CDM

Camp Dresser & McKee

San Joaquin County

Flood Control and Water Conservation District

Water Management Plan

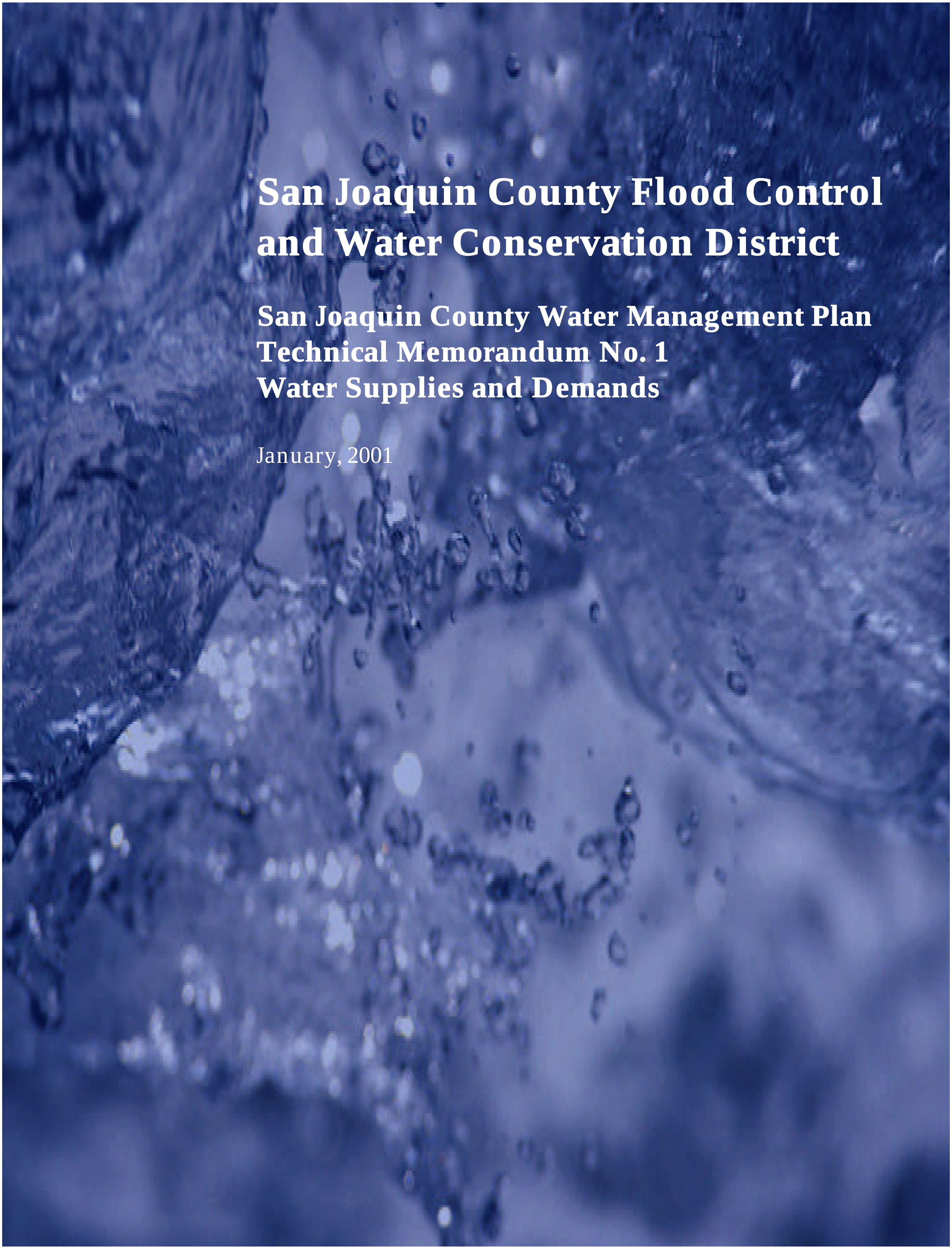
Phase 1 - Planning

Analysis and Strategy

September 2001

Volume 2

Volume II



San Joaquin County Flood Control and Water Conservation District

San Joaquin County Water Management Plan
Technical Memorandum No. 1
Water Supplies and Demands

January, 2001

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Section 1
Introduction and Overview

1.1 Memorandum Objectives

The objective of this memorandum is to present the information that was compiled as part of the data collection task of the San Joaquin County Water Management Plan. This memorandum serves as documentation for ensuing analysis.

1.1.1 Background

San Joaquin County recognizes the potential benefit in addressing its primary water management issues – supply, quality, and groundwater basin – on a regional basis. To develop a plan for San Joaquin County, County Staff, a Steering Committee and the County's consultants will:

- Gather relevant data to develop a shared understanding of County water resources;
- Develop a set of technically-feasible alternatives for future water management;
- Evaluate the alternatives according to an agreed-upon method; and
- Formulate a recommended plan of action for the future.

This memorandum documents the first step listed above.

1.1.2 Involved Agencies

The County has elected to formulate the WMP through a collaborative effort involving representatives from water agencies; regulatory agencies and its own staff, supported by a technical consulting team. Development of recommendations for surface and groundwater projects, programs, policies and operational strategies to include in the plan is being conducted by these representatives in two groups: a Steering Committee and a Water Management Plan (WMP) Technical Team.

1.1.2.1 Steering Committee

The WMP Steering Committee comprises representatives from San Joaquin County agricultural and urban water providers. The County identified and approved Steering Committee representatives at the beginning of this effort. Table 1-1 lists the people and agencies that have been invited to participate in the Steering Committee to serve as a Technical Advisory Group.

Table 1-1 Steering Committee Members	
Representative	***Agency***
Morris Allen	City of Stockton
Scott Bailey	California Water Service
Steve Bayley	City of Tracy
Andy Christensen	Woodbridge Irrigation District
Bob Clark	North Delta Water Agency
James Cornelius	Calaveras County Water District
Jon Crawford	City of Lathrop
Alex Hildebrand	South Delta Water Agency
Kevin Kauffman	Stockton East Water District
Wayne Marcus	Oakdale Irrigation District
Diane Martin	City of Manteca
Rick Martin	South San Joaquin Irrigation District
Russ Matthews	San Joaquin Farm Bureau
Frances Mizuno	San Luis and Delta Mendota Water Authority
Dante John Nomellini	Central Delta Water Agency
Richard Prima	City of Lodi
Dale Ramey	City of Ripon
Reid Roberts	Central San Joaquin Water Conservation District
Ed Steffani	North San Joaquin Water Conservation District
Douglas Stidham	City of Escalon
Richard Whitson	U.S. Bureau of Reclamation
Mark Williamson	East Bay Municipal Utility District

In addition, Bill Jennings of the Delta Keeper has been invited to participate to provide advisory input for local environmental issues. To date, the Delta Keeper has not participated.

1.1.2.2 Technical Team

The Plan Technical Team includes representatives of the County, the Department of Water Resources (DWR) and their technical consultants. County offices, including the Flood Control District, are in Stockton, in central San Joaquin County. The DWR is providing technical assistance as a part of their Integrated Storage Investigation. The Team of consultants to the County includes:

- Camp Dresser & McKee Inc. (CDM);
- Borcalli & Associates;
- Surface Water Resources Inc. (SWRI);

- James C. Hanson Consulting Engineer;
- Boyle Engineering Corporation; and
- Buethe Public Relations.

1.2 Memorandum Overview

As noted above, this memorandum is intended to provide an overview of the data that has been collected in support of WMP development. The remainder of Section 1 provides a general description of San Joaquin County and its ground and surface water features and conditions. Section 2 of this memorandum describes information gathered by the County's consulting team pertaining to regional geology, hydrogeology and surface and groundwater interaction. Section 2 also presents what is known regarding the County's water balance and overviews known or potential groundwater supply problems. Section 3 presents the urban, agricultural and environmental water demands and supplies projected for the planning period, and explains the surface and groundwater rights applicable to County water sources. Finally, Section 4 reviews water quality of County water resources, and describes known or potential water quality problems.

1.3 Study Area Description

The San Joaquin County WMP will present an approach to surface water and groundwater management within San Joaquin County. San Joaquin County is in California's Central Valley, which runs north-south and is bordered by the Sierra Nevada mountain range to the east and the Coastal Range to the west. Rivers in the Central Valley flow from the north and south towards the Sacramento/San Joaquin Delta, which feeds the water through a break in the Coastal Range to the San Francisco Bay. San Joaquin County includes portions of the Delta on its western edge and the Sierra Nevada foothills on the eastern edge. The area of San Joaquin County is approximately 1,400 square miles. Figure 1-1 illustrates the County's location within California.

San Joaquin County encompasses seven urban areas, including Stockton, Lodi, Tracy, Manteca, Escalon, Lathrop and Ripon. Urban water agencies in those areas provide water to residential, commercial, and industrial uses within their boundaries. Thirteen agricultural water agencies provide water for irrigation in approximately 70% percent of agricultural areas of the County. Approximately 280,000 acres of land in San Joaquin County is unincorporated. Additional information on urban areas and agricultural agencies is presented in Section 3. Table 1-2 lists the water agencies in the County.

Table 1-2 Water Agencies in San Joaquin County	
Agricultural Water Agencies	
Banta-Carbona Irrigation District	Plain View Water District
Central Delta Water Agency	South Delta Water Agency
Central San Joaquin Water Conservation District	South San Joaquin Irrigation District
Hospital Water District	Stockton East Water District
North Delta Water Agency	West Side Irrigation District
North San Joaquin Water Conservation District	Woodbridge Irrigation District
Oakdale Irrigation District	
Urban Water Providers	
Escalon	Ripon
Lathrop	Stockton
Lodi	California Water Service Company
	County of San Joaquin
Manteca	Tracy

Agriculture is the primary land use within San Joaquin County, as shown in Figure 1-2. The semi-arid climate in San Joaquin County is ideal for farming, with long, warm, dry summers (May through October) and cool, rainy winters. The average annual precipitation in the area is 14 inches, with 70% of the rain falling between December and March. In 1999, the value of agricultural production in San Joaquin County was $1.35 billion, which was the sixth largest County agricultural production in the state. Table 1-3 shows the top five crops (in terms of production value).

Table 1-3
Top Five Production Value Crops

Crop	Production Value
Grapes	$291.2 million
Milk	$257.4 million
Tomatoes	$103.7 million
Cherries	$71.9 million
Almonds	$69.8 million

Source: Web site for California Farm Bureau Federation, accessed on August 22, 2000. http://www.cfbf.com/co-39.htm. Values shown are for the year 1999.

Historically, both urban and agricultural areas used primarily groundwater. Within the past 25 years, surface water from the Mokelumne, Calaveras, and, more recently, Stanislaus Rivers started to reduce the County's dependence on groundwater. Table 1-4 shows what percentage of the County, in terms of surface area, uses ground and surface water, and Figure 1-3 depicts the water sources by area of the County.

Table 1-4 County Water Sources		
Eastern San Joaquin	**Land (acres)**	**Percent**
Groundwater	222,450	40%
Surface Water	53,940	10%
Mixed	129,300	23%
Non-irrigated, Vacant, Water Surface	156,720	28%
Eastern San Joaquin subtotal	*562,410*	*62%*
Delta and Southwest County		
Groundwater	14,800	4%
Surface Water	212,900	61%
Mixed	12,060	3%
Non-irrigated, Vacant, Water Surface	110,640	32%
Delta & Southwest County subtotal	*350,400*	*38%*
County Total	**912,810**	

Source: California Department of Water Resources Land Use Surveys
Note 1: This analysis excludes land with an "Unknown" water source, comprising 1,690 acres or 0.2 percent of the County's total land.
Note 2: The cities of Escalon, Lathrop, Lodi, Manteca, and Ripon use groundwater. The cities of Stockton and Tracy use a combination of surface water and groundwater.
Note 3: Numbers are rounded off to the nearest 10 acres.

1.3.1 Groundwater Basins

The groundwater in San Joaquin County is found in multiple water-bearing formations. The Eastern San Joaquin County Groundwater Basin is east of the Delta, and is comprised of multiple geologic features, including the Laguna Formation and the Mehrten Formation. The Eastern Basin is primarily unconfined, but localized soil characteristics result in semi-confined and perched conditions.

The Delta area has Flood Basin Deposits underneath, which store poor quality saline water. The Tulare Formation is in the southwestern portion of the County, and is characterized by a layer of Corcoran Clay that divides the aquifer into a lower confined aquifer and an upper aquifer that is locally unconfined, semi-confined, or confined. The upper aquifer in the Tulare Formation produces low quality water, but the lower aquifer produces high quality water that is used for the City of Tracy.

More detailed descriptions of the groundwater basins can be found in Section 2, Geology and Hydrogeology.

1.3.2 Surface Water Features

The eastern section of San Joaquin County includes part of the Delta, a maze of streams, canals, and sloughs that create smaller Delta islands. The western side of San Joaquin County has several rivers, including the Mokelumne, Calaveras, Stanislaus, and San Joaquin Rivers. Figure 1-4 shows the major rivers and the Delta, and their relationship to San Joaquin County. The American River is not in San Joaquin County, but it is also shown on the map because it is often mentioned in County water policy issues. Table 1-5 lists major reservoirs in the area on each of these rivers.

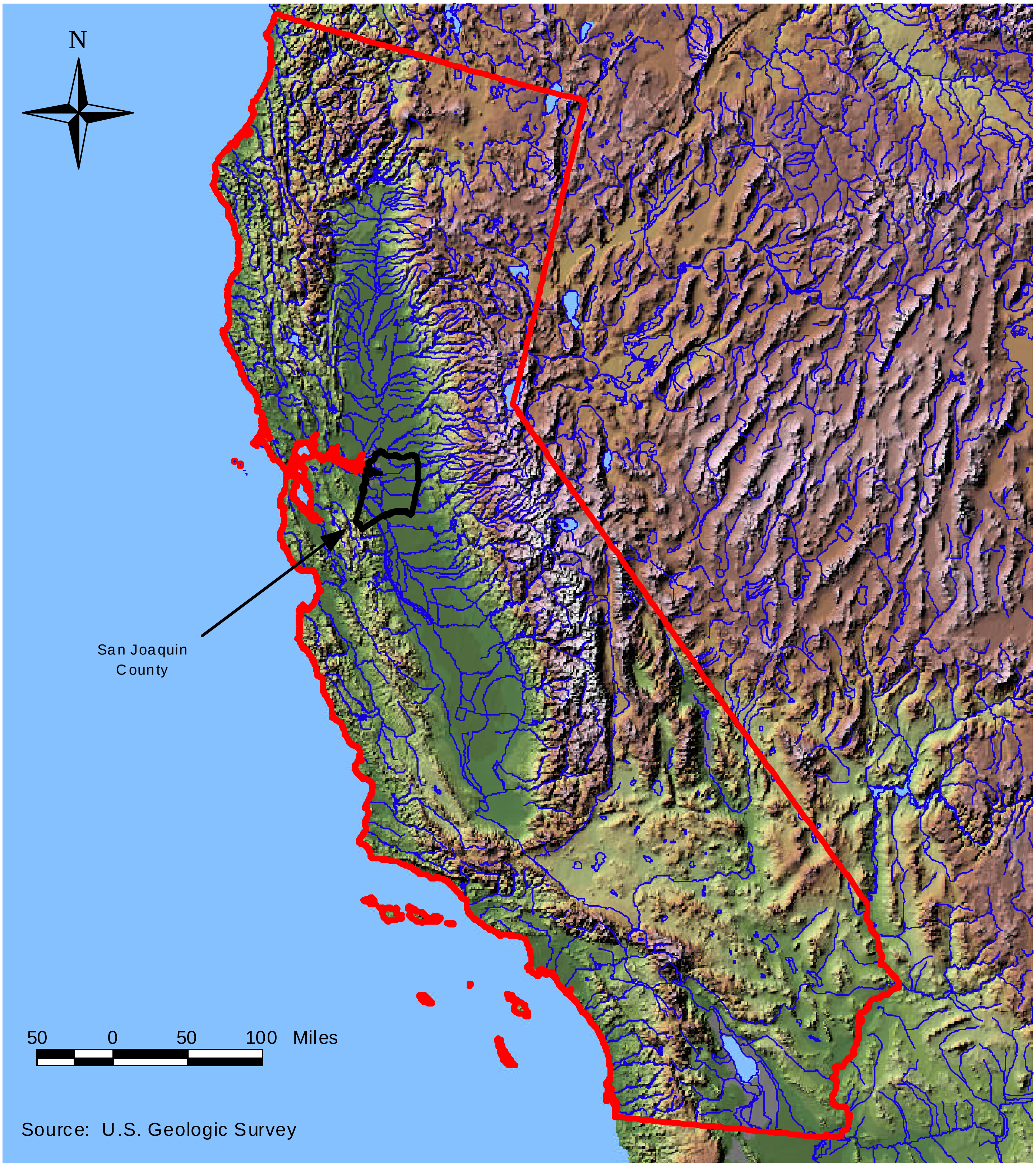
Table 1-5
Major Area Reservoirs

River	***Major Reservoirs***	***Size*** (thousand acre-feet)	***Agencies***
Mokelumne	Pardee Res. Camanche Res.	209.9 430.8	East Bay MUD
Calaveras	New Hogan Lake	317	U.S. Army Corps of Engineers, Stockton East Water District
Stanislaus	New Melones Res.	2,400	Central Valley Project
	Beardsley Res. Donnells Res. Tulloch Res. Goodwin Res.	98 64 70 0.5	Oakdale Irrigation District, South San Joaquin Irrigation District

Sources:
U.S. Department of the Interior, Bureau of Reclamation. *Central Valley Project Improvement Act, Draft Programmatic Environmental Impact Statement*. Sacramento, CA.
California Department of Water Resources. *The California Water Plan Update, Bulletin 160-98.*

1.3.3 Future Water Demand

Water use in San Joaquin County is expected to increase slightly. The population of San Joaquin County is expected to increase dramatically over the next thirty years, primarily due to people and businesses moving westward from the Bay Area. However, the growth in urban areas will cause a corresponding decrease in agricultural lands, which will offset the urban water use increase and cause overall County water use to increase more slowly. Planning level estimates of urban and agricultural water demands, as discussed in Section 3, indicate that demands are expected to increase from 1,626,000 acre-feet per year (AF/yr) County-wide to 1,631,000 (AF/yr) County-wide.



CDM Camp Dresser & McKee Inc.

Figure 1-1
San Joaquin County Location
San Joaquin County Water Management Plan

SAN JOAQUIN COUNTY WATER MANAGEMENT PLAN
LAND USE, 1996

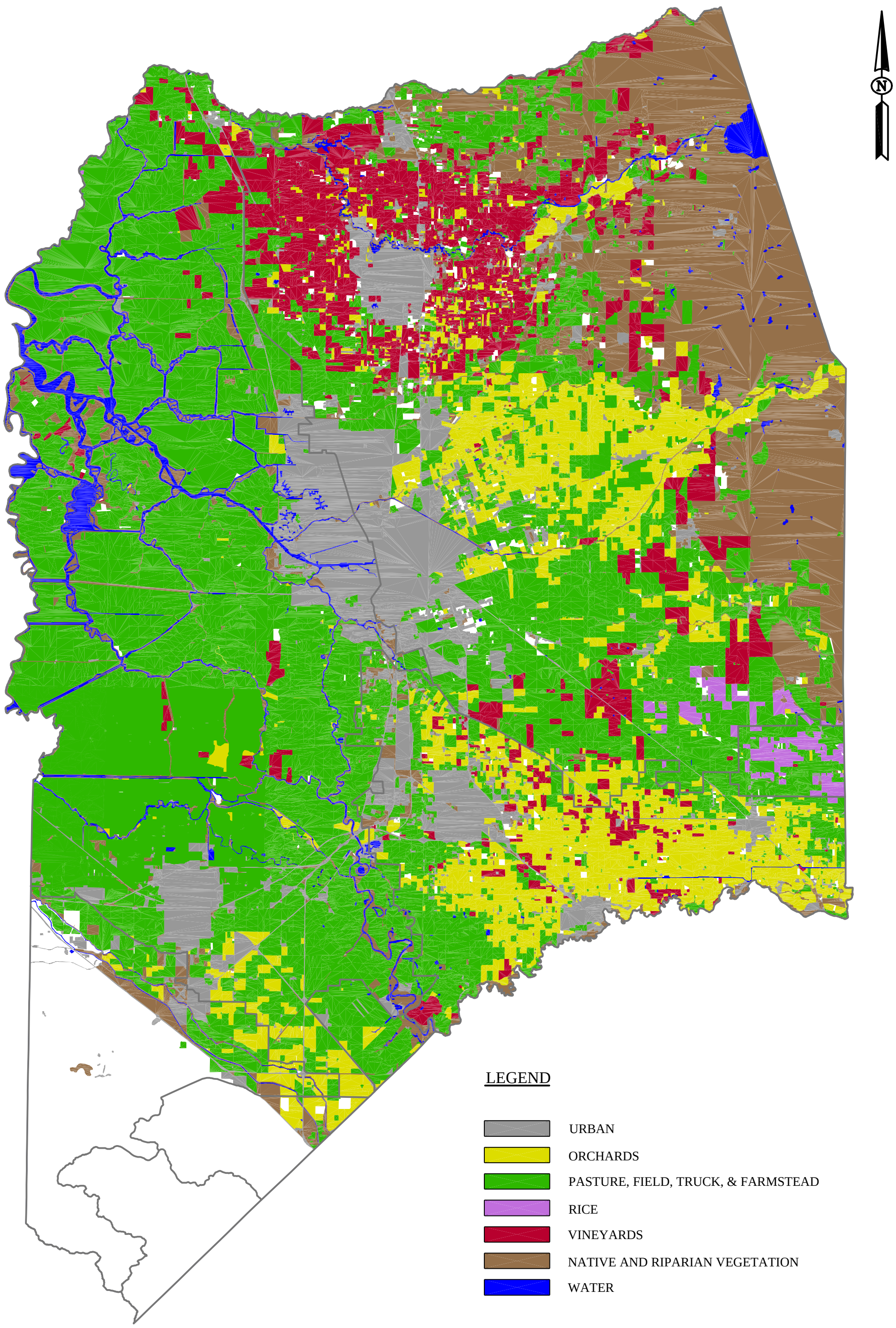


Figure 1-2

BORCALLI & ASSOCIATES, INC.
CONSULTING ENGINEERS

SAN JOAQUIN COUNTY WATER MANAGEMENT PLAN

WATER SUPPLY SOURCE, 1996

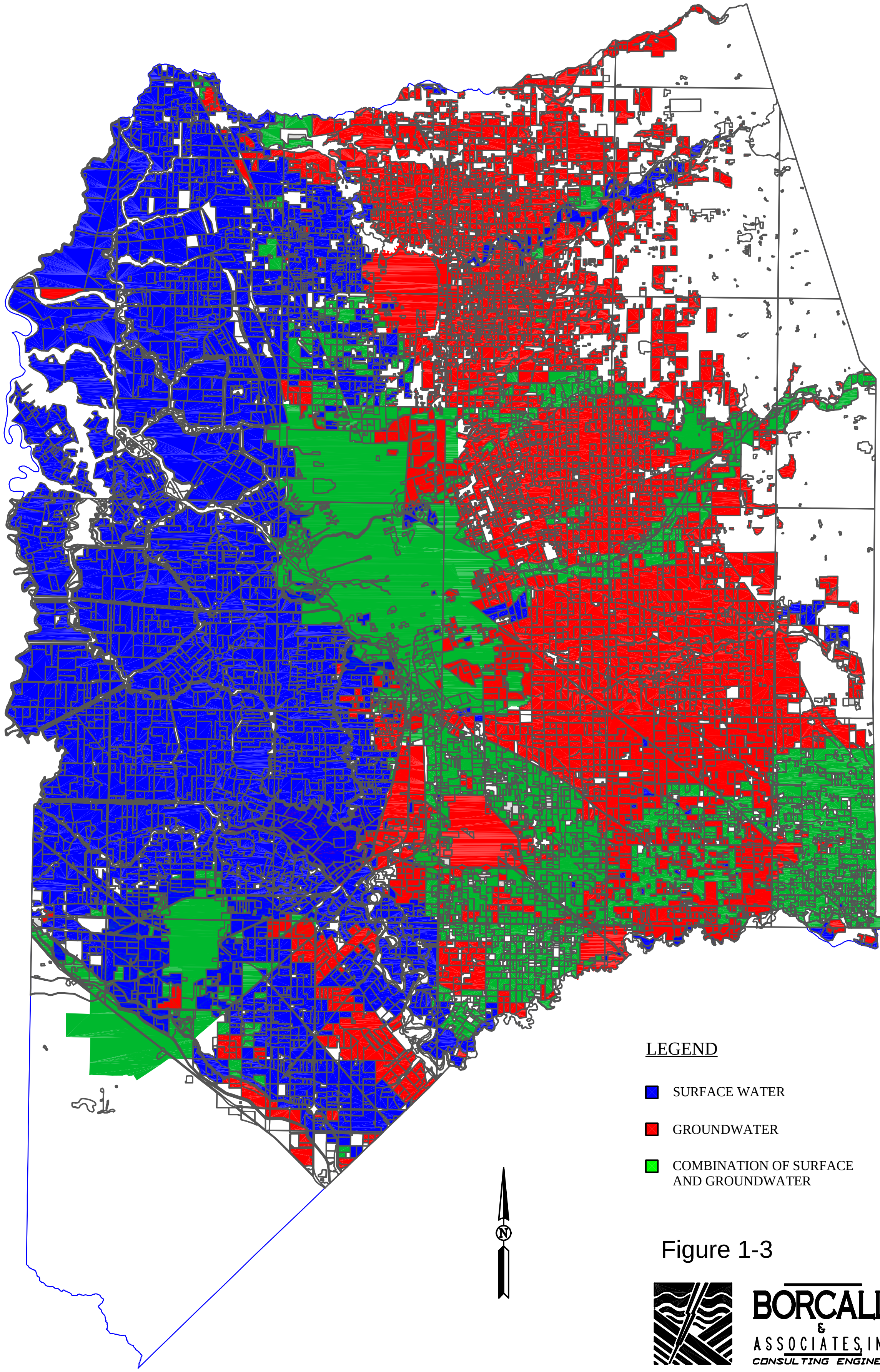
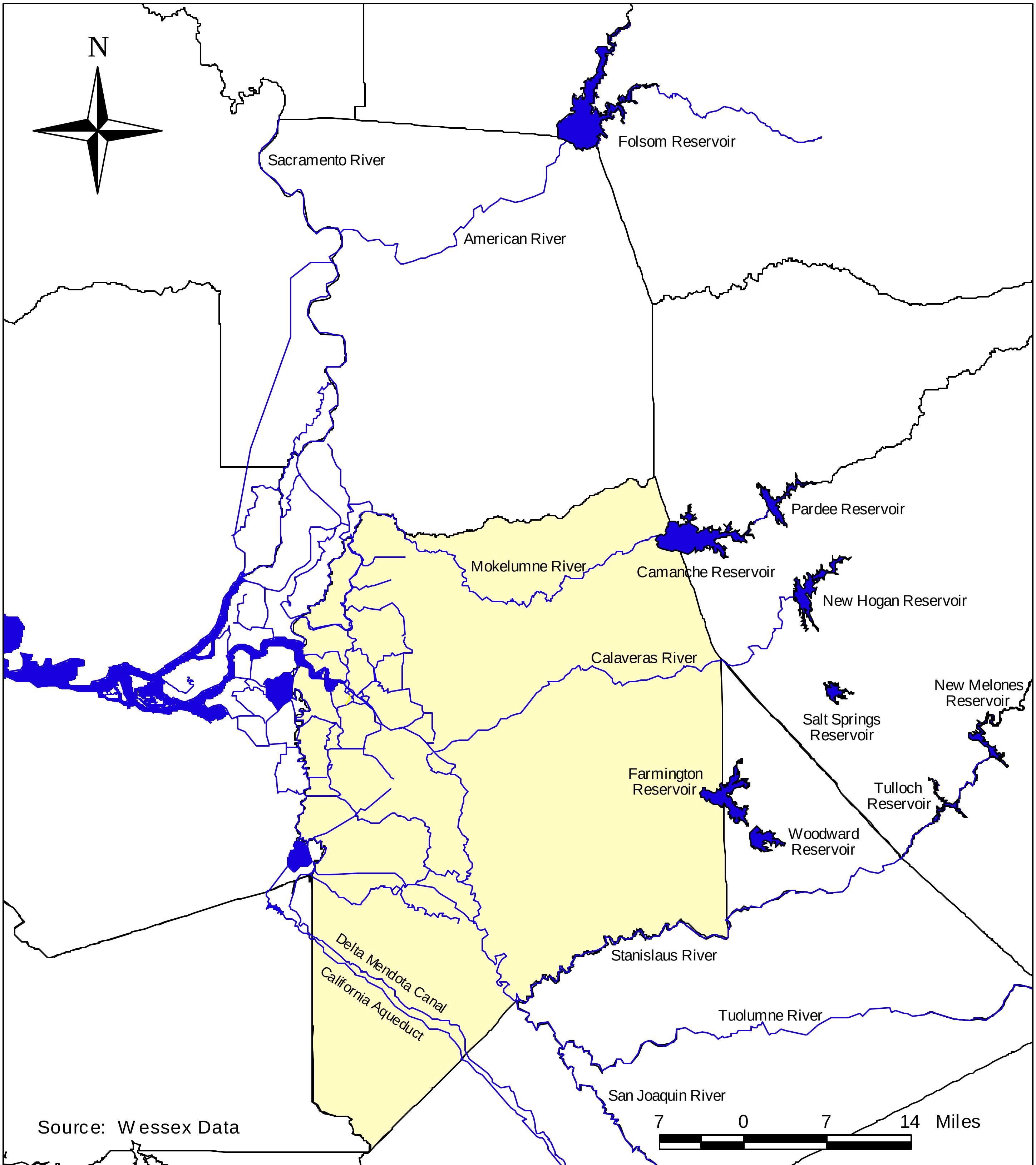


Figure 1-3

BORCALLI & ASSOCIATES, INC.
CONSULTING ENGINEERS



CDM Camp Dresser & McKee Inc.

Figure 1-4
Major Water Features
San Joaquin County Water Management Plan

Section 2
Geology and Hydrogeology

San Joaquin County overlies the northern most portion of the San Joaquin Valley Groundwater Basin. Within San Joaquin County this basin is further subdivided into three sub-basins - the Eastern San Joaquin County Groundwater Basin (ESJCGB), the Cosumnes and Tracy sub-basins. In this report the ESJCGB and the Cosumnes sub-basin, both located on the eastside of the San Joaquin River, are treated as one basin.

2.1 Geologic Setting

The regional geologic setting for the study area is described in the following subsections.

2.1.1 Regional Geology and Stratigraphy

The study area is set within the Central Valley, a 400-mile long and 50 mile wide northwestward trending, asymmetrical structural trough. To the east are the Sierra Nevada which are comprised of pre-Tertiary igneous and metamorphic rocks. The Coastal Range to the west is comprised of pre-Tertiary and Tertiary semi-consolidated to consolidated marine sedimentary rocks. The geologic formations within San Joaquin County cover a wide range of geologic time – from Recent to Pre-Cretaceous. Between 6 to 10 miles of sediment have been deposited within the Central Valley and include both marine and continental gravel, sand, silt and clay.

