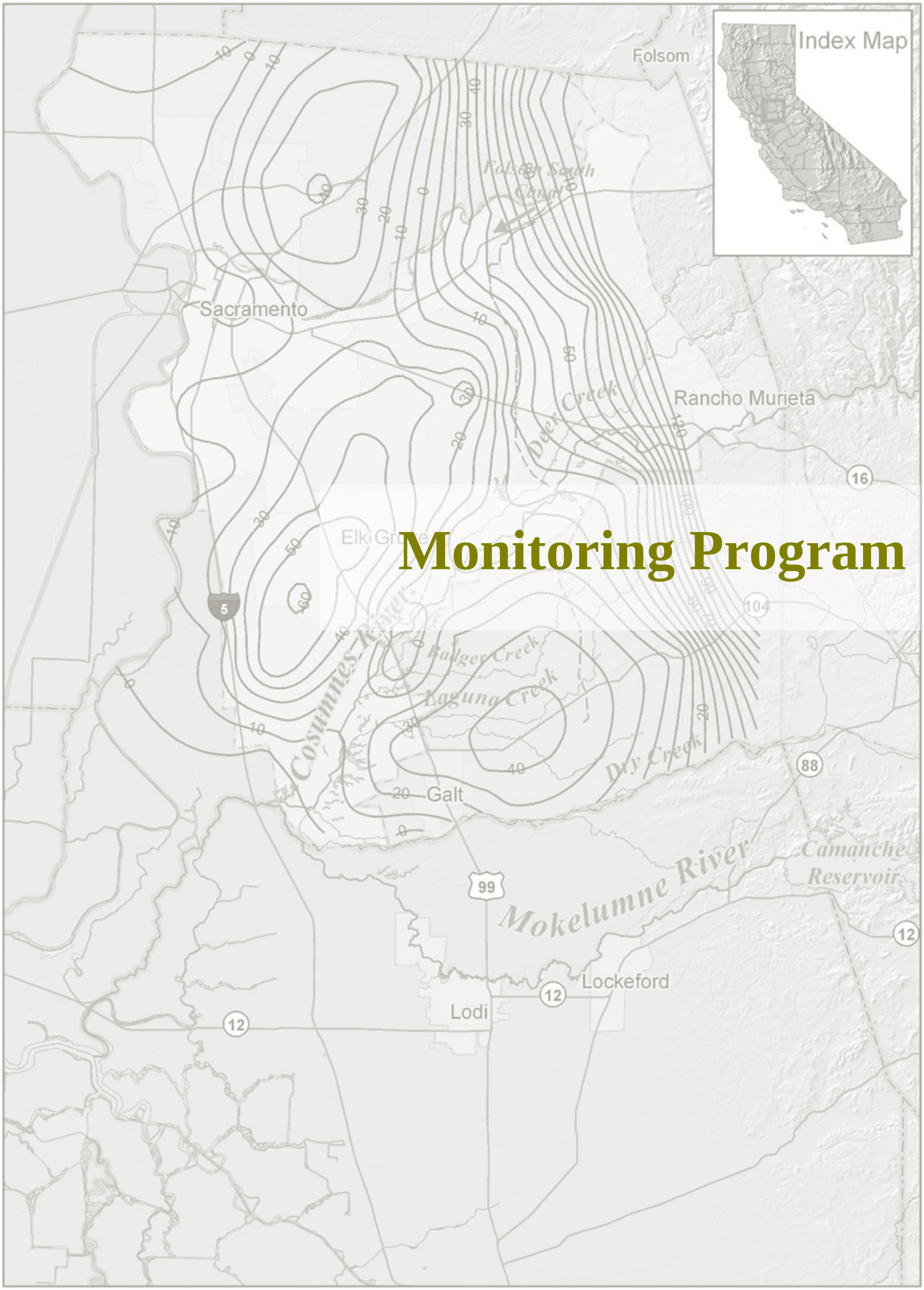
The governing body will continue coordination among its member agencies, local water agencies, land owners, and interested parties to manage the water supplies within the South Sacramento Basin. The governing body will also continue to cooperate and develop basinwide programs and projects to benefit the Basin's resources.

The governing body meetings will continue to be a forum where regional, state, and federal agencies can meet to discuss ongoing and future regulatory issues. The governing body will pursue the following water management actions under this BMO.

Actions

1. Develop working relationships with appropriate local, state, and federal regulatory agencies, and establish protocols for data exchange with these agencies.
2. Conduct periodic coordination meetings to ensure close collaboration.
3. Provide water efficiency measures to the public.

Monitoring Program



3 Monitoring Program

This section discusses the GMP groundwater monitoring program, which is designed to identify trends and changes in groundwater elevation and quality throughout the basin. The program includes monitoring groundwater elevation and quality, land subsidence, and groundwater-surface water interaction.

Groundwater level and quality monitoring protocols and programs are required components of Groundwater Management Plans prepared in response to Senate Bill (SB) 1938 (Amendments to Water Code section 10750). The monitoring program should include a map of monitoring sites, the type of monitoring at each site, the type of measurements and frequency of monitoring at each location.

This report section describes a monitoring program 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, leading to a better understanding of the relationship between surface water and groundwater along the Cosumnes River and other creeks in the basin. Also important is establishing monitoring protocols to ensure the accuracy and consistency of data collected. Finally, the monitoring program includes a tool (Data Management System) for assembling and assessing groundwater-related data.

3.1 Groundwater Elevation Monitoring

California Department of Water Resources (DWR) and Sacramento County Water Agency (SCWA) coordinate a program to collect semiannual (spring and fall) groundwater level data from more than 150 wells throughout Sacramento County. SCWA uses this data to generate semiannual groundwater contour maps for the county. However, comparison of a historical contour map with a recent levels map causes debate because wells have been added and dropped from the program over time. For this reason, the basin governance should plan to establish a standardized network of wells that combines those monitored by DWR, SCWA, member water purveyors, and other sources. It is the intent of the stakeholders that the wells comprising this program be maintained as a consistent long-term network that represents overall groundwater elevation conditions in the basin.

Figure 3-1 shows the wells currently proposed for this network. Well information, including well number, record length, well use, well depth and screened intervals is summarized in **Table 3-1**. The wells were selected to provide uniform geographic coverage of the entire South Basin.

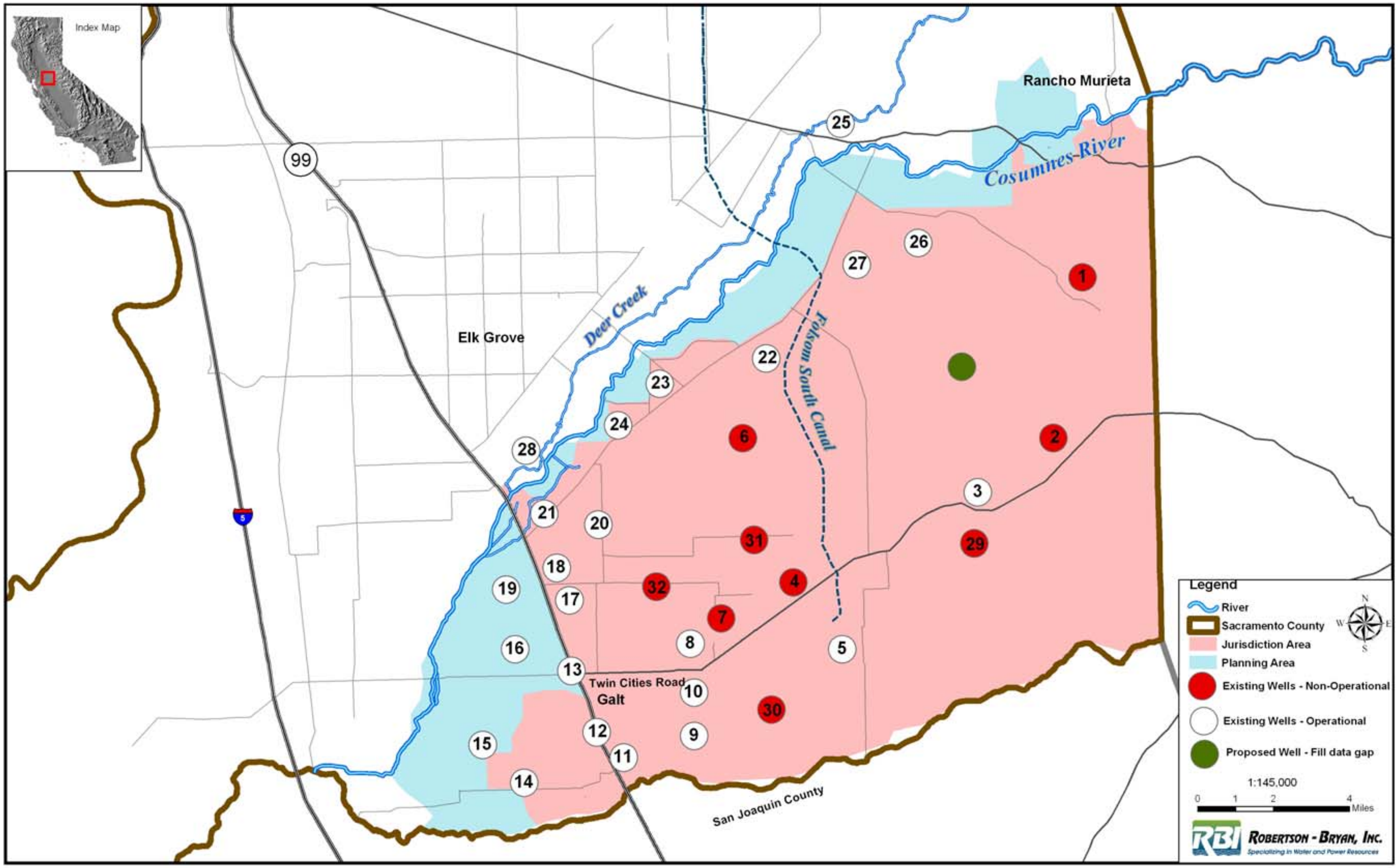


Figure 3-1. Wells currently proposed for the standardized monitoring network.

Table 3-1. Well network information.

Well No	State #	Data Range	Well Use	Well Depth (ft)	Screened Intervals (ft)	Notes
1	07N08E36B001M	1953–2009	Unused	15'	none	
2	06N08E15J001M	1954–2009	Domestic	150'	none	
3	06N08E21P003M	1972–2010	Domestic	305'	none	WWDR
4	06N07E34H001M	1966–2008	Unused	210'	none	
5	05N07E11R002M	1985–2010	Domestic	228'	none	WWDR
6	06N07E08R001M	1966–2008	Domestic	332'	none	
7	06N07E32P001M	1963–2008	Irrigation	545'	120'–124', 132'–136'	WWDR
8	05N06E12R001M	1990–2010	Irrigation	850'	none	
9	05N07E19N001M	1972–2010	Domestic	225'	none	WWDR
10	05N06E13R001M	1990–2010	Irrigation	240'	none	cased 0-170'
11	05N06E26K001M	1961–2010	Irrigation	310'	none	
12	05N06E26D001M	1963–2010	Irrigation	383'	263'to359'	WWDR
13	05N06E10P001M	1963–2010	Irrigation	384'	169'–193', 241'–265', 289'–361'	WWDR
14	05N06E33H001M	1990–2010	Irrigation	none	none	
15	05N06E30E001M	1991–2010	Irrigation	none	none	
16	05N06E08R001M	1972–2010	Irrigation	none	none	
17	06N06E34P001M	1990 -2010	Irrigation	375'	none	
18	06N06E33J002M	1966–2010	Irrigation	167'	none	
19	06N06E33L001M	1963–2010	Irrigation	226'	none	WWDR
20	06N06E23C001M	1990–2010	Irrigation	275'	none	
21	06N06E28C002M	1965–2010	Irrigation	none	none	
22	07N07E33G001M	1984–2010	Domestic	180'	none	WWDR
23	06N06E01G001M	1990–2010	Domestic/Irrigation	330'	none	cased 0-196'
24	06N06E11J003M	1990–2010	Domestic	215'	none	
25	07N07E02C001M	1990–2010	Irrigation	135'	none	
26	07N08E18F001M	1968–2010	Stock	none	none	
27	07N07E14R001M	1985–2010	Domestic	185'	none	WWDR
28	06N06E16E001M	1989–2010	Domestic	150'	none	
29	06N08E34E001M	1975–1994	Irrigation			
30	05N07E28A001M	1966–1994	Irrigation			
31	06N07E28E001M	1952- 1996	Domestic			
32	06N06E25Q001M	1990–1998	Domestic			

Individual wells were selected giving preference to wells currently in the DWR and SCWA monitoring program. These wells were selected because:

1. They have long records of historical groundwater level data and are useful in assessing trends within the groundwater basins, and
2. Uniform protocols were used in measuring and recording the water level data.

The monitoring network includes 23 currently operational monitored wells, 9 non-operational monitored wells and one proposed new well to fill a spatial gap in the network.

Additional actions by the basin governance body will include:

1. Construct new dedicated monitoring wells to eliminate influence of well operations on groundwater level data. Pursue state and other sources of funding to achieve this purpose.

2. Coordinate with DWR, SCWA and others to ensure that the selected wells are maintained as part of a long-term monitoring network and protected in the future from being dropped from the program.

3.2 Groundwater Quality Monitoring

Groundwater quality in the South Basin is generally acceptable for all potential uses and there are no known areas of contamination within the boundaries of the Planning or Jurisdiction areas. The City of Galt has monitored instances of arsenic in a few wells. A limited number of wells have available record of historical water quality data because few of the wells in the basin are used for public water supply. These wells are shown in **Figure 3-2** and they are:

- City of Galt Public Water System,
- Elk Grove Unified School District wells in Wilton, and
- Arcohe Elementary School in Herald.

Water purveyors compile available water quality data for constituents monitored as required by DHS under CCR Title 22. As part of this monitoring plan, the governing body will seek additional resources to gather additional water quality data from existing monitoring programs by agricultural and domestic pumpers. The water quality monitoring well network may be expanded to include additional DWR, USGS, and privately owned domestic and agricultural wells based on the outcome of coordination effort with these agencies and interested land owners.

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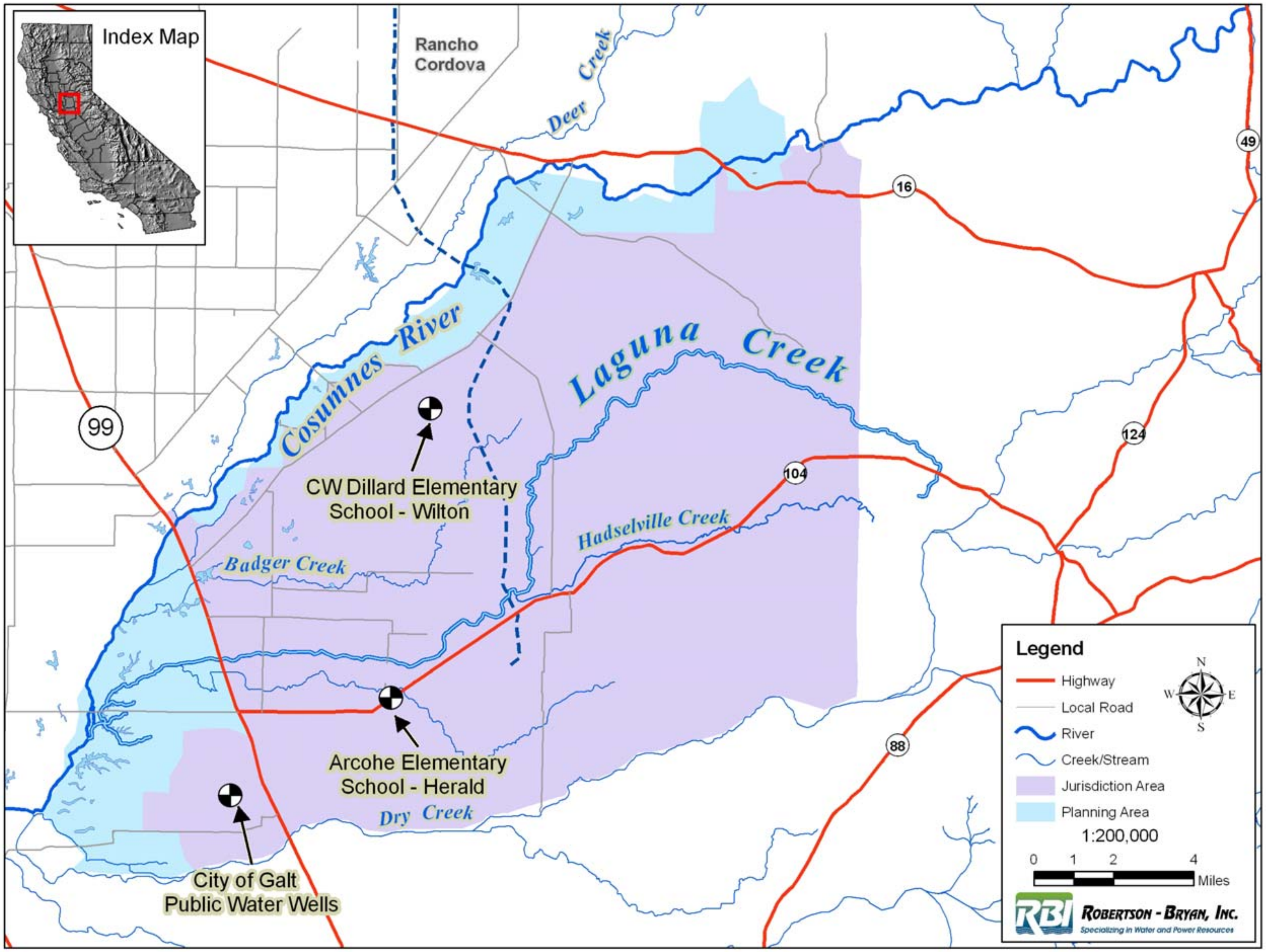


Figure 3-2. South Basin wells with historical water quality data records.

In Addition, the basin governance body will take the following actions:

1. Coordinate with cooperating agencies to verify that uniform protocols are used when collecting water quality data.
2. Periodically assess the adequacy of the groundwater quality monitoring well network.

3.3 Land Subsidence Monitoring

While available data and reports indicate that surface subsidence is not occurring in Sacramento County, the basin governance body will review and evaluate DWR, Sacramento County, and National Geodetic Survey (NGS) land subsidence surveys data for Sacramento County. If subsidence is reported, the governing body will examine reports of land subsidence and discuss potential monitoring activities based on the results of the evaluation.

3.4 Groundwater-Surface Water Interaction Monitoring

The governance body will coordinate with agencies that currently maintain existing gauging stations for stream flow rates and water quality monitoring along the Cosumnes River and creeks in the basin (USGS, OHWD, SMUD, etc.) to ensure that the selected gauging stations are maintained as part of a long-term monitoring network and protected in the future from being dropped from the program. Surface water data will be assembled as part of the groundwater information database and will be reported in the annual monitoring report.

Three gauging stations are currently operational along the Cosumnes River for stream flow measurements:

1. One USGS gauge at Michigan Bar, and
2. Two OHWD gauges at Rooney Dam and Mahon Dam.

In addition, SMUD maintained two stream flow gauges along Hadselville Creek and Laguna Creek until 2010. The location of these gauges is shown in **Figure 3-3.**

Additional actions by the basin governance body will include:

1. Coordinate with TNC and UC Davis, to incorporate and analyze data obtained from monitoring wells near the Cosumnes River to better understand the relationship between groundwater basin and surface water flows at that location.
2. Obtain and incorporate available surface discharge monitoring data from the local water quality coalition.