During the middle Cretaceous, parts of the Central Valley were inundated by the Pacific Ocean resulting in deposition of marine deposits. Marine conditions persisted into the middle Tertiary times after which time the sedimentation changed from marine to continental. The material source for the continental deposits are the Coastal Ranges and Sierra Nevada which are composed primarily of granite, related plutonic rocks and metasedimentary and metavolcanic rocks that are from Late Jurassic to Ordovician age (Bertoldi, et al, 1991). The Central Valley has one natural surface water outlet, the Carquinez Strait located east of San Francisco Bay (USGS).

The geologic formations within the Central Valley and San Joaquin County are generally grouped as either east-side or west-side formations based on their location relative to the San Joaquin River, and the source of the sedimentary material of which they are composed. Eastside formation material originated in the Sierra Nevada and west side in the Coastal Ranges. Table 2-1 shows a generalized stratigraphic column for San Joaquin County.

Table 2-1
Generalised Stratigraphic Column For San Joaquin County

System	Series	Formation	Location	Thickness	Symbols	Rock Characteristics and Environment	Hydrogeological Description
Quaternary	Recent	Stream Channel Deposits	Eastside & Westside		Qk	Continental unconsolidated gravel, and coarse to medium sand deposited along present stream channels	High permeability, unimportant to groundwater except as avenue for percolation
	Recent to Late Pleistocene	Alluvial Fan Deposits	Westside	0 to 150 ±	Qal	Continental fan deposits-heterogeneous, discontinuous mixtures of gravel, sand, silt, clay.	Moderate to locally high permeability, unconfined aquifers.
		Recent Alluvium and Victor	Eastside	0 to 150 ±	Qalv	Continental fan and interfan material, locally some basin type. Lenticular gravel, sand, silt, clay.	Moderate permeabilities, unconfined aquifers.
		Flood Basin Deposits	Eastside & Westside	0 to 1400 ±	Qb	Continental basinal equivalent of Laguna, Tulare, and younger fms. Clay, silt and sand, organic in part	Generally low permeabilities, saturated environmenta, unconfined to confined.
Tertiary	Plio-Pleistocene	Tulare	Westside	0 to 1400 ±	QTt	Continental semi-consolidated clay, sand & gravel. Contains Corcoran Clay member.	Moderate permeabilities, genreally unconfined above Corcoran Clay, confined below.
		Laguna	Eastside	0 to 1000 ±	QTL	Continental, semi to unconsolidated silt, sand & gravel, poorly sorted, includes Arroyo Seco Gravel pediment of Mokelumne River area.	Moderate permeability. Unconfined to locally semi-confined. Restricted perched bodies in some areas.
	Mio-Pliocene	Merhten	Eastside	0 to 600 ±	Tm	Continental andesitic derivatives of silt, sand & gravel & their indurated equivalents; tuff; Breccia; agglomerate.	Moderate to high permeability where "black sands" occur. Confined to unconfined. Saline west of Stockton
	Upper Miocene	San Pablo Group	Westside	0 to 1000 ±	Tsp	Continental to marine massive sandstone and shale. Westside equivalent of Mehrten and Valley Springs fms, in part	Low permeability. Saline in part. Essentially nonwater bearing except along fractures and joints.
	Miocene	Valley Springs	Eastside	0 to 500 ±	Tvs	Continental to marine (?) rhyolitic ash, clay, sand & gravel and their indurated equivalents	Low permeability. Saline in Stockton area. Not considered significant in groundwater studies.
	Eocene	Eocene Undifferentiated	Westside	?	Te	Marine shale, siltstone and sandstone	Contains saline waters except where flushed in outcrop areas. Unimportant to freshwater basin except as possible contaminant source.
Cretaceous	Cretaceous	Cretaceous Undifferentiated	Westside	?	K	Marine shale, siltstone and sandstone	Contains saline waters, unimportant to freshwater basin except as possible contaminant source.
Pre-Cretaceous	Jurassic	Franciscan Group, Undifferentiated	Westside	?		Marine shale, sandstone, chert metamorphics, serpentine.	Unimportant to freshwater basin except as possible contaminant source.

Source: Adapted from: San Joaquin County Ground Water Investigation, Bulletin No. 146, California Department of Water Resources.

Table 2-2
Generalised Stratigraphic Column

System	Series	Formation	Location	Thickness	Symbols	Rock Characteristics and Environment	Hydrogeological Description
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Tertiary		Laguna	Eastside	0 to 1000 ±	QTL	Continental, semi to unconsolidated silt, sand & gravel, poorly sorted, includes Arroyo Seco Gravel pediment of Mokelumne River area.	Moderate permeability. Unconfined to locally semi-confined. Restricted perched bodies in some areas.
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Source: Adapted from: San Joaquin County Ground Water Investigation, Bulletin No. 146, California Department of Water Resources.

The following formations have limited water-producing capabilities or contain water of marine origin (DWR Bulletin No. 146, 1967):

- Franciscan group,
- the undifferentiated Cretaceous formations west of Tracy,
- Eocene/Ione formation
- Undifferentiated Eocene
- Miocene eastside Valley Springs formation
- West side San Pablo group

The most important east-side fresh water-bearing formations are the Mehrten, Laguna, Victor, and alluvial deposits. The principal west side water bearing formations are the San Pablo Group, the Tulare, and alluvial deposits. They are discussed in more detail in subsequent sections.

2.1.2 Soil Distribution

DWR Bulletin 147 groups soils within San Joaquin County into five main categories which generally coincide with the general geology:

- Alluvial fan and flood plain soils
- Organic basin soils
- Interfan and basin soils
- Lower terrace soils
- Higher terrace and upland soils

The alluvial fan and flood plain soils are further classified into the Mokelumne, the Calaveras and the Stanislaus River Fans, which are moderately to highly permeable (Montgomery Watson, 1999). The organic basin soils are found in the lower Delta area of the County and have low infiltration rates (DWR, 1967). The basin and interfan soils are typically found between the Mokelumne, Calaveras and Stanislaus River Fans and very low infiltration rates (Montgomery Watson, 1999). The lower and higher terrace soils occur along the eastern edge of the County. The lower terrace soils contain clay and claypan, the higher terrace soils contain weathered materials originating from underlying rock formations and both exhibit very low infiltration capacities.

2.2 Hydrogeologic Setting

A description of the regional hydrogeological setting of the study is provided in the following subsections.

2.2.1 Regional Hydrogeology

The regional aquifer system within the Central Valley is comprised of post-Eocene continental fluvial deposits with some interbedded lacustrine deposits and volcanic material (Bertoldi, et al, 1991). These formations overlie Tertiary and pre-Tertiary formations that generally contain saline water (Williamson et al, 1989).

Within San Joaquin County the most important east-side fresh water-bearing formations are the Mehrten, Laguna, Victor, and alluvial deposits. The east-side formations are described in more detail below.

- **Mehrten**: The Mehrten Formation is considered the oldest significant fresh water-bearing formation within eastern San Joaquin County. It is exposed in the eastern most portion of the county, and slopes steeply from 90 to 180 feet per mile reaching a depth of 800 to 1000 feet and a thickness of 400 to 600 feet in the Stockton area, (DWR, 1967). Consisting of stream-deposited, semi-consolidated to consolidated silt, sand, and gravel, the formation is often subdivided into upper and lower units. The upper unit is reported to contain finer grained deposits (black sands interbedded with brown-to-blue clay) and the lower unit consists of dense tuff breccia (Page, 1986). Consequently, groundwater is reported to be semi-confined in the Stockton area. The Mehrten Formation has moderate to high permeability (where black sands occur) (DWR, 1967, Brown & Caldwell, 1985).

- **Laguna**: The Laguna Formation outcrops in the northeastern part of the County and dips at 90 feet per mile (DWR, 1967), and reaches a maximum thickness of 1,000 feet. It consists of discontinuous lenses of unconsolidated to semi-consolidated sand and silt with lesser amounts of clay and gravel. The Laguna Formation is moderately permeable with some reportedly highly permeable coarse-grained beds and generally unconfined, but semi-confined conditions probably exist locally. Some studies have suggested that Corcoran Clay (an extensive aquitard found in the westside Tulare Formation) extends into the Laguna Formation or separates the Laguna and Mehrten Formations (Brown & Caldwell, 1985).

- **Victor**: The Victor Formation is of Holocene to Pleistocene age and consists primarily of stream deposited unconsolidated gravel, sand, silt, and clay. Coarser sand and gravel is found to the east, and sand, silt and clay towards the west. This formation is generally more permeable than underlying formations, and groundwater within it is typically unconfined.

- **Alluvial/Stream channel deposits**: Stream channel deposits are found along major stream and river courses within the study area. Generally they consist of unconsolidated gravel and coarse sand, and have high permeability.

The western and southwestern portions of San Joaquin County are not as significant sources of groundwater as the eastern portion of the County. The principal formations in western and southwestern San Joaquin County are the San Pablo Group, Tulare , and the alluvial deposits.

- **San Pablo Group:** The San Pablo Group is a Miocene formation (westside equivalent of the Mehrten Formation) and consists of primarily continental to marine sandstone and shale. It is considered to have relatively low permeability and is essentially non-water bearing except in fractures and joints.

- **Tulare Formation:** A Plio-Pleistocene age formation (westside equivalent of the Laguna Formation) consisting of primarily continental semiconsolidated clay, sand and gravel. This formation contains the Corcoran Clay member, dividing the formation into upper and lower units. The Corcoran Clay is an impermeable confining lacustrine deposit varying in thickness from 0 to 150 feet. The eastern limit of the Corcoran Clay is the San Joaquin River (DWR, 1967). The upper section is permeable to moderately permeable and unconfined to confined. The lower section is highly to variably permeable and is generally confined.

- **Alluvial deposits:** These deposits in the west and southern parts of San Joaquin County are areally extensive but generally thin ranging from 0 to 150 feet (DWR, 1967). They consist of unconsolidated gravel and coarse sand derived from the Coast Ranges, and are permeable to moderately permeable.

Groundwater quality in the west portion of the County is generally poor. Historically salinity intrusion into the Delta has extended as far east and south as Roberts Island – approximately midway between Stockton and Manteca (California State Water Resources Control Board, 1978).

2.2.2 Aquifer Units

In general it is difficult to define the contacts between the Victor, Laguna and Mehrten Formations because of the similar nature of their lithology (DWR, 1967). Previous studies and investigations have generally considered the Sacramento Valley as containing one unconfined aquifer and the San Joaquin Valley as containing two aquifers separated by a regional confining unit. More recent studies have proposed the concept of a single heterogeneous aquifer system spanning the thickness of the continental deposits, that has varying vertical leakance and confinement depending on fine-grained sediments (Bertoldi, et al, 1991). Existing local and regional models of the Central Valley, (CVGSM model, Sacramento and San Joaquin County IGSM models) reflect both concepts of the Central Valley aquifer systems. These are described below:

The CVGSM model has 3-layer aquifer system. The layers within the Sacramento Valley are summarized below:

- Top layer: Represents mid-Pleistocene and younger deposits such as the Alluvium and Victor formations.

- Middle Layer: Represents Pliocene and younger formations such as Laguna, and Mehrten formations. The base of layer 2 is the base of the main groundwater-pumping layer.

- Bottom layer: Represents Miocene and older formations, the base of which is the base of fresh water.

- Within the San Joaquin Valley portion of the CVGSM, a regionally extensive confining unit is modeled which represents the Corcoran Clay.

- The Sacramento County IGSM model has a 3-layer system representing the Miocene Valley Springs, Pliocene Mehrten, the Pleistocene Laguna and Victor and the Holocene Alluviam formations. A regionally extensive aquitard is also represented.

- The San Joaquin County IGSM model has a 3-layer system with no explicit confining unit, but with variable vertical leakance in the 3 layers. No conceptual model was provided with the San Joaquin County model however, it appears that the model represents essentially a two-aquifer system. A shallow alluvial type aquifer, and a deeper Laguna/Mehrten aquifer. A third layer is modeled but is assumed to represent an unusable high TDS and/or marine water bearing formation, probably representing the Miocene Valley Springs Formation. This

- Brown and Caldwell developed a model of the Eastern San Joaquin Groundwater Basin in 1985. This model represented the aquifer system within San Joaquin County as a 2-aquifer (3 layer) system. The upper aquifer comprising of the Victor and Laguna formations, and a confined lower aquifer comprising of the Mehrten.

2.2.3 Aquifer Hydraulic Properties

Existing data on aquifer properties (e.g., transmissivities, hydraulic conductivities, storage coefficients, etc.) are primarily based on specific capacity data from installed wells. Aquifer heterogeneity is reflected in the large range of parameter values that have been used in various modeling efforts, summarized below:

- Under the USGS Regional Aquifer-System Analysis (RASA) modeling of the Central Valley, an average horizontal hydraulic conductivity of 6 ft/d was reported based on the model calibration (Williamson et al, 1989). Within the Eastern San Joaquin Basin values of horizontal hydraulic conductivity ranged from 1 to 13 feet per day. The San Joaquin IGSM model has been calibrated with a wide range of aquifer permmeabilities – but typically much higher than the USGS model. Horizontal hydraulic conductivity ranges from 5 to 300 feet per day.

- Analyses conducted on unconsolidated sediments in the Central Valley (Bertoldi, et al, 1991) showed hydraulic conductivities to be range from less than 1 to 14 feet per day. Measured porosity typically ranged from 30 to 40 percent.

2.2.4 Regional Groundwater Flow Patterns

Regional groundwater flow patterns have been significantly altered since pre-development conditions. The pre-development and current/post-development groundwater flow patterns are discussed below.

2.2.4.1 Pre-Development Conditions

Groundwater was used for agriculture in the Central Valley starting around 1850, prior to which time the groundwater system was in a state of hydrologic equilibrium (Williamson, et. al., 1989). Under equilibrium or steady-state conditions, groundwater flowed from the natural recharge areas along the perimeter of the valley towards the low areas along the San Joaquin River. The natural groundwater and surface water discharge was through the Delta westward to San Francisco Bay. Under pre-development conditions groundwater gradients within San Joaquin County were likely similar to the topographic gradient, or around 0.0012 ft/ft.

2.2.4.2 Post-Development Conditions

Beginning in 1850 the development of groundwater for agriculture expanded rapidly. Within the Central Valley irrigated agricultural has grown from less than 1 million acres around the turn of the century, to an estimated 7 to 8 million acres at present. Within eastern San Joaquin County, an estimated 800 thousand AF/year (TAF/year) of groundwater was being extracted by 1993.

Figures 2-1 through 2-4 illustrate groundwater table contours for spring and fall 1993 and 1998. The map clearly shows the significant cone of depression west of Stockton. Regional groundwater flow now converges on this low point, with relatively steep groundwater gradients (0.0018 feet/feet) westwards towards the cone of depression, and eastward gradients from the Delta area on the order of 0.0008 feet/feet. The eastward flow from the Delta area is significant because of the typically poorer quality water.

2.2.5 Groundwater Level Trends

The groundwater level trends illustrate the change in groundwater flow patterns described above. Hydrographs for selected wells and subregions are presented in Figure 2-5 through 2-8 and a map of the well locations is shown on Figure 2-9.

Figures 2-5 illustrates groundwater levels for selected wells located in and around the principal cone of depression in eastern San Joaquin County. The groundwater levels in these wells clearly illustrate the significant decline in water levels since the 1960s, an average drop of 60 feet. Wells on Figure 2-5 illustrate average groundwater level drops of around 1.3 feet per year. In general, the lowest groundwater levels were reached in the late 1970s, recovering 10 to 20 feet, but then declining again in the mid-1990s. Wells in this area have a significant seasonal variation of 10 to 20 feet.

Figure 2-6 illustrates groundwater levels for wells located further away from the main cone of depression, primarily further west and north. These wells show a less dramatic drop than wells in Figure 2-5, and more noticeable increase due to the wet years of 1981 through 1983 (total rainfall in 1983 was more than double the long-term average). The seasonal variation in these wells is distinct but not as pronounced as shown on Figure 2-5.

Towards the southern portion of the county and into Stanislaus county wells shown on Figure 2-7 also illustrate the decreasing trend from the 1960s through the 1980s. These wells exhibit a less dramatic response to both climatic and seasonal variations. Water levels in this area are also more influenced by surface water features such as the Stanislaus and San Joaquin River.

In the north and northeast areas of the County water levels do not generally show a dramatic decline in groundwater levels. Figure 2-8 shows groundwater levels at selected wells in this area. Groundwater levels in this area of the County are more controlled by the Delta.

In summary, the hydrographs reviewed illustrate the following general patterns:

- In the central part of the County the groundwater table dropped continuously from the 1950s and possibly earlier to the mid 1980s. The decline was temporarily reversed due to climatic events.

- In the northern part of the County groundwater table decline continued into the early 1990s.

- Starting in the early 1980s a distinct drawdown and recovery cycle appears to have developed. The cycle covers a 10 to 15 year time period, and appears to be driven by climatic conditions more than long-term changes in groundwater use.

- This recovery and drawdown cycle may indicate that groundwater levels are beginning to equilibrate under current groundwater/surface water use patterns.

2.2.6 Groundwater Discharge

The estimates of groundwater discharge and recharge presented in these sections are based on the modeling conducted by CDM for the San Joaquin County Water Management Plan, and the modeling originally conducted for for the American River Water Resources Investigation (AWRI, 1996), and updated in 1999 for the Bureau of Reclamation by CH2Mhill (CH2MHill, 1999). The results are for the ESJCGB only.

2.2.6.1 Pumping

Groundwater pumping records are not typically available for all wells within the study area. The approach adopted by DWR and other agencies to estimate groundwater withdrawals is based on land use and population. Figure 2-10 illustrates the 'simulated' total agricultural and municipal groundwater pumping for the for ESJCGB. Average annual groundwater withdrawal for the period from 1970 to 1993 was 850 TAF.

2.2.6.2 Lateral Outflow

Under predevelopment conditions, lateral outflow from the ESJCGB discharged to the San Joaquin River and the Delta area. For the period from 1970 to 1993, the net flow was positive, indicating no net groundwater outflow from study area.

2.2.7 Groundwater Recharge

2.2.7.1 Deep Percolation

The amount of water from natural and human activities that reaches the groundwater table is referred to as deep percolation. Deep percolation is the net of rainfall, applied irrigation water, consumptive use, evapotranspiration, runoff, and unsaturated zone retention. Average rainfall within the study area is 14-16 inches per year. Figure 2-11 illustrates total annual rainfall for the Lodi Station. Within ESJCGB the estimated net deep percolation based on the modeling results is 590 TAF. Figure 2-12 illustrates the deep percolation for eastern San Joaquin County.

2.2.7.2 Lateral Inflow

Lateral inflow into the study area occurs primarily across the northern, western and southern boundaries. Under predevelopment conditions a net outflow existed, however due to the changed hydraulic conditions in eastern San Joaquin area there is now a net groundwater inflow. The groundwater model estimates net lateral inflow to be 120 TAF for the 1970 to 1993 period.

2.2.8 Surface Water Interaction

A large number of streams and rivers dissect the study area. The rivers that have a regional impact on the hydrogeology are Cosumnes River, Mokelumne River, Dry Creek, Calaveras River, Stanislaus River, Tuolumne River and San Joaquin River.

Based on modeling results for the five-year period from 1989 to 1993 the Tuolumne and the upstream reaches of the Mokelumne and San Joaquin Rivers were gaining rivers – that is groundwater discharged into the rivers. The Calaveras, Dry Creek, Stanislaus and the downstream reaches of the Mokelumne and San Joaquin Rivers were all losing rivers – i.e. surface water recharged the groundwater. On average from 1970 to 1993 there was a groundwater gain from streams of 140 TAF, and a groundwater loss to streams of 100 TAF. The net gain to the groundwater system was 40 TAF.

2.3 Preliminary Assessment

In the following subsections a preliminary assessment of the key issues with regard to the groundwater basin are discussed.

2.3.1 Water Balance

Water budgets for the ESJCGB are presented in Table 2-3.

Table 2-3
Simplified Groundwater Balance for Eastern San Joaquin County

Groundwater Flow Component	Average Value	Explanation
	Inflows	
Net Deep Percolation/Recharge	590 TAF	Net infiltration from rainfall, irrigation, canal leakage etc.
Gain from Streams	140 TAF	Net inflow from streams to groundwater system
Lateral Inflow	120 TAF	Net of subsurface inflows and outflows.
Total Inflows	**850 TAF**	
	Outflows	
Groundwater Pumping	850 TAF	Net agricultural, municipal and industrial pumping
Loss to Streams	100 TAF	Net outflow from groundwater system to streams
Total Outflows	**950 TAF**	
Aquifer Storage Loss	**100 TAF**	Total Inflows – Total Outflows
Total Estimated Overdraft	**130 – 160 TAF**	Sum of Aquifer storage loss and saline water intrusion (lateral inflow)

Table 2-3 illustrates the issue concerning groundwater use in San Joaquin County – that is the current and historical groundwater pumping exceeds the groundwater replenishment rate or the sustainable yield of the ESJCGB. The net overdraft in the ESJCGB is estimated to be approximately 160 TAF, derived from the 100 TAF loss of aquifer storage, plus the lateral inflow from the Delta area, which groundwater modeling estimated to be between 30 and 65 TAF.

The result of this overdrafting is two fold. The first impact is a continued decline in groundwater levels as groundwater is withdrawn from storage. The second impact is increased inflows and recharge from rivers, streams and adjacent areas. This is not necessarily always a negative impact but, in the case of the ESJCGB, increased inflows from the west is undesirable due to the higher levels of salinity in groundwater west of the San Joaquin River. Increased salinity in the Stockton areas has caused several wells to be abandoned, and continued overdrafting will cause similar problems further east into the basin.

The estimated acreage that is irrigated with groundwater is approximately 352,000 acres, shown in Section 1 (222,400 groundwater only plus 129,300 mixed groundwater surface water irrigated) Given the estimated current pumping rate of 850 TAF, that equates to an average rate of withdrawal of 2.42 feet per acre (850 TAF divided by 352,000 acres). Furthermore, using the estimated overdraft of 160 TAF, per acre usage of groundwater would have to be reduced by approximately 0.45 feet. To summarize:

- Current groundwater withdrawal is estimated to be 2.42 feet per acre for groundwater, and mixed groundwater-surface water use areas.

- To reduce overdraft, groundwater withdrawal would need to be reduced by approximately 0.45 feet per acre.

- The sustainable rate of groundwater withdrawal is therefore approximately 1.96 feet per acre (2.42 feet minus 0.45 feet).

Figure 2-13 illustrates a cumulative change in groundwater storage for 1970 to 1993 for Eastern San Joaquin County. In general, this graph shows a significant loss of groundwater storage over the 24 year period. Only in wet years (Sacramento River Index 1982, 1983, 1984) does the basin show a temporary reversal in storage reduction.

If basin restoration measures were to be implemented an assumed upper limit of water levels would be the 1986 levels, and a lower limit the 1993 levels. The total groundwater storage change between 1993 and 1986 from the IGSM model results is 1.2 MAF. This can be considered as either (a) the total quantity of water required over the long term to restore the basin to 1986 levels, or (b) the available operational storage capacity and of the basin.

2.3.2 Baseline Conditions

The data and IGSM modeling results presented in preceding sections form the basis for evaluating the current/baseline condition of the basin. The baseline condition is important as it provides the basis for comparing different water management alternatives.

Specifically, the baseline conditions refer to the continued use of the San Joaquin Groundwater Basin without any countywide integrated management or basin restoration measures. For example:

- No San Joaquin County sponsored basin restoration or conjunctive use projects are implemented.

- Groundwater pumping continues in what has been referred to as "unrestricted" mode. That is, all water demands not met by surface water are met by groundwater pumping.

Some of the potential impacts of continued "business as usual" are:

- Possible continued decline of groundwater levels. Groundwater modeling studies of Eastern San Joaquin Groundwater Basin conducted under the ARWI and the Mokelumne Aquifer Recharge Study indicated that groundwater levels in the Stockton area could drop another 10 to 20 feet under 'no-action' or 'unrestricted groundwater pumping' conditions (ARWI, 1996).

- Continued degradation of water quality by lateral intrusion of higher salinity water from the Delta area.

- Possible continued degradation of water quality by "upconing" of poor quality water from deeper formations.

- Increased reliance on surface water resources (from within and outside of the County) – which may be less reliable, and are subject to more diverse and complex external factors.

These impacts all threaten the long-term sustainability of the groundwater resource.

- Continued decrease in total groundwater storage.

- Increased pumping costs.

- Increased capital costs in installing/redrilling wells.

The surface water/groundwater model will be applied to further quantify the baseline conditions. This involves simulating the baseline or 'no action' conditions with appropriate future water demands and supplies.

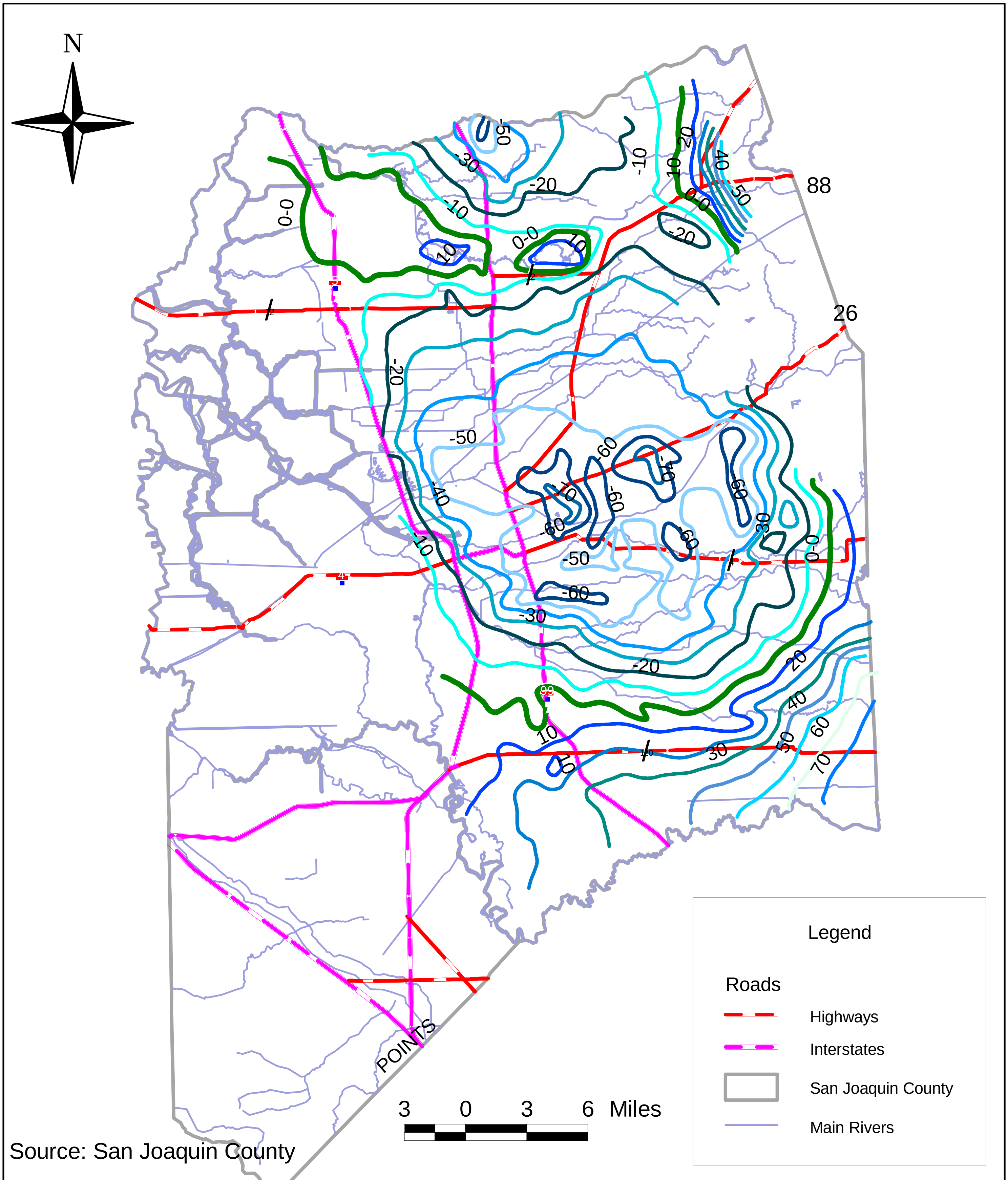
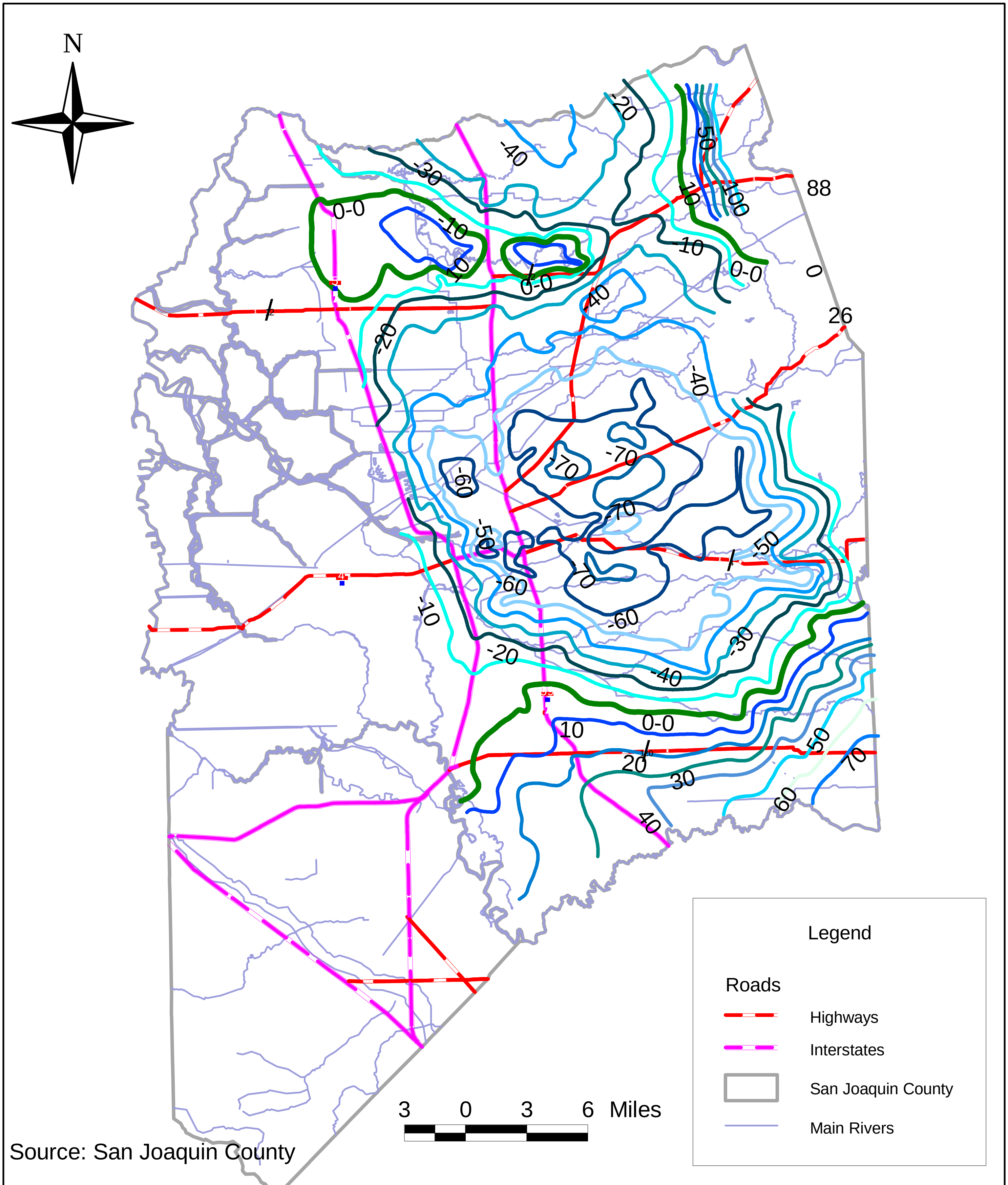


Figure 2-1
Spring 1993 Groundwater Table Elevation (Feet, msl)
San Joaquin County Water Management Plan

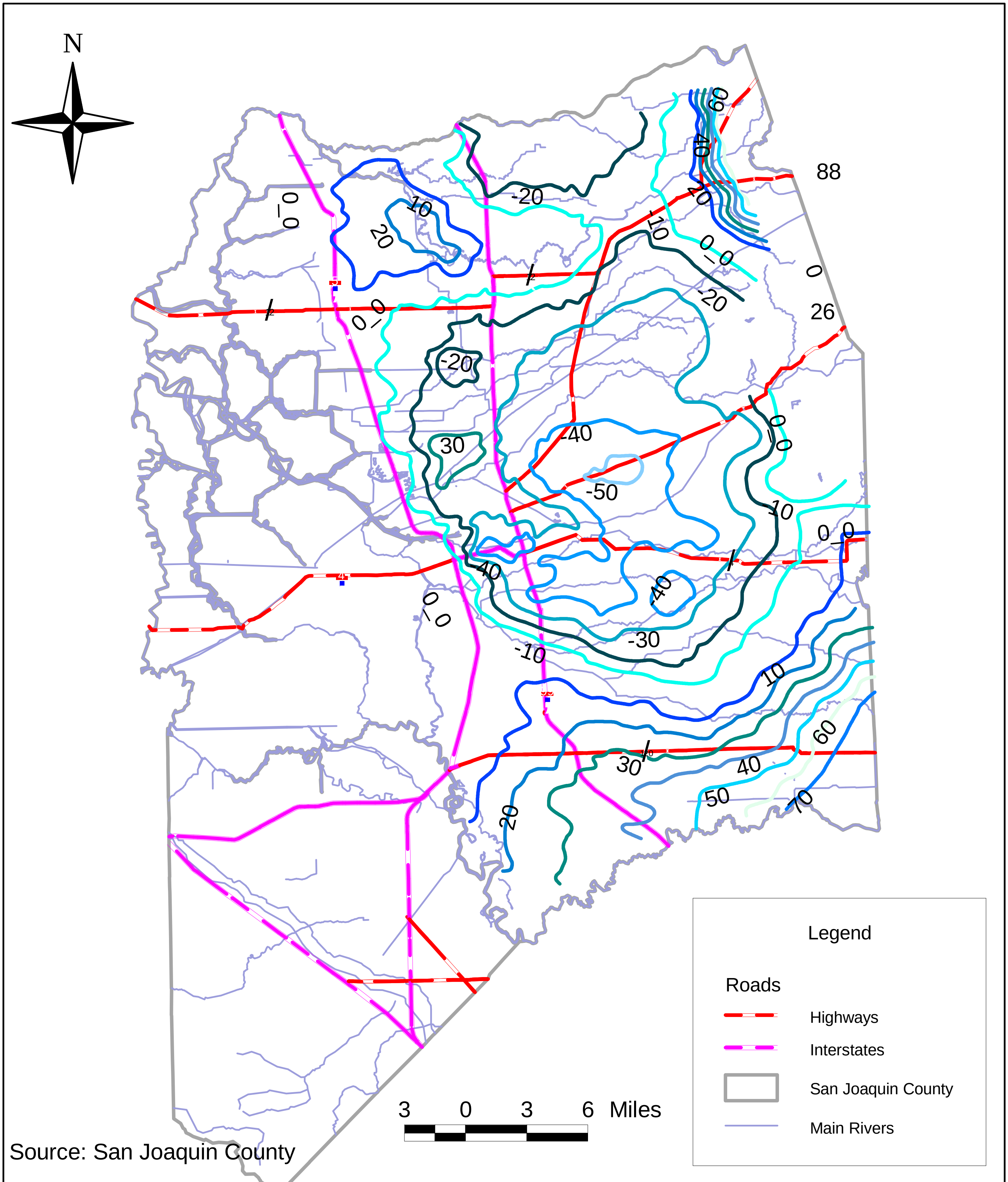
CDM Camp Dresser & McKee Inc.