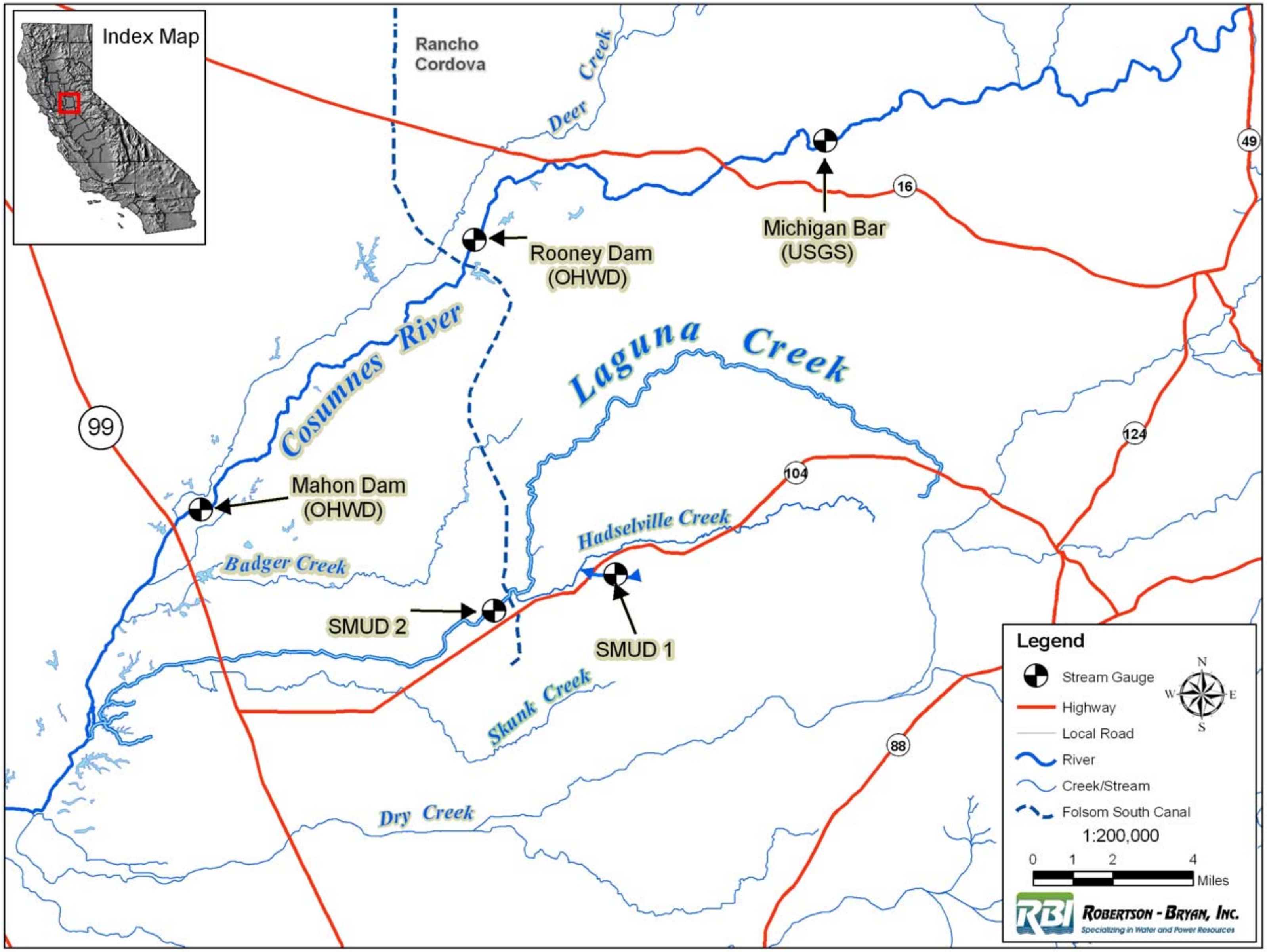


Figure 3-3. Location of stream flow gauges.

3.5 Protocols for Collecting Groundwater Data

The governance body will use DWR standard operating procedures (2010) for collection of water level data. The governance body will ensure that the procedure is consistent with protocols developed by other agencies involved in groundwater monitoring activities in the basin, such as SCWA, SMUD, USGS and USBR.

The governance body will also provide cooperating agencies with guidelines developed by DHS (DHS, 1995) or other agencies for the collection, pretreatment, storage, and transportation of water quality samples.

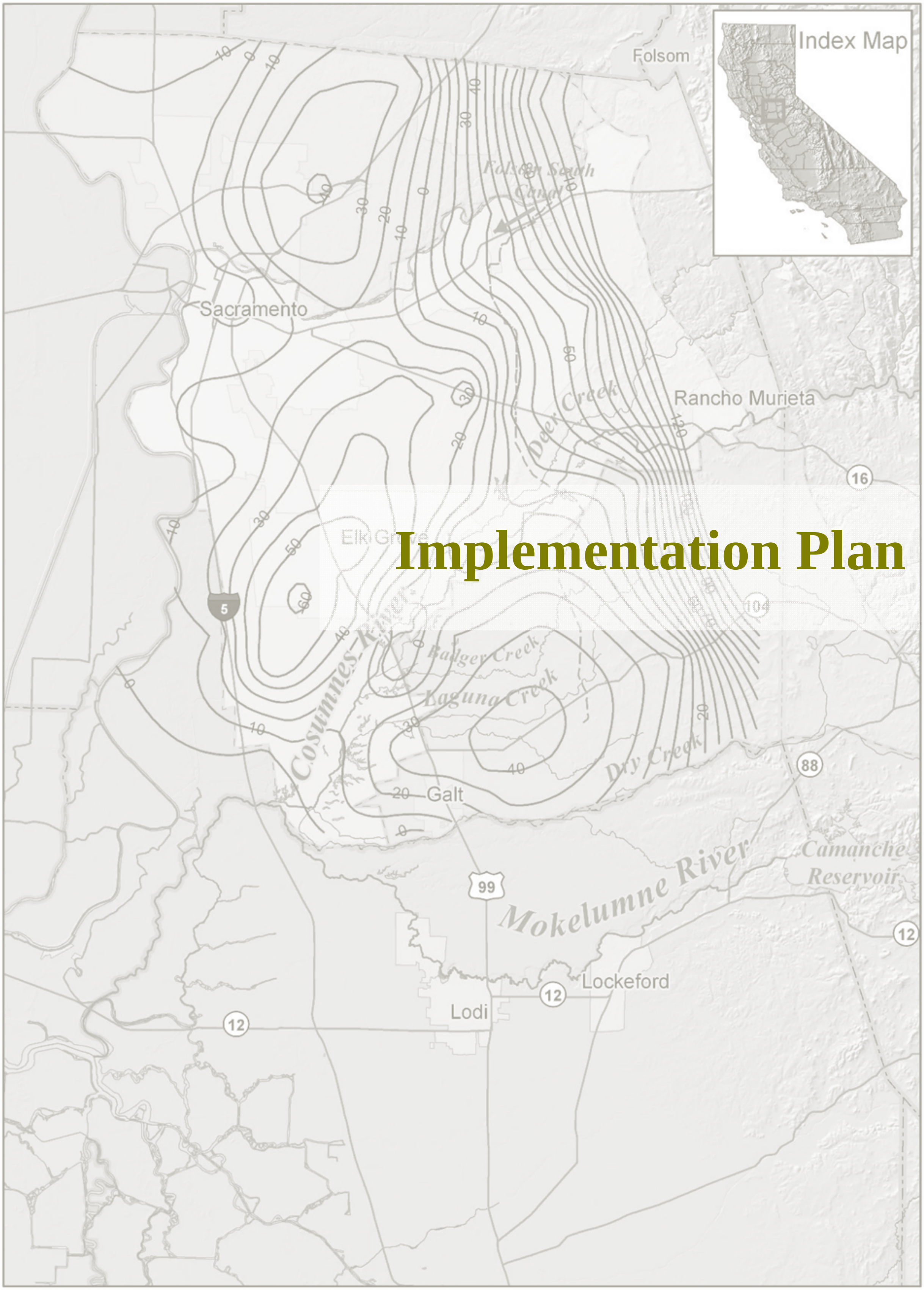
3.6 Data Management System

The Governance body will assemble and maintain a data management system (DMS) of groundwater information for the monitoring wells in the basin, establish a procedure to fill missing data and make data available to agencies, landowners, and stakeholders in the basin.

An annual groundwater report describing elevation and quality trends and basin development changes will be prepared.

The Basin governance body will take the following actions:

- Develop simple-to-use tools necessary to analyze groundwater data.
- Make groundwater information available to decision makers, agency staff, and the general public through the internet.
- Continue to update the DMS with current water purveyor data.
- Make recommendations to an assigned DMS developer to enhance the DMS to increase its functionality and ease of use.



Implementation Plan

4 Implementation Plan

This section describes the structure and the method for implementing the Groundwater Management Plan (GMP) after its adoption. The purposes of this implementation plan are to guide groundwater management efforts and carry out the proposed activities outlined in the basin management objectives (BMOs) section of this GMP. The overarching purpose of the BMOs and associated actions is to encourage a balance of surface water and groundwater use to protect the resources of the Basin and maximize the reliable supply of high quality water to meet the basin's current and future needs.

It is important to note that groundwater management requirements and responsibilities, as dictated by the California Code of Regulations, may change over time. Individual agencies, as well as the agency responsible for implementing this plan, will evaluate regulatory changes and determine how best to address those changes, when and if they occur. The recommendations and implementation priorities may change over time, to accommodate the changing regulatory framework.

4.1 Basinwide Management Actions

The following Basin-wide management actions are provided as suggested measures for facilitating the achievement of the BMOs described in Section 2:

1. Maintain the groundwater elevation and quality monitoring wells network as part of a consistent long-term monitoring network.
2. Implement GMP's monitoring program components by collection, analysis and assimilation of water levels and quality data and development and maintenance of a data base system. Data are needed to understand conditions within the Basin, evaluate trends, facilitate the implementation of management actions, and evaluate their effectiveness.
3. Investigate and pursue conjunctive use opportunities within the South Basin area. This entails seeking and obtaining permanent and/or temporary surface water supplies and identification of recharge, and in-stream and off-stream storage sites.
4. Promoting coordination and cooperation between water agencies (federal, state and local) within the basin and outside the basin. The Governing Body should continue to coordinate water management activities within the Basin and work cooperatively to implement the agreed-upon BMOs. The local water agencies also may work together to develop a coordinated outreach program to educate basin residents and groundwater users on groundwater management issues.
5. Annually review data, regulations, and reports from regulatory agencies on contaminant plumes, vulnerability summaries, and total dissolved solids (TDS) concentrations to provide warning of potential future problems.

6. Seek funding for projects and programs for future water conservation, recycling, public outreach and education and groundwater recharge in the Basin.

4.2 Governing Structure

The plenary committee recommended that a new Implementation Authority, formed through a Joint Powers Authority (JPA), represent the following interests in the basin to carry out the implementation plan:

- City of Galt
- County of Sacramento
- Galt ID
- Clay WD
- Omochumne-Hartnell WD
- RD 800
- Rancho Murieta CSD
- Sloughhouse RCD
- SMUD
- Representatives from within the Jurisdictional Boundaries of the Basin:
    - Commercial Irrigated Agriculture Interest
    - Commercial Aquaculture Interest
    - Conservation Landowners Commercial / Industrial Interest
    - Rangeland / Grazing Agriculture Interest
- Ag-Residential Representative from within the Jurisdictional Boundaries of the Basin:
    - Cosumnes CPAC
    - Herald CPAC

The JPA would also define the purpose, establish the Implementation Authority, identify powers and functions, and identify budget requirements. The final structure of the governing body is still being negotiated by the stakeholders in the basin.

The primary roles of the implementation authority could include:

- Securing and providing funds for implementation of the GMP.
- Issuing and managing contracts necessary for implementation of the GMP.
- Overseeing the accuracy and quality of all reports associated with GMP implementation.
- Advancing and facilitating pursuit of the goals and objectives identified in this GMP in a timely manner.
- Directing future updates to the GMP every 5 years, or more frequently if needed, to reflect changes in state laws or in local conditions/programs.

- Act as liaison between GMP implementation activities and agencies, individuals, and agencies represented by the group members.

The Implementation Authority will meet at least annually, unless the Authority decides it should meet more frequently, at which time it will:

1. Review, amend, and adopt the annual report on the status of the basin.
2. Review the progress on meeting the GMPs goals and objectives.
3. Discuss and approve the work plan for the upcoming year.
4. Consider any amendments to the GMP.
5. Review and approve an annual budget.

4.3 Annual Review and Report

The Implementation Authority would be responsible for reporting on the progress of implementing the Southeast Sacramento County Groundwater Management Plan (SSCGMP) in an annual State of the Basin report. The annual Review and State of the Basin report can 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. The reason for starting the review process in April is due to the time that data compilation process can take before it is ready for board members review. Prior to accepting the report, the Implementation Authority will consider comments from the general public.

The Annual Review and Report will include:

- Status of groundwater conditions within the Basin – levels and trends.
- Summary and analysis of monitoring effort.
- Summary and status of GMP elements implemented and proposed for implementation.
- Review annual work plan and BMOs, and assess achievement of BMOs.
- Contingency actions, if any BMO is violated or threatened.
- Prioritization of projects and programs to achieve BMOs, based on funding and other resources.
- A review of the political, institutional, social, or economic factors affecting groundwater management.
- Changes relative to the previous Annual Review and Report.
- Recommendations for revisions to BMOs or elements.

4.4 Financing Mechanisms

Operational funding for the Implementation Authority activities can be through annual member/participant contributions, county funding or state grants. Tasks to be performed under operational fund may include:

- GMP annual review and meetings
- Development of JPA and set up of Authority Board (first year)
- Public Outreach and development of relations with other agencies
- Set up of Data Management System (DMS)
- Monitoring
- Reporting
- Grant application and funding opportunities

The source and amount of funding should be spelled out in the JPA after negotiations with the stakeholders. The projects, policies, and programs that encompass the many groundwater-related management activities, can be funded through a variety of sources, which include, but are not limited to:

1. Member/participant contributions – the ability to fund plan implementation locally will depend on available resources and is subject to an individual agency's budgetary process.
2. Funding from other interested entities.
3. In-kind services by other entities within the Basin.
4. State or Federal grants programs; such USBR WaterSmart grants, California DWR grants, and NRCS grants.

It is important to note that state grant programs or other sources of outside funding often require local financial support or contributions; therefore, local contributions may aid in the acquisition of outside funding to implement the plan.

4.5 Implementation Schedule

The Implementation Authority must initiate certain activities within the first year to fulfill statutory requirements for its formation. These activities include:

- Establish an authority board, its strategies, and structure
- Monitoring groundwater status
- Develop a Data Management System

- Prioritize activities that can be undertaken immediately, taking into consideration public inputs
- Acquire funding for first year activities

The schedule for implementing the GMP must remain flexible to account for many factors that influence the implementation. Flexibility of the implementation schedule should not be considered as grounds for delay.

Table 4-1 provides an estimate of annual cost of plan operation and additional costs associated with the start-up of the first year of plan implementation.

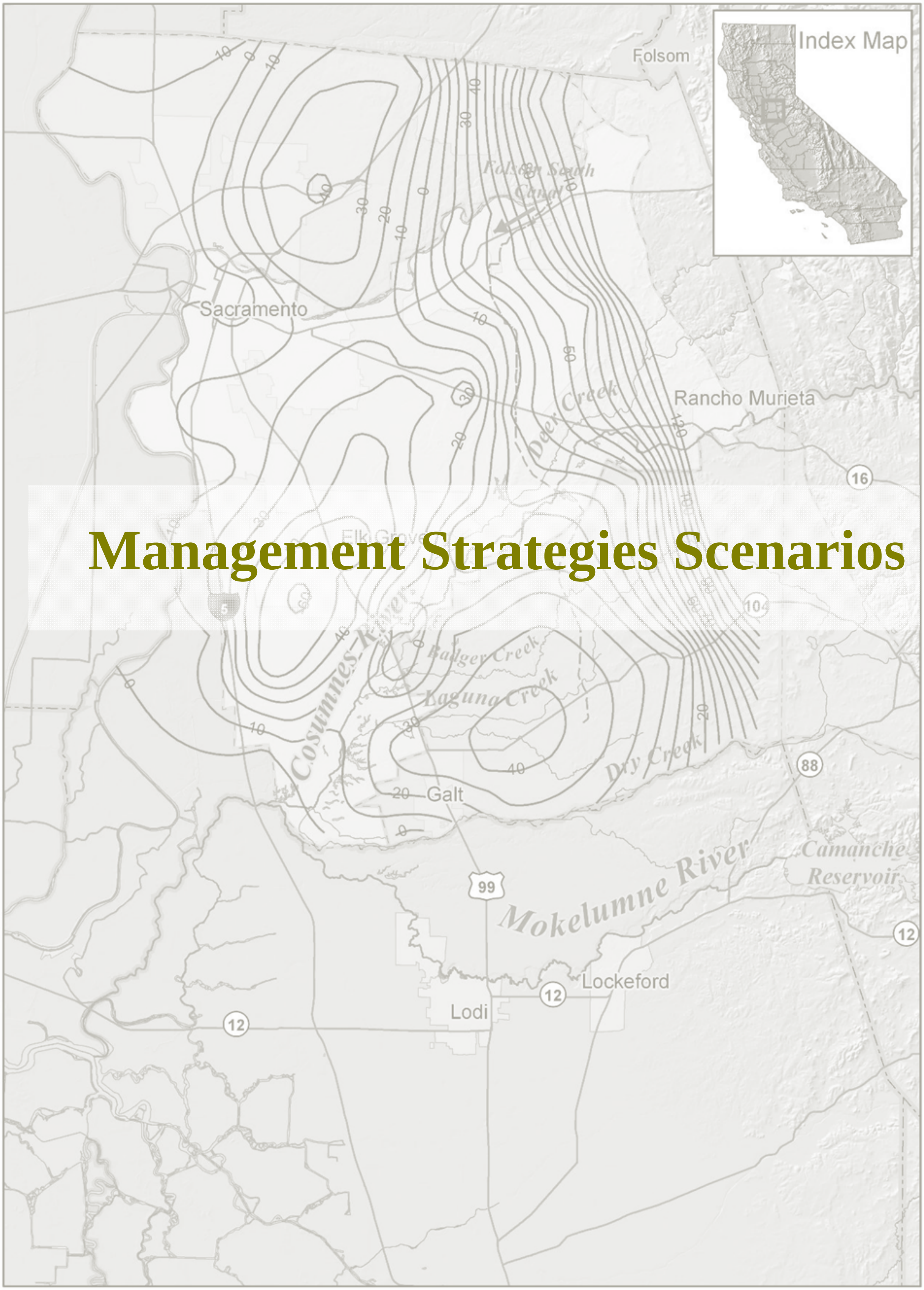
Table 4-1. Estimated Cost of Implementation of GMP.

Budget for GMP Implementation					
1st Year					
Task	**Legal**	**Project Mgt**	**Technical**		**TOTAL**
GMP annual review and meetings	$ -	$ 10,000	$ 10,000		$ 20,000
Development of JPA and set up of Authority Board	$ 20,000	$ 30,000	$ -		$ 50,000
Public Outreach and development of relations with other agencies	$ -	$ 20,000	$ 10,000		$ 30,000
Set up Data Management System	$ -	$ 2,000	$ 13,000		$ 15,000
Monitoring	$ -	$ 2,000	$ 8,000		$ 10,000
Reporting	$ -	$ 3,000	$ 7,000		$ 10,000
Grant application and funding opportunities		$ 5,000	$ 10,000		$ 15,000
TOTAL	**$ 20,000**	**$ 62,000**	**$ 48,000**	**$ -**	**$ 150,000**
Annual Implementation Cost					
Task	**Legal**	**Project Mgt**	**Technical**		**TOTAL**
GMP annual review and meetings	$ -	$ 10,000	$ 10,000		$ 20,000
Public Outreach and development of relations with other agencies	$ -	$ 10,000	$ 10,000		$ 20,000
Monitoring	$ -	$ 2,000	$ 8,000		$ 10,000
Reporting	$ -	$ 3,000	$ 7,000		$ 10,000
Grant application and funding opportunities	$ -	$ 5,000	$ 10,000		$ 15,000
TOTAL	**$ -**	**$ 30,000**	**$ 45,000**	**$ -**	**$ 75,000**

4.6 Future Re-evaluation of GMP

The GMP and documents developed as part of the implementation are part of an on-going and evolving groundwater management program. The GMP will be reviewed and updated based on new issues, changed conditions, and future technological advancements that will occur over time. Comprehensive review of the GMP will be scheduled every 5 years, unless the Authority decides it should be more frequently. This action will help maintain the GMP as a current and viable tool to guide continuing management of groundwater resources within the GMP management area.

Management Strategies Scenarios



5 Management Strategies Scenarios

In coordination and consultation with SSCAWA and stakeholders in the basin, RBI developed and evaluated alternatives for groundwater management that will facilitate achieving some of the BMOs—primarily conjunctive use and groundwater recharge. Alternatives are projects that could be reasonably implemented solely by the Authority or in conjunction with other stakeholders in the study area.

The SacIGSM Model simulated baseline and three alternative groundwater management strategies. The simulation results were evaluated in terms of groundwater elevation changes at several observation wells (**Figure 5-1**), groundwater contours changes, and changes to the groundwater budget. The focus of these simulations was a comparative analysis.

The results of the simulations were compared to each other, particularly the baseline case, in order to evaluate the potential benefits of pursuing a particular management strategy. The model simulated 35 years of hydrology (1970 to 2004) with initial conditions of fall 2004, which represents the model output at the end of the calibration period. The model delineated three aquifer layers based on DWR Bulletin 118-3, U.S. Geological Survey (USGS) reports, numerous well logs, and California Division of Oil and Gas geographical logs. The top two aquifer layers—Upper Aquifer (Model Layer 1) and Lower Aquifer (Model Layer 2)—are fresh-water bearing aquifers.

Four simulations covered a range of potential management scenarios or options:

- Continuation of existing conditions with no projects (**baseline**).
- **Conjunctive Use -** utilize available surface water supplies in lieu of pumping.
- **Direct Groundwater Recharge -** spread available surface water supplies onto percolation basins and existing channels to directly recharge groundwater.
- **Combination of In-lieu Recharge and Direct Recharge -** utilize available surface water supplies in lieu of pumping groundwater and directly recharge groundwater.

> **Above Average Year**
> March–November unimpaired inflow to Folsom Reservoir is above 1,600.

RBI and the plenary proposed these scenarios to meet the basin management objective to maintain or enhance groundwater elevations to meet the long-term needs of groundwater users within the Groundwater Management Area. The surface water supplies used in the scenarios employ the Water Forum specification that a maximum of 35,000 acre-feet per year of surface water will be available from the American River during **above average** and **wet years** (about 50 percent of the time) to the South Basin (SMUD Water for M&I use). This water is not available in dry years. Location of conjunctive use areas and direct recharge spreading ponds are shown in Figure 5-1.

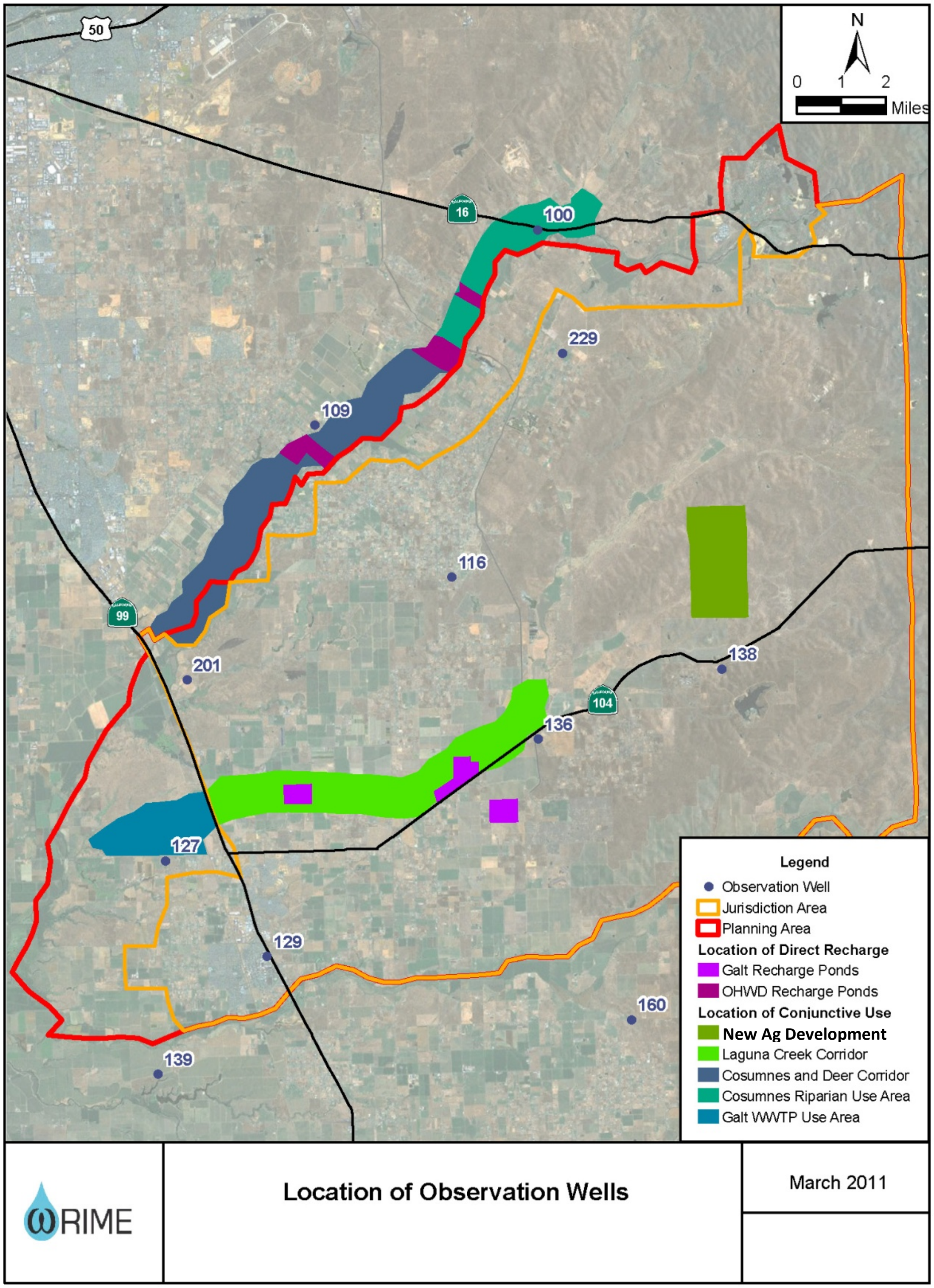


Figure 5-1. Location of Observation wells, Conjunctive Use, and Direct Recharge.

5.1 Baseline

The key objective of simulating this baseline scenario is to assess the impact of maintaining existing conditions (pumping, land use) unchanged with no management project employed in the future.

5.1.1 Description of the Scenario

The assumptions used to develop the SacIGSM Model simulation for the Existing Conditions Baseline (EC Baseline) are presented below. The simulations for the scenarios are based upon the EC Baseline.

Land Use – Land use is based on DWR Land Use Survey of 2000 for Sacramento County. Non-urban parcels that have been converted to urban land between 2000 and 2007 were urbanized for the model based on Sacramento County Assessor Parcel Number data. The area of the new agricultural development north of Highway 104 is set to 2,000 acres.

Rancho Murrieta Demand and Supply – Urban demand and surface water supply for Rancho Murrieta use 2004 data. RMCSD diverted about 2,000 acre-feet per year from 1992–2001 to meet its water demand. For model runs, water use by RMCSD is set to 2,200 acre-feet per year to reflect current conditions and projected conditions until 2015.

City of Galt Demand and Supply – Urban demand and municipal groundwater production for City of Galt are based on well production data from the SGA and SCGA data management system. The City of Galt municipal pumping and demand were scaled up to 5,000 acre-feet per year to reflect current conditions and projected conditions until 2015.

Rural Residential Demand and Supply – Urban demand and supply for rural residential pumping is calculated based on land use using a water duty of 0.5 acre-feet/acre.

Fish Farms – Fish farm operations use 2004 calibration data, which is approximately 11,000 acre-feet per year.

Agricultural Water Demand – The IGSM model calculates agricultural water demand based on land use and model parameters.

Tail Water Reuse – Agriculture surface supply and tail water reuse uses 2004 calibration data.

Agricultural Pumping – Agriculture pumping is the difference between demand and surface water supply.

SMUD Deliveries – SMUD deliveries and release uses 2004 calibration data. This source of surface water provides about 4,000 acre-feet annually to meet a portion of the agricultural water demand in the Jurisdiction Area.

5.1.2 Results

Figure 5-2 shows well hydrographs for three wells in the basin that represent the different water elevation trends resulting from simulating existing conditions. The groundwater elevation trend is declining slightly for wells away from the Cosumnes River, as shown in the well 138 hydrograph. Wells closer to the Cosumnes River exhibit a stable groundwater elevation trend, as shown in wells 229 and 201 hydrographs.

The water budget for the Existing Conditions Baseline is summarized in T**able 5-1**. Inclusion of 3,600 acre-feet per year direct recharge from SMUD releases in the model has slightly improved the overall annual groundwater storage to stay on the positive side by an average of 1,200 and 1,900 acre-feet in the Jurisdiction and Planning areas respectively.

Table 5-1. Groundwater Budget for Baseline.

Average Annual Groundwater Budget for Jurisdiction Area (ac-ft/year)						
Model Run	**Net Inflow**				**Outflow**	Change in Storage
	Deep Percolation	Seepage From Rivers	Subsurface Boundary Flow	Direct Recharge	Pumping	
Existing Conditions Baseline	37,700	21,300	52,200	3,600	113,600	1,200
Average Annual Groundwater Budget for Planning Area (ac-ft/year)						
Model Run	**Net Inflow**				**Outflow**	Change in Storage
	Deep Percolation	Seepage From Rivers	Subsurface Boundary Flow	Direct Recharge	Pumping	
Existing Conditions Baseline	48,800	58,100	36,300	3,600	145,000	1,900

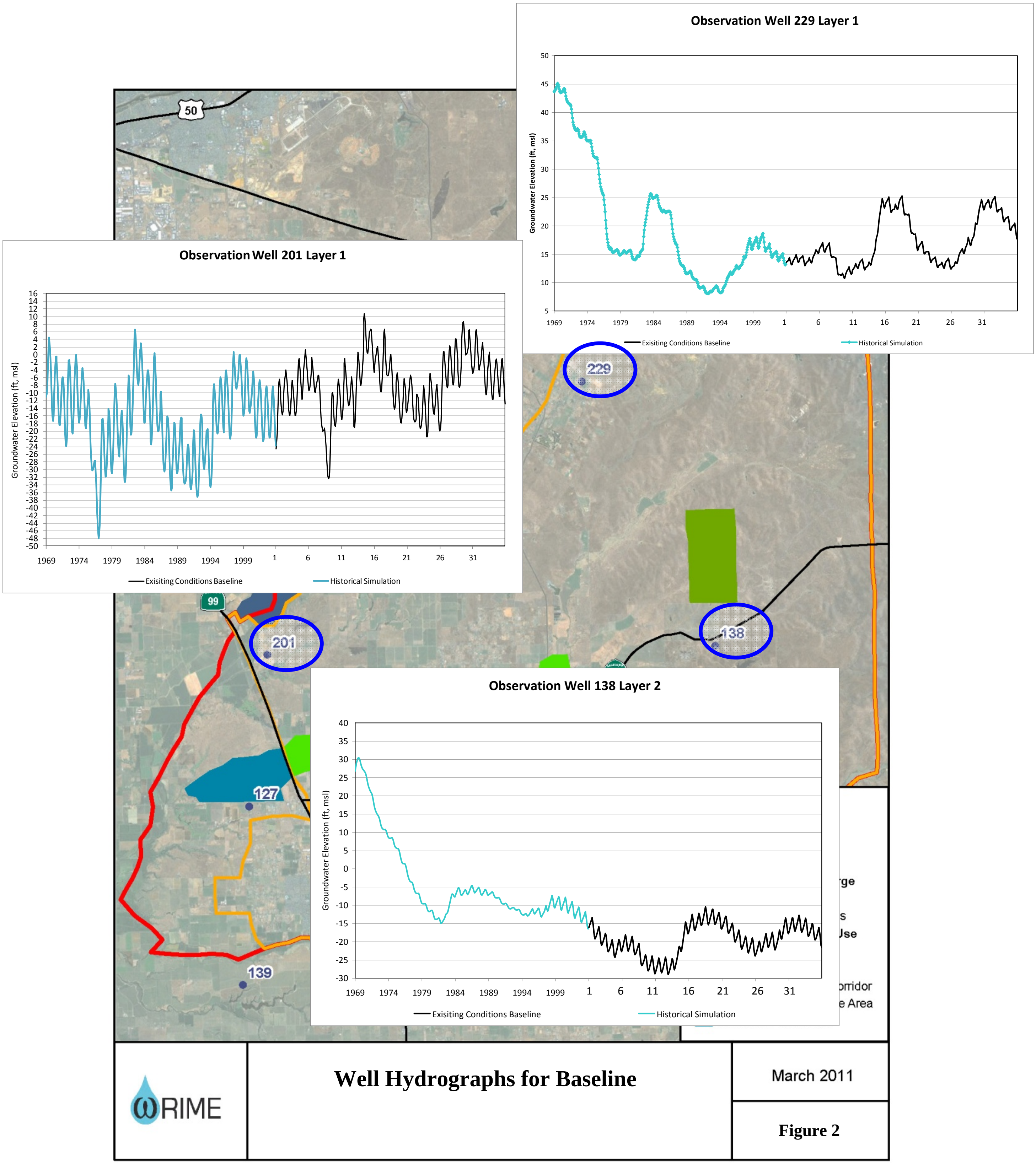


Figure 5-2. Well Hydrographs for Baseline.

5.2 Conjunctive Use: Surface Water Supplies in lieu of Pumping Groundwater

A key objective of simulating the conjunctive use scenario is to assess the impact of utilizing available surface water supplies in lieu of groundwater pumping.

5.2.1 Description of the Scenario

The conjunctive use scenario utilizes available surface water supplies from the American River in lieu of groundwater pumping in the Laguna Creek Corridor, Cosumnes River-Dry Creek Corridor, and new agricultural development during above-normal years. The simulation used an average of 12,300 acre-feet per year of surface water at these locations. Additionally, the simulation used 2,400 acre-feet per year of recycled water from the Galt Wastewater Treatment Plant for this scenario.

This scenario employs the following assumptions:

- Potential sources of water supplies:
  - Water Forum / SMUD water during above normal and wet years; no additional surface water in below normal years.
  - Galt Wastewater Treatment Plant discharge.
  - Riparian Water Rights: farmers with riparian rights will exercise these rights whenever water is available.
- Potential surface water users: New water delivered by GID, OHWD.
  - GID: In-lieu irrigation demand – within about ¼ mile of Laguna Creek.
  - OHWD: In-lieu irrigation demand – within about ¼ mile of Cosumnes River.
- Conveyance – Folsom South Canal, Hadselville Creek, Laguna Creek, Deer Creek, and Cosumnes River.

5.2.2 Results

Figures 5-3 and 5-4 present the change in groundwater elevation between the baseline and the conjunctive use scenario for fall of model simulation year 31 (2000 hydrology) in the two layers included in the model. Note that the change in groundwater elevation was calculated as the difference between water elevations resulting from the conjunctive use scenario minus the baseline water elevation.

The groundwater elevation would increase by 5 to 30 feet throughout the basin under assumed conjunctive use in both model layers, depending on the proximity to the conjunctive use locations. Figure 5-2 showed higher water elevations in Layer 2 of the model concentrated in the eastern side of the basin. This indicates that replacing pumping from the deeper wells with surface water in that area of the basin results in these higher water elevations.

These higher water elevation observations were confirmed by comparing well hydrographs resulting from the conjunctive use scenario and baseline in several wells in the area, as seen in **Figure 5-5**.

The water budget for this scenario is summarized in **Table 5-2**. Groundwater pumping in this scenario is reduced in both the Jurisdiction and Planning areas by an average of 6,600 and 8,500 acre-feet annually when compared to the baseline. Accordingly, this resulted in increased aquifer storage by an average of 2,800 and 3,300 acre-feet per year in the Jurisdiction and Planning areas, respectively. Note that the Cosumnes River in-lieu areas and the Galt WWTP recycled water use area are outside the Jurisdiction Area and a majority of the Cosumnes River in-lieu area is outside the Planning Area. Compared to the baseline, the subsurface boundary flow decreased in this scenario due to the higher water elevations.

Based on these results, the following can be concluded regarding the conjunctive use scenario:

- Water elevation increased throughout the basin due to the conjunctive use in both aquifers by 5 to 30 feet.
- Groundwater storage increases by an average of 2,800 and 3,300 acre-feet per year in the Jurisdiction and Planning areas, respectively.
- Neighboring areas and jurisdictions would benefit as a result of this scenario's implementation by 3,900 and 5,200 acre-feet per year.

Table 5-2. Water Budget Summary for Scenario 1 – Conjunctive Use.