Source: San Joaquin County

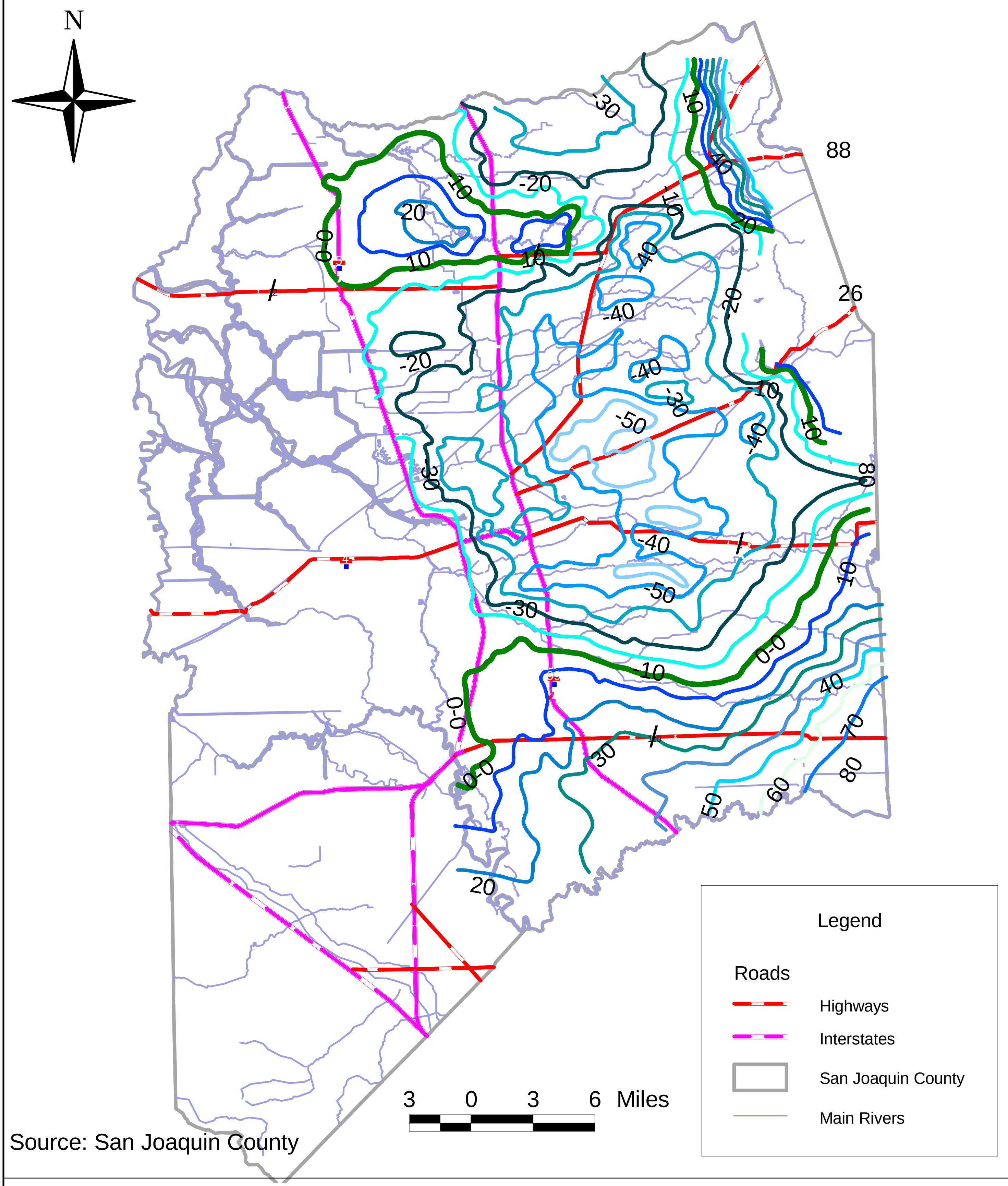
Figure 2-2
Fall1993 Groundwater Table Elevation (Feet, msl)
San Joaquin County Water Management Plan

CDM Camp Dresser & McKee Inc.



CDM Camp Dresser & McKee Inc.

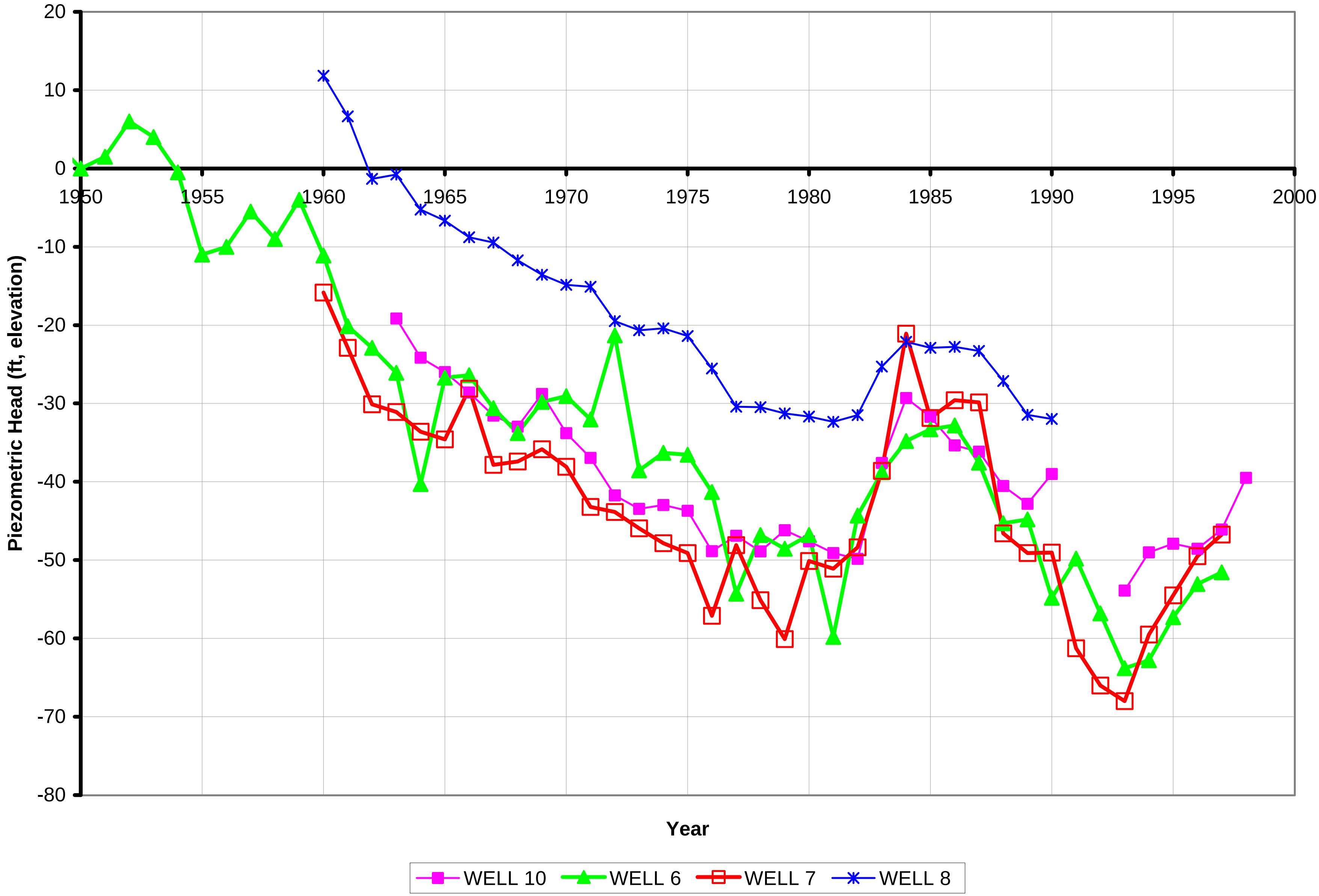
Figure 2-3
Spring 1998 Groundwater Table Elevation (Feet, msl)
San Joaquin County Water Management Plan



Source: San Joaquin County

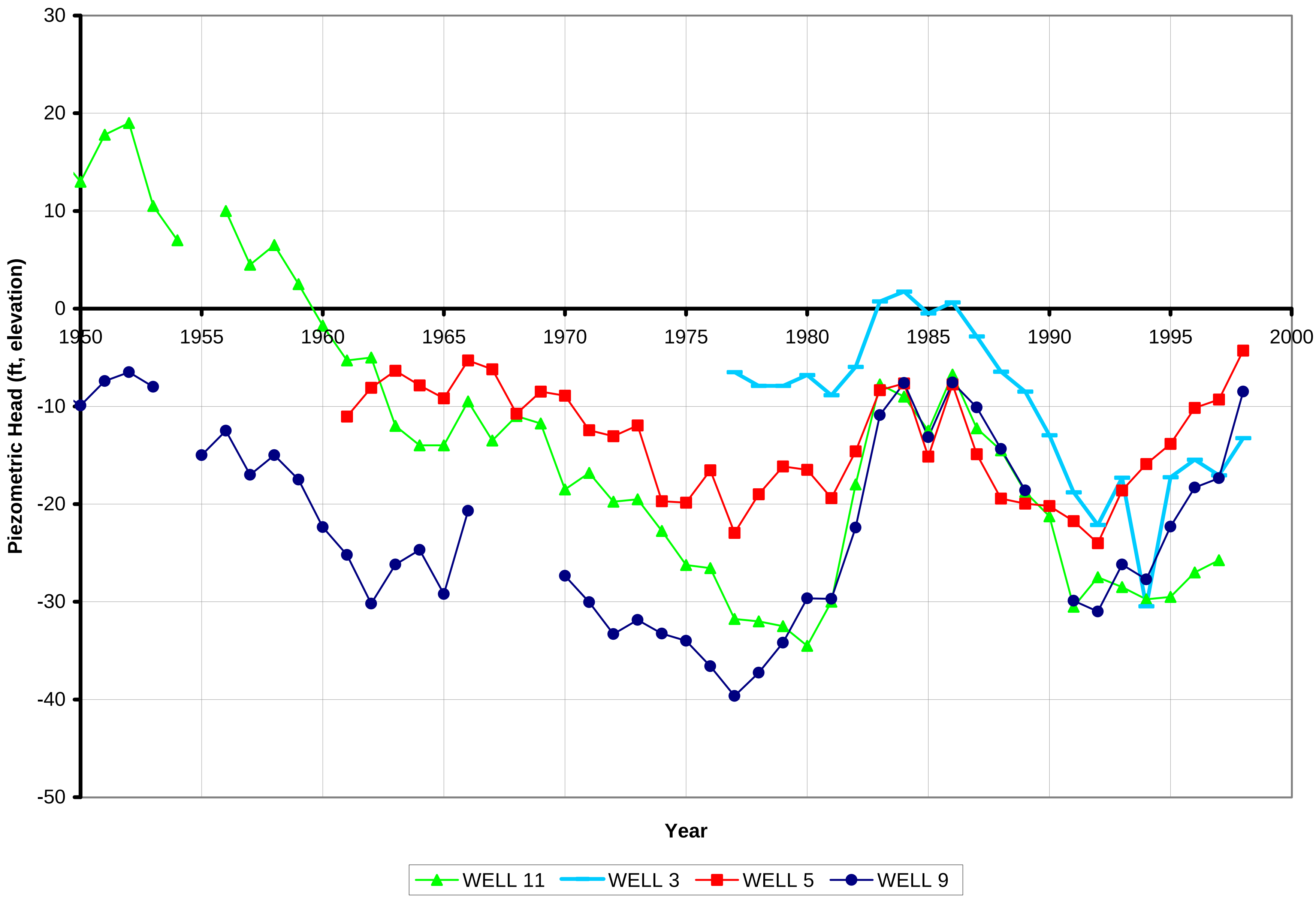
Figure 2-4
Fall 1998 Groundwater Table Elevation (Feet, msl)
San Joaquin County Water Management Plan

CDM Camp Dresser & McKee Inc.



CDM Camp Dresser & McKee Inc.
10/1/01
Selected Water Level Charts-Annual.xls-6,7,8,10

Figure 2-5
Groundwater Hydrographs for Selected Wells
San Joaquin County Water Management Plan



CDM Camp Dresser & McKee Inc.
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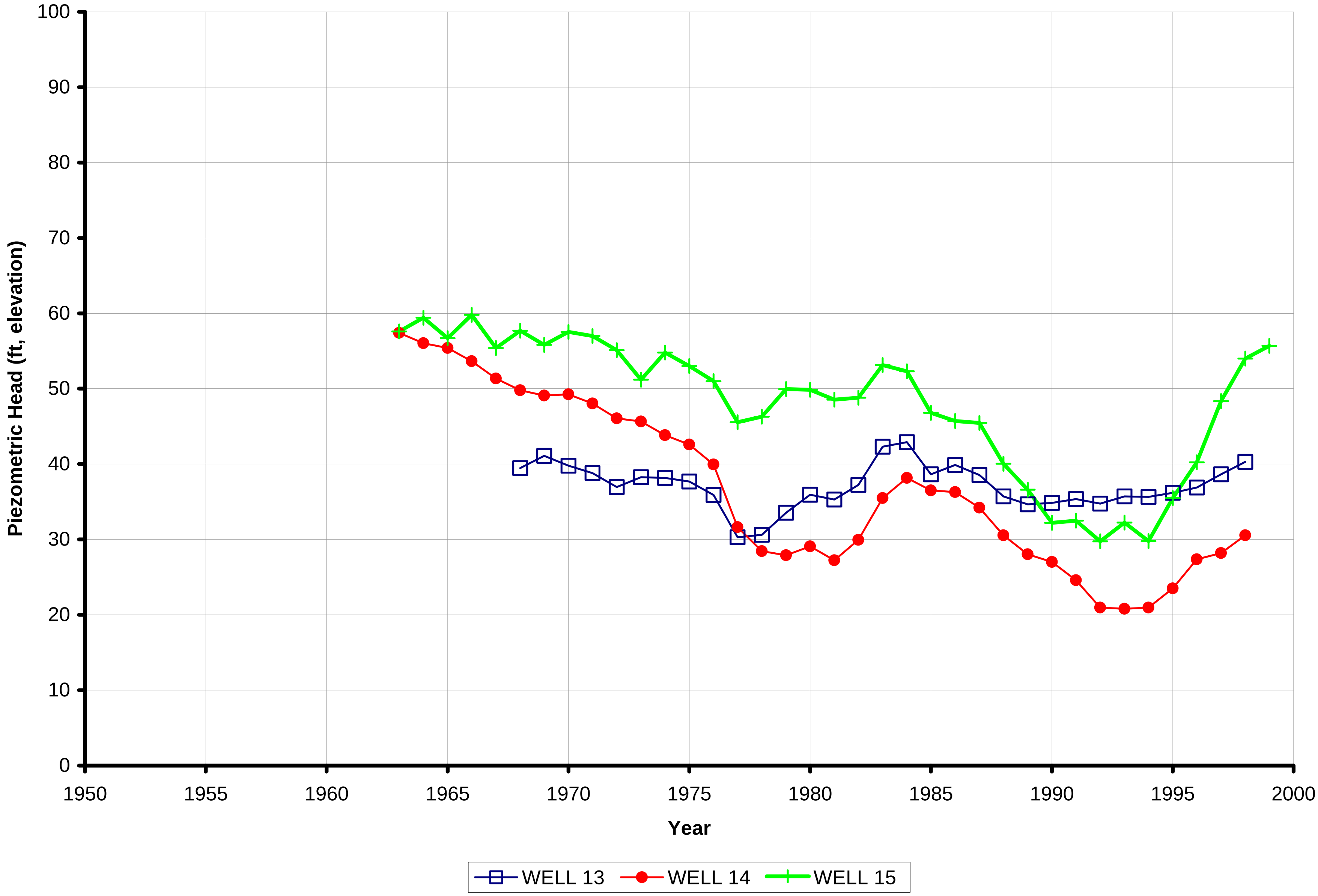
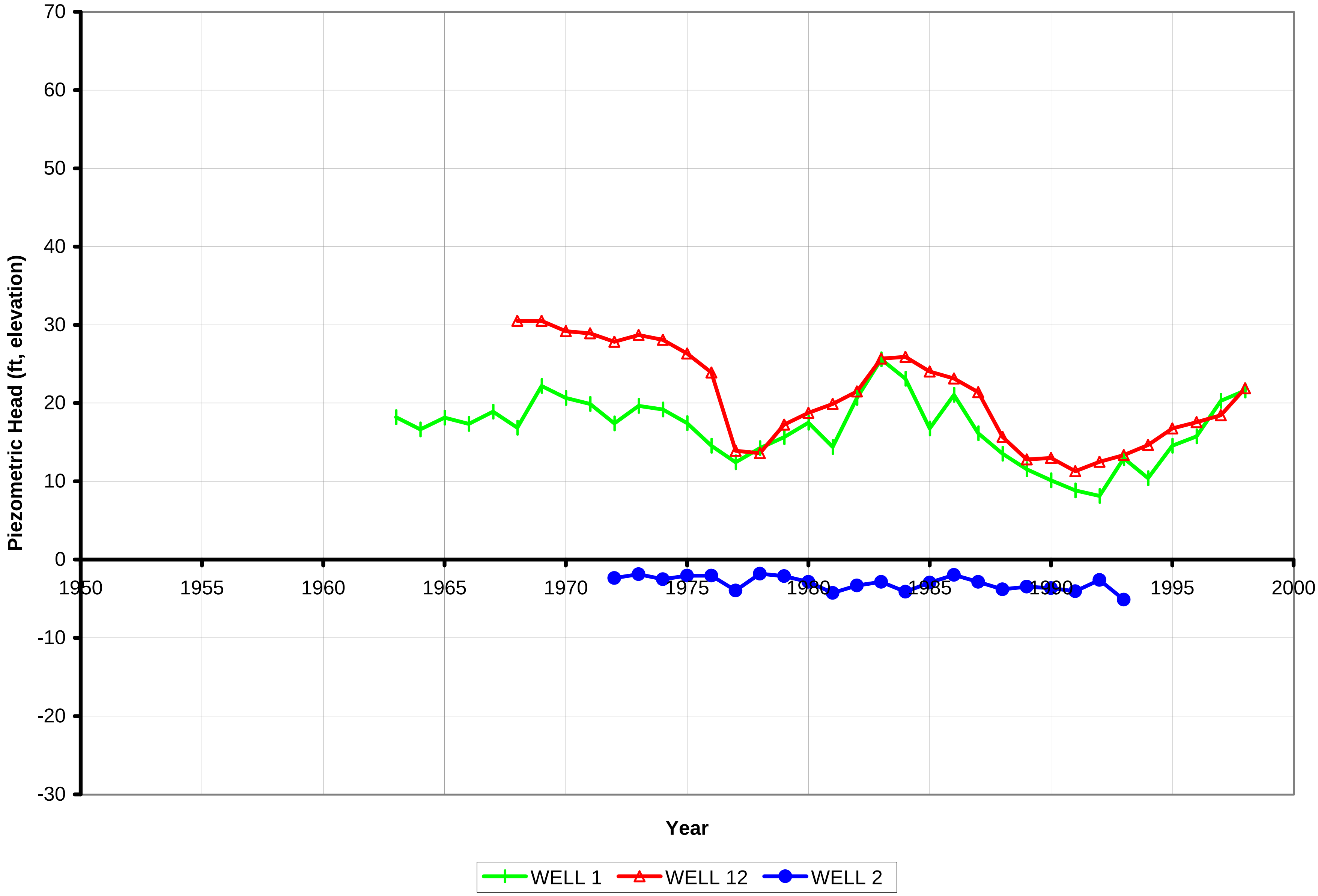
Selected Water Level Charts-Annual.xls-3,4,5,9,11

Figure 2-6
Groundwater Hydrographs for Selected Wells
San Joaquin County Water Management Plan



CDM Camp Dresser & McKee Inc.
10/1/01
Selected Water Level Charts-Annual.xls-13,14,15

Figure 2-7
Groundwater Hydrographs for Selected Wells
San Joaquin County Water Management Plan



CDM Camp Dresser & McKee Inc.
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Selected Water Level Charts-Annual.xls-1,2,12

Figure 2-8
Groundwater Hydrographs for Selected Wells
San Joaquin County Water Management Plan

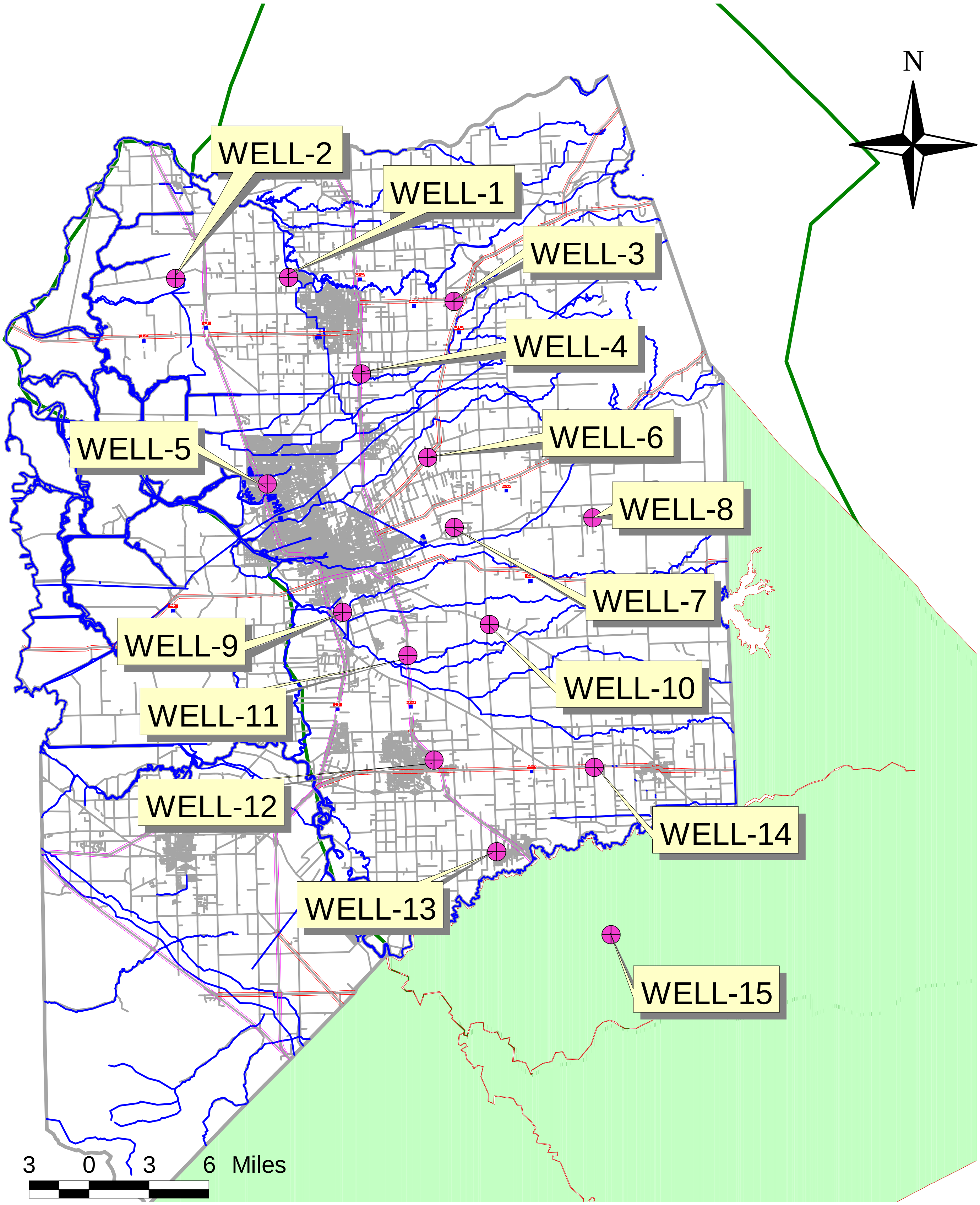


Figure 2-9
Well Hydrograph Location Map
San Joaquin County Water Management Plan

CDM Camp Dresser & McKee Inc.