Average Annual Groundwater Budget for Jurisdiction Area (ac-ft/year)						
Model Run	Net Inflow				Outflow	Change in Storage
	Deep Percolation	Seepage From Rivers	Subsurface Boundary Flow	Direct Recharge	Pumping	
Existing Conditions Baseline	37,700	21,300	52,200	3,600	113,600	1,200
Scenario 1	37,800	21,300	48,300	3,600	107,000	4,000
Difference Scenario 1 - Baseline	100	0	-3,900	0	-6,600	2,800

*Note: The Cosumnes River direct recharge and in-lieu areas and the Galt WWTP recycled water use area are outside the Jurisdiction Area

Average Annual Groundwater Budget for Planning Area (ac-ft/year)						
Model Run	Net Inflow				Outflow	Change in Storage
	Deep Percolation	Seepage From Rivers	Subsurface Boundary Flow	Direct Recharge	Pumping	
Existing Conditions Baseline	48,800	58,100	36,300	3,600	145,000	1,900
Scenario 1	48,900	58,000	31,100	3,600	136,500	5,200
Difference Scenario 1 - Baseline	100	-100	-5,200	0	-8,500	3,300

*Note: The Cosumnes River direct recharge area and a majority of the Cosumnes River in-lieu area are outside the Planning Area

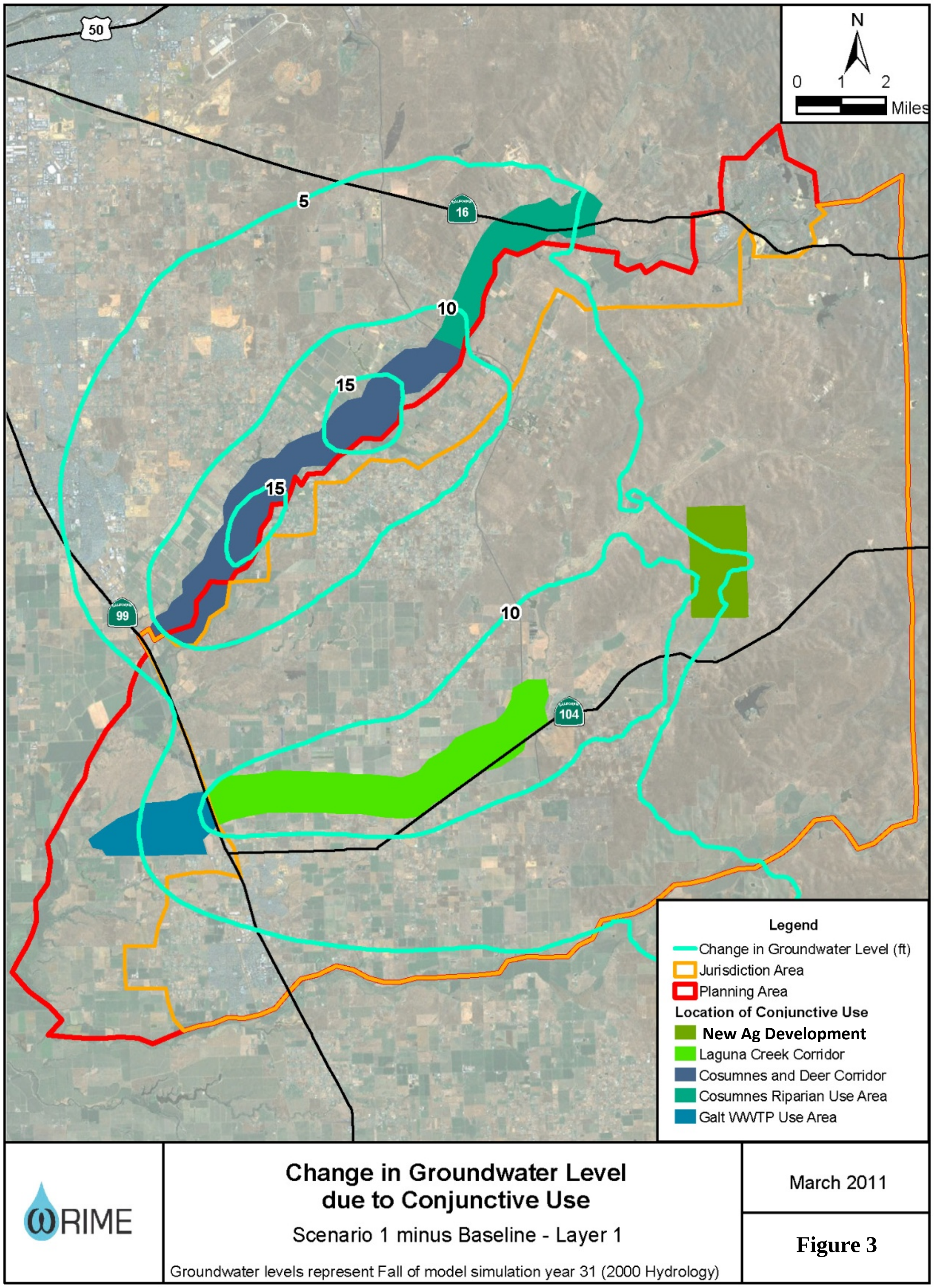


Figure 5-3. Change in groundwater level due to Conjunctive Use – Layer 1.

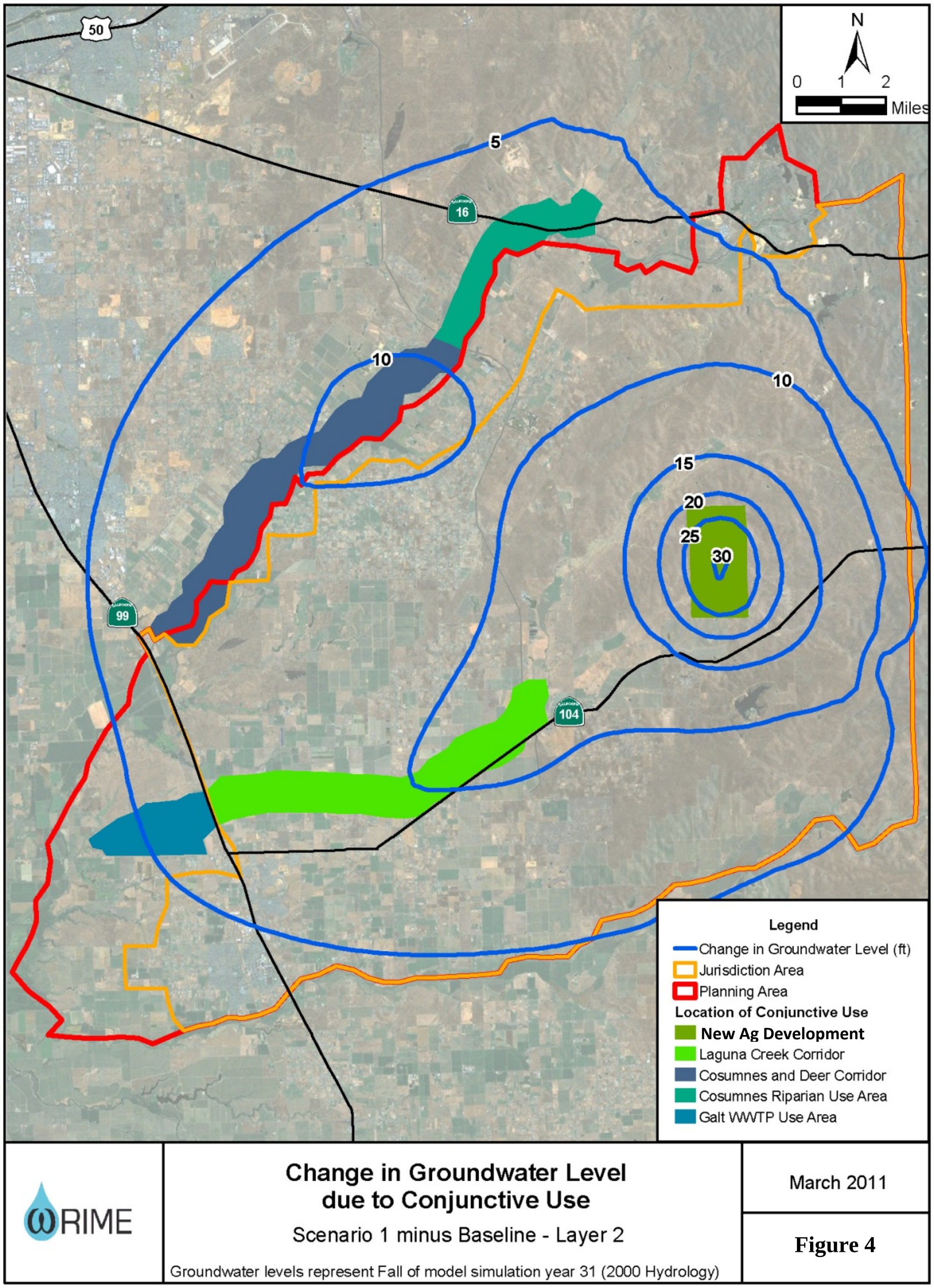


Figure 5-4. Change in groundwater level due to Conjunctive Use – Layer 2.

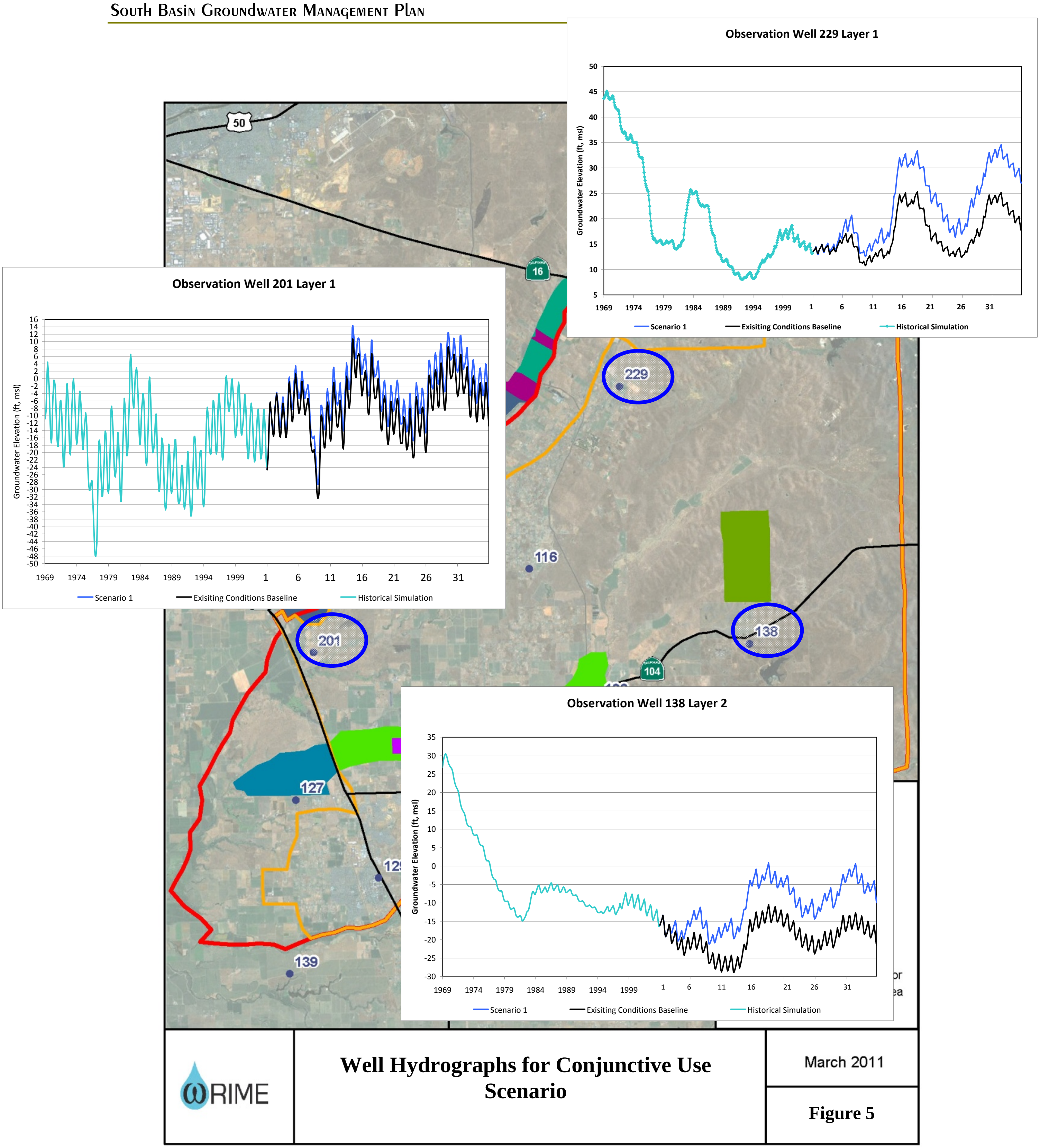


Figure 5-5. Well hydrographs for Conjunctive Use Scenario.

5.3 Direct Groundwater Recharge: Spread Surface Water Supplies onto Percolation Basins

A key objective of simulating the direct groundwater recharge scenario is to assess the impact of spreading available surface water supplies onto percolation basins to directly recharge groundwater.

5.3.1 Description of the Scenario

The direct groundwater recharge scenario presumes surface water spreading to percolation basins in GID at 8,500 acre-feet/year and OHWD at 10,500 acre-feet/year. The presumed basins are close to the main surface water conveyance channels in the basin.

The scenario employs the following assumptions:

- Potential source of water supply is Water Forum/SMUD water during above average and wet years; no water will be available during below normal years.
- Potential locations for percolation basins.
- Conveyance – Folsom South Canal, Hadselville Creek, Laguna Creek, Laguna Creek, Deer Creek, and Cosumnes River.

5.3.2 Results

Figures 5-6 and 5-7 present the change in groundwater elevation between the baseline and the direct recharge scenario for fall of model simulation year 31 (2000 hydrology) in the two layers included in the model. Note that the change in groundwater elevation was calculated as the difference between water elevations resulting from the direct recharge scenario minus the baseline water elevation.

The water elevation increased by 10 to 30 feet throughout the basin in both model layers due to the direct recharge, depending on the proximity to the direct recharge locations. The figures also show that higher water elevations in Layer 1 of the model—the shallow aquifer—uniformly concentrated around the recharge areas with higher elevations nearest the spreading basins (30 feet). In Layer 2, the water elevations rose by about 15 feet near the recharge basins and about 5 to 10 feet elsewhere in the basin. This observation demonstrates that the water percolating from direct recharge spreading basins will have a greater impact in the shallow aquifer more than in the deeper aquifer.

These higher water elevation observations were verified by comparing well hydrographs resulting from the direct recharge scenario and baseline in several wells in the area, as seen in **Figure 5-8**.

Table 5-3 summarizes the water budget for the direct groundwater recharge scenario. Groundwater pumping in this scenario was the same as baseline in both Jurisdiction and Planning areas. The project surface water spread onto percolation basins in GID (8,500 acre-feet per year) and in OHWD (10,500 acre-feet per year) resulted in increased aquifer storage by an average of 3,300 and 3,900 acre-feet per year in the Jurisdiction and Planning areas, respectively. Note that the OHWD direct recharge areas are outside the Jurisdiction Area and the Planning Area. The subsurface boundary flow decreased in this scenario compared to the baseline and conjunctive use scenario due to the higher water elevations.

The following conclusions derive from the direct recharge scenario:

- Water elevation increased throughout the basin due to the direct recharge in both aquifers by 10 to 30 feet.
- Groundwater storage increases by an average of 3,300 and 3,900 acre-feet per year in the Jurisdiction and Planning areas, respectively.
- Neighboring areas would benefit by 5,100 and 4,300 acre-feet per year under this scenario.

Table 5-3. Water Budget Summary for Scenario 2 – Direct Recharge.

Average Annual Groundwater Budget for Jurisdiction Area (ac-ft/year)						
	Net Inflow				**Outflow**	Change in Storage
Model Run	Deep Percolation	Seepage From Rivers	Subsurface Boundary Flow	Direct Recharge	Pumping	
Existing Conditions Baseline	37,700	21,300	52,200	3,600	113,600	1,200
Scenario 2	37,800	21,300	47,100	11,900	113,600	4,500
Difference Scenario 2 - Baseline	100	0	-5,100	8,300	0	3,300

*Note: The Cosumnes River direct recharge and in-lieu areas and the Galt WWTP recycled water use area are outside the Jurisdiction Area

Average Annual Groundwater Budget for Planning Area (ac-ft/year)						
	Net Inflow				**Outflow**	Change in Storage
Model Run	Deep Percolation	Seepage From Rivers	Subsurface Boundary Flow	Direct Recharge	Pumping	
Existing Conditions Baseline	48,800	58,100	36,300	3,600	145,000	1,900
Scenario 2	48,900	58,000	32,000	11,900	145,000	5,800
Difference Scenario 2 - Baseline	100	-100	-4,300	8,300	0	3,900

*Note: The Cosumnes River direct recharge area and a majority of the Cosumnes River in-lieu area are outside the Planning Area

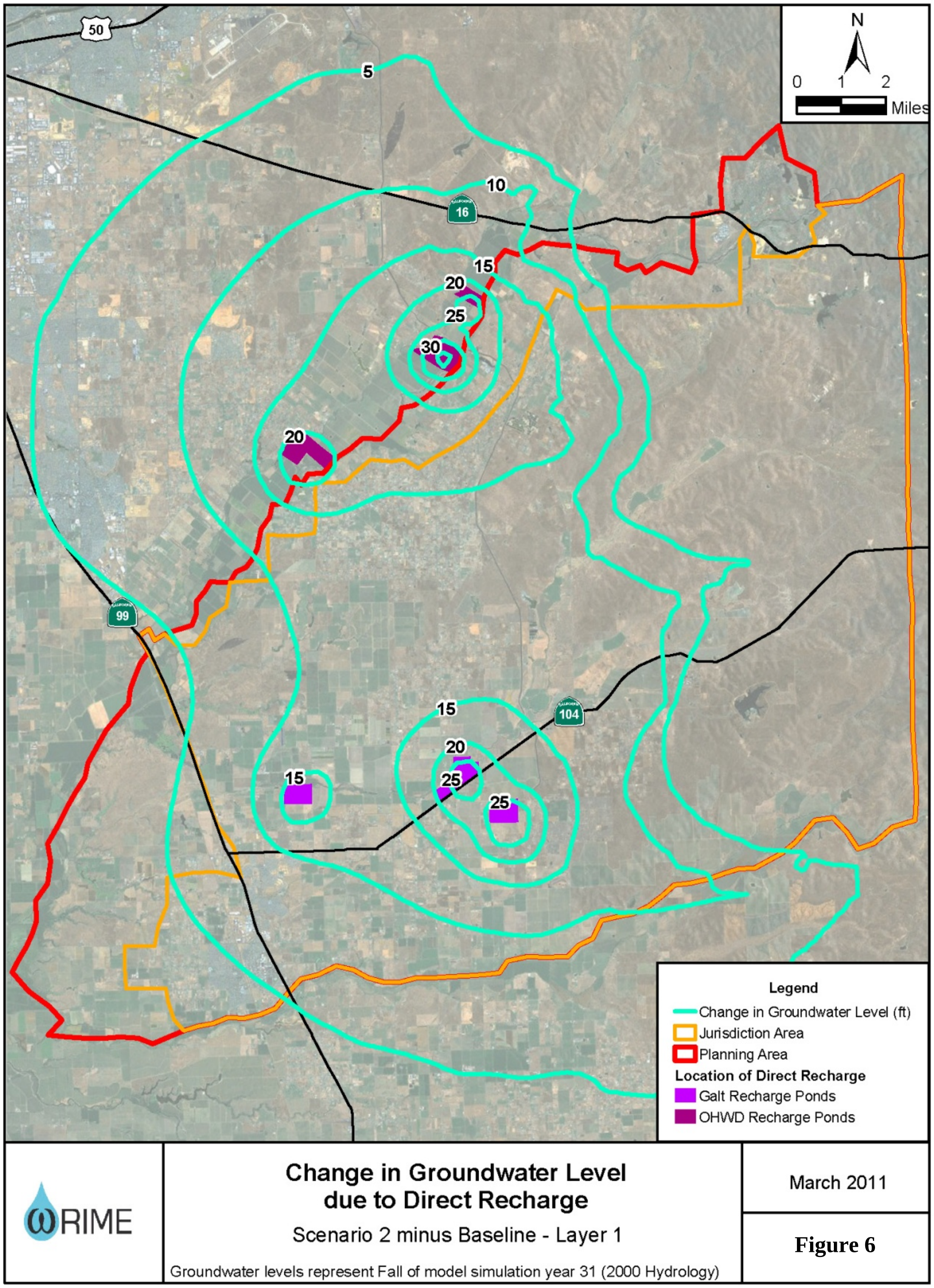


Figure 5-6. Change in groundwater level due to Direct Recharge – Layer 1.