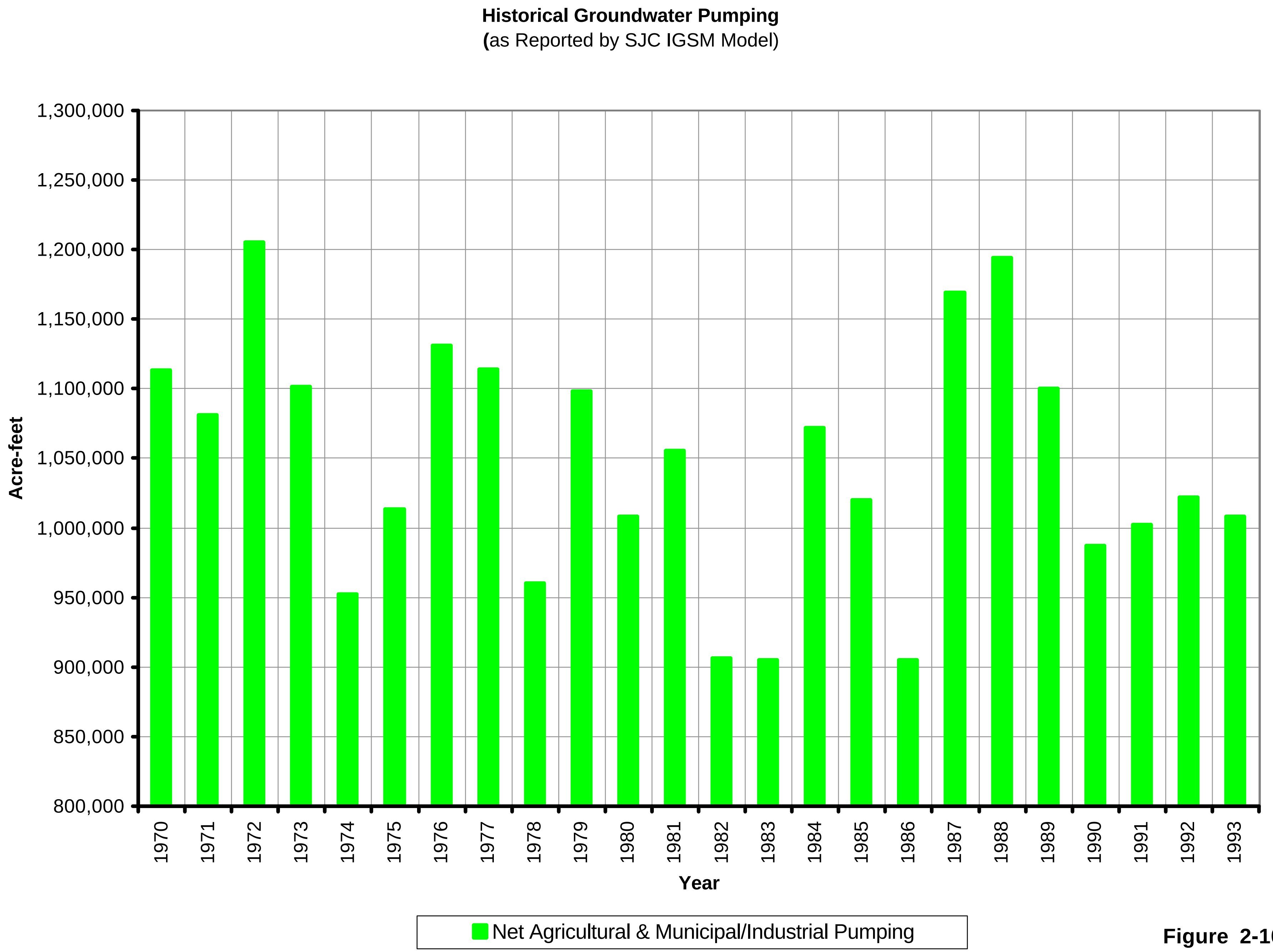
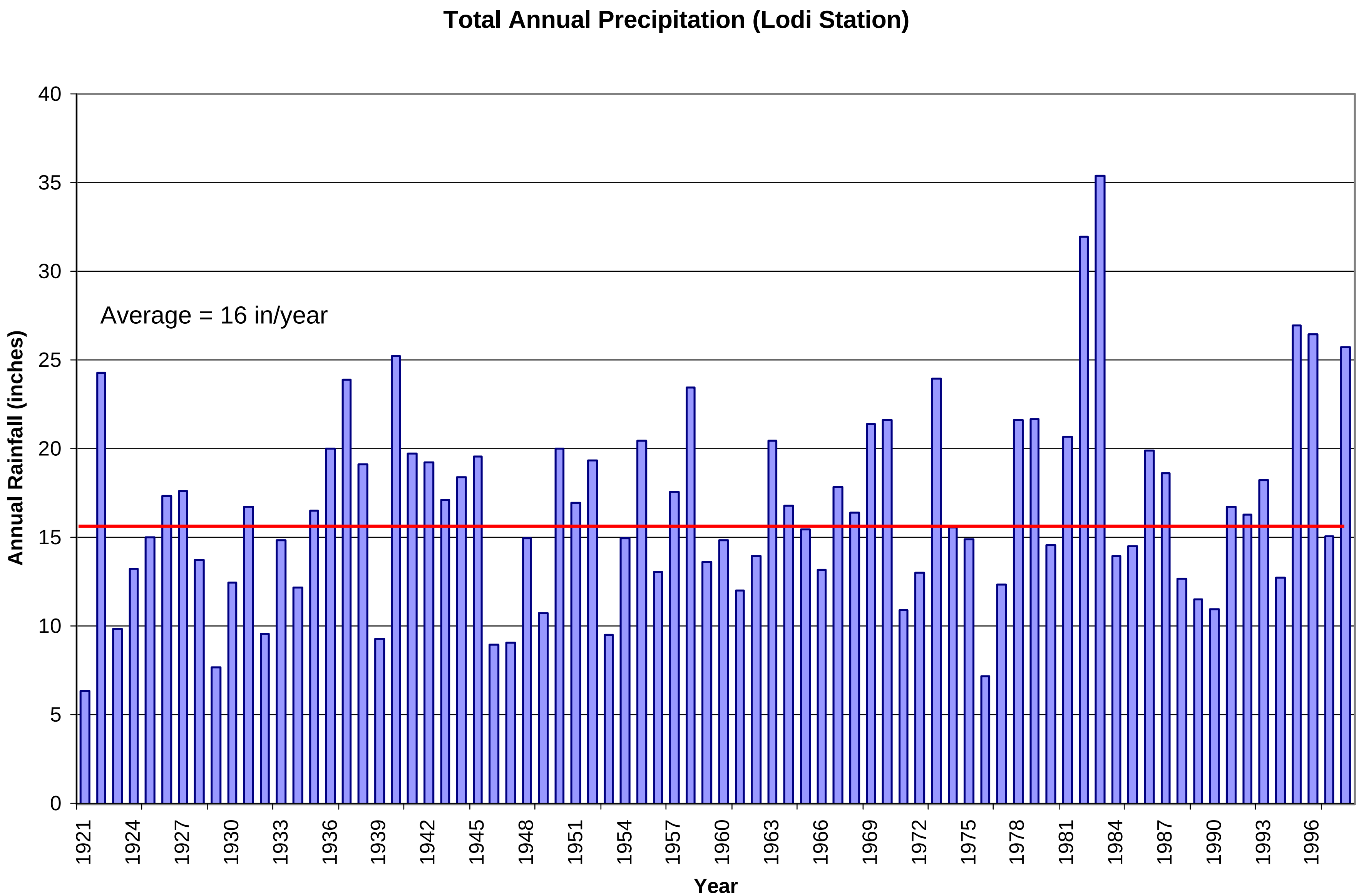


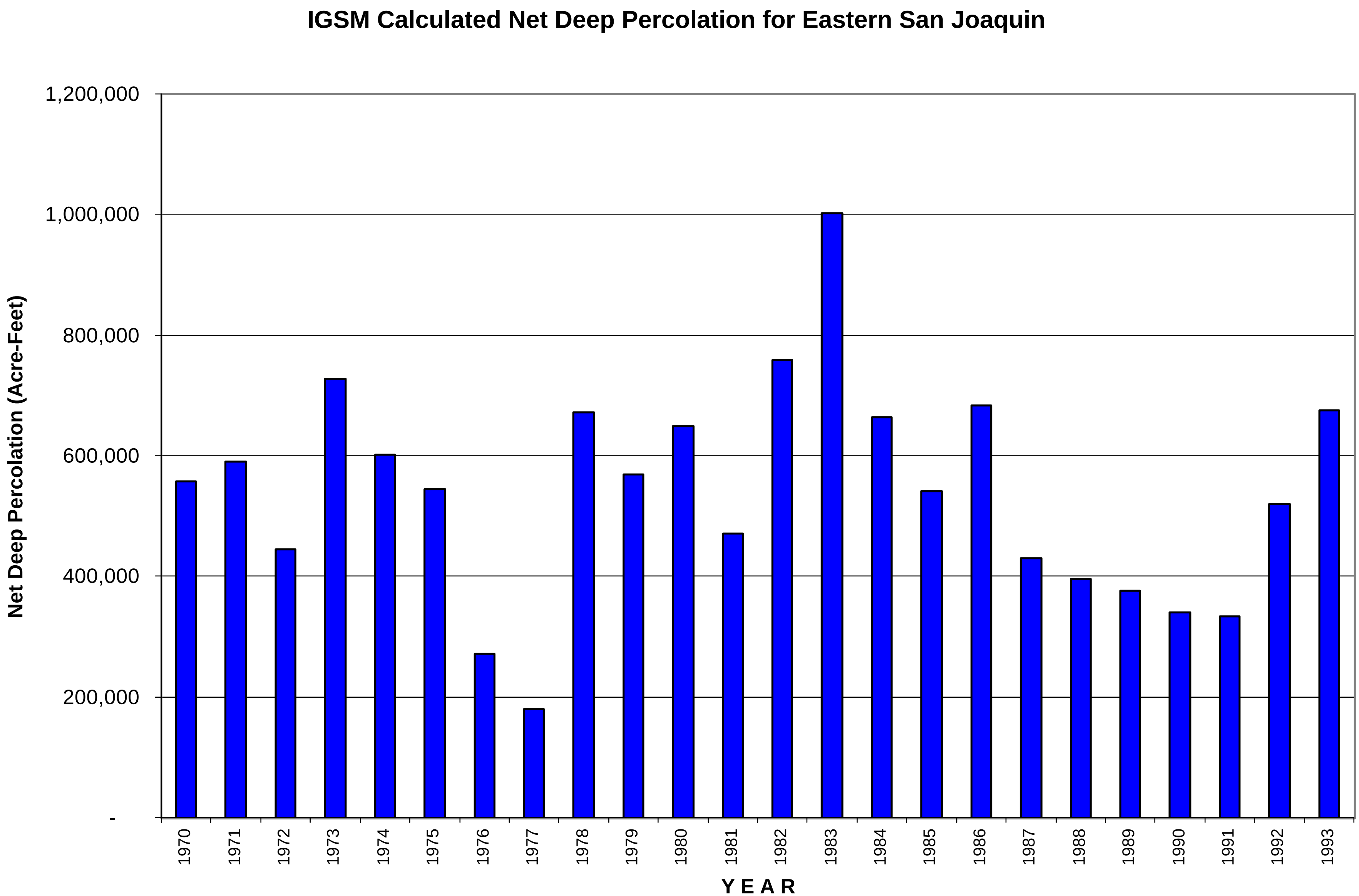
Figure 2-10
Historical Groundwater Pumping Estimates (IGSM)
San Joaquin County
Water Management Plan

A B
IGSM Model Water Balance.xls-IGSM Pumping



A C
IGSM Precipitation.xls-Lodi

Figure 2-11
Total Annual Precipitation (Lodi Station)
San Joaquin County Water Management Plan



A B
IGSM Balance By Subreg.xls-Deep Percolation

Figure 2-12
Net Deep Percolation for Eastern San Joaquin (IGSM Calculated)
San Joaquin Water Management Plan

Cumulative Change in Storage from San Joaquin County IGSM Model

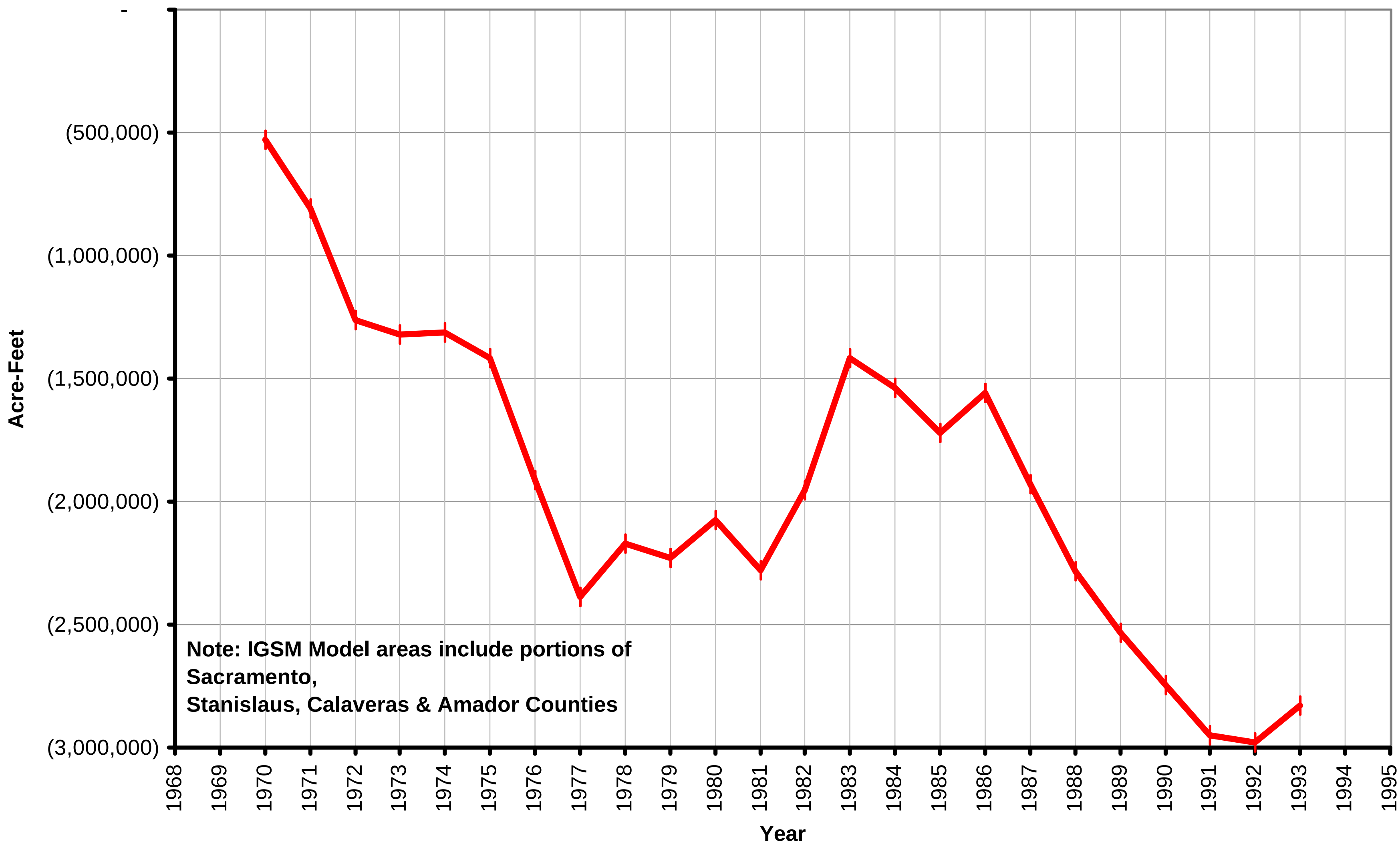


Figure 2-13
Cumulative Change in Storage for IGSM Model Area
San Joaquin Water Management Plan

Section 3
Technical Evaluation

This section outlines the methodology to calculate future (2030) urban and agricultural water demands. Future demands are critical to the plan and must be calculated to determine the amounts of water that must be accounted for in the master plan. In addition, surface water and groundwater rights are described to provide a background for future discussions that will explore new sources of water for the County.

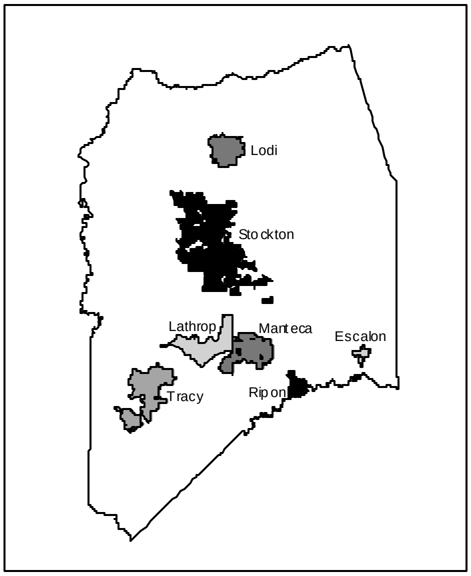


Figure 3-1: Urban Areas in San Joaquin County

3.1 Urban Demand

Urban water agencies provide water for residential, commercial and industrial customers within city boundaries.[1] Figure 3-1 shows the locations of urban areas in the County. Urban populations within San Joaquin County are expected to increase rapidly in the upcoming years due to an influx of Bay Area residents moving eastward in search of more affordable housing. Growth is expected to occur primarily along the western edge of San Joaquin County, including the cities of Tracy and Stockton. The countywide population of approximately 579,712 is projected to increase by an estimated 83%, to 1,060,442 by the year 2030.[2]

3.1.1 Urban Water Agencies

Table 3-1 summarizes general data for these urban areas. The subsections below provide additional information regarding water supply for each of these cities.

3.1.1.1 Escalon

The city of Escalon is located in the southeastern part of San Joaquin County, and has a population of approximately 5,700. Escalon has four groundwater wells that supply all of their water needs, with two wells on standby due to nitrate problems. The city plans to screen one well below the nitrate contamination, and use the other well to irrigate a city park. One well in the city has traces of DBCP below the health limits, and a treatment facility will be installed if the levels appear to be rising.

Escalon has a growth ordinance that limits new building permits to 75 per year, and only about 45 are actually allocated per year. The slow growth means that groundwater should provide adequate water supply in the near future. Escalon is also

[1] Unincorporated communities within San Joaquin County comprise an estimated population of 160,000. These areas are served by agricultural water providers or private groundwater wells.
[2] State of California, Department of Finance, *County Population Projections with Race/Ethnic Detail*. Sacramento, CA, December 1998. Accessed on August 24, 2000 from website: http://www.dof.ca.gov/html/Demograp/Proj_race.htm.

a partner in the South County Surface Water Supply Project, which will transfer surface water from South San Joaquin Irrigation District to Escalon, Lathrop, Manteca and Tracy to augment groundwater supplies. The initial phase of the project will include a tee for a pipeline to Escalon, but the pipeline and associated treatment capacity upgrade will not be constructed until 2010.

Table 3-1
Summary of Urban Areas Planning Data
Current Conditions

City	***1999 Population Population***	***Area*** [1] *(sq. mi)*	***Water Purveyor***	***Water Source***
Escalon [2]	5,816	2.0	City of Escalon Department of Public Works	Groundwater
Lathrop [3]	9,513	16.9	City of Lathrop Department of Public Works	Groundwater
Lodi [4]	57,935	12.4	City of Lodi Water Utility	Groundwater
Manteca [5]	48,027	15.9	City of Manteca Department of Public Works	Groundwater
Ripon [6]	10,000	4.3	City of Ripon Department of Public Works	Groundwater
Stockton [7]	243,700	56.1	City of Stockton Water Utility California Water Service Company County of San Joaquin	Combination of Surface and Groundwater
Tracy [8]	48,000 (approx.)	20.8	City of Tracy Department of Public Works	Combination of Surface and Groundwater

Notes:

1) Areas from San Joaquin County Planning Department GIS Files, updated May 17, 2000 (Stockton area updated July 24, 2000).

2) Population from personal communication, City of Escalon, November 13, 2000. Water information from personal communication with Douglas Stidham, City of Escalon Department of Public Works, November 2, 2000.

3) Population from Pam Carter, City Manager, personal communication on November 13, 2000. Water information from City of Lathrop Water System Master Plan (Lew-Garcia-Davis, 1992).

4) Population: January 2000 population, personal correspondence, Richard Prima, City of Lodi. Water information from City of Lodi Water Utility's Consumer Confidence Report, accessed on-line on August 24, 2000. http://www.lodi.gov/html/water_report.html.

5) Population: City of Manteca website, accessed August 24, 2000. http://www.manteca.org/economic.html. Water information from City of Manteca Water System Master Plan (Kennedy/Jenks, 1985) and City of Manteca Water Report, September 1999, accessed on August 24, 2000 from City of Manteca website: http://www.ci.manteca.ca.us/eng/ccr99.html.

6) Population: City of Ripon website, accessed August 24, 2000. http://www.ci.ripon.ca.us/Community/com_res.htm#Population Growth. Water information from City of Ripon General Plan (City of Ripon, 1998)

7) Population: City of Stockton website, accessed August 24, 2000. http://www.ci.stockton.ca.us/CTMGR/PAGES/Checkout.htm. Water information from City of Stockton Urban Water Management Plan (City of Stockton Department of Municipal Utilities, 1996).

8) Population: City of Tracy website, accessed August 24, 2000. http://www.ci.tracy.ca.us/lifeintracy.html Water information from City of Tracy Water Master Plan (Kennedy/Jenks, 1994).

3.1.1.2 Lathrop

The city of Lathrop has a population of 9,513 and is located just south of Stockton. The City of Lathrop Department of Public Works operates four groundwater wells that meet its supply needs, but may require other supplies in the future, as the city has found that the underlying groundwater could not support additional pumping capacity.

Lathrop is investigating both the potential for using surface water supplies to augment groundwater supplies and the possibly of starting a conjunctive use program. Lathrop is one of the urban areas involved in the potential implementation of the South County Surface Water Supply Project which would provide additional surface water.

3.1.1.3 Lodi

The City of Lodi is located northeast of Stockton, along Highway 99. Lodi has an approximate population of 54,000. The City of Lodi Water Utility provides citizens with groundwater from 24 wells. The groundwater is chlorinated when necessary, but is usually delivered without any chlorine or treatment. The current groundwater wells produce generally high quality water, however, Dibromochloropropane (DBCP), an agricultural pesticide that was banned in 1977, is present in the supply. Approximately one-third of Lodi’s wells have DBCP levels above State and Federal standards, which has resulted in the closure of some wells. The remaining contaminated wells have filtration systems to remove the DBCP.

The City of Lodi’s future water use projections indicate that groundwater in the area should be sufficient to meet the City’s needs over the next 20 years. However, they have recognized that groundwater levels are declining, and would like to obtain surface water supplies to implement a conjunctive use program in the area.

3.1.1.4 Manteca

Manteca is in the southern portion of the County between Highways 5 and 99. The City of Manteca Department of Public Works provides water from 15 groundwater wells. Manteca has several additional wells that have been abandoned due to concentrations of DBCP and manganese above State Drinking Water Standards.

Manteca plans to drill additional wells to help meet future demand. Manteca will receive surface water from the South County Surface Water Project if implemented. The U.S. Bureau of Reclamation has historically indicated that Manteca was eligible to receive water from New Melones Reservoir, but surface water is not used in Manteca currently.

3.1.1.5 Ripon

As of January 1, 1999, the City of Ripon had a population of 10,000 people. Ripon’s growth is illustrated by comparing this figure with the 1985 population of 5,131. The City of Ripon Department of Public Works provides water to the City from seven groundwater wells, which produce high-quality water. The city plans to meet future demand growth with additional ground water wells.

3.1.1.6 Stockton

The City of Stockton has a population of approximately 243,700, and has three water suppliers to serve the area:

- City of Stockton Water Utility (28,000 connections);
- California Water Service Company (40,000 connections within the city, 10,950 outside of city limits); and
- County of San Joaquin (2,387 unmetered connections through County Maintenance Districts).

The City of Stockton Water Utility has 22 wells in North Stockton and seven wells in South Stockton providing groundwater for the above suppliers. Stockton East Water District (SEWD) provides surface water to the three suppliers. Approximately 45% of the City's water deliveries comes from groundwater, and 55% is treated surface water from SEWD.

California Water Service Company (Calwater) has 60 wells, although 12 are not in service due to nitrate or sanding problems. SEWD also provides surface water, which is less expensive than pumping groundwater. Calwater receives approximately 51% of SEWD's supplies delivered to Stockton.

Groundwater quality in the Stockton area is a continual concern even with surface water deliveries from SEWD to offset some pumping. Declining groundwater levels within San Joaquin County have caused eastward migration of highly saline water from under the Delta. The City and Calwater cut back pumping significantly in the southeast section of the City to reduce saline water intrusion, which has helped raise the groundwater levels in those areas. Concentrated pumping in the north of the City however, has caused groundwater levels in those areas to decline. Stockton recognizes the need for more surface water to meet future demand and prevent further saline water intrusion.

3.1.1.7 Tracy

The City of Tracy Department of Public Works provides water to the City's approximately 48,000 residents, as well as about 400 residents of the Larch-Clover County Services District. Tracy is expected to grow rapidly in the upcoming years, as indicated by predictions that the population will rise to 85,000 people by 2010.

Tracy has a contract with the U.S. Bureau of Reclamation to receive 10 TAF of water from the Central Valley Project through the Delta-Mendota Canal. This amount can be reduced by the Bureau during dry years, and Tracy typically takes only 7.5 – 9 TAF/yr. The surface water supplies are augmented with groundwater supplies from

10 wells. Area groundwater studies have indicated that the safe yield for the aquifer underlying Tracy is 6 TAF/yr.

There are water quality problems associated with both the surface water and groundwater supplies in Tracy. Surface water supplies for Tracy come from the Delta and are high in bromide and organic matter which produce undesirable disinfection by-products when combined with chlorine during treatment. The water treatment plant has switched from chlorine to chloramines to reduce this effect, and the success of this change is currently being determined by the Department of Health Services.

Tracy's groundwater is chlorinated before it enters the distribution system, and does not undergo any additional treatment. The groundwater has high levels of total dissolved solids (TDS) and sulfates, which can result in an objectionable taste. The city mitigates this problem by blending the groundwater with surface water.

In the future, Tracy plans to eliminate groundwater usage except in emergency situations. To meet future demands, Tracy needs to secure other surface water sources. Several possibilities have been identified, including the South County Surface Water Project.

3.1.2 Urban Water Demands

General plans and master plans from the cities within the County present current and projected water demands. Table 3-2 lists planning year and projected city demands including the demands for the "current" year in which each plan was written, for reference.

Table 3-2
Urban Water Demand Projections

City	*Source*	*"Current" Year*	*"Current" Demand (TAF/yr)*	*1999 Demand (TAF/yr)*	*Planning Horizon*	*Projected Use (TAF/yr)*
Escalon	1	1981	0.8	Not Available	2000	1.4
Lathrop	2	1995	2.9	2.1	2030	18.8
Lodi	3	1999	16.6	16.6	2020	22.7
Manteca	4	1985	8.2	11.2	2010	19.3 – 20.6
Ripon	5	1998	3.5	3.9	Not Available	
Stockton	6	1996	47.0	51.7	2015	68.4 – 73.2
Tracy	7	1993	11.9	12.8	2018	46.7

Notes:

1) City of Escalon Master Water Plan (Kjeldsen-Sinnock & Associates, Inc., 1981).
2) "Current" year and demand information from City of Lathrop Water System Master Plan (Lew -Garcia-Davis, 1992). 1999 Demand from personal communication with Roger Bennett, City of Lathrop, November 13, 2000. Projected use from City of Lathrop Water, Wastewater, Recycled Water Master Plan (Nolte, 2000).
3) "Current" Demand and 1999 Demand from personal communication with Frank Beeler, City of Lodi Public Works Department, May 1, 2000. Projected use from City of Lodi Urban Water Management Plan (Brown and Caldwell, 2001).
4) 1999 Demand: personal communication with Diane Martin, City of Manteca, November 16, 2000. Remainder of information from City of Manteca Water System Master Plan (Kennedy/Jenks, 1985)
5) 1998 and 1999 Demand: City of Ripon 1999 Water Quality Report, available from Public Works Department.
6) Combined information for the City of Stockton Water Utility and California Water Service Company. City information from the City of Stockton Urban Water Management Plan (City of Stockton Department of Municipal Utilities, 1996). 1999 Demand interpolated from data presented in plan. Calwater information from website, accessed on November 15, 2000. http://www.calwater.com/calwater/districts/stockton.htm. Approximately ¾ of Calwater service is within City limits.
7) 1999 Demand: City of Tracy website, accessed August 24, 2000. http://www.ci.tracy.ca.us/waterquality.htm. Remainder of information from City of Tracy Water Master Plan (Kennedy/Jenks, 1994)

A variety of methods may be used to forecast water demands. Many local water districts use water multipliers to determine future water use within their area. This method uses planning predictions for future residential, commercial, and industrial growth, and standard multipliers indicating water use for different types of urban development. This method works well for cities, but requires urban planning information to be effective. All cities within San Joaquin County have general plans, but the majority do not extend to 2030.

For the purposes of this plan, spheres of influence for each city were used to estimate urban water demands. Each city has slightly different water use, so water use per acre was determined for each city, as shown in Table 3-3. The area for each city was determined from DWR land use maps for San Joaquin County in 1996. The water use figure shown is the closest year available to 1996. Future water use figures assumed that all undeveloped area within existing city limits and the sphere of influence will be developed.

Table 3-3
Future Urban Water Demands

City	Current Water Use (TAF)	Current Land Use (acres)	Water Use/ Acre (ac-ft/ac)	Future Land Use (acres)	Future Water Demand (TAF)
Escalon	1.4	932	1.5	2,106	3.2
Lathrop [1]	2.9	3,409	0.85	13,254	11.3
Lodi	16.6	6,071	2.7	9,650	26.4
Manteca	11.2	5,056	2.2	14,140	31.3
Ripon	3.5	1,764	2.0	6,676	13.2
Stockton	47	29,746	1.6	61,353	96.9
Tracy	11.9	6,388	1.9	31,570	58.8

Sources: Land use from Department of Water Resources, 1996. Current water use from Table 3-2. Future land use from San Joaquin County General Plan 2010 update, 2000.

Note 1: Lathrop water use per acre is lower than the remainder of the cities because their developments are less dense than other cities. The city's future projections indicate that their water use per acre will increase to 1.4 ac-ft/ac. To maintain consistency, the water use per acre has been calculated as if it will stay the same over time. It is difficult to predict how development patterns will change, and the error that could be associated with this assumption is less than 0.5% of the future County demand.

The figures in Table 3-2 indicate that the total urban demand in the future will be 241,145 acre-feet. This value is substantially higher than the future demands in Table 3-2, but those predictions only extend to 2010 or 2015. These future demands account for the buildout scenario, where no more development can occur. It is anticipated that future buildout will not be achieved until well after 2015.

These demand calculations also predict values higher than the values predicted for the American River Water Resources Investigation. However, the ARWRI only accounted for the east side of the County, which results in lower demands. The ARWRI indicates that the increase in urban demand is balanced by a decrease in agricultural demand, for a negligible overall increase. The agricultural demand predictions are detailed in Section 3.3, and indicate that the overall change in future demand using sphere of influence calculations will be approximately a 0.3% increase.

3.2 Agricultural Water Agencies

Twelve agricultural water agencies serve the non-urban areas of San Joaquin County with water for irrigation. Some water provided by these agencies is applied to domestic, commercial and industrial uses. Water supplies for these providers include "water right" water and "contract" water. The County agricultural water providers are described in more detail below by geographic area of the County: East; Delta; and South.

3.2.1 East County Water Agencies

3.2.1.1 Woodbridge Irrigation District

Woodbridge Irrigation District (WID) was organized as an "Irrigation District" under state law in 1924. In 1928, WID acquired the surface water rights held by its predecessor, a private enterprise, in the mid-1880s.

The boundaries of WID encompass a gross area of approximately 42,900 acres. Numerous "islands," or lands that are not included in WID, exist within the overall boundaries. WID boundaries overlap with the North San Joaquin Water Conservation District (NSJWCD), Stockton East Water District (SEWD), and the City of Lodi.

The principal water delivery facilities owned and operated by WID include the Woodbridge Diversion Dam located on the Mokelumne River and an extensive canal system serving irrigation water to approximately 13,000 acres.

Flashboards installed at the dam in March of each year form Lodi Lake and allow the delivery of water into the system. The flashboards are removed in October. WID is currently working with the National Marine Fishery Service (NMFS) and California Department of Fish and Game (CDFG) on the design of a new facility to improve fish passage. Of approximately 100 miles of canals, only about 18 miles are concrete-lined or pipeline. The unlined canal system functions as an effective groundwater recharge facility, and it is estimated that 24,000 acre-feet are lost out of an annual delivery of 60,000 acre-feet.

Based upon 1996 data, 28,600 acres are irrigated with surface water, 700 acres are irrigated with groundwater, and 5,000 acres are irrigated with surface water and/or groundwater.

3.2.1.2 North San Joaquin Water Conservation District

The North San Joaquin Water Conservation District (NSJWCD) was organized in 1948 under provisions of the Water Conservation District Act of 1931.

The NSJWCD owns a pumping plant on the south bank of the Mokelumne River approximately 1-1/2 miles upstream from the town of Victor. This facility is used to divert surplus water from the Mokelumne River to an underground pipeline system. Also, the NSJWCD owns a pumping plant on the north bank of the Mokelumne River approximately two miles northeast of the town of Victor. The NSJWCD owns a pipeline system in the Acampo Road area north of the Mokelumne River. Water is also diverted into several natural channels, including Bear Creek and Pixley Creek, where water users divert water for irrigation.

The boundaries of the NSJWCD include approximately 53,100 acres. Approximately 4,740 acres are within the Lodi city limits and 5,600 acres are within Lodi's sphere of influence.

Based upon 1996 data, approximately 36,600 acres are irrigated with groundwater and 900 acres are irrigated with surface water. Approximately 650 acres are irrigated with surface water and/or groundwater.

3.2.1.3 Stockton East Water District

The Stockton East Water District (SEWD) was formed in 1948, under provisions of the Water Conservation Act of the State of California. In 1971, SEWD's boundaries were expanded to include the City of Stockton, and provides surface water to augment groundwater supplies for all Stockton water suppliers. Annexations to the City of Stockton became part of SEWD.