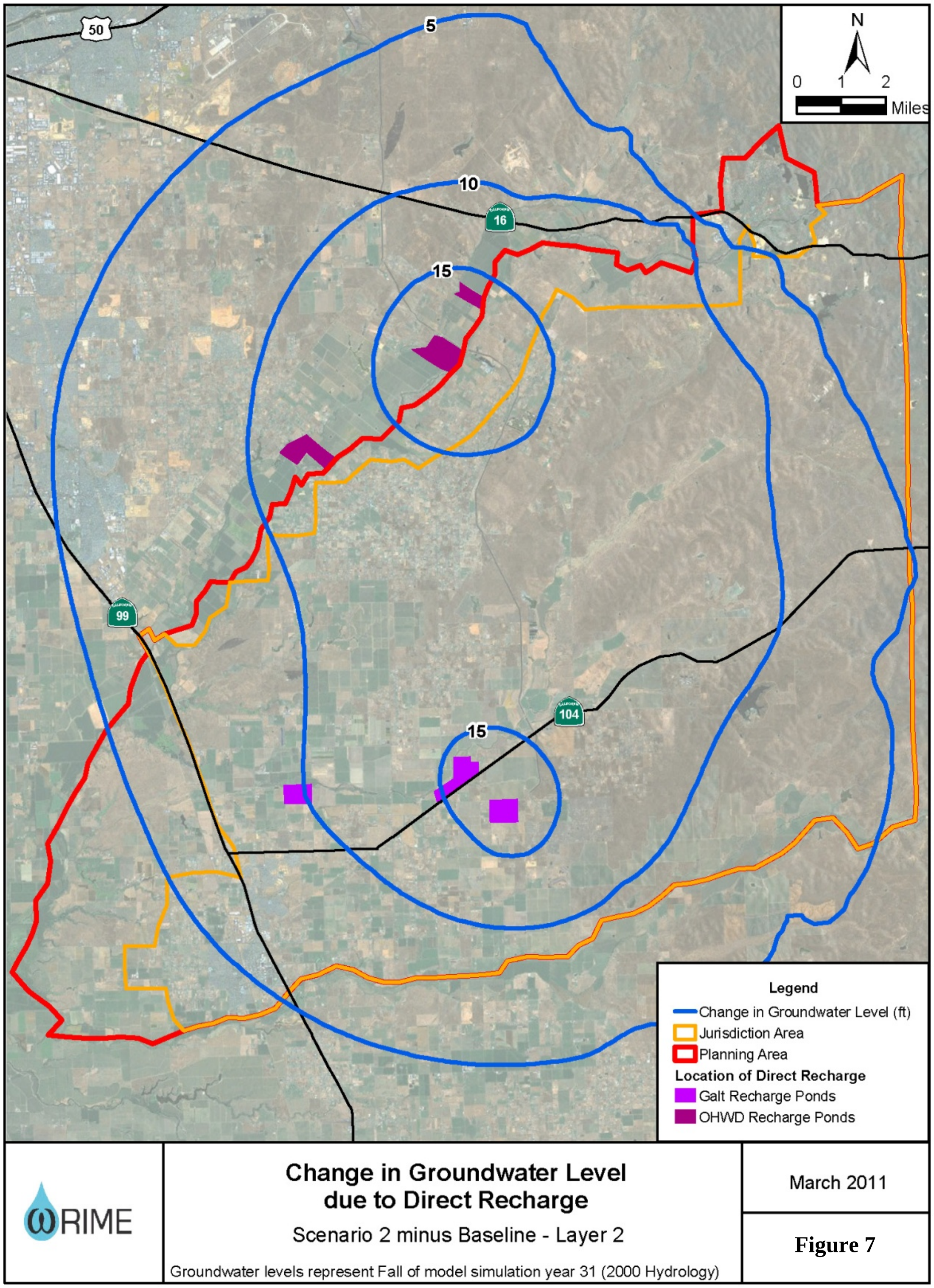


Figure 5-7. Change in groundwater level due to Direct Recharge – Layer 2.

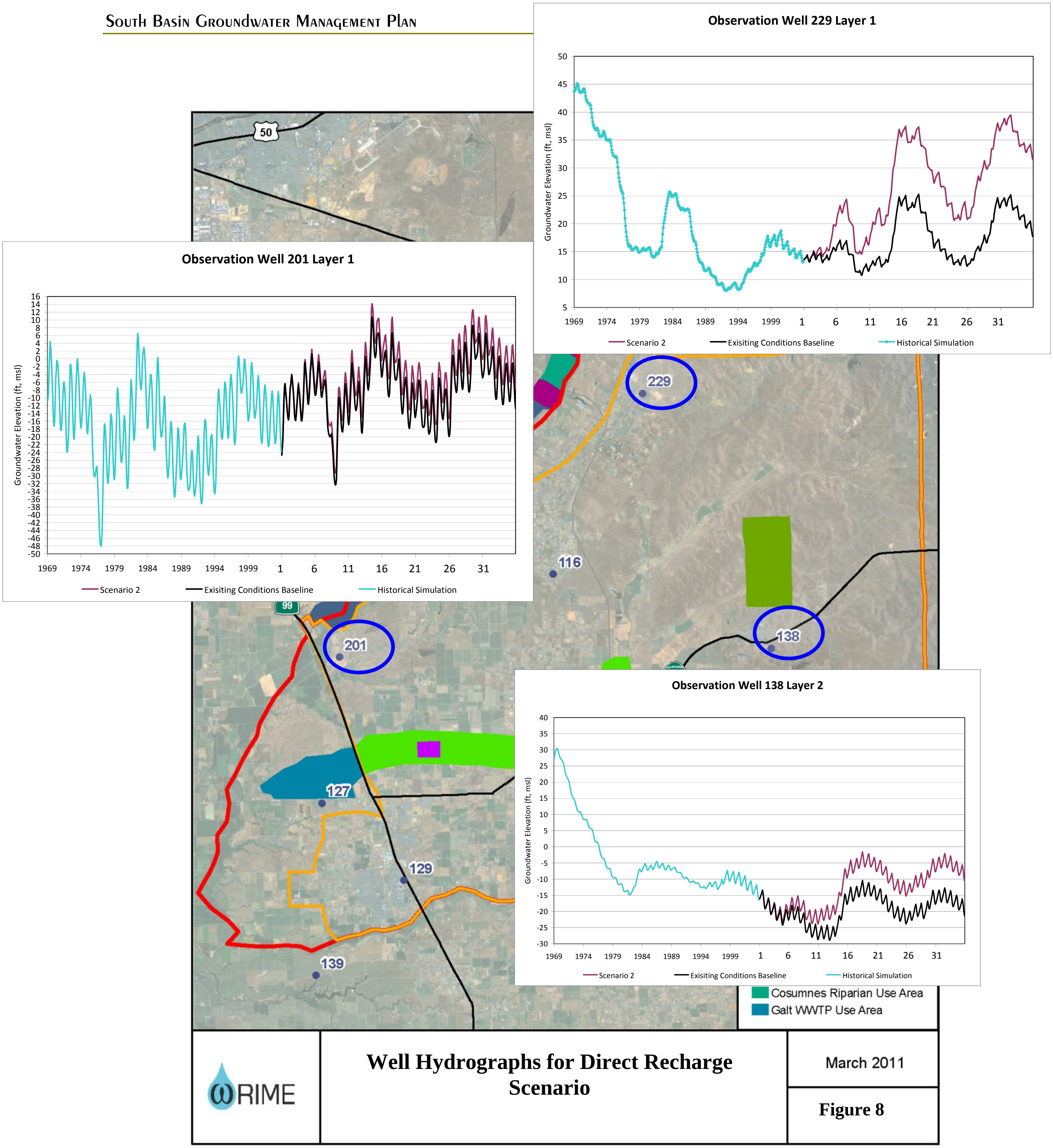


Figure 5-8. Well hydrographs for Direct Recharge Scenario.

5.4 Combination of in lieu Recharge and Direct Recharge: Utilize Available Surface Water Supplies in lieu of Pumping Groundwater and to Directly Recharge Groundwater

The objective of simulating the combination of in-lieu and direct recharge scenario is to assess the impact of combining utilization of available surface water supplies in lieu of groundwater pumping and spreading available surface water supplies onto percolation basins to directly recharge groundwater.

5.4.1 Description of the Scenario

This scenario utilizes the available surface water for a combination of in lieu recharge and direct recharge projects. The available surface water is used for in lieu recharge projects and any remaining surface water is recharged at the Galt recharge ponds first. The reason for such priority in water distribution is that the Galt recharge ponds are the only ones within the Planning and Jurisdiction boundaries, and they are close to the cone of depression in the basin. A reduced recharge rate is used for direct recharge at GID ponds.

- Potential sources of water supplies:
  - Water Forum/SMUD water during above normal and wet years; no water will be available during below normal years
  - Galt WWTP Discharge
  - Riparian water rights
- Potential surface water users: GID and OHWD
  - GID: In lieu Irrigation demand – within about ¼ mile of creeks
  - OHWD: In lieu Irrigation demand – within about ¼ mile of river
- Conveyance – Folsom South Canal, Hadselville creek, Laguna Creek, Deer Creek, and Cosumnes River

5.4.2 Results

Figures 5-9 and 5-10 present the change in groundwater elevation between the baseline and this scenario for fall of model simulation year 31 (2000 hydrology) in the two layers included in the model. Note that the change in groundwater elevation is calculated as the difference between water elevations resulting from the direct recharge scenario minus the baseline water elevation.

The water elevation increased by 15 to 30 feet throughout the basin in both model layers due to the combination of conjunctive use and direct recharge, depending on the proximity to the direct recharge locations. The figures also show that higher water elevations in Layer 1 of the model—the shallow aquifer—uniformly concentrated around the in lieu recharge areas with even higher elevations directly near the percolation basins (30 feet). In Layer 2, the water elevations increased by about 20 feet near the percolation basins, 30 feet near the conjunctive use locations east of GID, and about 5 to 10 feet elsewhere in the basin.

These higher water elevation observations were verified by comparing well hydrographs resulting from the direct recharge scenario and baseline in several wells in the area, as seen in **Figure 5-11**.

Table 5-4 summarizes the water budget for this scenario. Groundwater pumping in this scenario is reduced in both Jurisdiction and Planning areas by an average of 6,600 and 8,500 acre-feet annually when compared to the baseline. A portion of surface water was spread onto percolation basins at GID at 6,500 acre-feet per year with no water left to be spread onto the recharge ponds in OHWD, which resulted in increased aquifer storage by an average of 4,200 acre-feet per year in the Jurisdiction Area and 4,900 acre-feet per year in the Planning Area. Note that the OHWD direct recharge areas are outside both the Jurisdiction Area and the Planning Area. The subsurface boundary flow decreased in this scenario compared to the baseline and both the conjunctive use scenario and the direct groundwater recharge scenario due to the higher water elevations.

Based on these results, the following can be concluded regarding the combination of in lieu recharge and direct recharge scenario:

- Water elevation increased throughout the basin because of direct recharge in both aquifers by 15 to 30 feet.
- Groundwater storage increases by an average of 4,200 and 4,900 acre-feet per year in the Jurisdiction and Planning areas, respectively.
- This combination of conjunctive use and direct recharge has the significant impact on the aquifer regarding both groundwater storage and the spatial distribution of the rise in water elevations.
- Neighboring areas would respectively benefit by 9,100 and 10,100 acre-feet per year with this scenario.

Table 5-4. Water Budget Summary for Scenario 3 – Combination of Conjunctive Use and Direct Recharge.

Average Annual Groundwater Budget for Jurisdiction Area (ac-ft/year)						
	Net Inflow				**Outflow**	
Model Run	Deep Percolation	Seepage From Rivers	Subsurface Boundary Flow	Direct Recharge	Pumping	Change in Storage
Existing Conditions Baseline	37,700	21,300	52,200	3,600	113,600	1,200
Scenario 3	37,900	21,300	43,100	10,100	107,000	5,400
Difference Scenario 3 - Baseline	200	0	-9,100	6,500	-6,600	4,200

*Note: The Cosumnes River direct recharge and in-lieu areas and the Galt WWTP recycled water use area are outside the Jurisdiction Area

Average Annual Groundwater Budget for Planning Area (ac-ft/year)						
	Net Inflow				**Outflow**	
Model Run	Deep Percolation	Seepage From Rivers	Subsurface Boundary Flow	Direct Recharge	Pumping	Change in Storage
Existing Conditions Baseline	48,800	58,100	36,300	3,600	145,000	1,800
Scenario 3	49,000	57,900	26,200	10,100	136,500	6,700
Difference Scenario 3 - Baseline	200	-200	-10,100	6,500	-8,500	4,900

*Note: The Cosumnes River direct recharge area and a majority of the Cosumnes River in-lieu area are outside the Planning Area

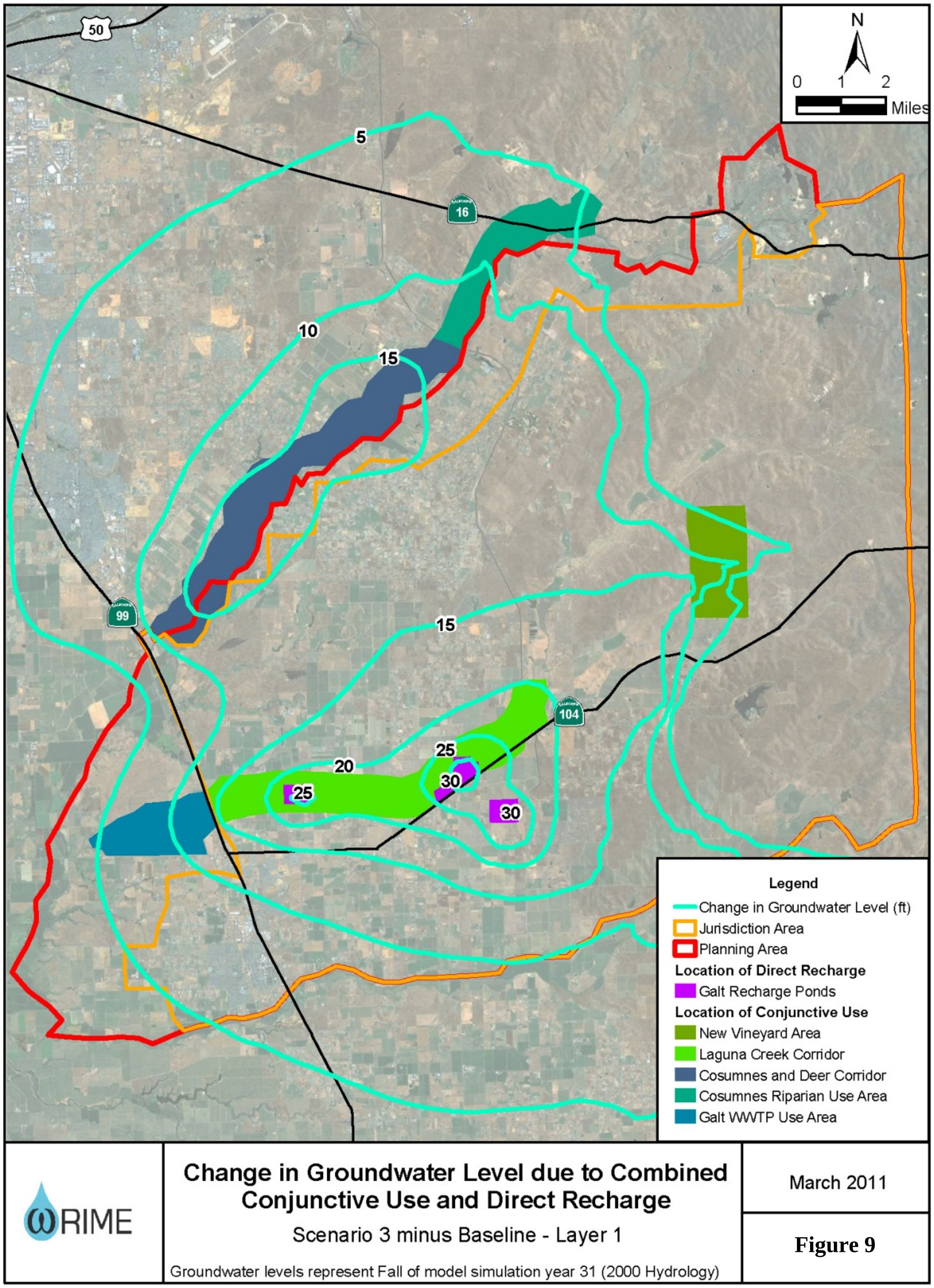


Figure 5-9. Change in groundwater level due to Combined Conjunctive Use and Direct Recharge – Layer 1.

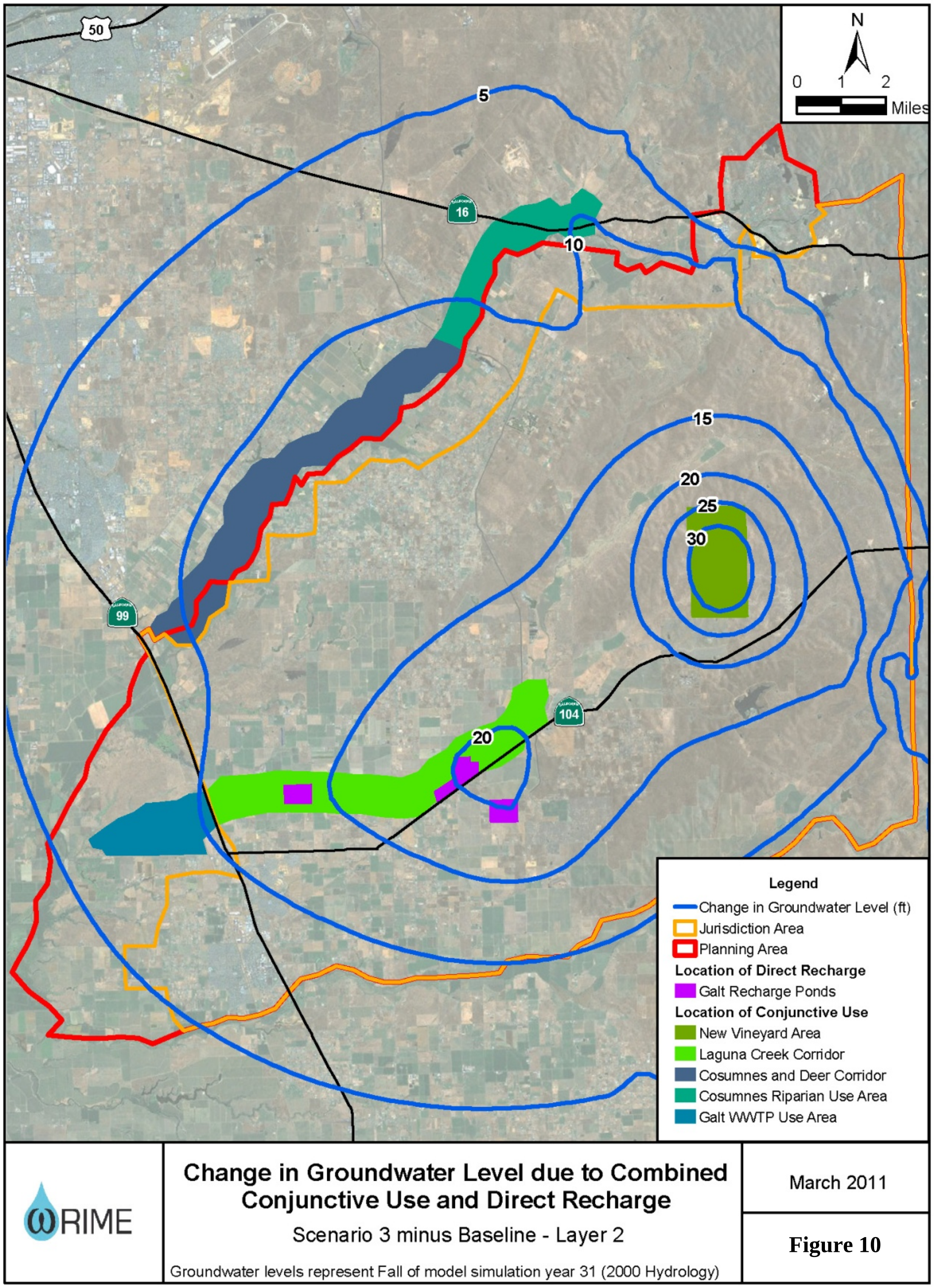


Figure 5-10. Change in groundwater level due to Combined Conjunctive Use and Direct Recharge – Layer 2.

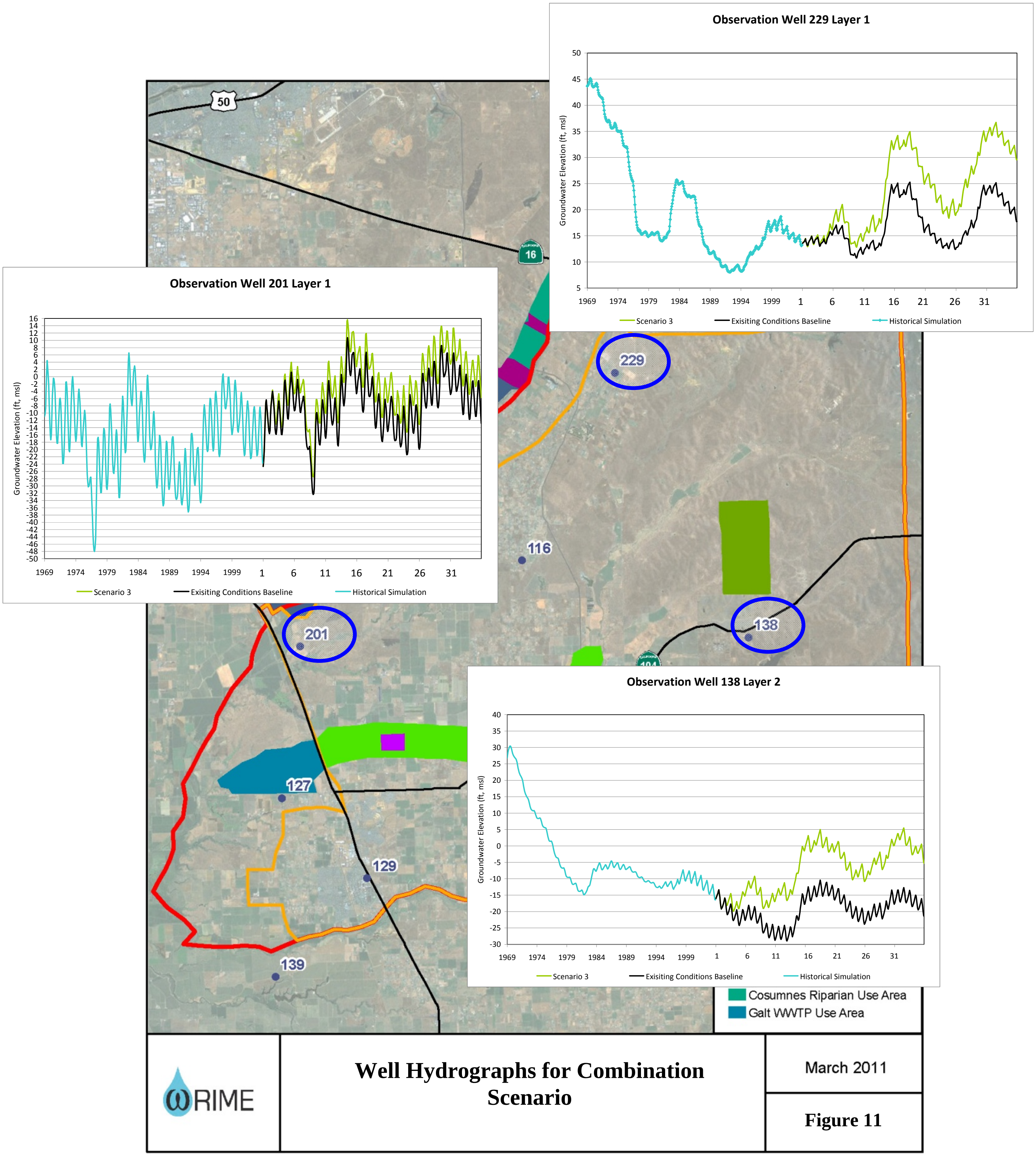
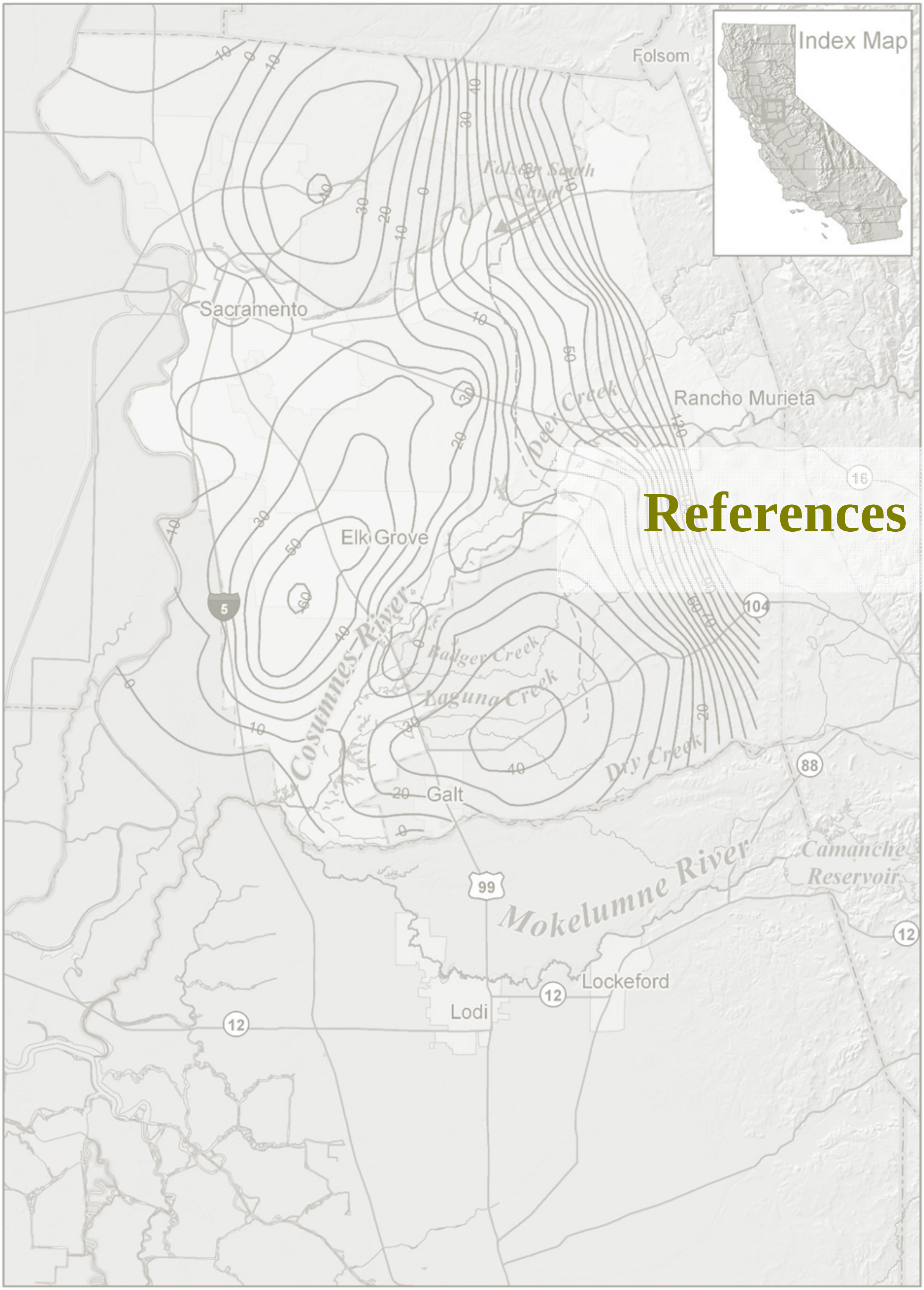


Figure 5-11. Well hydrographs for Combination Scenario.

5.5 Conclusion

- The results of the three scenarios showed higher groundwater elevations and increased average annual groundwater storage when compared to the baseline scenario.
- The combination of conjunctive use and direct recharge has the significant impact on the aquifer regarding both groundwater storage and the spatial distribution of the rise in water elevations when compared to the other management scenarios.
- The baseline conditions show somewhat stable, if not slightly increasing, water levels.
- Each of the alternatives would benefit neighboring areas almost equally as it benefits the targeted Planning and Jurisdictional areas by reducing the long-term subsurface boundary flow.

References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Badger Creek
Laguna Creek
Dry Creek
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Appendix A

DWR Methodology to Determine Applied Water and Return Flow in Sacramento County

Department of Water Resources Methodology to Determine Applied Water and Return Flow in Sacramento County

The California Department of Water Resources (DWR) has collected vital information related to the water used in various human activities. It covers urban, agricultural, and managed wetlands water use, known collectively as cultural water use. These data are critical to water resources planning studies, evaluation of water use efficiency measures and other water management options, and for estimating future water use in California. This Technical Memorandum (TM) describes the methods that DWR uses to estimate crop water use in Sacramento County.

The methods described in this report were used to determine the water use in the South Basin. These water use values were input into the SacIGSM model to develop an overall water budget and balance for the South Basin.

Agricultural Water Budget:

The basic water budget equation for any agricultural land is:

Inflow – Outflow = Change in storage

$$R + I - ET - DP - SR = \Delta WS \qquad (1)$$

where,

R = Rainfall

I = Irrigation water added to the area

ET = Evapotranspiration

DP = Deep percolation

SR = Surface runoff out of the field

Δ WS = Change in water stored in the root zone during a given time period

Figure 1 below provides the basic components of agricultural water budget.

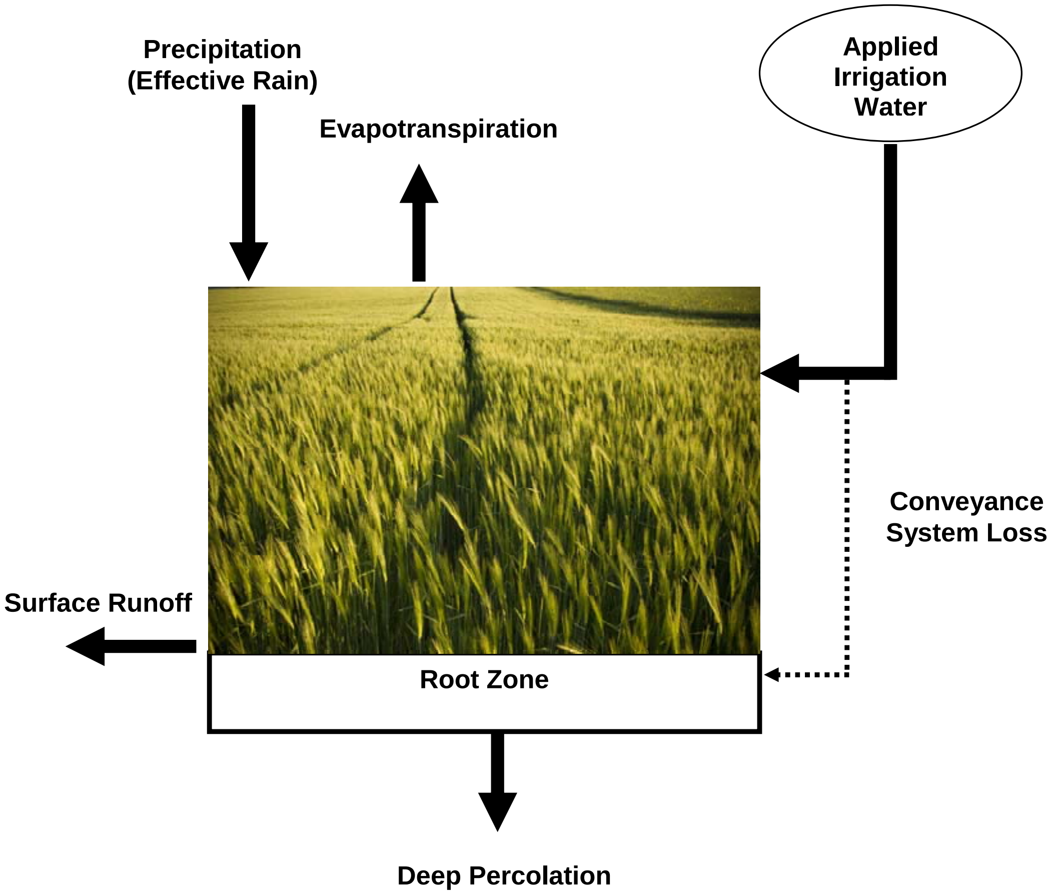


Figure 1. Basic components of agricultural water budget

Applied Water:

According to DWR Bulletin 160-98, applied water is the volume of water from any source needed to meet the demand of the user. For agricultural use, it is equal to the volume of water delivered to the field. The main components used to calculate the applied water are:

- Evapotranspiration
- Effective Rainfall
- Irrigation Efficiency

$$AW = (\mathrm{ET_c} - P_e) / IE \qquad (2)$$

where,

$\mathrm{ET_c}$ = Evapotranspiration

P_e = Effective Precipitation

IE = Irrigation Efficiency

Evapotranspiration (ET_c)

Evapotranspiration (ET_c) is the volume or depth of water that is transpired by a crop, evaporated from the adjacent soil surface or retained within the plant tissue. The amount of water required for a crop is directly related to the water lost through evapotranspiration. Energy from solar radiation is the primary factor that determines the rate of crop evapotranspiration. ET also depends on humidity, temperature, wind, stage of crop growth, and irrigation efficiency. In addition to ET_c, other crop water requirements can include water needed to leach soluble salts below the crop root zone, water that must be applied for frost protection or cooling, and water for seed germination.

As the direct measurement of crop ET_c requires costly investments in time and sophisticated equipment, DWR uses a more practical approach by using reference evapotranspiration (ET_o) along with crop coefficients to estimate the evapotranspiration of a specific crop (ET_c).

Evapotranspiration rates (ET_c) vary from crop to crop and with the crop growth stage. Reference evapotranspiration (ET_o) provides a constant reference point. It is the evapotranspiration rate of a reference crop at a particular growth stage. For California, grass is used as the reference and ET_o is defined as:

> *The rate of evapotranspiration from an extended surface of 8-15 cm tall green grass of uniform height, actively growing, completely shading the ground and not short of water' (FAO 2002).*

Evapotranspiration for a particular crop is calculated by multiplying ET_o by a crop coefficient or K_c value. K_c values are crop specific and vary from day to day as a function of the crop growth stage or crop development.

$$\mathbf{ET_c = ET_o * K_c}$$

where,

ET_o = Reference Evapotranspiration

ET_c = Evapotranspiration

K_c = Crop Factor

The ET_o, a measure of evaporative demand, is calculated using solar radiation, relative humidity, wind speed, and air temperature data collected by automated weather stations which are part of California Irrigation Management Information System (CIMIS) network. CIMIS uses the Modified Penman, also known as the CIMIS Penman, equation to estimate ET_o. DWR also uses Hargreaves Samani equation, which uses maximum and minimum air temperature for areas without CIMIS stations.

Crop coefficients generally vary by crop, planting and harvest dates, and growing season duration. DWR derives crop coefficients based on pan evaporation studies. Hence, crop coefficients are applied to reference evapotranspiration to estimate evapotranspiration rates for specific crops.

Effective Precipitation (P_E)

Part of a crop's water requirements is met by precipitation. The amount of rainfall beneficially used for crop production is called effective precipitation. Effective precipitation (P_e) is the precipitation stored in the root zone both before and during the growing season that is subsequently used consumptively by the crop. It excludes precipitation that is 'lost' either through surface runoff or deep percolation. Effective rainfall is stored in the soil and is available to satisfy crop ET.

Evapotranspiration of Applied Water (ETAW)

The evapotranspiration of applied water (ETAW) is the volume of irrigation water that is consumptively used by the crop. The rest of the applied water contributes to runoff or deep percolation.

Therefore,

$$ETAW = \mathbf{ET_c} - P_e \qquad (3)$$

where,

ETAW = Evapotranspiration of applied water

P_e = Effective precipitation

Irrigation Efficiency (IE):

Irrigation efficiency is often used to quantify irrigation performance and as such has been open to many definitions. Typically it is defined as the percentage of applied water that is used beneficially for crop production. Beneficial uses include consumptive use, leaching, frost protection, and soil preparation. Irrigation efficiency (IE) is defined as follows (Burt et al. 1997):

$$IE = \frac{Volume\ of\ \ Irrigation\ Water\ \ Beneficially\ used}{Volume\ of\ \ Irrigation\ Water\ \ Applied} * 100\% \qquad \textbf{(4)}$$

Hence,

$$Applied\ Water = \frac{Evapotranspiration\ of\ \ Applied\ Water\ (ETAW)}{Irrigation\ Efficiency\ (IE)} \qquad \textbf{(5.a)}$$

Or

$$Applied\ Water = \frac{\left(Evapotranspiration\ (ET_c) - Effective\ \Pr ecipitation\ (Pe)\right)}{Irrigation\ Efficiency\ (IE)} \qquad \textbf{(5.b)}$$

Crop Water Use

The total irrigated agriculture demand in Sacramento County is obtained by multiplying the applied water with Irrigated Crop acreage. DWR has performed land use surveys periodically since the 1950s to quantify acreage of irrigated land and corresponding crop types. The base data for land use surveys is obtained from aerial photography or satellite imagery, which is superimposed on a cartographic base. Site visits are used to identify or verify crop types growing in the fields.

In the years between land use surveys, DWR estimates crop types and acreage using data collected from county agricultural commissioners, local water agencies, University of California Cooperative Extension Programs, and the California Department of Food and Agriculture.

Hence,

Irrigated agriculture demand = Applied Water * Area

Table 1 provides the average applied water for all crops grown in Sacramento County collected in the period from 1998 to 2002.

The data presented in Table 1 clearly shows that most of the applied water is consumed and depleted by agricultural crops. Depletion is the volume of water within a service area that is no longer available for reuse. Within the agricultural area in Sacramento County, depletion is mostly equivalent to the evapotranspiration of applied water (ETAW). About 56 percent to 80 percent of the applied water is depleted by the agricultural crops in the County. Figure 2 shows that the water that contributes to surface runoff and deep percolation is in the range of 20 percent to 44 percent of the total applied water.