SEWD has been actively involved in the pursuit of projects to mitigate declining groundwater levels with the consequent increase in intrusion of saline ground water.

In 1963, SEWD installed check dams on the Calaveras River and the Mormon and Mosher Sloughs to facilitate irrigation with surface water along the waterways and to increase groundwater recharge.

In 1978, SEWD completed and began delivering water from the Calaveras River through its 30 MGD water treatment plant to the Stockton urban area. In 1994, the water treatment plant was expanded to 60 MGD to accommodate water from New Melones.

Most recently, an agreement was executed with South San Joaquin Irrigation District and Oakdale Irrigation District, whereby SEWD would be supplied 30,000 acre-feet of water for a 10-year period.

The total area within SEWD is approximately 116,300 acres, of which 9,700 acres are within the Stockton city limits and 38,200 acres are within Stockton’s sphere of influence. SEWD overlaps with WID by approximately 9,700 acres.

Based upon 1996 data, approximately 45,400 acres were irrigated with groundwater, 1,900 acres were irrigated with surface water, and 19,000 acres were irrigated with surface water and/or groundwater.

3.2.1.4 Central San Joaquin Water Conservation District

The Central San Joaquin Water Conservation District (CSJWCD) was formed in 1959 under provisions of the California Water Conservation Act of 1931.

In 1997, the CSJWCD, to mitigate declining groundwater levels, completed construction of facilities to release water into natural channels and install check dams to allow agricultural water users to divert water for irrigation. The irrigation facilities are installed and operated by individual landowners.

The CSJWCD includes approximately 65,100 acres, of which 670 acres are within the sphere of influence for the City of Stockton.

Based upon 1996 data, approximately 57,800 acres were irrigated with groundwater, 1,900 acres with surface water, and 600 acres with surface water and/or groundwater.

3.2.1.5 South San Joaquin Irrigation District

The South San Joaquin Irrigation District (SSJID) was formed in 1909 under provisions of the California Irrigation Act.

The SSJID has an extensive irrigation water delivery and distribution composed of system throughout its boundaries. The majority of its distribution system is composed of pipelines. The SSJID's delivery of surface water for irrigation has minimized the pumping of groundwater for agriculture.

To assist in improving the management of available surface water and groundwater resources, SSJID together with Oakdale Irrigation District, executed an agreement to provide 30,000 acre-feet of water for use within the City of Stockton's urban area. In addition, SSJID has proposed to implement the South County Surface Water Supply Project to transfer treated surface water to the cities of Escalon, Lathrop, Manteca and Tracy.

SSJID includes approximately 70,800 acres of which approximately 14,300 acres are within Manteca, Ripon, and Escalon. Approximately 22,900 acres of the spheres of influence of the same cities are within SSJID.

Based upon 1996 data, approximately 13,400 acres were irrigated with groundwater and 44,000 acres were irrigated with surface water and / or groundwater.

3.2.1.6 Oakdale Irrigation District

The Oakdale Irrigation District (OID) was formed in 1909 pursuant to the Irrigation District Act. OID and SSJID jointly own facilities on the Stanislaus River to capture, store, and divert water for agricultural use.

OID contains 72,345 acres, but only 12% are within San Joaquin County with the remainder in Stanislaus County. The primary crops within the district are irrigated pasture, grains, rice, and orchards.

3.2.2 Delta Water Agencies

The Delta Water Agency was formed in 1968, but in 1974 split into three separate districts: the North Delta Water Agency, the Central Delta Water Agency, and the South Delta Water Agency. The split took place because of the different needs of the three areas. The North Delta Water Agency uses water from the Sacramento River, the Central Delta Water Agency uses Delta water, and the South Delta Water Agency uses water from the San Joaquin River.

3.2.2.1 North Delta Water Agency

The purpose of the North Delta Water Agency (NDWA) is to ensure a dependable supply of acceptable quality water. The NDWA works as a contracting Agency to assess land and to assure water supply from the DWR. The Agency's boundaries are from the San Joaquin River to the legal Delta. Parts of Sacramento County, Yolo County, Solano County and San Joaquin County are included within the Agency's boundaries.

There are approximately 300,000 acres in the Agency's boundaries. Much of the area is open water, therefore only 230,000 are assessed by the Agency. The majority of the acreage is used for agricultural production. The only main urban area included is West Sacramento. Of the assessed acres, approximately 60,697 are within Sacramento County, 90,275 are in Yolo County, 60,536 are in Solano County and 18,469 are in San Joaquin County.

All the facilities within the Agency's boundaries are either privately owned or owned by the reclamation districts. Surface water is the main source of water, but there are several water users that have groundwater wells as a source for domestic use and farm irrigation.

3.2.2.2 Central Delta Water Agency

The purpose of the Central Delta Water Agency is to protect water supply within the area and to assist landowners and reclamation districts with water issues. There are 120,000 acres with in the boundaries of the Agency. The primary land use is agriculture, with crops such as vineyards, trees, row and field crops.

No facilities are owned by the Agency. The Agency represents the landowners and reclamation districts in water and flood control matters. The only source of water is surface water from the Delta. No groundwater is used within the Agency boundary.

3.2.2.3 South Delta Water Agency

The South Delta Water Agency (SDWA) was formed to represent the area landowners to address water supply problems. The water source for the SDWA is the San Joaquin River, which has a variety of quality and quantity problems. In addition, surface within the southern Delta have caused many problems for landowners that need to pump water from these area s.

There are approximately 150,000 acres within the Agency's boundaries, with 70 – 80% of the land used for farming. Asparagus, corn and alfalfa are the main crops grown within the agency boundaries, with smaller areas of row crops and vineyards. The remaining acres are urban including parts of Tracy and Lathrop.

The Agency does not own any facilities or water rights. Property owners have individual water rights, and the SDWA helps to protect these property owners. The majority of water within the agency boundaries is surface water. There are some shallow groundwater wells that are used by individuals, but most of the groundwater is unusable because of salt water intrusion.

3.2.3 South County Water Agencies

3.2.3.1 San Luis and Delta Mendota Water Authority

The San Luis and Delta Mendota Water Authority (SLDMWA) is the agency that operates the Delta Mendota Canal. The water agencies that receive water from the CVP through the canal are all within the SLDMWA's jurisdiction.

3.2.3.2 West Side Irrigation District

The West Side Irrigation District (WSID) has two main water supply sources: CVP water from the Delta-Mendota Canal, and water from the San Joaquin River. To divert the CVP water into the district from the Delta-Mendota, two gravity-flow turnouts are used. The water is distributed from the turnouts throughout the district using two main canals (9 miles each) and 24 miles of piped laterals.

Water is diverted from the San Joaquin River, via an unlined intake canal, to the District's pumping facilities. From the pumping facilities, pipelines lift the water to the two main canals where the water is then delivered to the users by gravity.

There is no groundwater use from private irrigation wells within the WSID. The CVP water from the Delta-Mendota Canal and the surface water from the San Joaquin River are the districts only sources.

The district is a part of the San Luis and Delta Mendota Water Authority, which has produced an AB3030 Groundwater Management Plan for the water districts within San Joaquin County.

The district is currently 9,500 acres in size with 8,500 irrigated acres and approximately 100 water users. Alfalfa, tomatoes, and beans are at presently the main crops produced within the district. Two small parcels of apricots and walnuts are also grown within the district.

The WSID was formed and organized in 1915, and began making its first water deliveries four years later in 1919. Two-thirds of the district is located to the west of the City of Tracy in southwest San Joaquin County, while the remaining third is located on the east side of the city.

WSID has no municipal and industrial (M & I) use at present, and desires to continue to be solely an agricultural district despite the rapid growth predicted for the City of Tracy. It is out of this desire that the district plans to have 1,400 acre-feet annexed by the City of Tracy over the next few years. The district is also working on a deal with the City to permanently transfer 5,000 acre-feet of CVP water supply in an attempt to meet the City's growing demand.

3.2.3.3 Plain View Water District

CVP water from the Delta-Mendota Canal is the sole water supply source for Plain View Water District (PVWD). The district takes the water from the canal using 28 turnouts and distributes it using 9.2 miles of pipeline. The distribution system is entirely enclosed, and propeller meters are used to measure the flow volume to each point of delivery.

PVWD is also a part of SLDMWA's AB3030 plan for the CVP water districts within San Joaquin County.

Plain View Water District is 6,422 acres in size and is located near the City of Tracy along the eastern side of Interstate 5 in San Joaquin County. The district was formed in 1951.

The district contains 5,987 irrigated acres. Agricultural land use within the district consists of row crops (mainly alfalfa), permanent crops (almonds and cherries), and some dry farming. Although it is chiefly an agricultural district, since 1990 PVWD has converted roughly 500 acres of its land to M & I use. The water supplied for M&I is passed through the treatment facilities of the City of Tracy before it is delivered to its users. It is possible that as the City of Tracy continues to grow, more land will be allocated for M & I use. The district now has plans to transfer some of its CVP supply to the City of Tracy by 2025.

3.2.3.4 Banta-Carbona Irrigation District

The Banta-Carbona Irrigation District formed in 1921. The district is located in southern San Joaquin County just south of the City of Tracy and is 17,920 acres in size. The district collects and distributes water from the Delta-Mendota Canal using two turnouts that are measured daily and a distribution system that includes a main canal, manually operated gates, and 87.2 miles of canals and pipelines.

The district receives surface water from two sources: the Delta-Mendota Canal and the Sacramento-San Joaquin Delta (Delta). No groundwater is used within the district. The water received from the Delta is now less dependable than in the past due to an increase in granted water rights.

The Banta-Carbona Irrigation District is part of SLDMWA's AB3030 Groundwater Management Plan for districts within San Joaquin County.

The district contains 16,500 irrigated acres and has between 60 and 70 water users. There are roughly ten times more landowners than water users in the district. This is because the majority of the landowners lease their land to farmers. Farms in the district grow row crops like cannery tomatoes, dry beans, and alfalfa, as well as permanent crops like almonds, walnuts, and apricots. All of the water in the district is used for agriculture, and no water is used for M & I. As the City of Tracy and the Interstate 5 corridor continue to grow, some areas within the district may be annexed by the City or detached from the district in an effort to keep Banta-Carbona's water use strictly agricultural. At present there are a few parcels of land within the district that are already targeted for separation. The district also plans to transfer some of its CVP supply to the City of Tracy by 2025.

3.2.3.5 Hospital Water District

Hospital Water District falls under Del Puerto Water District along with ten other districts. The first long-term contract for the Del Puerto Water District was signed in 1953, granting the district 10,000 acre-feet of CVP water. In 1995 all eleven of the water districts were consolidated into the Del Puerto Water District, giving the District 140,210 acre-feet of CVP water.

The Del Puerto Water District receives its CVP supply through turnouts on the Delta-Mendota Canal. The district does not own any of the facilities (pipelines, pumps or canals). All the facilities are privately owned, operated and maintained.

There are no groundwater wells in the district.

The district uses the majority of its water for irrigation purposes, only one-acre foot of water each month is used for M & I purposes (dust suppression at the city landfill). Approximately 170 water users make up the district. In 1999, only 5,880 acres were left furrow of the 45,068 acres in the district. Almost half of the district's agricultural productions are permanent such as almonds, apricots and walnuts. Though there has been urban growth in the area due to the expansion of Patterson and Tracy, the district would like to remain mostly agricultural.

3.3 Agricultural Water Demands

Current and future agricultural water demands used in this planning effort were calculated based on land uses within the County. The acreage of each land use type (typically by crop) was multiplied by appropriate unit water use values for each crop to determine total water use. Future demands were calculated based on anticipated reduction in agricultural land due to the conversion of agricultural land to urban land within the city limits and spheres of influence for the respective cities.

3.3.1 Land Use

3.3.1.1 Existing

The California Department of Water Resources (DWR) performs detailed land use surveys at unspecified intervals. For San Joaquin County, land use surveys were performed in 1976, 1982, 1988, and 1996. A summary of the land use in these years is presented in Table 3-4. The table illustrates trends of increasing vineyards, orchards, and urban areas, with decreasing amounts of land for pasture, truck, field, and farmstead crops, as well as rice. The 1996 land use data is shown in Section 1, Figure 1-1. The acreage of land devoted to vineyard and urban areas increased dramatically between 1976 and 1996.

To determine the extent to which 1996 land use was appropriate to use to represent existing or baseline conditions, information from the Agricultural Commissioner's office was compiled for the 11-year period – 1989 to 1999. Although this information is not geographic-specific, it does provide a basis for judging the reasonableness of the 1996 agricultural land use information for use in representing existing and future agricultural land use.

The information shows an increase in agricultural land use from 1989 to 1999 of 43,480 acres or an increase of eight percent. However, for the period 1996 to 1999, the increase was only 2,640 acres or 0.5 percent.

Certainly, during this period irrigated agriculture was expanding to new land, however, the increase was being offset by lands changing from agricultural to urban land uses. During this same period (1996-1999) agricultural crops showed a decrease of 22,300 acres in field crops and an increase in land devoted to the other crop categories of 25,000 acres, with vineyards and vegetables accounting for 20,000 acres.

Based upon the fact that the change in total agricultural land did not change appreciably from 1996 to 1999, and the agricultural water use would be somewhat less changing from field crops to largely vineyards and vegetables, it is deemed appropriate for purposes of the Water Management Plan to use the 1996 land use to represent existing or baseline conditions.

Table 3-4
San Joaquin County Land Use Summary

Land Use	***1976***	***1982***	***1988***	***1996***
Urban	59,221	57,557	74,186	86,550
Orchard	87,294	96,322	102,895	107,784
Pasture, Truck, Field, & Farmstead	458,248	439,497	454,778	393,297
Rice	7,918	7,865	6,141	5,991
Vineyards	60,921	65,646	63,860	76,975
Native & Riparian Vegetation	213,922	202,073	201,133	218,056
Water Surface	17,576	27,128	22,755	22,621
TOTAL	**905,100**	**896,088**	**925,748**	**911,273**

Source: Department of Water Resources Land Surveys.

Note: San Joaquin County comprises 901,760 acres. The difference between the land use total and the area of the County is attributed to double-cropping.

3.3.1.2 Future

Future land use is based on the conversion of agricultural land to urban land use within the city limits and spheres of influence for the cities in San Joaquin County, as described in the prior section on urban water use predictions. The analysis assumes that all agricultural land within the cities' spheres of influence will go out of production and become part of the urban area. Table 3-5 illustrates the acres of each crop type that will go out of production in each urban sphere of influence.

Table 3-5
Agricultural Land within Urban Spheres of Influence (in acres)

Crops	Escalon	Lathrop	Lodi	Manteca	Ripon	Stockton	Tracy
Grain	125.5	1,233.8	115.8	535.1	153.8	4,390.5	3,573.6
Rice	0	0	0	0	0	0	0
Safflower	0	1,205.3	17.7	0	0	59.2	938.2
Sugar Beets	0	34.0	0	0	0	472.8	363.4
Field Corn	20.0	1,021.5	262.5	951.3	33.5	789.2	592.9
Misc. Field	28.3	390.3	99.8	46.6	87.8	1,373.4	1,836.5
Alfalfa	0	2,222.0	54.4	1,412.2	50.4	1,922.6	3,408.5
Misc. Pasture	53.7	226.0	28.2	820.4	16.6	735.4	790.6
Tomatoes	0	249.9	23.7	88.4	0	2,022.8	961.0
Misc. Truck	4.9	903.1	92.4	551.5	176.1	1,964.9	5.2
Almonds	353.9	299.8	12.8	2,171.3	2,046.5	92.3	75.3
Vineyard	38.2	8.4	1,397.6	480.4	92.0	96.4	0
Misc. Deciduous	70.9	466.4	286.2	31.3	934.8	1,529.0	898.3
TOTAL [1]	1,769.6	8,260.7	2,391.1	7,088.5	3,591.5	15,448.5	13,443.5

Source: Department of Water Resources Land Surveys and San Joaquin County Planning Department.

Note 1: In Table 3-3, the difference between the current land use and projected land use indicates the city's growth potential within the sphere of influence. The expanded area does not equal the agricultural land in this table because some of the land is already developed for urban uses.

3.3.2 Water Use

3.3.2.1 Existing

Agricultural water use for various crops is based upon estimates prepared by the DWR for use in updating Bulletin No. 160. DWR prepares its estimates of water use according to Demand Analysis Units (DAU) to account for varying hydrologic and climatological differences. The water use was estimated for both normal and dry weather years to reflect differences in effective precipitation. The U.C. Extension Service reviewed this information. It was noted that irrigation efficiency for vineyards, which are usually installed with "drip" irrigation systems, was probably higher and a value of 90 percent is applied. Table 3-6 and Table 3-7 show unit crop water use figures for normal and drought years, respectively.

The consumptive use or evapotranspiration (ET) of a crop represents the total amount of water transpired by the plant, retained in the plant tissue, and evaporated from adjacent soil surfaces during the growing period of the crop. In San Joaquin County and other areas as well, rainfall provides a portion of the water required to meet the ET of a particular crop. This amount of water provided from rainfall is referred to as "effective precipitation." In dry years, the effective precipitation is less, thus the amount of applied water must be increased to meet the ET of the crop. The balance of the water required to produce a crop is applied through irrigation practices, thus applied water (AW). For irrigators to provide the AW, an additional amount of water is applied to account for inefficiencies in application. For example, if the irrigator was 100 percent efficient, the AW would equal the ET of the applied water (ETAW). In most instances, the total applied water is greater than the ETAW. Dividing the ETAW by the efficiency of application results in the total AW.

Table 3-6 Annual Agricultural Unit Water Use Average Hydrologic Conditions									
Crop	***Delta Area***			***Valley Area***			***Foothill Area***		
	ETAW (AF/ac)	***IE (%)***	***AW (AF/ac)***	***ETAW (AF/ac)***	***IE (%)***	***AW (AF/ac)***	***ETAW (AF/ac)***	***IE (%)***	***AW (AF/ac)***
Grain	0.6	67	0.9	0.7	70	1.0	0.7	70	1.0
Rice	3.3	56	5.9	3.5	56	6.3	3.6	56	6.4
Safflower	0.7	78	0.9	0.7	78	0.9	0.7	78	0.9
Sugar Beets	2.3	68	3.4	2.4	69	3.5	2.7	68	4.0
Field Corn	1.8	69	2.6	1.8	64	2.8	1.8	69	2.6
Misc. Field	1.5	68	2.2	1.4	67	2.1	1.3	65	2.0
Alfalfa	2.7	68	4.0	3.1	70	4.4	3.0	68	4.4
Misc. Pasture	3.0	64	4.7	3.4	64	5.3	3.2	64	5.0
Tomatoes	1.9	69	2.8	2.1	69	3.0	2.1	69	3.0
Misc. Truck	1.7	71	2.4	1.2	67	1.8	1.1	67	1.6
Almonds	1.8	69	2.6	1.8	72	2.5	1.7	68	2.5
Vineyard	1.8	90	2.6	1.9	90	2.8	1.9	90	2.8
Misc. Deciduous	2.5	70	3.6	2.6	70	3.7	2.6	70	3.7

ETAW = Evapotranspiration of Applied Water
IE = Irrigation Efficiency
AW = Applied Irrigation Water
Source: California Department of Water Resources

The 1996 agricultural water demand was calculated using the 1996 land use figures and the water use values presented in Tables 3-6 and 3-7. For the County's 901,974 acres, the estimated applied water was 1,522,098 ac-ft, the evapotranspiration was 1,074,174 ac-ft, and the excess applied water was 447,924 ac-ft. This evaluation is based upon a "normal" hydrologic year, as defined by DWR. Water usage counts irrigation water only. Water applied for the following uses have been neglected: urban, semi-agricultural, irrigated idle (fallow) land, native vegetation, and riparian habitat.

Table 3-7 Annual Agricultural Unit Water Use Dry Hydrologic Conditions									
Crop	***Delta Area***			***Valley Area***			***Foothill Area***		
	ETAW (AF/ac)	***IE (%)***	***AW (AF/ac)***	***ETAW (AF/ac)***	***IE (%)***	***AW (AF/ac)***	***ETA, (AF/ac)***	***IE (%)***	***AW (AF/ac)***
Grain	1.1	67	1.6	1.3	70	1.9	0.8	70	1.1
Rice	3.4	56	6.1	3.7	56	6.6	3.5	56	6.3
Safflower	0.8	78	1.0	0.8	78	1.0	0.8	78	1.0
Sugar Beets	2.7	68	4.0	3.2	58	4.7	2.5	69	3.6
Field Corn	1.9	69	2.8	1.9	69	2.8	1.9	64	30
Misc. Field	1.6	68	2.4	1.4	65	2.2	1.5	67	2.2
Alfalfa	3.4	68	5.0	3.7	68	5.4	3.3	70	4.7
Misc. Pasture	3.7	64	5.8	4.0	64	6.3	3.4	64	5.3
Tomatoes	2.1	69	3.0	2.3	69	3.3	2.3	69	3.3
Misc. Truck	1.8	71	2.5	1.2	67	1.8	1.2	67	1.8
Almonds	2.0	69	2.9	1.9	68	2.8	2.0	72	2.8
Vineyard	2.0	90	2.9	2.1	90	3.1	2.1	90	3.1
Misc. Deciduous	2.8	70	4.0	2.9	70	4.1	2.8	70	4.0

ETAW = Evapotranspiration of Applied Water
IE = Irrigation Efficiency
AW = Applied Irrigation Water
Source: California Department of Water Resources

3.3.2.2 Future

Future agricultural water use is estimated based upon the future land use, which accounts for the reduction of agricultural land due to its conversion to urban use. Table 3-8 illustrates the current agricultural water use within the spheres of influence for each urban area. This water will no longer be used for agricultural use, and results in the decrease of 132,174 acre-feet.

Table 3-8
Agricultural Applied Water within Urban Spheres of Influence (in acre-feet)

Crops	*Escalon*	*Lathrop*	*Lodi*	*Manteca*	*Ripon*	*Stockton*	*Tracy*
Grain	126	1,143	116	528	97	4,253	3,020
Rice	0	0	0	0	0	0	0
Safflower	0	1,085	16	0	0	53	844
Sugar Beets	0	119	0	0	0	1,891	1,236
Field Corn	56	2,687	683	2,664	94	2,052	1,541
Misc. Field	59	877	200	98	184	2,868	4,067
Alfalfa	0	8,927	239	6,214	222	8,266	13,634
Misc. Pasture	284	1,095	83	4,348	88	3,650	3,716
Tomatoes	0	700	0	265	0	6,069	2,691
Misc. Truck	9	2,128	63	993	274	3,523	13
Almonds	885	766	32	5,428	4,950	226	196
Vineyard	80	17	2,688	1,009	163	202	0
Misc. Deciduous	262	1,681	1,004	116	3,436	5,648	3,234
TOTAL	1,761	21,225	5,124	21,663	9,508	38,701	34,192

Source: Department of Water Resources Land Surveys and San Joaquin County Planning Department.

The decrease of 132,174 acre-feet of agricultural water use can be compared to an increase in urban water use of 136,845 acre-feet. The comparison indicates that there will be very little change in overall water use in the future for San Joaquin County. On a County-wide level, the figures for water use per acre are very similar for both agricultural and urban water use. Most land around urban areas is currently farmed, so for the urban areas to expand, agricultural land is lost at an approximate one-to-one ratio. Because each acre of new urban land results in one less acre of agricultural land, and the water use figures are similar, the water demands are projected to remain essentially constant into the future.

The demand projections for agricultural and urban water use were developed using the following assumptions:

- Agricultural changes will not change significantly. The analysis uses 1996 agricultural data, and some practices have already changed. However, these changes are within an acceptable margin of error for a planning-level document. The overall estimates assume that no major changes will occur, such as new technology that dramatically alters water use.

- Countywide urban development practices will not change significantly. The County's 2010 General Plan update calls for increased urban densities to allow population increase in urban areas without developing agricultural land. However, this trend has not yet started, so it is not possible to predict future densities. In the future, if urban densities do increase, then countywide water use will increase because urban water use increases will not correspond to a loss in agricultural water use.

- Local urban development practices will result in new developments with similar water uses. Water use figures were calculated for each individual urban area, and these figures were applied to future development. This assumption was made because different urban areas have different values, such as amounts of open space and conservation practices.

- The urban spheres of influence reflect 2030 development. The urban spheres reflect the local plans for where expansion could occur in the future, but it is possible that development will occur in different areas, or in different amounts than predicted. The State Department of Finance predicts future populations, and the 2030 population can fit within the predicted spheres at current urban densities.

Many planning studies in San Joaquin County refer to demand estimates performed by DWR for the American River Water Resources Investigation in 1993. This study projected 2030 water demands based on 1990 water use figures. DWR utilized population predictions from the Department of Finance, and applied per capita water use figures to the future population. The study area included the east side of San Joaquin County, and found that agricultural demand would decrease by 96.5 TAF, and urban demand would increase by 125.1 TAF, with a total demand increase of approximately 2%. However, this study did not include the entire County area.

3.4 Water Rights

This section provides a brief overview of surface and groundwater rights as it pertains to San Joaquin County. Water rights are of importance as water uses change in the County and as districts and agencies seek supplies to meet future demands.

3.4.1 Surface Water Rights

Riparian water rights are associated with lands adjacent to waterways such as rivers, streams or sloughs. In San Joaquin County the major riparian water rights are associated with the districts and lands in the Sacramento-San Joaquin Delta. These lands may use as much water as needed to produce a beneficial use of the water. To protect the beneficial use of this water the SWRCB has set water quality standards that must be adhered to by the CVP & SWP in the delta environment. There are also minor quantities of riparian water rights along the rivers and streams in San Joaquin County. Riparian right holders have the most senior water rights, and they generally need to reduce water use only if other right holders have completely stopped using water.

Appropriative water rights are associated with developed infrastructure water supplies for beneficial water uses. Appropriative water rights are a system of water rights that are prioritized by the date of first development during periods of low water supply. In San Joaquin County, many districts (such as Woodbridge ID, EBMUD, South San

Joaquin ID, Oakdale ID) developed their water supplies through the application of appropriate water rights. As additional reservoir facilities and water rights have been developed on the river system in San Joaquin County, many older appropriative water rights have been negotiated into contractual relationships with the entity that built the additional reservoir facilities.

Water service contracts are contracts to the use of water supplies developed by the holder of a water rights and owner of the supply infrastructure. In San Joaquin County water service contracts typically apply to water supplies and water rights developed by the federal government.

The *area of origin concepts* are sections of the California water code intended to give preference to water supply development for counties and lands upstream of the Sacramento-San Joaquin delta in deference to the Federal CVP exports and State SWP exports of water out of the Delta.

In the last 25 years, county water agencies have begun to pursue surface water rights to attempt to remove the county's dependence on groundwater. Table 3-9, at the end of this section, indicates the major surface water rights in San Joaquin County.

3.4.2 Groundwater Rights

Groundwater use is not governed by the SWRCB, which is the agency set up to regulate surface water rights. There is no system of groundwater rights except in adjudicated basins, and people do not need to apply for rights before groundwater can be used. There is currently no method to control groundwater pumping outside of adjudicated basin. However, there are basic concepts for groundwater use that are considered for groundwater adjudications.

The concepts of groundwater use are similar to those of surface water rights. For groundwater, the land owners overlying the groundwater basin have first priority for use. The priority of each owner is equal and correlative to the priority of all other owners over the basin. This concept is very similar to surface water riparian rights.

If there is surplus groundwater in a basin, this water may be withdrawn and used on lands that are not over the basin as long as this withdrawal does not result in a groundwater overdraft. There is no permit required to use this groundwater, so the water can simply be used. This concept is similar to surface water appropriative rights in that the water can be used outside of the basin as long as there is not a shortage within the basin. Surface water rights, in contrast, require the water user to go through an extensive permit process.

To dig, bore, drill, deepen, or reperforate a well, landowners must submit a Notice of Intent and a report of completion to the Department of Water Resources.

3.5 External Agencies

The water agencies within the County have been described in the urban and agricultural sections. However, there are several agencies that are external to the County that play an important role in San Joaquin County water management. Two of these agencies, Calaveras County Water District and East Bay Municipal Utilities District (EBMUD), are a part of the Steering Committee because the County recognizes the important interconnections in water management.

3.5.1 Calaveras County Water District

Calaveras County is located to the east of San Joa quin County, and is upstream on several of the river systems that flow into San Joaquin County. If Calaveras County grows in the future, then they the additional water they would need could result in a decrease in water available to San Joaquin County.

In 1996, the Calaveras County Water District prepared a County Water Master Plan to examine the long term (2040) water demands in the County. This work was performed in close coordination with the County Planning Department to ensure that land use, particularly from an urban / residential standpoint reflected County Policy. This work was performed according to the Mokelumne, Calaveras, and N.F. Stanislaus River systems. The water needs projected for Calaveras County can be met with water available through exercising water right permits, agreements, and water service contracts. Exercising certain entitlements will require new infrastructure which, in certain areas will be expensive. Nevertheless, to the extent these projected water demands occur in Calaveras County, the resources available with the respective river systems will be reduced.

The projected increases for both urban / domestic and agricultural uses through 2040, according to river system, are summarized in Table 3-10.

Table 3-9
Future Calaveras County Water Demands

River System	***Increase in Water Demand (acre-feet/acre)***
Mokelumne	3,000 to 7,000
Calaveras	2,500 to 5,300
North Fork Stanislaus	19,000 to 31,000

3.5.2 East Bay Municipal Utility District

EBMUD provides water to the East Bay area, including Richmond, Berkeley, and Oakland. Their primary source of water is the Mokelumne River, and they own and operate Pardee and Camanche Reservoirs. The water is delivered to their service area through the Mokelumne Aqueducts, which run through San Joaquin County.

EBMUD also has a contract with the USBR to receive water from the American River, and they have historically proposed projects with San Joaquin County to utilize this water. These projects have not materialized, and EBMUD has been developing options to determine how to divert the water. EBMUD recently released an EIS/EIR for public comment that included options for diversion points on the American River and the Sacramento River. The public comment period is over, and the agency is expected to reach a decision soon on how to utilize the water.