Irrigated Agriculture Demand in South Sacramento County

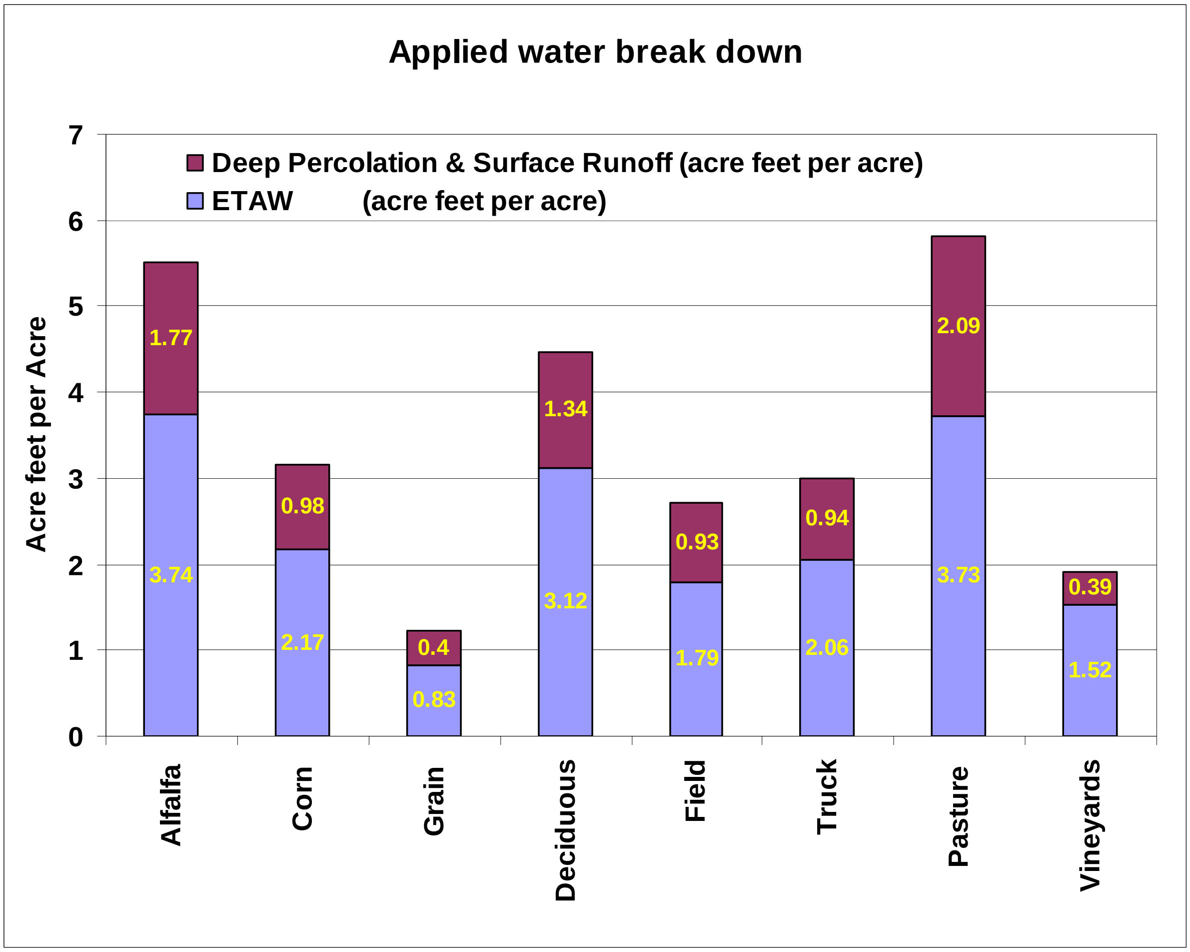
Water demand estimates for South Basin are based on updated DWR 2000 water use survey data for Sacramento County (table 1) and the Sacramento County Integrated Groundwater, and Surface Water Model (SacIGSM). The latest DWR land and water use survey data for Sacramento County, which was collected in the year 2000, was augmented with Sacramento County land use planning data from 2004 by WRIME, Inc. The updated crop water use data was used as input to the SacIGSM and the model was applied to obtain a more refined water use and water balance for the South Basin. Table 2 and 3 provides estimates of the total agricultural water use in the Planning the Jurisdiction areas of the South Basin, respectively.

Although DWR crop use data was used as input to the SacIGSM, the resulted model crop use for the South Basin showed differences from the initial DWR data especially for pasture crops. The reasons for these differences are:

1. Data is presented for different periods of record.
    a. DWR: 1998–2002.
    b. SacIGSM: 2000–2004.
2. DWR data represents an average crop water use for the entire county. SacIGSM utilizes a refined water use data specifically for the South Basin.

Table 1: Average Applied water for all crops grown in Sacramento County from 1998 to 2002, DWR.

Crop Type	Evapotranspiration (acre feet per acre)	Effective Rainfall (acre feet per acre)	ETAW (acre feet per acre)	Irrigation Efficiency	Applied Water (acre feet per acre)
Almond & Pistachio	3.35	0.45	2.90	0.68	4.26
Alfalfa	4.49	0.75	3.74	0.68	5.51
Corn	2.43	0.26	2.17	0.69	3.15
Cucumber	1.30	0.14	1.16	0.67	1.73
Dry Bean	1.95	0.15	1.79	0.67	2.68
Grain	1.57	0.74	0.83	0.67	1.23
Onion & Garlic	3.33	0.43	2.90	0.67	2.60
Other Deciduous	3.63	0.50	3.12	0.70	4.46
Other Field	1.97	0.18	1.79	0.66	2.72
Other Truck	2.87	0.82	2.06	0.69	3.00
Pasture	4.37	0.64	3.73	0.64	5.82
Potato	2.55	0.38	2.18	0.71	3.06
Tomatoes	2.58	0.31	2.28	0.69	3.30
Rice	3.32	0.24	3.08	0.56	5.50
Safflower	1.91	1.35	0.56	0.78	0.72
Sugar Beet	3.20	0.40	2.79	0.68	4.11
Subtropical	3.22	0.62	2.60	0.68	3.81
Vineyards	1.96	0.43	1.52	0.80	1.91



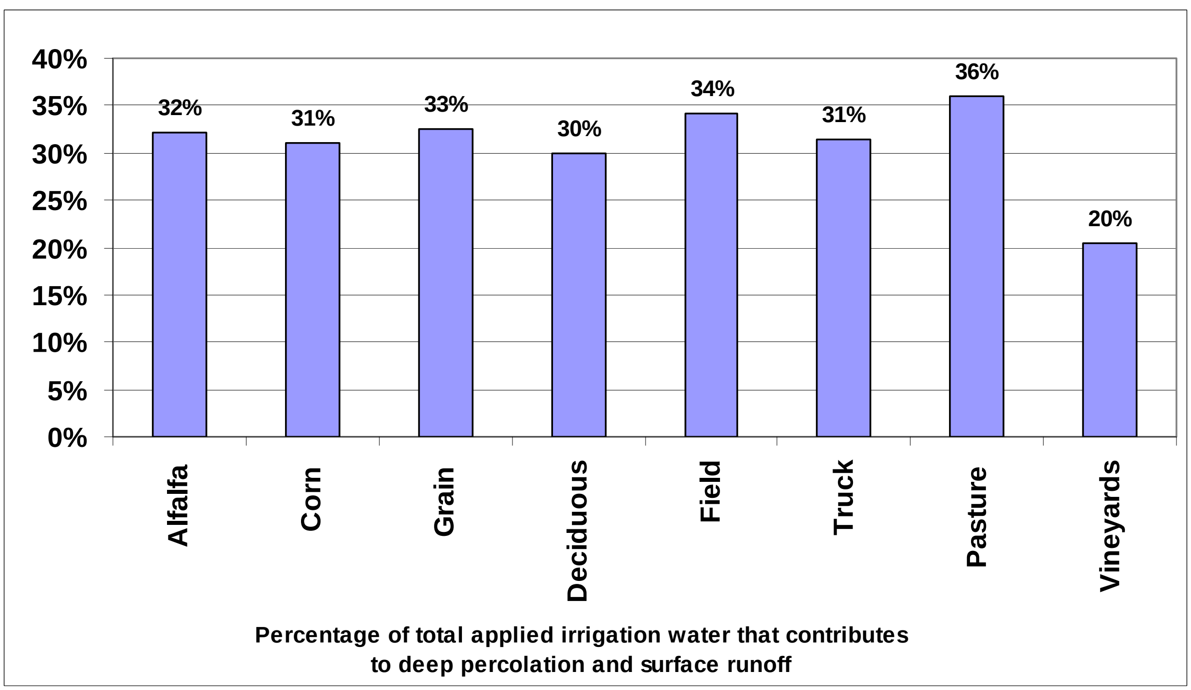


Figure 2. Applied water breakdown and percentage of total applied irrigation water that contributes to deep percolation and surface runoff, DWR Water Use Survey.

Table 2. Average Water Demand in the Jurisdiction Area.

Landuse and its sub-classifications	Area (acres)	Evapotranspiration (acre-feet/acre)	Effective Rainfall (acre-feet/acre)	Evapotrans-piration of Applied Water (acre-feet/acre)	Irrigation Efficiency	Applied Water (acre-feet/acre)	Total Applied Water (acre-feet)
Citrus & Subtropical	**175**						**664**
Olives	22	3.2	0.62	2.58	68%	3.79	83
Eucalyptus	153	3.2	0.62	2.58	68%	3.79	581
Deciduous Fruits	**806**						**3,341**
Appricots	-	3.6	0.5	3.1	69%	4.49	-
Pears	31	3.6	0.5	3.1	69%	4.49	139
Miscellaneous	-	3.6	0.5	3.1	69%	4.49	-
Almonds	14	3.35	0.5	2.85	69%	4.13	58
Walnuts	758	3.35	0.5	2.85	69%	4.13	3,131
Pistachios	-	3.35	0.5	2.85	69%	4.13	-
Unspecified	3	3.6	0.5	3.1	69%	4.49	13
Field Crops	**7,926**						**22,423**
Safflower	-	1.91	1.35	0.56	69%	0.81	-
Sugar beets	171	3.2	0.4	2.8	69%	4.06	694
Corn (field & sweet)	3,087	2.43	0.25	2.18	69%	3.16	9,753
Sudan	3,901	1.97	0.2	1.77	69%	2.57	10,007
Beans (dry)	32	1.95	0.15	1.8	69%	2.61	83
Rice	-	3.32	0.25	3.07	69%	4.45	-
Miscellaneous	-	1.97	0.2	1.77	69%	2.57	-
Unspecified	735	1.97	0.2	1.77	69%	2.57	1,885
Grain & Hay Crops	**1,273**						**1,653**
Unspecified	1,273	1.6	0.73	0.87	67%	1.30	1,653
Pasture	**10,020**						**47,425**
Alfaalfa	669	3.5	0.74	2.76	68%	4.06	2,715
Clover	869	3.7	0.64	3.06	64%	4.78	4,155
Mixed Pasture	7,383	3.7	0.64	3.06	64%	4.78	35,300
Native Pasture	514	3.7	0.64	3.06	64%	4.78	2,458
Turf Farms	-	3.7	0.64	3.06	64%	4.78	-
Unspecified	585	3.7	0.64	3.06	64%	4.78	2,797
Truck, Nursery and Berry (	**489**						**2,005**
Asparagus	-	2.87	0.82	2.05	50%	4.1	-
Beans (green)	-	2.87	0.82	2.05	50%	4.10	-
Melons, squash, and cucumbers	321	2.87	0.82	2.05	50%	4.10	1,316
Onions and Garlic	-	3.33	0.43	2.9	50%	5.80	-
Tomatoes	-	2.58	0.31	2.27	50%	4.54	-
Flowers	54	2.87	0.82	2.05	50%	4.10	221
Mixed	-	2.87	0.82	2.05	50%	4.10	-
Strawberries	7	2.87	0.82	2.05	50%	4.10	29
Peppers	90	2.87	0.82	2.05	50%	4.10	369
Unspecified	17	2.87	0.82	2.05	50%	4.10	70
Vineyards	**10,764**	2.3	0.5	1.8	80%	2.25	**24,219**
Total Area:	**31,453**					**Total Applied Water (Demand):**	**101,730**

Table 3. Average Water Demand in the Planning Area.

Landuse and its sub-classifications	Area (acres)	Evapotranspiration (acre-feet/acre)	Effective Rainfall (acre-feet/acre)	Evapotrans-piration of Applied Water (acre-feet/acre)	Irrigation Efficiency	Applied Water (acre-feet/acre)	Total Applied Water (acre-feet)
Citrus & Subtropical	**181**						**687**
Olives	22	3.2	0.62	2.58	68%	3.79	83
Eucalyptus	159	3.2	0.62	2.58	68%	3.79	603
Deciduous Fruits	**877**						**3,638**
Appricots	2	3.6	0.5	3.1	69%	4.49	9
Pears	28	3.6	0.5	3.1	69%	4.49	126
Miscellaneous	9	3.6	0.5	3.1	69%	4.49	40
Almonds	24	3.35	0.5	2.85	69%	4.13	99
Walnuts	806	3.35	0.5	2.85	69%	4.13	3,329
Pistachios	5	3.35	0.5	2.85	69%	4.13	21
Unspecified	3	3.6	0.5	3.1	69%	4.49	13
Field Crops	**10,332**						**29,534**
Safflower	168	1.91	1.35	0.56	69%	0.81	136
Sugar beets	130	3.2	0.4	2.8	69%	4.06	528
Corn (field & sweet)	5,212	2.43	0.26	2.17	69%	3.14	16,391
Sudan	3,815	1.97	0.2	1.77	69%	2.57	9,786
Beans (dry)	82	1.95	0.15	1.8	69%	2.61	214
Rice	56	3.32	0.25	3.07	69%	4.45	249
Miscellaneous	6	1.97	0.2	1.77	69%	2.57	15
Unspecified	863	1.97	0.2	1.77	69%	2.57	2,214
Grain & Hay Crops	**2,232**						**2,898**
Unspecified	2,232	1.6	0.73	0.87	67%	1.30	2,898
Pasture	**13,418**						**63,225**
Alfaalfa	1,262	3.5	0.75	2.75	68%	4.04	5,104
Clover	1,174	3.7	0.64	3.06	64%	4.78	5,613
Mixed Pasture	9,687	3.7	0.64	3.06	64%	4.78	46,316
Native Pasture	561	3.7	0.64	3.06	64%	4.78	2,682
Turf Farms	155	3.7	0.64	3.06	64%	4.78	741
Unspecified	579	3.7	0.64	3.06	64%	4.78	2,768
Truck, Nursery and Berry C	**908**						**3,860**
Asparagus		2.87	0.82	2.05	50%	4.1	4
Beans (green)	6	2.87	0.82	2.05	50%	4.10	25
Melons, squash, and cucumbers	409	2.87	0.82	2.05	50%	4.10	1,677
Onions and Garlic	19	3.33	0.43	2.9	50%	5.80	110
Tomatoes	229	2.58	0.31	2.27	50%	4.54	1,040
Flowers	95	2.87	0.82	2.05	50%	4.10	390
Mixed	9	2.87	0.82	2.05	50%	4.10	37
Strawberries	7	2.87	0.82	2.05	50%	4.10	29
Peppers	113	2.87	0.82	2.05	50%	4.10	463
Unspecified	21	2.87	0.82	2.05	50%	4.10	86
Vineyards	**12,688**	2.3	0.52	1.78	80%	2.23	**28,231**
Total Area:	**40,636**					**Total Applied Water (Demand):**	**132,072**

Literature Review of Studies on contribution of Agricultural Applied Water to Groundwater Recharge:

RBI reviewed several studies that were conducted to evaluate the contribution of the agricultural applied water to groundwater recharge (i.e., deep percolation due to irrigation water from fields). Table 4 summarizes those studies and their findings.

Table 4. Literature review summary.

Title	Organization/ Author	Summary of Findings
Estimates Of Deep Percolation Beneath Native Vegetation, Irrigated Fields, and the Amargosa - River Channel, Amargosa Desert, Nye County, Nevada	U.S. Geological Survey (USGS) **Stonestrom, D.A., et al.**	• Environmental tracers analysis to understand flow patterns and estimate recharge components • Irrigation system: Center pivot • Crops: alfalfa, barley, and vegetables. • Estimated fraction of water becoming deep percolation averaged 8 to 16 percent.
Irrigation Technologies	U. S. Department of Agriculture (USDA) **Evans, R.G.**	• Estimates of deep percolation from applied water on sandy loam soils under different crops in different locations • Surface furrow w/land leveling: 10 - 40 percent • Sprinkler center pivot: 10 -30 percent • Drip: 2 – 20 percent
Improving California Water Management: **Optimizing Value and Flexibility**	University of California – Davis **Lund, J.R., et al.**	• Developing an economic-engineering optimization model of California's water supply system (CALVIN) • Estimates of irrigation water becoming deep percolation using DWR efficiencies, Central Valley groundwater surface water model (CVGSM) 1922-1993. • Estimated fraction of deep percolation came from applied water averaged 19 percent for Central Valley.

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Appendix B

SacIGSM Model Refinement Executive Summary

SACIGSM Model Refinement

Executive Summary

The Sacramento County Integrated Groundwater and Surface water Model (SACIGSM) was developed in the early 1990s to meet the need for an analytical tool to

- Evaluate and quantify the basin yield,
- Evaluate the impacts of the changes in land and water use in the county, and
- Evaluate the impacts of various county-wide and localized projects on the groundwater and surface water resources in the basin.

SACIGSM has widely been used over the past 15 years by the local and state agencies. The model has been maintained by various agencies responsible for the water resources planning and management in the Sacramento County area, and is a living model of the regional water resources conditions in the basin. The broad acceptance of the model across the community as the best available regional model for the area has allowed for the utilization of the model in numerous projects across the county. Refinements and updates are made to the model to meet the needs of each project, improving the model for future work. Major projects include the Water Forum Agreement, American River Basin Cooperative Agencies studies, Zone 40 Water Supply Master Plan, assessment of impacts from development projects, assessment of project impacts to private wells, environmental impact studies, river restoration projects, and Cosumnes River flow enhancement analyses.

The model has been used by government, non-profits, and private parties and underwent a major refinement in 2007. As part of this update and refinement, the database for the north sub-basin was updated and refined, model was recalibrated, and baseline conditions were developed. This work was performed for the Regional Water Authority (RWA) and Sacramento Groundwater Authority (SGA) with partial funding available from the California Department of Water Resources (DWR).

In 2006-07 time periods, DWR also funded the update and refinement of the model datasets in the Central and South Sub-basins. This work was completed for DWR and the South Sacramento Area Agricultural Water Authority (The Authority). In 2008, the Nature Conservancy (TNC) funded the re-calibration of the model to ensure that a completely over-hauled, updated, and refined model is available to the SACIGSM user community for planning and management of the water management scenarios in the County.

This report presents the calibration and sensitivity analysis of refined model, including calibration of water balance, regional and local groundwater levels, streamflows, and sensitivity analysis. This report was prepared in coordination with the Water Forum Successor Effort and the Authority's consultant, RBI.

The resulting calibrated model was used in development of Baseline conditions and is intended to be used for analysis of alternative water management scenarios by the stakeholders in the North, Central and South Sacramento groundwater basins.