Table 3-10
Current Surface Water Supplies

Water District	Water Source	Contract or Water Right	Water Supply	Contract/Water Rights Quantity	Major Point of Diversion(s)
South San Joaquin I.D.	Stanislaus River	Water right settlement agreement with USBR	New Melones	Up to 600 TAF based on water year inflow to New Melones	Joint main canal to S.J.C. side of Stanislaus River. South main canal to Stanislaus County lands. Woodward Reservoir serves as a regulating facility to South San Joaquin I.D.
Oakdale I.D.	Stanislaus River	Water right settlement agreement with USBR	New Melones		
Central San Joaquin WCD	Stanislaus River	USBR contract	New Melones	Up to 49 TAF firm water plus up to 31 TAF interim water (subject to future water demand on Stanislaus River)	Farmington Tunnel
Stockton East WD	Stanislaus River	USBR contract	New Melones	Up to 105 TAF (subject to future water demand on Stanislaus River)	Farmington Tunnel
	Calaveras River	USBR contract	New Hogan	Operational Yield (subject to Calaveras County future water demand)	Calaveras River and Mormon Slough
City of Stockton	Stockton East WD and Well Fields	Stockton East WD agreements	South San Joaquin ID and Stockton East WD	City of Stockton is allocated 42% of the water produced by Stockton East WD	Service to City of Stockton Water Treatment Facility
North San Joaquin WCD	Mokelumne River	EBMUD agreement	Camanche	Up to 20 TAF (subject to EBMUD storage)	Lower Mokelumne River
Woodbridge I.D.	Mokelumne River	Settlement agreement with EBMUD	Camanche	Up to 60 TAF based on Pardee inflow	Lake Lodi
	Mokelumne River	Utilization of water rights junior to EBMUD	Camanche	Water availability limited to excess of EBMUD needs	Lake Lodi
Central Delta WD	Delta	Water rights	CVP-SWP Delta Standards	Up to water demand	Delta
South Delta WA	Delta	Water rights	CVP-SWP Delta Standards	Up to water demand	Delta

Table 3-10
Current Surface Water Supplies

Water District	Water Source	Contract or Water Right	Water Supply	Contract/Water Rights Quantity	Major Point of Diversion(s)
City of Tracy	Delta Mendota Canal	USBR contract	CVP	10 TAF contract	Tracy Pumping Plant/Upper Delta Mendota Canal
Westside Irrigation Dist.	Delta Mendota Canal	USBR contract	CVP	7.5 TAF contract	Tracy Pumping Plant/Upper Delta Mendota Canal
	San Joaquin River	Water right	Old River	30 TAF from April to September	Old River
Plainview Water Dist.	Delta Mendota Canal	USBR contract	CVP	20.6 TAF contract	Tracy Pumping Plant/Upper Delta Mendota Canal
Banta-Carbona Water Dist.	Delta Mendota Canal	USBR contract	CVP	25 TAF contract	Tracy Pumping Plant/Upper Delta Mendota Canal
	San Joaquin River	Water right	San Joaquin River	30 TAF depends on water flow	River mile 63.5
Hospital Water Dist.	Delta Mendota Canal	USBR contract	CVP	34.1TAF	Tracy Pumping Plant/Upper Delta Mendota Canal

Sources of Information:
USBR-Stockton East WD contract W0329.
USBR-Central San Joaquin WCD contract W0330.
USBR-Oakdale and South San Joaquin ID's Agreement and Stipulation dated 9/30/1988.
EBMUD-North San Joaquin WCD Supplementary Agreement dated 5/27/1969.
USBR-City of Tracy Contract 7858A.
USBR-Westside Irrigation District Contract W0045.
USBR-Plainview WD Contract 785.
USBR-Banta Carbona WD Contract 4305A.
USBR-Hospital WD Contract 923.

Section 4
Water Quality

4.1 Surface Water Quality

The surface water quality for San Joaquin County water sources can generally be categorized into three geographical water service units, Sierra Nevada rivers and streams, Sacramento-San Joaquin Delta, and CVP export water sources.

The Sierra Nevada rivers and streams are generally excellent sources of high water quality with a low TDS loads. Reservoir storage on the Mokelumne, Calaveras and Stanislaus River systems helps to reduce solid particulate levels by settlement. During high water or flooding events, particulate levels can increase as the carrying capacity of large river or stream flow increases.

The Sacramento-San Joaquin Delta water quality is influenced by Central Valley hydrology as well as being a controlled and regulated objective standard. The Staff Water Resources Control Board (SWRCB) has designated delta agricultural water quality standards during the irrigation season for the protection of delta agricultural lands and water rights. The agricultural water quality protection standards vary on a hydrologic year-type basis and typically degrade through the irrigation season. Generally, the Sacramento-San Joaquin Delta water quality is best during the winter and spring months as precipitation and snowmelt runoff have the greatest inflow influence on Delta hydrology. The Sacramento-San Joaquin Delta water quality during the irrigation season is protected by SWRCB delta standards and is managed by the operations of the Staff Water Project (SWP) and the Central Valley Project (CVP).

The southern Delta water quality and San Joaquin River, in the vicinity of Vernalis and the South Delta Water Agency, experiences degraded water quality conditions. The SWRCB has set standards in the Vernalis local area of 455 TDS during the irrigation season and 600 TDS during the non-irrigation season. This standard is a water right permit condition to New Melones Reservoir on the Stanislaus River and significantly influences water management on the lower Stanislaus River. The water quality in the San Joaquin River is influenced by factors such as; hydrologic conditions in the San Joaquin River basin, reservoir operations in the San Joaquin River basin, as well as irrigation practices and irrigation return flows in the San Joaquin River basin. The development of the CVP agriculture along the westside of the San Joaquin basin and the inherent salt management issues along the westside have contributed greatly to the reduced south delta water quality. In the southern delta the hydrodynamics of water flow and water quality barrier placement and operation also significantly influence local water quality.

Many areas of southwest San Joaquin County receive surface water supplies from the CVP through the upper Delta Mendota Canal. The water quality in the upper Delta

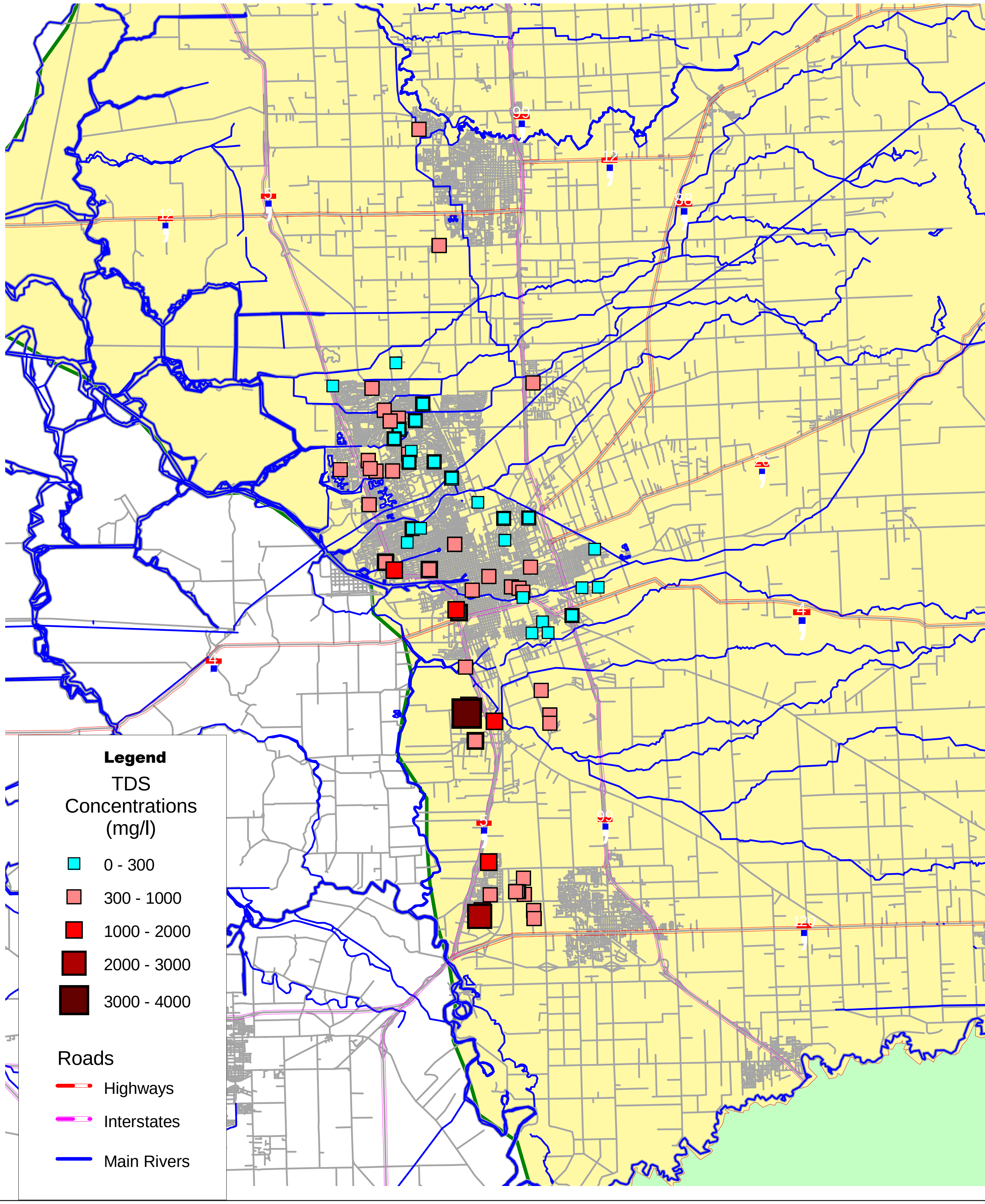
Mendota Canal is directly influenced by daily water quality conditions and standards in the Sacramento-San Joaquin Delta.

4.2 Groundwater Quality

The primary concern is the on-going degradation of water quality due to lateral (and potential upconing) of saline water. Previous studies have estimated lateral intrusion from the Delta area to be occurring at a rate of 140 to 150 feet per year (Brown & Caldwell, 1985).

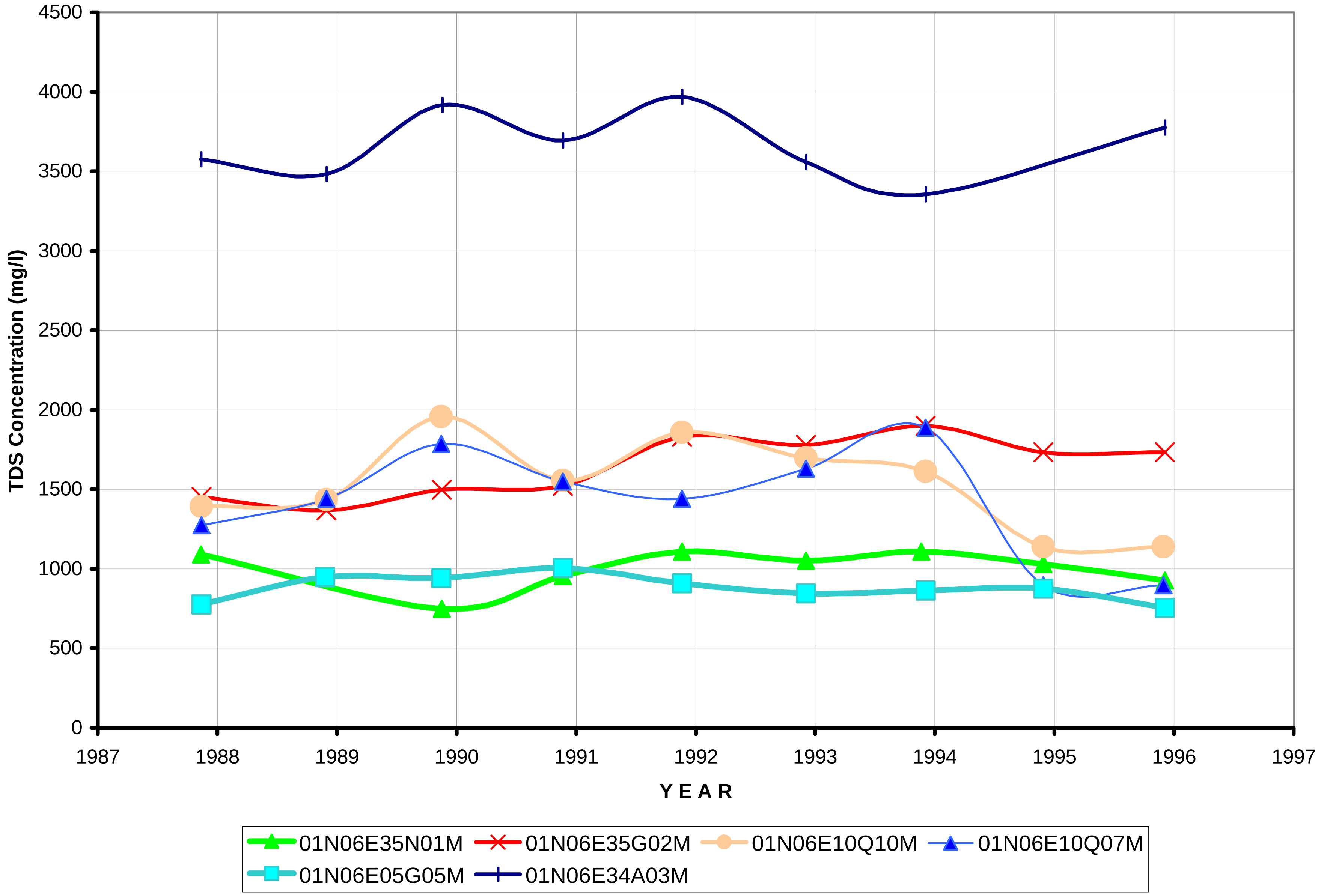
San Joaquin County monitors approximately 30 wells in the Stockton area for total dissolved solids, chlorides, and electrical conductivity. The results of this monitoring program (including groundwater levels) are published semi-annually the San Joaquin County Department of Public Works.

Figure 4 -1 illustrates a spatial distribution of total dissolved solids (TDS) concentrations for 1988-1996, and Figure 4 -2 shows the time-history of TDS at selected wells. Figure 4-3 illustrates a spatial distribution of average chloride concentrations for 1988-1996 and Figure 4-4 shows the time-history of chloride concentrations at selected wells. Figure 4-5 is a well location map for the selected wells in Figures 4-2 and 4-4. These wells exhibit one of the fundamental problems caused by the over-exploitation of the basin; chloride concentrations increasing above water quality standards of 1000 mg/1.



CDM Camp Dresser & McKee Inc.

Figure 4-1
Average 1988-1996 TDS Concentrations (mg/l)
San Joaquin County Water Management Plan



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TDS Charts.xls-TDS Charts

Figure 4-2
Time-History of TDS Concentrations in Selected Wells (mg/l)
San Joaquin County Water Management Plan

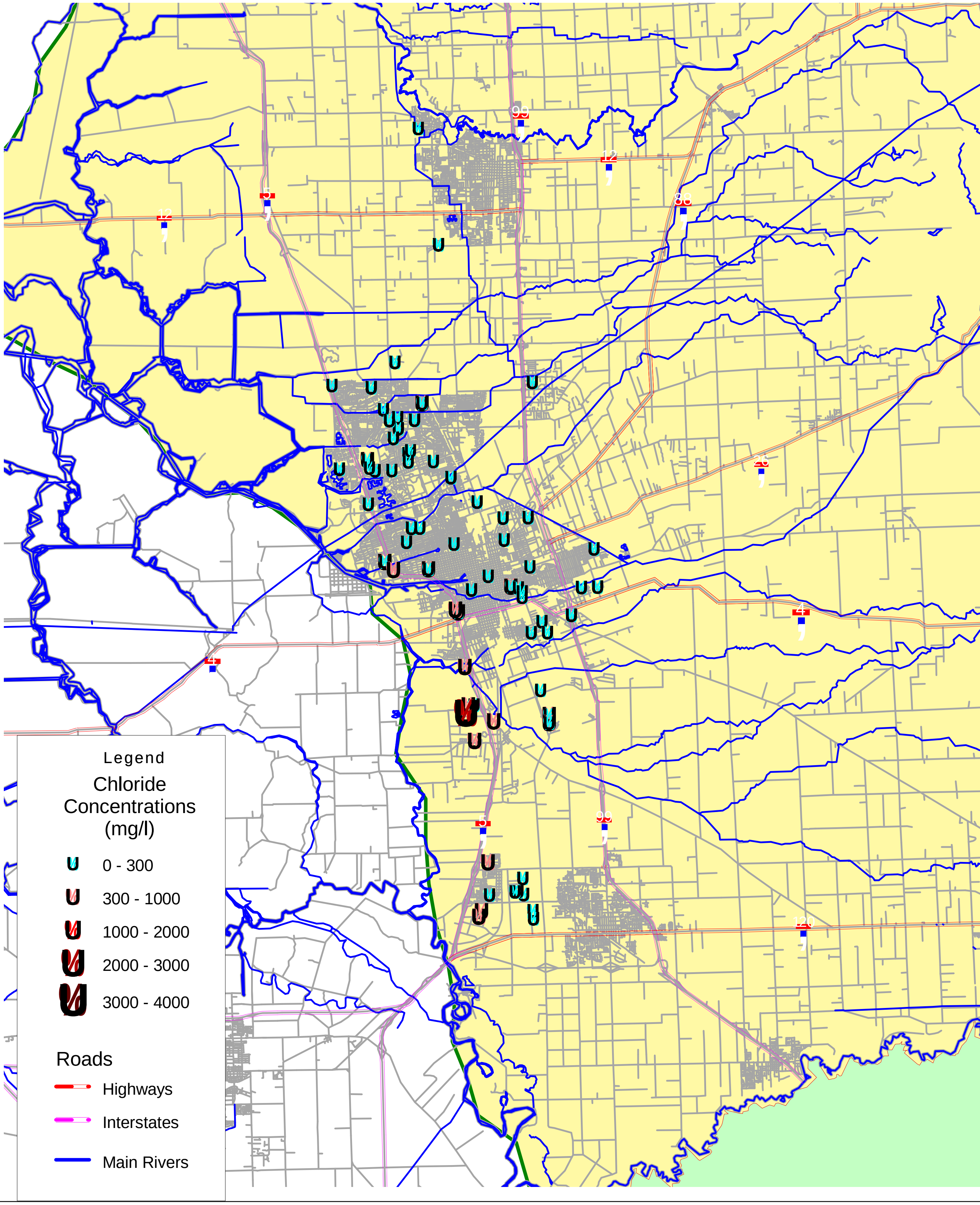

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Figure 4-3
Average 1988-1996 Chloride Concentrations (mg/l)
San Joaquin County Water Management Plan

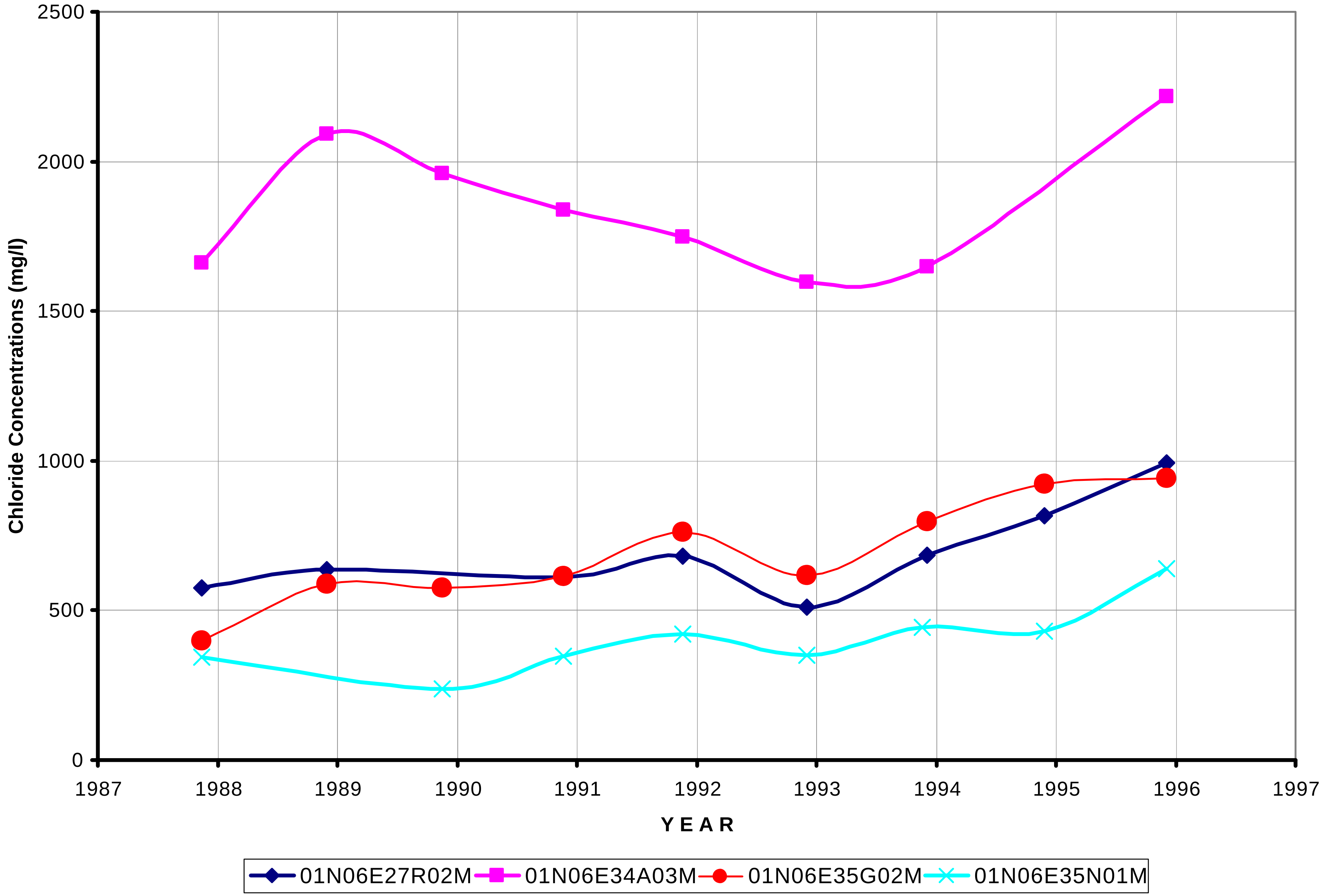

Figure 4-4
Time-History of Chloride Concentrations in Selected Wells (mg/l)
San Joaquin County Water Management Plan

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TDS Charts.xls-CL Charts

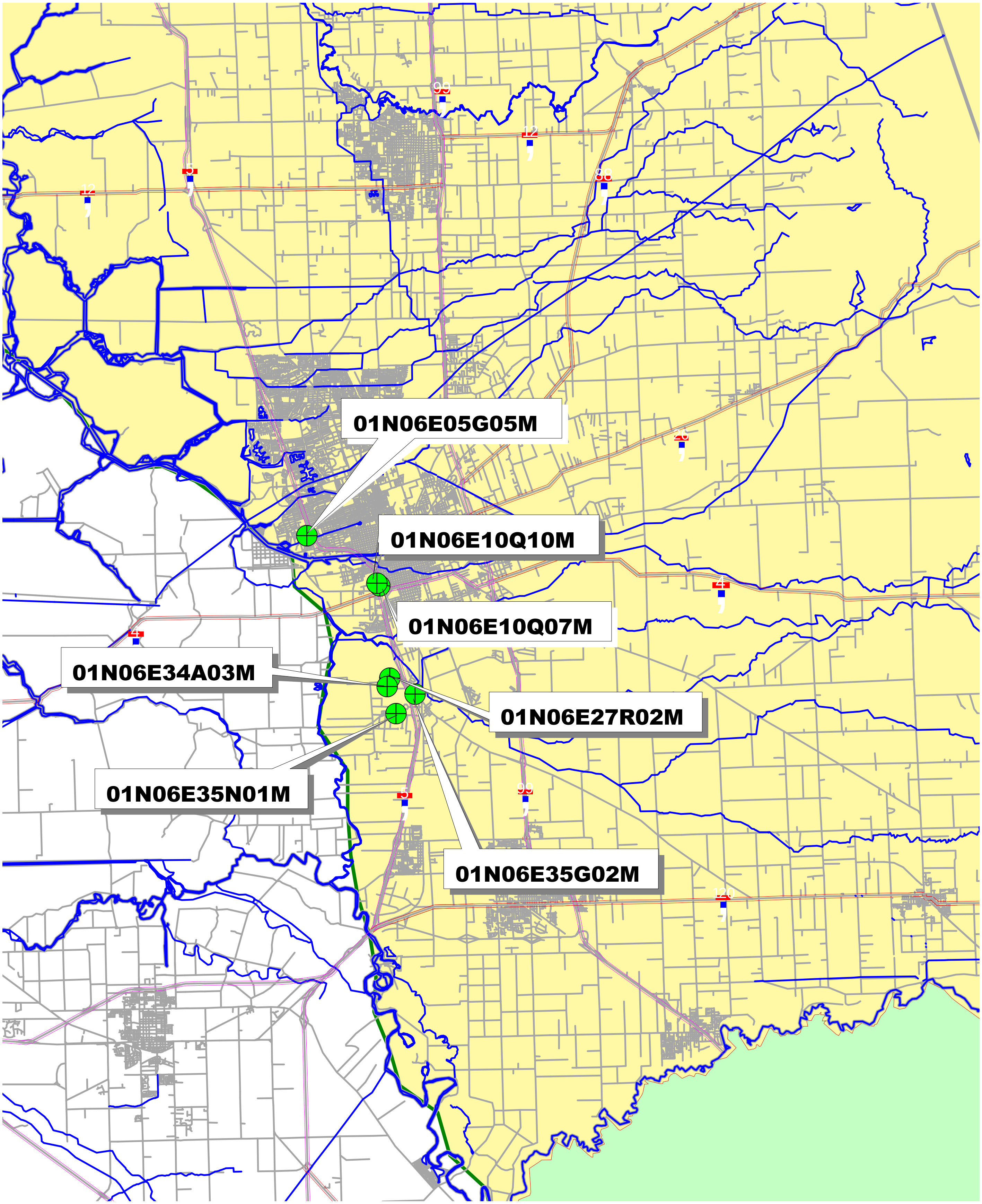

Figure 4-5
Groundwater Quality Well Location Map
San Joaquin County Water Management Plan

CDM Camp Dresser & McKee Inc.

Section 5
Recommended Further Studies

Provided in this section are recommended studies to augment the existing work, and provide information to assist in final implementation of the water management plan.

5.1 Characterization of Saline Water Migration

The salinity intrusion problem near Stockton is poorly understood. Current monitoring programs and estimates of intrusion are primarily two-dimensional, and provide little hydrogeologic basis for describing the problem. CDM recommends that the County implement the comprehensive salinity intrusion monitoring and evaluation program recently proposed by Montgomery Watson.

5.2 Groundwater Model Refinement and Documentation

The groundwater modeling for the SJCWMP is based on the existing IGSM model, and incorporates new data including updated land use information. Additionally, model input files and results are being converted into GIS and database friendly format to facilitate future application of the model aquifer management. In addition to these efforts CDM recommends that the following issues relating to the groundwater model be addressed through future studies:

- Compilation of new and historical lithological data and incorporation of this data into the groundwater model to refine the stratigraphy and aquifer parameters. This data should include well logs, geophysical logs, aquifer performance tests and infiltration tests. Important data will become available from the hydrogeologic investigations conducted as part of the saline water intrusion monitoring program.

- Incorporation of latest data from Sacramento and Stanislaus Counties. The latest land use, groundwater pumping data and river diversion from Sacramento and Stanislaus Counties should be collected and incorporated into the San Joaquin Model. Currently land use data for these counties is not up to date.

- Refinement of the northern portion of the SJC Model. Lithologic data from Sacramento County should be collected and incorporated into the model as the San Joaquin County model extends up to the Cosumnes River in Sacramento County. Currently there are some discrepancies between the Sacramento and San Joaquin County models in the overlap area in terms of model structure, aquifer parameters and boundary conditions.

5.3 Investigate Payment Capacity of County Crops in Various Districts

Investigate payment capacity for water districts for different crops grown. Options for groundwater management may involve economic incentives (subsidies) or disincentives (taxes or other fees). Since the Plan will likely be countywide, economic policies could cause inequitable distribution of cost and benefits between farmers. CDM recommends that the County undertake a study of the payment capacity of different crops in different districts to assist in designing economic policies related to the Water Management Plan.

5.4 Investigate and Evaluate Future Cropping Patterns

Cropping patterns and other land use could have a significant impact on water use and demand within the planning window of the Water Management Plan (2030). Most recent land use estimates were completed in 1996 and future land use has not been forecasted. CDM recommends that land use data be updated, digitized and forecasts of cropping patterns estimated to 2030.

5.5 Countywide Infiltration Testing

For artificial recharge alternatives, field studies to determine infiltration capacity in selected areas will be required. Several of these studies have been conducted under on-going projects such as the Farmington Project. However, since the local lithology varies so widely in San Joaquin County, additional detailed studies will be required at selected sites. The long-term infiltration capacity testing is also important to ensure that infiltration rates can be maintained over the long-term.

5.6 Develop Integrated Data Management

San Joaquin County is well aware of the need for an integrated data management system that incorporates available hydrogeologic data such as well lithology, construction, water levels and water quality. Currently, the County is the process of developing a relational database, the Data Management Model (DMM), to serve as the platform storing and analyzing this data. CDM recommends that the County incorporate other data into this system such as:

- Municipal and industrial monthly pumping data from countywide water purveyors,
- Surface water diversion and irrigation data from water districts.

In addition to the DMM, the County should link its DMM with the available spatial/geographic data such as land use information from DWR. The model that CDM will provide the County will have input files in GIS format, and this information will need to be updated on a periodic basis.

5.7 Update Land Use and Crop Information

The management of water resources within the County requires a reasonable estimate of water use, both surface water and groundwater, on a regular basis. Currently no program exists for this activity.

The water used by the cities can be compiled, however, beyond the cities there is no reasonable data on water use amount and location. The information available from the Agricultural Commissioner's Office is useful however, it lacks specific geographic information and identification of the source of irrigation water. An effective means to determine water use is to inventory land use and calculate water use similar to the methodology applied for the Water Management Plan. Historically, DWR performed detailed land use surveys in 1976, 1982, 1988, and 1996. The work performed by DWR is very good however, without being a component of a deliberate water management program, the information is obtained only when convenient.

The current groundwater model has estimated that approximately 100 af/year is needed to halt the salinity intrusion into the aquifer. This figure is based on data prior to water transfer agreements currently in place of approximately 70,000 af/yr . Therefore, the water needed may be less than 100 af/yr dependent on when and where the transferred are delivered to users. While the contractual amounts for the transfers are known, no analysis has been performed on whether the water is actually being delivered and to whom. CDM recommends that the water transfers be tabulated and analyzed as to where the when the water is actually being delivered and used.

Accordingly, CDM recommends that San Joaquin County work with DWR to develop a program that provides for detailed land use information to be obtained at a three to five year interval. The next land use survey should be performed in 2001. Subsequent surveys should be expanded over time to include the location of agricultural wells. This information can be incorporated into the County's GIS mapping data base. Previous land use surveys performed by DWR have summarized information according to hydrographic areas. This can continue to be done however, the County should require that the information be summarized according to internal water districts also.

Working closely with the respective water districts, the Farm Bureau, and the Cooperative Extension Service, the land use information should be translated into water use and evaluated as part of an ongoing water management program.

5.8 Prepare Map of Cities and Water Districts

CDM utilized available information to prepare a digitized map of water districts and cities for use in evaluating land and water use. This information needs to be refined and coordinated with the work recommended above regarding the updating of land and water use information.

Accordingly, CDM recommends that the County prepare ditigitized maps and make them available to all water districts and cities so that a common base for compiling data pertinent to water resource evaluation and planning is utilized. Data compiled by water districts and cities and their methods and formats for reporting needs to be standardized as part of this effort to facilitate evaluation on a regular basis.

Section 6
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CDM Camp Dresser & McKee

San Joaquin County

San Joaquin County Management Plan
Technical Memorandum No. 3
Water Management Option Screening and Development

January 18, 2001

Contents

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Section 1
Introduction

This Technical Memorandum presents the framework for selecting water management options that will eventually be developed into County-wide water management alternatives. A future selected water management alternative will form the basis of the County Water Management Plan with a planning horizon meeting the County's Water demand in the year 2030.

The purpose of this TM is to give the San Joaquin County Water Management Plan Steering Committee a background for decision making, and to explain the rationale of the technical team for the development of water management options. The water management options are primarily organized to address the complexities of the east county overdraft problem.

Your task as a Steering Committee member is to review the background information, the example alternative presented in Section 5, and finally the option sheets in Section 6. The technical team will need your assistance with the development of a County-wide water management alternative that meets your organizational needs. This will be accomplished through our January Steering Committee meeting and a workshop in February.

The technical team recognizes that the information presented is very detailed and perhaps cumbersome, however, the format is intended to simplify a very complex set of potential solutions that can be organized and ranked to address County-wide water issues.

1.1 Definition of Terms

- Water Management Option – A surface water, groundwater, or other option that provides water supply, groundwater recharge in terms of capacity, or solves a water management issue in one of the four geographic regions of the County.
- County-wide Water Management Alternative – A collection of water management options that address County-wide water supply and quality issues in the four regions.
- County Baseline Water Demand – Current county-wide water demand for the year 2000 and projected water demand in the year 2030.
- East County Baseline Groundwater Conditions – Current overdraft of the east side basin in thousands of acre feet per year. The baseline is used to project what will happen to the groundwater aquifer in the year 2030 if nothing is done to correct the overdraft problem.
- County Region – The four County regions, defined as the Central Delta, South Delta, East side and Southwest. These "Regions" were defined in the early stages of this process by the Steering Committee as the areas in the County with water quality or quantity issues.

Section 2
Baseline Conditions

Provided in this section is an abbreviation of the County-wide water demand and East County groundwater conditions that are significant factors to consider when developing alternatives for the County WMP.

2.1 County-Wide Water Demand

Current and future water demands were derived as a part of Technical Memorandum No. 1 (TM 1). The results indicated that while overall demand would not change significantly, the composition of that demand would change. Current applied water demands are approximately 1,626,000 acre-feet per year. The County's urban population will increase in the future, which will likely result in an increase in urban land and water use. The new urban land area will come from the conversion of land that is currently in agricultural production. As urban water use increases, agricultural land will go out of production and agricultural water use will decrease. Urban water use is slightly higher per acre, so the newly urbanized areas will have slightly higher water demand after they convert from agricultural acreage. Urban water use is predicted to increase 137,000 acre-feet per year, and agricultural water use is predicted to decrease 132,000 acre-feet per year. Figure 2-1 illustrates this change in the expected composition of demand into the future.

Figure 2-1
Current and Projected Agricultural and Urban Water Demands

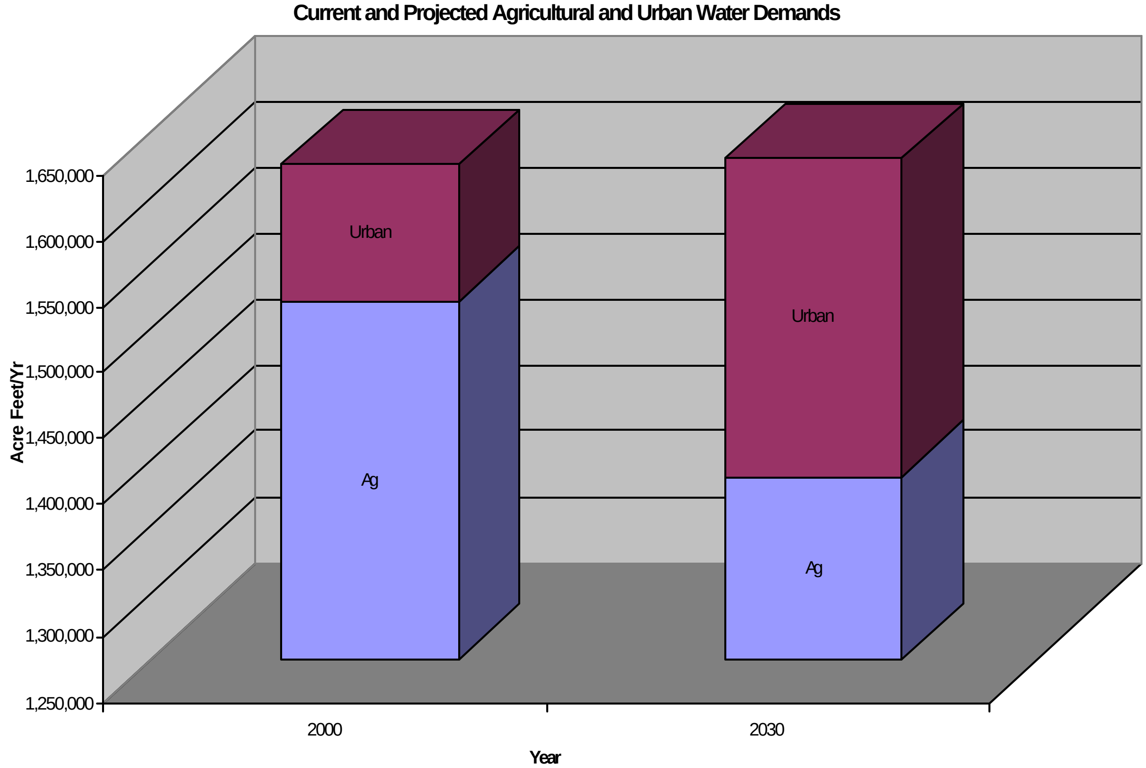
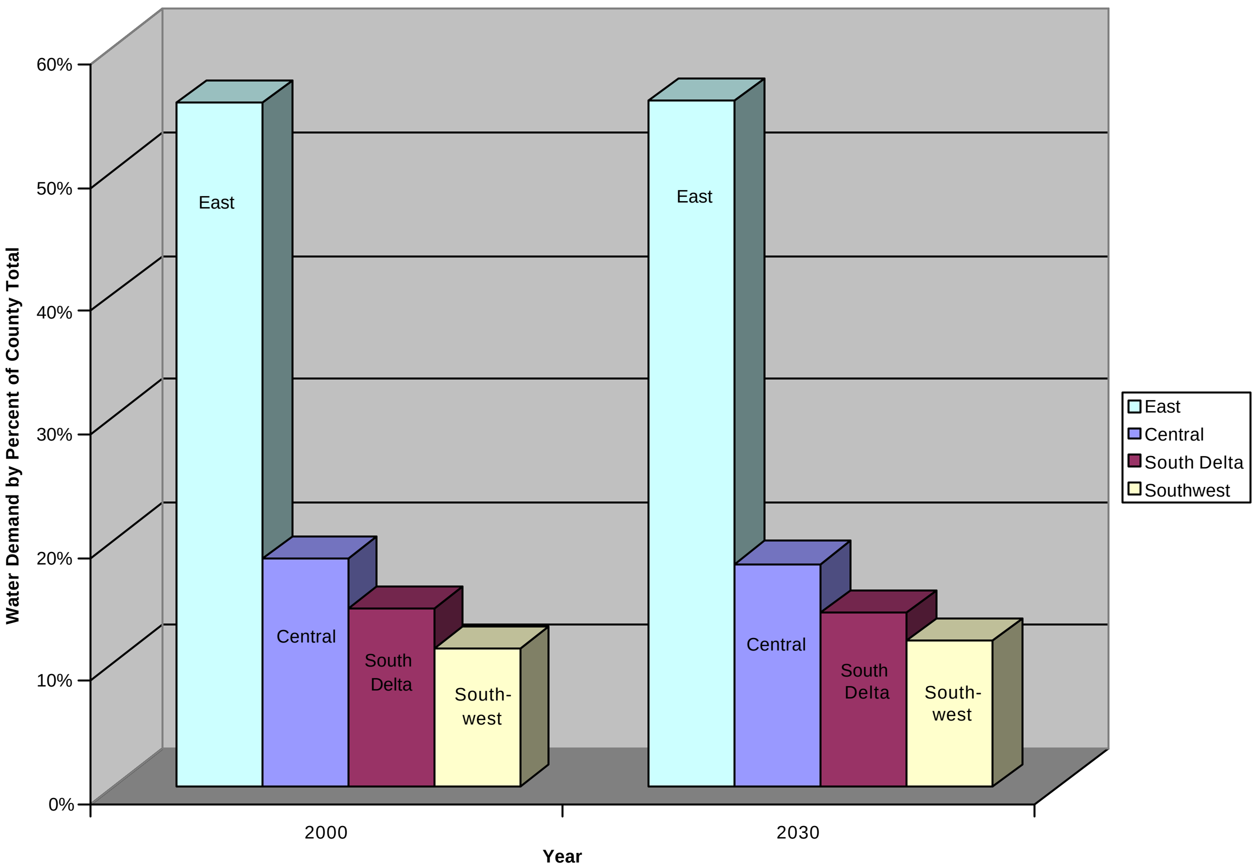


Figure 2-2 Current and Projected Water Demand by Region



TM 1 predicted that future demands would total 1,631,000 acre-feet per year. Future demand is not anticipated to change significantly between the four regions of the County. Figure 2-2 illustrates the regional distribution of these projected demands.

2.2 Regional Water Supply and Quality Concerns

The San Joaquin County water quality and supply problems can be summarized geographically, as described below:

- In the southwestern portion of the County, issues of concern are related to unreliable Central Valley Project (CVP) contract water supplies, lack of alternative supplies, and significant population growth in the City of Tracy.

- In South Delta Water Agency area, a drop in water levels in Delta channels during the irrigation season and poor water quality present problems. The drop in water level is due primarily to CVP and State Water Project (SWP) pumping from the south Delta. Water quality problems are due to reduced San Joaquin River flows caused by upstream development and increased salt load from the west side of the San Joaquin Valley.

- The Central Delta Water Agency area has no serious water management problems at present, but potential concerns are the closure of the CVP Delta Cross Channel gates (to protect emigrating salmon smolts) and the construction of an isolated canal from Hood (on the Sacramento River) to the CVP/SWP pumps, which could lead to permanent closure of the Cross Channel gates. Water levels have also started to decline in the Central Delta area.

- In the north Delta region, no specific water quality or supply concerns have been identified.

- In Eastern San Joaquin County, the principal concern is the degradation of groundwater quality because of groundwater pumping that exceeds recharge and consequent lateral inflow of poorer quality groundwater from the Delta area. Excessive groundwater pumping has also resulted in declining groundwater levels, and a net reduction of aquifer storage.

Figure 2-3 illustrates the different regions of the County and the current conditions associated with each area.

The County-wide Water Management Plan and the implementation plan will include recommended projects, policies and programs for all regions of the County addressing the water quality and quantity concerns presented above. Solutions have already been identified, however, for many of the problems in the Southwest County and Delta regions. These solutions are being developed by entities other than the County, including federal, state and local agencies. Therefore, this document will focus attention on developing options for the east side groundwater overdraft problem. The east side problem is significantly complex, with myriad solutions to correct the overdraft problem. The technical team has chosen to represent the potential solutions through the linking of “options” to simplify identification and development of an east side solution. The other regions have significantly fewer actions to be taken by the County. The difference in the number of options should not be construed as implying that some regional problems are less important. In the Delta regions, for example, we have identified only a single option, essentially making the option “the solution.” For the purposes of this TM, we have chosen to keep the nomenclature consistent and use the word “option” for all potential solutions in the various County regions.

2.3 Eastern County Baseline Groundwater Conditions

For the purpose of the SJCWMP, the eastern County baseline groundwater condition refers to the continued use of the eastern San Joaquin Groundwater Basin without any county-wide integrated management or basin restoration measures. More specifically, no San Joaquin County-sponsored basin restoration or conjunctive use projects are implemented and groundwater pumping continues in what has been referred to as an "unrestricted" mode. All water demands not met with surface water are met with groundwater pumping.

The fundamental concern with the groundwater resources in eastern San Joaquin County is that historical groundwater withdrawals or pumping has exceeded the groundwater replenishment, in other words, a groundwater overdraft exists. Table 2-1 provides an average historical groundwater flow budget based on groundwater modeling of the period 1970 to 1993, and estimated current and future groundwater water budgets based on mass balance calculations.

Table 2-1
Average Historical and Predicted Water Budgets
Based on Geographic Analysis and Groundwater Modeling
Eastern San Joaquin County

Component	***Average 1970 to 1993 (Units: TAF)***	***Estimated Current Values[1] (1996-2000)***	***Estimated Future Values[1] (2020-2030)***
Outflows			
Agricultural Groundwater Pumping	NA	837	777
Municipal Groundwater Pumping	NA	60	119
Total Groundwater Pumping	852	895	896
Lateral Outflow			
Discharge to Surface Water	35	35	35
Total Outflows	***886***	***930***	***931***
Inflows			
Deep Percolation	542	*542*	*542*
Other Recharge	42	*42*	*42*
Lateral Inflow	112	*112*	*112*
Gain from Streams	39	*39*	*39*
Total Inflows	***735***	***735[2]***	***735[2]***
Change in Storage/Deficit	***-117***	***-161***	***-162***

Note 1: These values are based on estimates of current and projected water use presented in the SJCWMP Technical Memorandum 1.

Note 2: Estimated inflows are based on average values from groundwater modeling of historical conditions. These numbers will be adjusted once predictive groundwater modeling has been completed.

Under natural or predevelopment conditions, groundwater and surface water in eastern San Joaquin County would discharge through the Delta westward to San Francisco Bay. The over-pumping has changed this natural flow pattern with two principal effects. The first is that groundwater levels have declined significantly within eastern San Joaquin County. The second effect is that groundwater quality in and around Stockton is declining due to increased salinity levels. The exact cause of the increasing salinity levels is not clearly understood, however, it is generally attributed to the reversal of the natural groundwater flow regime. That is, groundwater no longer flows westward from eastern San Joaquin towards the San Joaquin River and the Delta, but instead flows eastward from the Delta area. The groundwater flowing east into the cone of depression near Stockton has higher salinity levels and is therefore causing degradation of groundwater quality. Some studies have also cited the possibility of up-coning of poor quality groundwater from deeper marine sediments. Figure 2-4 illustrates the salinity intrusion and groundwater depression near Stockton.

As shown in Table 2-1, the historical overdraft was estimated to be 117 TAF. Based on current estimates, the overdraft may be as high as 160 TAF. This value is based on 'mass-balance' calculations, and is being refined through the predictive groundwater model simulations. These simulations will account for changes in deep percolation due to agricultural changes and surface transfers to urban areas. As noted previously, TM 1 suggests that overall net water demand within San Joaquin County will change by only a few percent over the next 20 to 30 years. The average deficit is therefore not expected to change significantly from current values. It should also be emphasized however, that this range of 117-160 TAF is subject to many factors other than predicted water demands. Climatic variations, changes in surface water use, and unanticipated changes in cropping patterns could have significant impact on the aquifer deficit.

Given this baseline condition, two objectives for the SJCWMP are appropriate: stabilization of the basin to minimize salinity intrusion; and use of the available basin storage for conjunctive use or aquifer storage and recovery (ASR) projects.

2.3.1 Saline Water Intrusion/Aquifer Stabilization

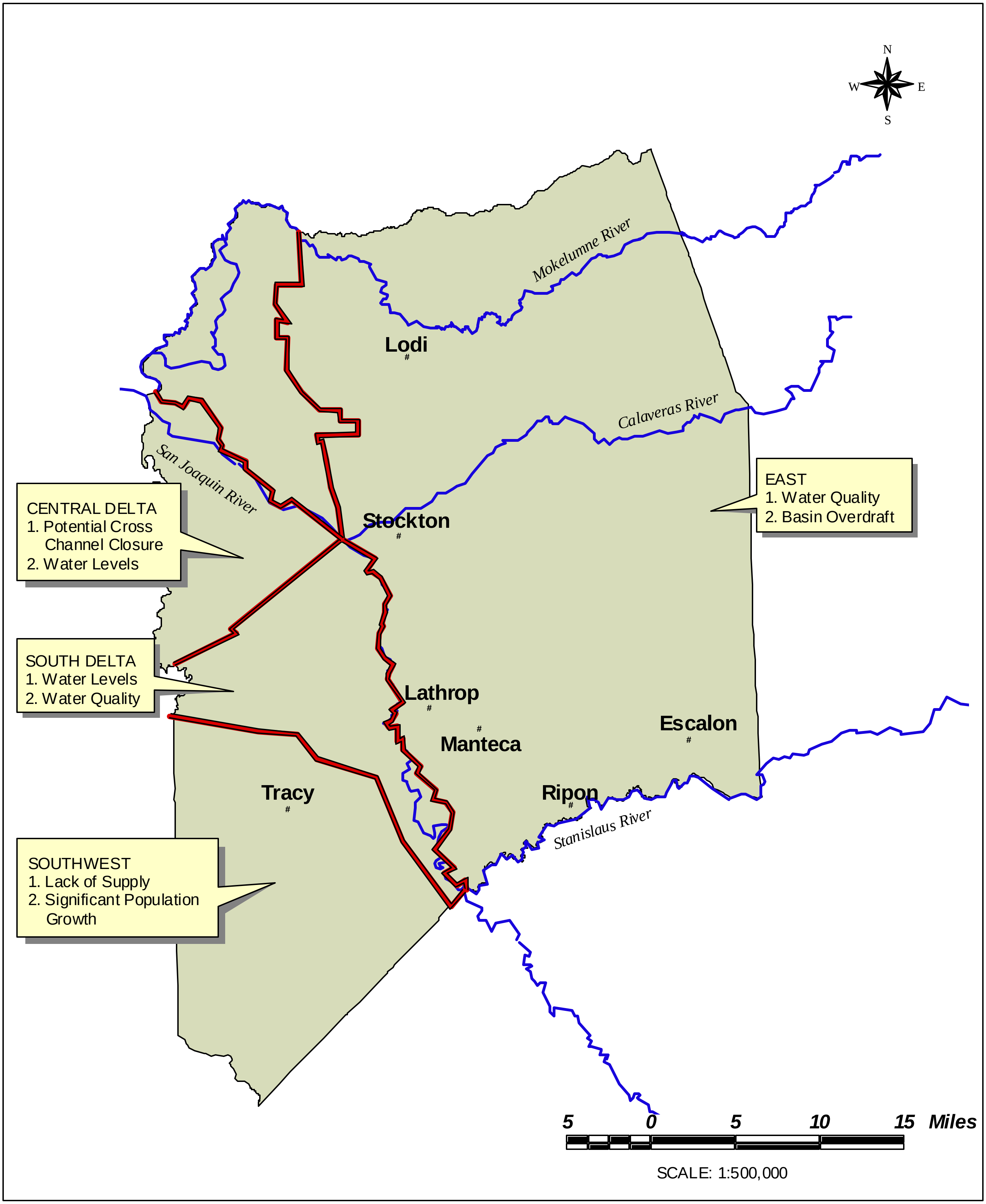
Based on the current overdraft and the anticipated future water demands, 120 to 160 TAF of reduced groundwater withdrawal or artificial recharge would be required to bring the entire East County groundwater basin back into equilibrium and minimize saline water intrusion. The principal area of concern, however, is the depression near Stockton. Preliminary studies and groundwater modeling have shown that approximately 100 TAF of ground water recharged in the Stockton area will minimize the intrusion problem, while still leaving an overall East County-wide overdraft problem.

The simulated/calculated loss of groundwater storage from 1970 to 1993 from modeling was approximately 2.8 million acre feet (MAF). If the groundwater overdraft continues at the historical rate, aquifer storage volume will continue to decline, causing increased lateral inflow and possibly resulting in further degradation of water quality. If the East County overdraft was eliminated, and the basin was 'stabilized', the long-term result would be that groundwater storage volume would no longer decline. Figure 2-5 shows a schematic view of the groundwater basin along with a graphical representation of the key issues.

Appendix A contains a more detailed description of the groundwater modeling efforts to determine these numbers.

2.3.2 Conjunctive Use/Aquifer Storage-Recovery

For conjunctive use or ASR projects, an assumed upper limit of basin storage could be the 1986 level and the lower limit the 1993 value. The 1986 level was selected as an upper limit based on historical data, which shows that flooding and structural damage could result if water levels exceed the 1986 levels. Using the 1986 to 1993 range as a guide, the total aquifer storage volume available for such projects would be approximately 1.2 MAF, as depicted in Figure 2-5.

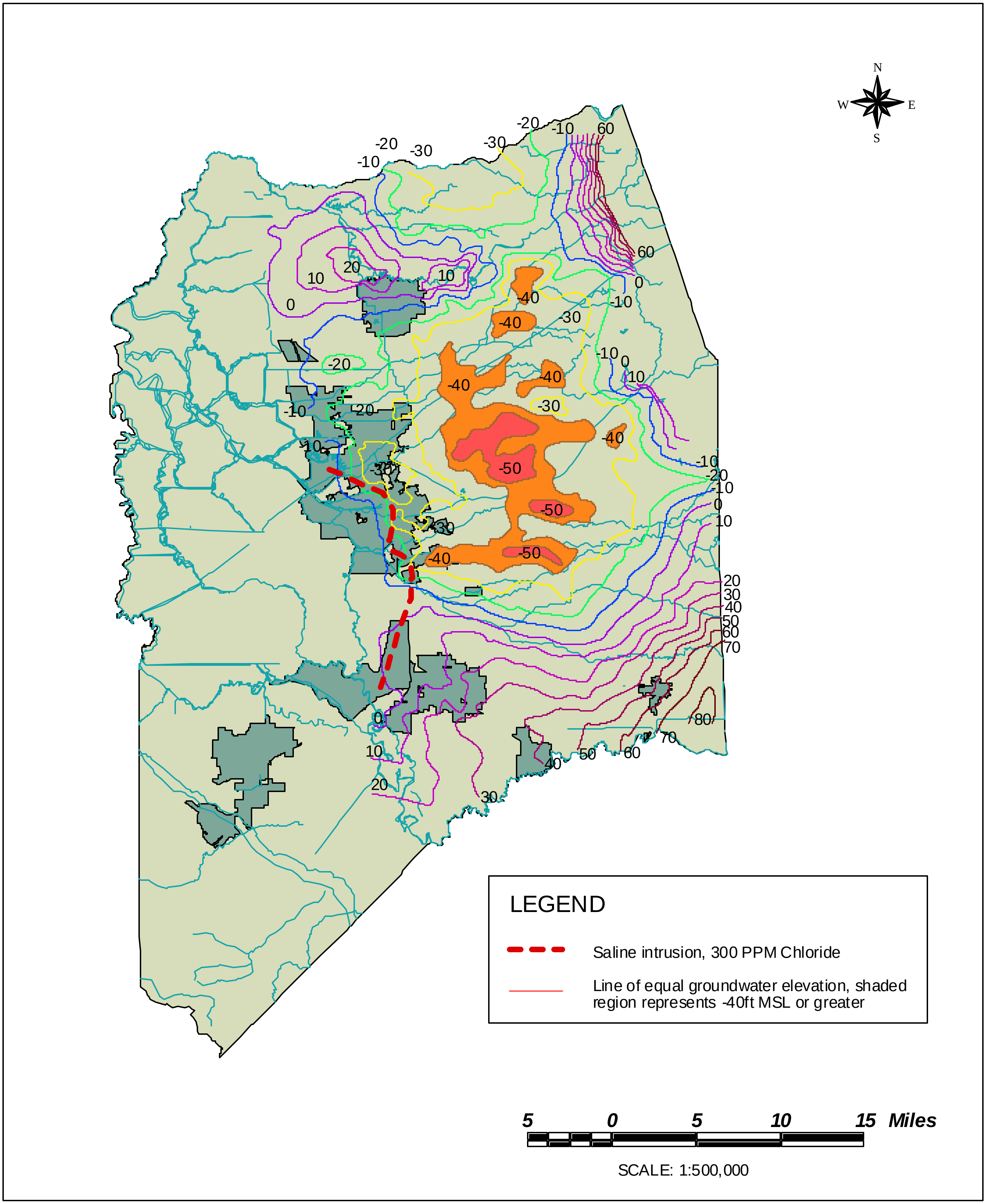


Source:

Figure 2-3

CDM Camp Dresser & McKee Inc.

SAN JOAQUIN COUNTY
REGIONS AND ASSOCIATED PROBLEMS



Source:

Figure 2-4

CDM Camp Dresser & McKee Inc.

EAST SAN JOAQUIN COUNTY GROUNDWATER
DEPRESSION AND EXTENT OF SALINE INTRUSION

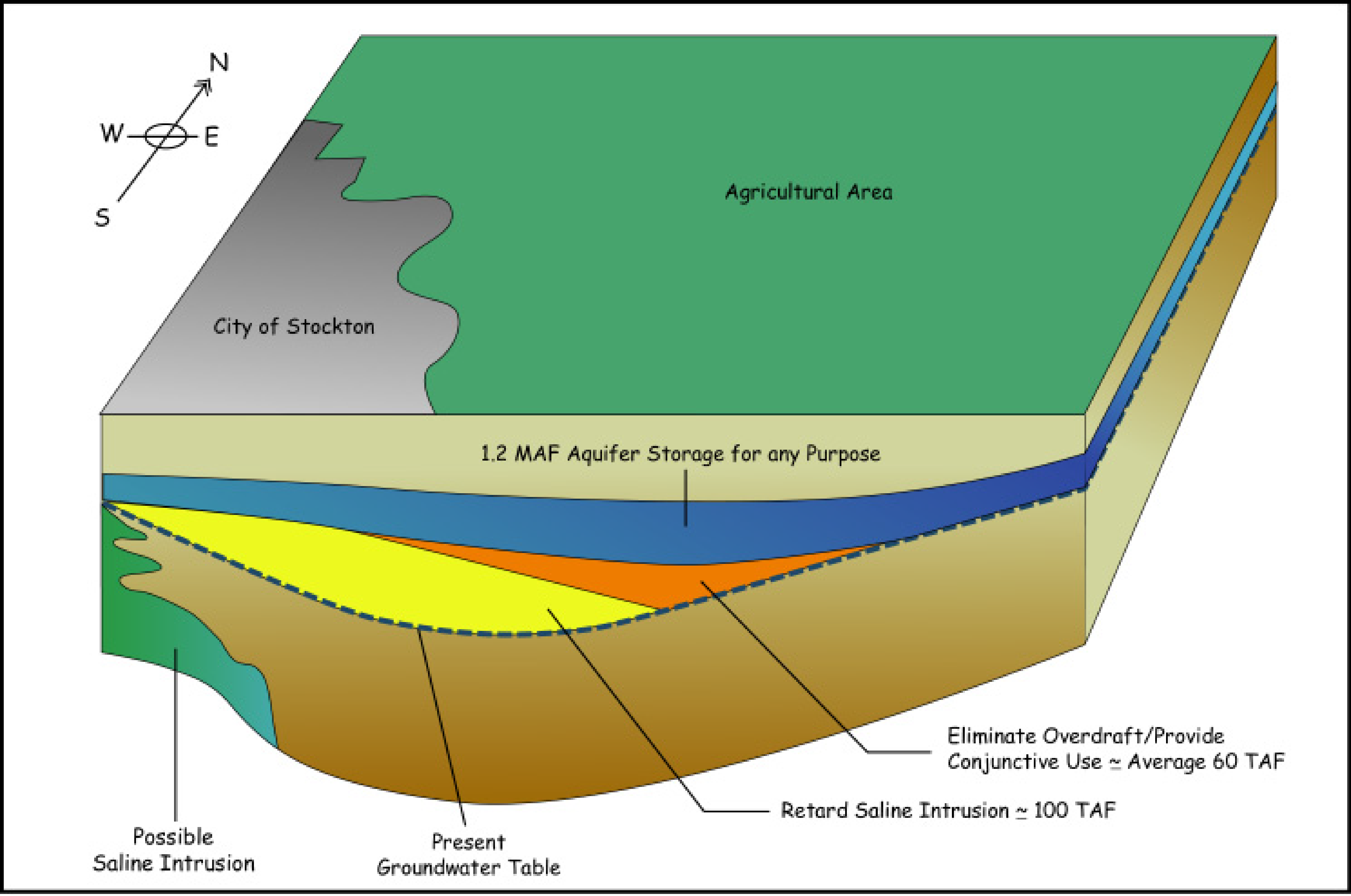


Figure 2-5
Schematic of Groundwater Basin

Section 3
East County Management Strategy

This section describes the management strategy proposed for the East County groundwater basin to protect the basin from saline intrusion and overdraft and provide opportunities for longer term conjunctive water management. Developing longer term storage would provide a more reliable supply of water for the County during droughts as well as opportunities for potential future export.

The projected baseline County-wide water demand in 2030 is not significantly higher than current demand (See Figure 2-1). Baseline groundwater conditions for the East County aquifer suggest that the basin is currently overdrafted by up to 160 TAF. No significant additional water is therefore needed to meet County 2030 demand aside from that needed to protect the basin aquifer from saline intrusion and overdraft.

Management Strategy:

1. ***Identify 100 TAF of water for strategically located recharge or in-lieu transfer to the east basin***. Groundwater modeling performed as a part of this study has shown that approximately 100 TAF of water, either recharged to the aquifer or provided in lieu of current pumping in the appropriate east County areas, would halt the salinity migration. This water must be recharged in the area of the groundwater depression to have the most impact on the salinity migration.

2. Identify at least 60 TAF of *"average"* yearly recharge or in-lieu transfer to halt basin overdraft and provide aquifer storage. This recharge of 60 TAF would be in addition to the 100 TAF provided in the first phase of the management strategy. Current groundwater modeling shows that the basin is in overdraft by approximately 120-160 TAF per year. Recharging an average of 60 TAF (i.e., 100 TAF in 2002, 20 TAF in 2003, and 60 TAF in 2004) will halt basin overdraft, while allowing recharge when water is available (wet years) and storage in dry years. More flexibility exists in the geographic location of this recharge, however, it would be most effective if positioned over the cone of depression.

3. Identify other opportunities for aquifer storage. The aquifer has 1.2 MAF of potential storage based upon current groundwater modeling. Any amount of the potential storage could be used in conjunction with the 160 TAF needed to protect the basin from overdraft and saline intrusion. This stored water, in excess of County demand, would be available for export. Recharge for this strategy presents even greater flexibility, and need not be as geographically specific as 1 and 2.

4. Implement a comprehensive groundwater monitoring and assessment program and manage the basin as a dynamic system. Regularly update the groundwater model to reflect changes in the aquifer for both quality (saline intrusion) and quantity parameters.

Section 4
Screening of Water Management Options

This section presents the options that were reviewed to solve the County water management issues associated with the four regions of the County, and the criteria used to perform a preliminary screening of these options. The primary emphasis of the review is the East County groundwater overdraft and saline intrusion problem.

4.1 Grouping of Options

For ease in the development of a County-wide alternative, the options have been categorized as surface water projects, groundwater projects or other water projects. These project options are more fully described below.

Option Groupings:

Surface Water Project Options

Surface water projects are new surface water resources within County. Facilities associated with these types of projects are used to store or divert available surface water to or within the County. Example surface water option*: Reoperation of New Hogan Reservoir.*

Ground Water Project Options

Groundwater projects include ways to recharge the groundwater, through in lieu, direct recharge or injection methods and should be thought of in terms of capacity for recharge. Facilities associated with groundwater projects are used to distribute current or new surface water resources to land or recharge facilities. In lieu project are grouped with groundwater due to potential aquifer benefits, although no direct groundwater recharge infrastructure would be developed. Example groundwater option*: Injection wells in the City of Stockton.*

Other Water Project Options

Other water projects have benefits to the County by either increasing supply or improving quality without developing a new water source. Example other option: *Urban wastewater reclamation.*

4.2 Option Screening Criteria

After a comprehensive list of options was compiled, the options were screened to narrow the list to those options that are considered feasible and would help to address the County water management issues in the four regions of the County. All water management options initially considered as part of this study were screened according to seven criteria.