Major Model Updates

The major model datasets that are updated are as follows:

1. Southern Model Boundary- Extended to the Mokelumne River
2. Eastern Model Boundary- Extend to include City of Folsom
3. Northern Boundary- Sacramento model is linked with North Area model
4. Subregion Definitions- More appropriately defined to match water purveyors more accurately
5. Rainfall and Rainfall Distribution- Updated to 2004 with daily time step
6. Streamflow Data- Updated to 2004 with daily time step
7. Hydrologic Soil Types- Updated based on latest NRCD digital maps
8. Land Use and Crop Mix- Updated to include the latest county APN
9. Agricultural Demand Estimates- Updated based on the latest land use and crop mix data
10. Municipal Groundwater Production- Updated to the latest data available from the agencies
11. Agricultural Residential Demand and GW Pumping- Updated based on latest estimates from the Zone 40 WSMP project and South Sacramento area data
12. Surface Water Supply- Updated based on latest data in the Central and South basins
13. Target Calibration Wells- Updated data from DWR Water Data Library, as well as the UCD model database
14. Aquifer Parameters- Updated to calibrate the model and include latest field tests as available

Model Calibration Results

The model calibration was conducted in several stages:

1- **Water budget Calibration-** Water use, soil zone, groundwater, and stream budgets were used to ensure that the water balances developed by the model are appropriately representing the regional water balance for each model subregion.

2- **Regional Groundwater Levels-** Calibrate the model to ensure that the regional groundwater levels contours and flow directions for specific time periods match the observed data and meet the calibration targets.

3- **Local Groundwater Levels-** Calibrate the model to ensure that the model simulations represent long-term trends and seasonal changes to observed groundwater levels at target calibration wells.

4- **Streamflow Calibration-** Calibrate the model to provide a reasonable match between the simulated daily streamflows and observed data for major water courses in the model.

Several model parameters were modified to ensure that a reasonable fit is obtained for calibration. These include hydrologic soil parameters, such as hydraulic conductivity, field capacity, and porosity; aquifer parameters, such as hydraulic conductivity, storativity, and leakance; and streambed parameters, such as hydraulic conductivity, stream bed thickness, and channel geometry. In addition, the water use parameters, such as irrigation efficiency and crop water use parameters were modified to ensure that a reasonable water use estimates are developed by the model.

In addition, due to the uncertainties inherent in the model parameters, a sensitivity analysis was performed to develop better understanding of the sensitivity of the model calibration results to uncertainties in some major parameters.

Baseline Conditions

Two baseline conditions were developed for the SACIGSM model. Baseline conditions define the land and water use and hydrologic conditions to be used as the basis for comparison of alternative water management scenarios. The Existing Conditions baseline represents the conditions of the basin under the existing conditions and water management rules. The Future Conditions baseline represents the conditions of the basin at the 2030 level of development.

SACIGSM Relation with Other Local Models

The Sacramento County IGSM (SACIGSM) is a regional model of the hydrologic conditions in the county. The model is fully capable of simulating the regional groundwater flow conditions, streamflow, and stream-aquifer interaction in the County. The intended use of the model is for analysis of water planning and management scenarios at a regional scale. Local conditions can be simulated using more site-specific models, which can potentially be linked to the regional model. The regional model can also be used to develop hydrogeologic parameters and data and/or boundary condition information for the local models. In specific, the UCD MODFLOW model for the Cosumnes River can be linked to the regional SACIGSM model to better simulate the hydrogeologic conditions in the shallow and perched aquifer system.

Potential Future Model Applications

The SACIGSM model is reasonably calibrated to be used for potential applications, including:

- Update of Basin Yield analyses for various parts of the basin
- Analysis of projects considered under the Groundwater Management Plan in various parts of the county
- Analysis of impacts of projects considered in the county-wide IWRMP
- Evaluation of potential impacts of options considered under the water accounting framework in the North and Central basins.
- Analysis of Cosumnes and Mokelumne River Floodplain Integrated Resources Management Plan
- Evaluation of Cosumnes River Flow Augmentation Project and fish flow evaluations
- Evaluation of hydrologic impacts on groundwater and/or surface water resources of potential proposed developments in various parts of the county

Appendix C

Documentation of Public Involvement

Documentation of Public Involvement in Developing a Groundwater Management Plan for the South Sacramento Basin

Overview of Activities Leading to the South Basin Collaborative Effort

A number of previous planning efforts, ongoing programs and collaborative agreements have created the context for the current effort of groundwater and conjunctive management planning for the South Basin. The following is a summary of the key steps in this evolving history toward locally-driven water planning and management for the region. The common thread in all of these agreements and activities is recognition of the central importance of broad stakeholder involvement in developing plans for the future of water management in Sacramento County. That principle continued to be recognized as the guiding theme in organizing the collaborative process for the South Basin that yielded this GMP.

Water Forum Agreement (2000)

Signed in January 2000, the Water Forum Agreement (WFA) was the result of a six-year collaborative problem-solving negotiation which included agricultural and business leaders, citizen and environmental organizations, water managers and local governments in Sacramento County. (Water managers from Placer and El Dorado Counties became part of the negotiations in 1995.) The Agreement addresses two co-equal objectives: 1) provide a reliable and safe water supply for the region's economic health and planned development to the year 2030, and 2) preserve the fishery, wildlife, recreational, and aesthetic values of the lower American River. In April of 2000, the agreement was signed by forty stakeholder organizations/agencies. The WFA provided for the establishment of the Water Forum Successor Effort which is responsible for overseeing, monitoring and reporting on the implementation of the Agreement. The Successor Effort, composed of representatives of the stakeholder organizations that are WFA signatories, continues the interest-based collaborative process that was used in developing the Agreement. The Successor Effort has no independent governing or regulatory authority.

Recognizing that the groundwater basin supplies over half the water used in the region, the Groundwater Element of the Agreement sets out specific recommendations designed to protect the viability of this resource for both current and future users. Among the most important of these were recommendations concerning sustainable yield in the three Sacramento County groundwater basins and groundwater management governance structures that achieve the WFA objectives.

- ❖ Sustainable yield is defined as the amount of groundwater that can be safely pumped from the groundwater basin over a long period of time while maintaining acceptable groundwater elevations and avoiding undesirable effects such as increased pumping costs, accelerated movement of underground pollutants, etc.

- ❖ Recommendations for a groundwater management governance structure in the North Area of the County (i.e., in the area between the American River and the Sacramento-Placer County boundary) were spelled out in some detail. These recommendations were subsequently implemented by Sacramento County and the Cities of Citrus Heights, Folsom and Sacramento and led to the creation of the Sacramento North Area Groundwater Management Authority (now know as the Sacramento Groundwater Authority).
- ❖ With regard to groundwater management governance in other areas of Sacramento County, the Agreement recommended: "…Discussions involving all parties interested in the negotiation of groundwater management arrangements in the [Central] area and the [Galt or South] area will continue. These discussions, employing the principles of interest-based negotiation, are part of a public process designed to provide all community interests the opportunity to participate in tailoring a groundwater management plan to fit each area's unique circumstances."

Starting in 2002, stakeholders of the Central groundwater basin began a process of groundwater management planning and development of a governance structure. That effort resulted in the creation of the Sacramento Central Groundwater Authority in August 2006 and the adoption of the Central Sacramento County Groundwater Management Plan in November 2006.

Another important element of the WFA relating to the South Basin is a commitment that a 15,000 acre-feet portion of the Central Valley Project contract supply of the Sacramento Municipal Utility District (SMUD) would be assigned for agricultural use in the South basin.

The WFA set out a framework for water policy in Sacramento County, and the County's General Plan update reflects its basic agreements and policy goals. Central to implementation of the WFA objectives is continuation of the collaborative process and involvement of the affected interests in key decisions. Thus, to help achieve sound groundwater management, the Water Forum Successor Effort has supported locally driven negotiations in the groundwater basins of the County. The Water Forum staff has support local stakeholders in the South Basin as they initiate water planning through a collaborative process.

Role of Southeast Sacramento County Agricultural Water Authority (formed in 2002)

The SSCAWA is a Joint Powers Authority formed by three agricultural districts: Omochumne-Hartnell Water District, Galt Irrigation District, and Clay Water District. These three districts joined to form a Joint Powers Agreement in 1997 to support the development of a Coordinated Groundwater Management Plan. In 2002 the group modified their organization to a Joint Powers Authority and formally recognized itself as the SSCAWA.

The fundamental purpose of SSCAWA is, under Section 3.4 of the JPA agreement, "to develop, adopt and implement a coordinated groundwater management plan for the [groundwater] Basin [underlying the three member districts]..." Among other objectives, the plan is intended to: facilitate implementation of Basin conjunctive use; mitigate conditions of Basin groundwater overdraft; replenish Basin groundwater extractions and mitigate any Basin groundwater contamination migration.

Since 2002 the SSCAWA has taken a leading role in the South Basin for water management activities and has been instrumental in developing regional partnerships to support collaborative water resources planning. In 2002 the SSCAWA adopted a Groundwater Management Plan under AB 3030 as the first step towards developing an integrated approach to groundwater management.

In 2005, SSCAWA began a series of discussions with five other agencies about the need to develop a comprehensive and integrated approach to the management of groundwater and surface water resources in the South Basin. Those discussions were memorialized in a Memorandum of Understanding completed in 2007 (see below for further detail) that articulated the goal of developing a collaborative process. That MOU has led directly to the current assessment prior to convening a stakeholder group.

SCWA-TNC-SSCAWA MOA (2005)

In February 2005, The Nature Conservancy (TNC), the Southeast Sacramento County Agricultural Water Authority (SSCAWA) and the Sacramento County Water Agency (SCWA) concluded the Memorandum of Agreement for the Management of Water and Environmental Resources Associated with the Lower Cosumnes River. This MOA recognized the shared interest of the three signatories in the conjunctive management of surface and groundwater resources in the Central and South groundwater basins and took steps to undertake projects to protect and restore the resources of the lower Cosumnes River. It also contained provisions to facilitate planning for conjunctive water management and groundwater recharge in the South Basin.

Specifically, it recognized the leading role of SSCAWA in developing a groundwater management plan and an Integrated Regional Water Management Plan for the South Basin. SCWA committed funding to support SSCAWA in this effort in the amount of $50,000 per year for three years beginning in 2005. The shared interests of the signatory parties are described in Section 2.0 of the MOA as follows:

- Developing a governance structure and framework agreement for the local participants.
- Updating the existing SSCAWA Groundwater Management Plan to include local partners and increased level of detail.

- Perform Resource Assessments to clearly identify areas of common interest.
- Outline a Conjunctive Use Program.
- Recommend Integrated Management Actions.
- Develop funding proposals.

Thus, this agreement put into place an initial funding source from SCWA to begin the process of water resources planning. That funding has helped SSCAWA complete the early organizing efforts to convene a South Basin collaborative process. The agreement also helped build a partnership among SCWA, TNC and SSCAWA to address water concerns in the Cosumnes River Corridor and the South Basin in an integrated manner, emphasizing the conjunctive use of surface water and groundwater.

American River Basin IRWMP (2006)

During 2005, efforts to develop Integrated Regional Water Management Plans (IRWMPs) under state law proceeded separately for the northern part of the American River Basin under the sponsorship of the United States Army Corps of Engineers and the Regional Water Authority (RWA) and for the Central and South basins under the sponsorship of the SCWA and the Freeport Regional Water Authority (FRWA). At the suggestion of the California Department of Water Resources, these two plans were combined into a single American River Basin IRWMP to be prepared jointly by RWA, SCWA and FRWA. This combined plan was approved by these agencies in June 2006 with the recognition that it should be considered a living document, containing criteria and a process for qualifying additional water management strategies for potential funding. The projects that were included in the IRWMP upon its adoption were those that had been clearly defined and significantly developed by their proponents. It was recognized that further work and an update to the IRWMP would be done to incorporate information about the South Basin relating to groundwater management, a governance structure for the area and potential water management strategies.

The IRWMP is an essential planning document for securing state funding to plan and construct water management strategies that integrate multiple purposes, according to local priorities, such as groundwater recharge, surface water supply integration, environmental protection, habitat improvement, flood control and other objectives. Including South Basin water resource information in the American River Basin IRWMP, especially a Groundwater Management Plan and integrated water management strategies, is a critical step in qualifying for state funding under Proposition 50 programs and future state bond-financed opportunities. The planning requirements for state funding also create an important incentive for stakeholders of the South Basin to complete collaborative planning efforts in a timely manner.

Sacramento Central Groundwater Authority (2006)

As noted above, the completion of the Central Basin Groundwater Management Plan and formation of the Sacramento Central Groundwater Authority (SCGA) were important steps in achieving the goals of both the WFA and the Central Basin stakeholders. The Central Basin process was important for the South Basin for several reasons. First, its use of the stakeholder collaborative approach affirmed the importance of this model for development of water plans for the South Basin. Second, the boundaries of the Central Basin, as delineated by the Water Forum Agreement, include lands south of the Cosumnes River. Programs negotiated by Central Basin stakeholders and now being implemented by the SCGA, most notably the Well Protection Program, apply to these areas south of the Cosumnes River that are within the current boundaries of the Central Basin.

Thus, several stakeholders involved in the Central Basin and currently represented on the Board of Directors of the SCGA are also deeply involved in efforts to initiate a South Basin process. TNC, OHWD and SSCAWA, for example, see the Cosumnes River corridor as playing a major role in future water management strategies for the South Basin, especially involving groundwater recharge. There will thus have to be close coordination between the two basins to ensure that the goals and programs of both are met in harmonious ways.

MOU to Establish Collaborative Process (2007)

As noted above, SSCAWA organized discussions with five other agencies during 2005-2006 with the aim of defining goals and objectives of a collaborative planning process that would meet the needs of the South Basin for a groundwater management plan, a potential governance structure to implement that plan and information that would support a South Basin role in the American River Basin IRWMP. The other agencies involved in developing the MOU were SCWA, TNC, Rancho Murieta CSD, the City of Galt and the California Department of Water Resources.

The MOU was concluded and approved in late 2006 and signed in early 2007. It contains a statement of the objectives of the six parties signing the MOU and an agreement to convene a stakeholder process with the proposed name of the South Area Water Council (SAWC). The key principle guiding the proposed collaborative planning process is that all proposed solutions to water needs must be acceptable to all participants. To quote from the MOU:

"The Parties will work cooperatively to accomplish the following objectives:

1. *Develop mutually beneficial regional solutions to meet the water supply and related needs of the Parties by pursuing water supply availability, reliability, and quality* ***that are acceptable to all participants in the South Area Water Council****. [Emphasis added.]*

2. *Develop solutions consistent with the Water Forum Agreement that:*
   a) *maximize the long-term beneficial use of all water resources of the area while protecting the environment;*
   b) *provide for the existing and projected dry-year water needs of the Parties;*
   c) *provide an economical and reliable existing and future water supply for urban, agricultural, and environmental needs within the region;*
   d) *provide water for the ecological resources of the Cosumnes River;*
   e) *enhance Sacramento County's regional water supply."*

It is important to understand this MOU as a statement of goals and objectives for the six signatory agencies only. It was not an attempt to set goals for all stakeholders of the South Basin. Instead, it memorializes the concerns and aims of these six as they began the process of convening a larger stakeholder process. The stakeholders of the proposed SAWC will need to adopt their own charter with a statement of purposes, ground rules and other elements of their choosing.

Public Involvement and Stakeholders Collaborative Effort in Developing the Groundwater Management Plan

In 2007, the MOU partners started the development of the groundwater management plan for South Sacramento County. Using stakeholder collaborative approach the MOU partners invited other stakeholders in the Basin to participate in the GMP development process.

LEAD AGENCY

In accordance with California Water Code (CWC) § 10753, groundwater management plans can be developed by "Any local agency, whose service area includes a groundwater basin or a portion of a groundwater basin…". SSCAWA is an entity in this basin that qualifies as a local agency as defined by CWC) § 10752, therefore it is the lead agency on this GMP.

PUBLIC OUTREACH AND NOTIFICATION

The South Sacramento Basin GMP was completed as an open process with public participation, consistent with CWC §10750 et seq. For this GMP, the following steps were taken to provide opportunity for public input:

1. Initial Notice of Intent

In accordance with CWC § 10753.2, a notice of intent to adopt a resolution to prepare a GMP was published in the Elk Grove Citizens and Galt Herald Newspapers on March 11,

2010. The SSCAWA board of Directors adopted the resolution of intent at their publicly held Board meeting on March 16, 2010. The Notice of Intent is included in **Appendix 1.**

2. Public Outreach and Notification

During the GMP development, the public was provided information on the GMP progress through the following:

- Initial Invitation List – A list of 25 groups potentially interested in the GMP process was compiled. These groups include businesses, organizations, individuals, government agencies, and basin water users. These groups were mailed invitations to attend kick-off meeting in 2008 and following stakeholders meetings.

- Direct Mail and e-mail list – the list consisted of 35 interested individuals and organizations that expressed an interest in the GMP, or who had attended meetings about development of the GMP.

- Web Pages – SSCAWA web page was maintained to allow all basin stakeholders to comment in the GMP process, download the draft GMO and suggest edits to the Draft GMP. http://sscawa.org/sscawa/index.cfm

3. Public Comment Period for the Draft GMP

The draft GMP was made available to the public on April 27, 2011. Public comment was accepted on the draft GMP between April 27, and June 30, 2011.

4. Public Meetings

In the period 2007–2011 the MOU partners and other stakeholders were involved in the process of developing the GMP. The public involvement included participation in regularly monthly plenary meetings to discuss GMP progress and resolve stakeholders concerns. It also included review of GMP reports and presentations, provision of comments and approval of schedules and milestones for the GMP. SSCAWA also held three educational meeting to inform different stakeholders in the basin about the plan.

Stakeholder Group Assistance with GMP Development

A stakeholder group was convened regularly during the GMP development to facilitate community input into the process. The stakeholder group was open to all groundwater users, interested regulatory agencies, and all members of the public. The invited stakeholders included:

- Herald Area Civic Association
- The Fishery Foundation of California
- South County Citizens for Responsible Growth

- Sacramento Central Groundwater Authority
- SMUD
- Sacramento Valley
- Reclamation District 800
- AKT Development
- Cosumnes CPAC
- East County Landowners
- Sacramento County Farm Bureau
- Sloughhouse Resource Conservation District
- California Association of Resource Conservation Districts
- Amador-El Dorado-Sacramento Cattlemen's Association
- Galt District Chamber of Commerce

The MOU partners solicit the basin stakeholders to provide issues of concern that encouraged their decision to join the process to develop the GMP. Although there were many differing opinions among the members of the stakeholders group, every effort was made to reach some level of consensus on contentious issues.

Several common themes emerged in reviewing the issues list provided by the basin's stakeholders, such as concerns about declining groundwater levels in some parts of the basin. Other themes emphasized by many different groups included protection of property rights, the need for affordable water, the use of surface water for recharge and concerns about the Cosumnes Corridor. These common themes provided a basis for areas of agreement as the process moved forward.

Appendix 1

Notice of Intent

NOTICE OF INTENT TO ADOPT A RESOLUTION TO PREPARE A GROUNDWATER MANAGEMENT PLAN

The Southeast Sacramento County Agricultural Water Authority (SSCAWA) intends to consider the adoption of a resolution to prepare a groundwater management plan at its board meeting on March 16, 2010. The meeting which the public is invited to attend will begin at 9:45 am at the Herald Fire Station Community Hall at 12746 Ivie Road, Herald, CA 95638.

The Southeast Sacramento County Agricultural Water Authority is a Joint Powers Authority in southern Sacramento County and provides representation on water development and supply for the local water districts and landowners. Any individual interested in the development of the groundwater management plan is encouraged to attend the meeting. For more information please contact Mike Wackman at SSCAWA at (209) 748-5044.