Screening Criteria

The following criteria and elements were applied to the options qualitatively for the purpose of removing them from further consideration and/or ranking for implementability:

Cost ($/ac-ft):

- Cost of water per acre foot
- Cost includes new or improved water supply, delivery, distribution, or treatment infrastructure for project implementation

Legal Feasibility:

- Legally implementable by County interests
- Ease of obtaining necessary regulatory permits (water rights, contract amendments, water transfer agreements, etc.)
- Potential legal challenges

Political Feasibility:

- Political controversy
- Level of educational process for the project to be fully understood
- Divisive to County interests (agricultural, urban growth etc.)

Financial Feasibility:

- Potential for out-of-County partners to share cost
- Funding from Prop. 13, DWR's ISI program, or CALFED
- Economic impacts on the affected local community
- Impact of infrastructure costs on the affected local community
- Potential for a financial program (and program incentives) to share the affected community costs and benefits

Environmental Impacts:

- Likely environmental project impacts
- Infrastructure construction impacts

Water Quality:

- Potential to improve or degrade water quality of County interests
- Potential project implementation effects on water quality

Benefits:

- Potential to improve County's ground water problems
- Benefit uncertainty due to factors outside of the County

4.3 Results of Screening Process

Table 4-1 presents all of the water management options initially considered as part of this study**.** The projects or options that could not reasonably meet all the screening criteria as a water management project have been removed from further technical evaluation. Those options removed from further technical evaluation are check marked in Table 4-1. Brief notes in the table explain why options were dropped from further technical consideration.

4.4 Evaluation of Viable Options

The water management options surviving the initial 'fatal flaw' screening process are further developed and ranked as water management options. The water management options are presented in 33 option sheets, as an attachment to this TM. The options have been categorized and grouped as follows:

- 18 groundwater options (GW1 through GW18)
- 9 surface water options (SW1 through SW9)
- 6 other water options (O1 through O6)

The above options have been further grouped into Tiers I through III as described below. The criteria used in the screening process were the measures used, on a qualitative basis, to subjectively develop each Tier. As shown on the option sheets, each option is assigned a ranking of good, fair, or poor according to each criterion. The rankings were determined by comparing the variety of options within each group (groundwater, surface water, or other). A ranking of "good" indicates that the option is among the best of that group according to that criterion.

Where applicable, option sheets (primarily surface water options) show the amount of water in acre-feet that can be reasonably expected with implementation of the option. For groundwater options, capacity for recharge is shown. This is an important element when evaluating the quantity of water needed to solve the East County saline intrusion and overdraft problem stated in the management approach.

Option Tiers

Tiers have been developed to help the reader quickly assess which of the presented water management options have a high degree of potential success for solving the water management issues in the County when compared to costs and benefits.

Tier I Options: Options that have strong potential for addressing the County's immediate water management issues, especially salinity degradation of the groundwater resource. Cost is low to moderate and implementation appears relatively straight-forward.

Tier II Options: Options that have favorable potential to address the County's water management issues, salinity intrusion and/or groundwater overdraft. There may be other political, environmental, or economic factors that result in higher cost or difficulty with implementation.

Tier III Options: Options that have potential to address San Joaquin County's water management issues, but either have small benefit or are potentially too expensive to implement.

San Joaquin County Water Management Plan Option Screening
Table 4-1

	Option Number	Project Name	Screening Criteria (X = option is unacceptable in this category)							Notes
			Legal	Political	Cost	Financial	al	Benefits	Water Quality	
Groundwater	1	Direct Recharge in CSJWCD								
	2	Direct Recharge in SEWD								
		Direct Recharge in SSJID						X		Existing groundwater levels are already high.
	3	Direct Recharge in WID								
	4	Farmington Groundwater Recharge and Wetlands Feasibility Study								
		Groundwater Desalination			X					$/AF treatment cost renders this infeasbile
		Groundwater recharge north of Mokelumne River						X		No Benefits - Water would travel North into Sacramento County
	5	Injection Wells in CSJWCD								
	6	Injection Wells in NSJWCD								
	7	Injection Wells in SEWD								
		Injection Wells in SSJID						X		Existing groundwater levels are already high.
	8	Injection Wells in the City of Stockton								
		Injection Wells in WID						X		Existing groundwater levels are already high.
	9	In-lieu Recharge in CSJWCD								
	10	In-lieu Recharge in NSJWCD								
	11	In-lieu Recharge in SEWD								
		In-lieu Recharge in the City of Escalon						X		Surface water to Escalon is already included in the option for the South County Surface Water Supply Project
		In-lieu Recharge in the City of Lathrop						X		Surface water to Lathrop is already included in the option for the South County Surface Water Supply Project
	12	In-lieu Recharge in the City of Lodi								
	13	In-lieu Recharge in the City of Manteca								
	14	In-lieu Recharge in the City of Ripon								
	15	In-lieu Recharge in the City of Stockton								
	16	In-lieu Recharge in WID								
	17	NSJWCD Groundwater Recharge Project								
	18	Unlined Flat Canal								
		Auburn Dam	X	X	X	X	X			New on-stream storage would be difficult to implement in the current political climate.
		Beaver Slough Delta Diversion	X				X		X	Diverting water from this location in the Delta would be difficult to permit and environmentally sensitive.
	1	Calaveras River Flood Flows								

San Joaquin County Water Management Plan Option Screening
Table 4-1

			Screening Criteria (*X = option is unacceptable in this category*)							
	Option Number	***Project Name***	***Legal***	***Political***	***Cost***	***Financial***	***al***	***Benefits***	***Water Quality***	***Notes***
Surface Water		Delta Wetlands Project			X			X		Cost very high. Benefits uncertain due to uncertain regulatory constraints.
	2	EBMUD/Sacramento County/San Joaquin County-Sacramento River Diversion								
	3	Mokelumne River Flood Flows								
	4	New CVP Diversion Facility on the Lower San Joaquin River								
	5	New Hogan Reservoir Reoperation								
		New, On-stream Mokelumne River Reservoir Middle Bar Reservoir	X	X	X	X	X			New on-stream storage would be difficult to implement in the current political climate.
	6	NSJWCD-Mokelumne River water right and agreement with EBMUD for storage								
		Seawater Desalination			X					$/AF treatment cost renders this infeasbile
	7	Stanislaus River Flood Flows								
	8	Water Transfers within San Joaquin County								
	9	WID and WWUCD use of additional Mokelumne River Flood Flows								
	10	New Melones Full rights to SEWD								
	11	Farmington (Little John's Flood Flows)								
Other		Adjudicate Basin		X						This option would not be politically acceptable to County residents.
		Agricultural Land Fallow Program		X						Inconsistent with San Joaquin County Water Management objective.
	1	Delta Area San Joaquin County Water Supply Activities								
	2	Delta Mendota Canal Recirculation Study								
		Rationing		X						This option would not be politically acceptable to County residents, except as a short term measure during extreme droughts.
	3	Southwest San Joaquin County Water Supply Activities								
	4	SSJID Transfers								
	5	Urban Wastewater Reclamation								
	6	Water Conservation Improvements								

Section 5
Example County Water Management Alternative

This section presents an example Water Management Alternative and directions to the Steering Committee for assistance in the development of County Water Management Alternatives. A Water Management Alternative is defined as a collection of water project options that meets the comprehensive needs of the County's four geographic regions. The County Water Management Alternatives are constructed by combining options.

The purpose of this section is to provide a framework for the Steering Committee to select combinations of water management options that can be further evaluated by the CDM technical team. The technical team will perform technical, economic and benefit analyses on three alternatives developed by the Steering Committee.

Direction to the Steering Committee:

As established in the baseline conditions, there is a need in the East County to develop surface water (SW) options and groundwater (GW) options together equaling a total of 100 TAF per year to decrease saline intrusion and protect the aquifer from water quality degradation. An additional 60 TAF per year is needed to eliminate basin overdraft (see Section 2.3). Any additional water added to the aquifer can be banked as potential storage. Any number of the options can be sequentially implemented over time to address all or part of these management strategies.

Please examine the option screening table (Table 4-1) to determine if there are any options missing that your organization believes may be feasible. These options will be added to the initial list, and considered during the alternatives evaluation process. Also, please review Table 4-1 and the option descriptions in Section 6 to select options that your organization believes are most feasible for implementation and provide the greatest benefit. Options that survive this screening process will undergo further evaluation that will be described in the next technical memorandum. Remember that Tiers are only presented as a guideline to assist your organization in making a decision.

An example of an alternative is included for your guidance and consideration as you evaluate options.

Example Alternative

In the first phase of this alternative, the surface water options for New Hogan Reoperation and Water Transfers within San Joaquin County would be included to provide a total of approximately 100 TAF. To utilize 100 TAF, groundwater would be recharged with the following options: In-lieu Recharge to the City of Stockton, In-lieu Recharge to SEWD, and the Farmington Groundwater Recharge Project. Other options included in the first phase would be the Delta Area San Joaquin County Water Supply Activities, the Southwest San Joaquin County Water Supply Activities and Water Conservation Improvements.

The second phase of this alternative would stabilize the groundwater overdraft and initiate an aquifer storage and recovery program. The second phase would include surface water options of teaming with EBMUD and Sacramento County on a Sacramento River Diversion Facility, a New CVP Diversion Facility on the Lower San Joaquin River, and helping WID and WWUCD to acquire additional Mokelumne River Flood Flows. These surface water options would provide water during wet years, and would be paired with the groundwater options for In-lieu Recharge in CSJWCD, In-lieu Recharge for the City of Manteca, and In-lieu Recharge for NSJWCD. The summary of options included in this alternative:

- First Phase: SW 4 + SW 7 + GW 15 + GW 11 + GW 4 + O 1 + O 3 + O 5
- Second Phase: SW 2 + SW 3 + SW 8 + GW 9 + GW 13 + GW 10

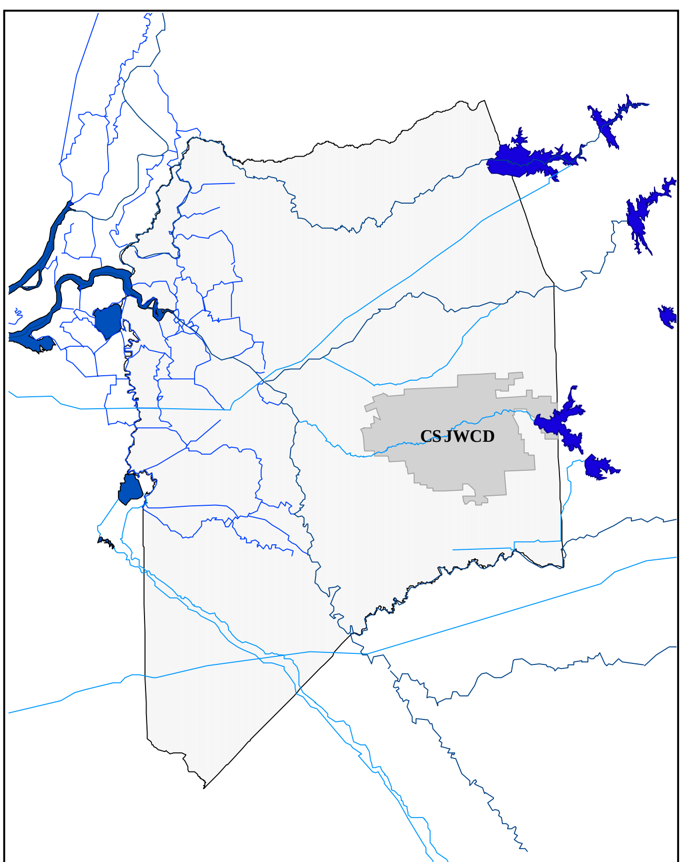
(GW1) Direct Recharge in CSJWCD

Average Annual Capacity: *TBD*

OPTION DESCRIPTION:
Recharge water directly to the aquifer through spreading basins, field flooding, or recharge pits within CSJWCD.

Tier II

PRIMARY BENEFITS AND DRAWBACKS:
Benefits: Direct recharge does not require landowners to change practices on their land, and field flooding can co-exist with farming efforts. CSJWCD is directly over the groundwater depression, so recharge efforts within the district have potentially significant benefits.
Drawbacks: Direct recharge has limited effectiveness in getting water into the ground, requires large areas of land, and requires significant maintenance efforts.



SCREENING CRITERIA

Criteria	Rating
Cost	Fair
Legal Feasibility	Good
Political Feasibility	Good
Financial Feasibility	Good
Environmental Impacts	Good
Water Quality	Depends on source.
Benefits	Good

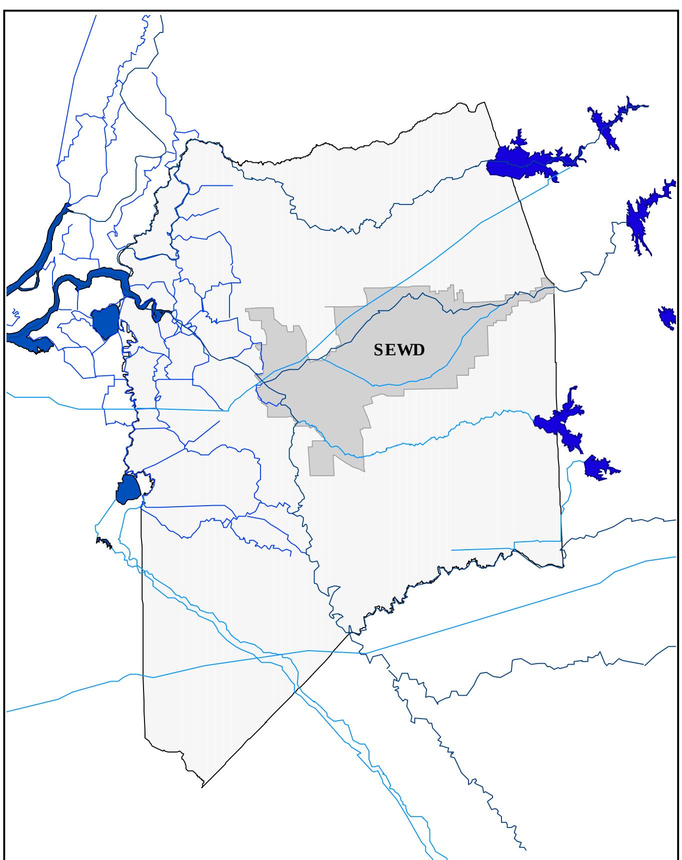
(GW2) Direct Recharge in SEWD

Average Annual Capacity: *TBD*

OPTION DESCRIPTION:
Recharge water directly to the aquifer through spreading basins, field flooding, or recharge pits within SEWD.

Tier II

PRIMARY BENEFITS AND DRAWBACKS:
Benefits: Direct recharge does not require landowners to change practices on their land, and field flooding can co-exist with farming efforts. SEWD is directly over the groundwater depression, so recharge efforts within the district have potentially significant benefits.
Drawbacks: Direct recharge has limited effectiveness in getting water into the ground, requires large areas of land, and requires significant maintenance efforts.



SCREENING CRITERIA

Criteria	*Rating*
Cost	Fair
Legal Feasibility	Good
Political Feasibility	Good
Financial Feasibility	Good
Environmental Impacts	Good
Water Quality	Depends on source.
Benefits	Good

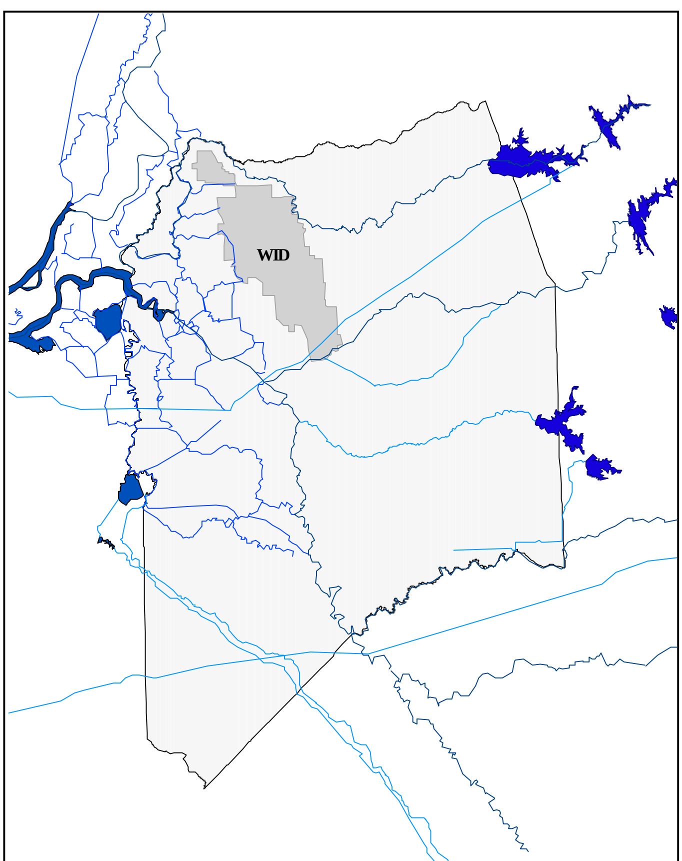
(GW3) # Direct Recharge in WID

Average Annual Capacity: *TBD*

OPTION DESCRIPTION:
Recharge water directly to the aquifer through spreading basins, field flooding, or recharge pits within WID.

Tier III

PRIMARY BENEFITS AND DRAWBACKS:
Benefits: Direct recharge does not require landowners to change practices on their land, and field flooding can co-exist with farming efforts.
Drawbacks: Direct recharge has limited effectiveness in getting water into the ground, requires large areas of land, and requires significant maintenance efforts. Recharge within WID is potentially less effective than other areas of the County because most of the area is north of the groundwater depression.



SCREENING CRITERIA

Criteria	*Rating*
Cost	Fair
Legal Feasibility	Good
Political Feasibility	Good
Financial Feasibility	Good
Environmental Impacts	Good
Water Quality	Depends on source.
Benefits	Poor

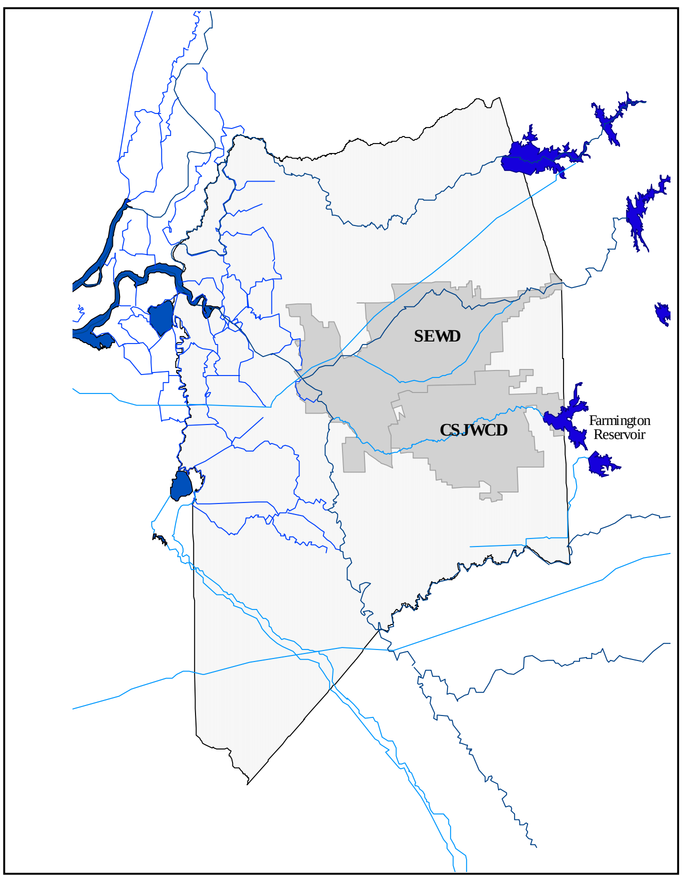
(GW4) Farmington Groundwater Recharge and Wetlands Feasibility Study

Average Annual Capacity: *TBD*

OPTION DESCRIPTION:
SEWD and COE have been evaluating potential methods to increase groundwater recharge of water supplies available at the Farmington location.

Tier I

PRIMARY BENEFITS AND DRAWBACKS:
Benefits: Up to 20 TAF yearly could be recharged to the overdrafted area of the groundwater basin. This project has already been developed and has political support.
Drawbacks: Options for groundwater recharge are potentially land use intensive.



SCREENING CRITERIA

Criteria	*Rating*
Cost	Good
Legal Feasibility	Good
Political Feasibility	Fair
Financial Feasibility	Good
Environmental Impacts	Good
Water Quality	Good
Benefits	Good

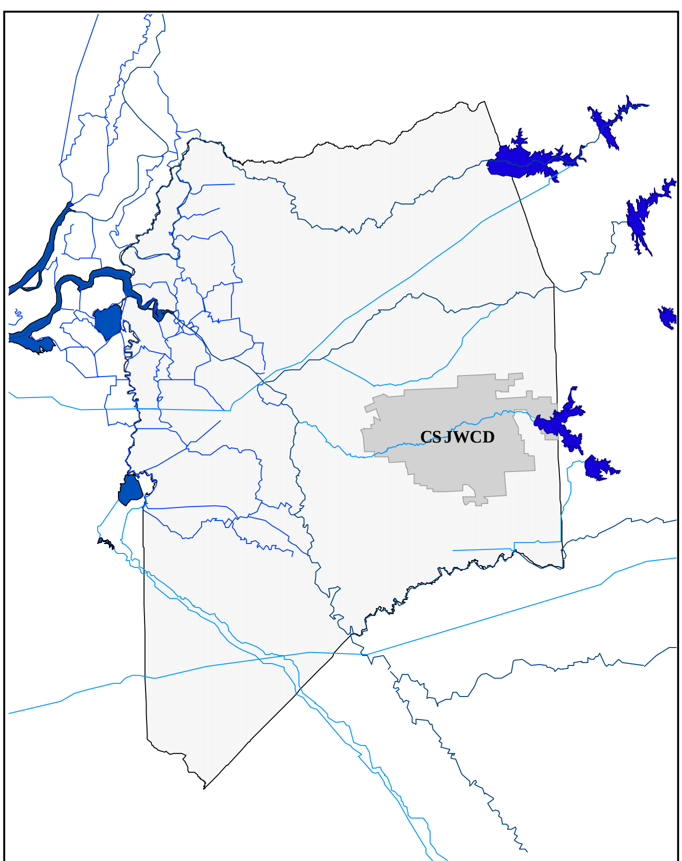
(GW5) Injection Wells in CSJWCD

Average Annual Capacity: *TBD*

OPTION DESCRIPTION:
Install wells to inject water into the aquifer within CSJWCD.

Tier III

PRIMARY BENEFITS AND DRAWBACKS:
Benefits: Injection wells can be potentially effective in localized areas, and do not require major changes by individual landowners to use the water. CSJWCD is directly over the groundwater depression, so recharge efforts have potentially significant benefits.
Drawbacks: Many wells are required to inject significant amounts of water into the ground, and land is required to support the well. Infrastructure is required to move water to wells, and injection wells can clog and require regular maintenance.



SCREENING CRITERIA

Criteria	*Rating*
Cost	Poor
Legal Feasibility	Good
Political Feasibility	Good
Financial Feasibility	Fair
Environmental Impacts	Fair
Water Quality	Depends on source.
Benefits	Fair

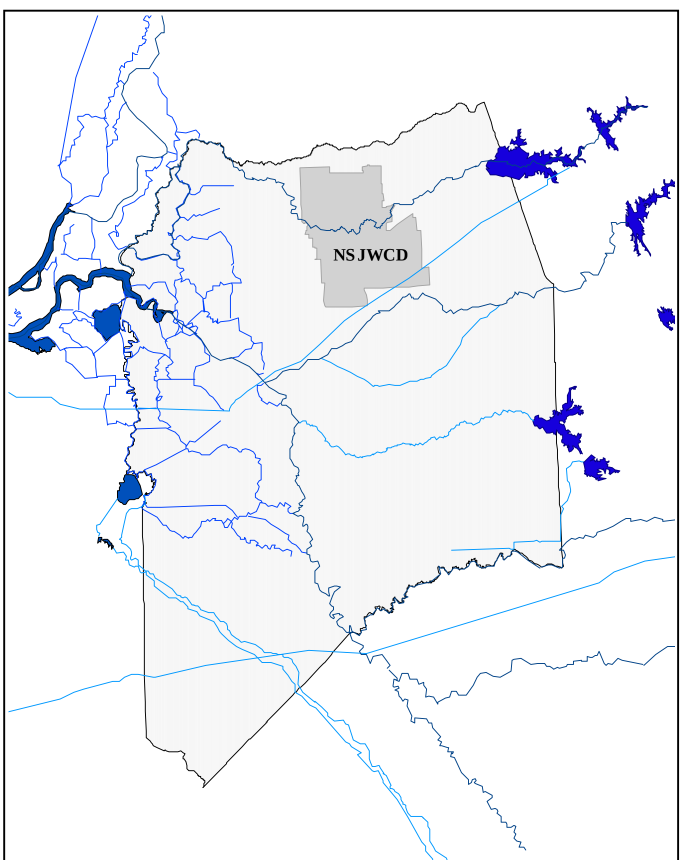
(GW6) Injection Wells in NSJWCD

Average Annual Capacity: *TBD*

OPTION DESCRIPTION:
Install wells to inject water into the aquifer within NSJWCD.

Tier III

PRIMARY BENEFITS AND DRAWBACKS:
Benefits: Injection wells can be potentially effective in localized areas, and do not require major changes by individual landowners to use the water.
Drawbacks: Many wells are required to inject significant amounts of water into the ground, and land is required to support the well. Infrastructure is required to move water to wells, and injection wells can clog and require regular maintenance. Injection wells in NSJWCD are potentially less effective than other County areas because groundwater could migrate to the north towards the Sacramento County groundwater depression.



SCREENING CRITERIA

Criteria	*Rating*
Cost	Poor
Legal Feasibility	Good
Political Feasibility	Good
Financial Feasibility	Fair
Environmental Impacts	Fair
Water Quality	Depends on source.
Benefits	Fair

(GW7)

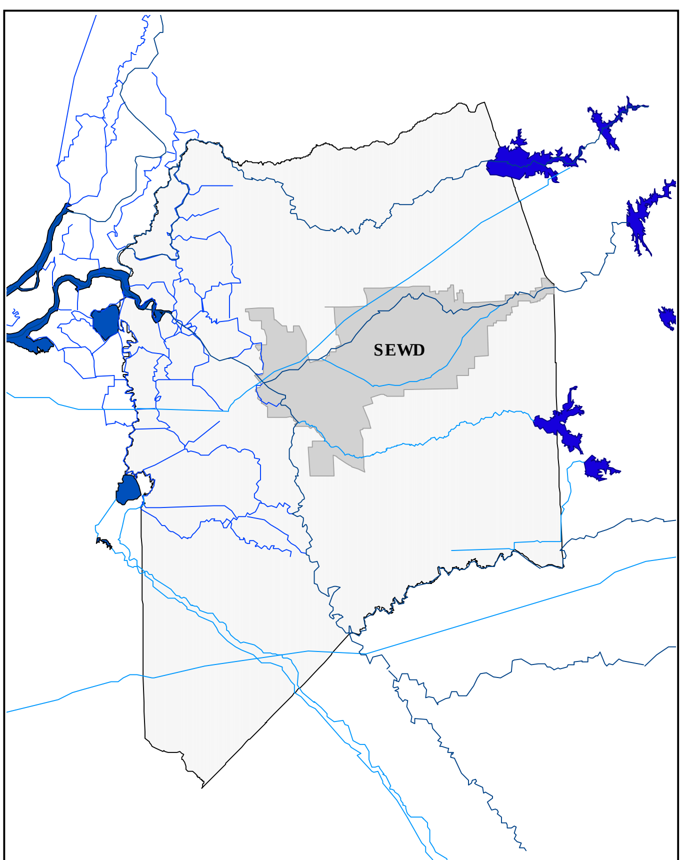
Injection Wells in SEWD

Average Annual Capacity: *TBD*

OPTION DESCRIPTION:
Install wells to inject water into the aquifer within SEWD.

Tier III

PRIMARY BENEFITS AND DRAWBACKS:
Benefits: Injection wells can be potentially effective in localized areas, and do not require major changes by individual landowners to use the water. SEWD is directly over the groundwater depression, so recharge efforts have potentially significant benefits.
Drawbacks: Many wells are required to inject significant amounts of water into the ground, and land is required to support the well. Infrastructure is required to move water to wells, and injection wells can clog and require regular maintenance.



SCREENING CRITERIA

Criteria	*Rating*
Cost	Poor
Legal Feasibility	Good
Political Feasibility	Good
Financial Feasibility	Fair
Environmental Impacts	Fair
Water Quality	Depends on source.
Benefits	Fair

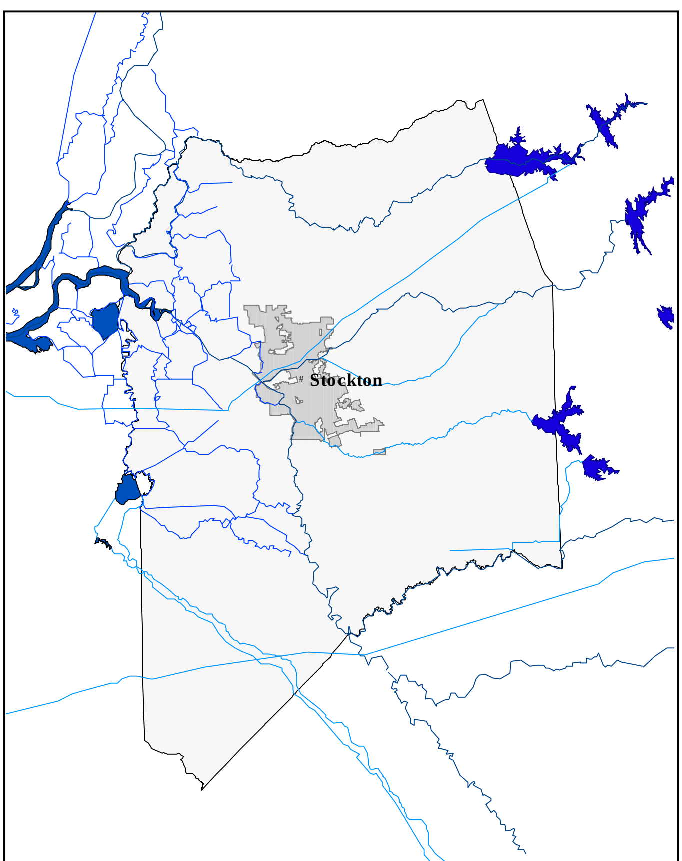
(GW8) Injection Wells in the City of Stockton

Average Annual Capacity: *TBD*

OPTION DESCRIPTION:
Install wells to inject water into the aquifer within the City of Stockton.

Tier II

PRIMARY BENEFITS AND DRAWBACKS:
Benefits: Injection wells can be potentially effective in localized areas, and do not require major changes by individual landowners to use the water. Injection wells in the City of Stockton could be used to create a barrier to repel the salinity migration, with potentially significant benefits.
Drawbacks: Many wells are required to inject significant amounts of water into the ground, and land is required to support the well. Infrastructure is required to move water to wells, and injection wells can clog and require regular maintenance.



SCREENING CRITERIA

Criteria	*Rating*
Cost	Poor
Legal Feasibility	Good
Political Feasibility	Good
Financial Feasibility	Fair
Environmental Impacts	Fair
Water Quality	Depends on source.
Benefits	Good

(GW9) In-lieu Recharge in CSJWCD

Average Annual Capacity: *TBD*

OPTION DESCRIPTION:

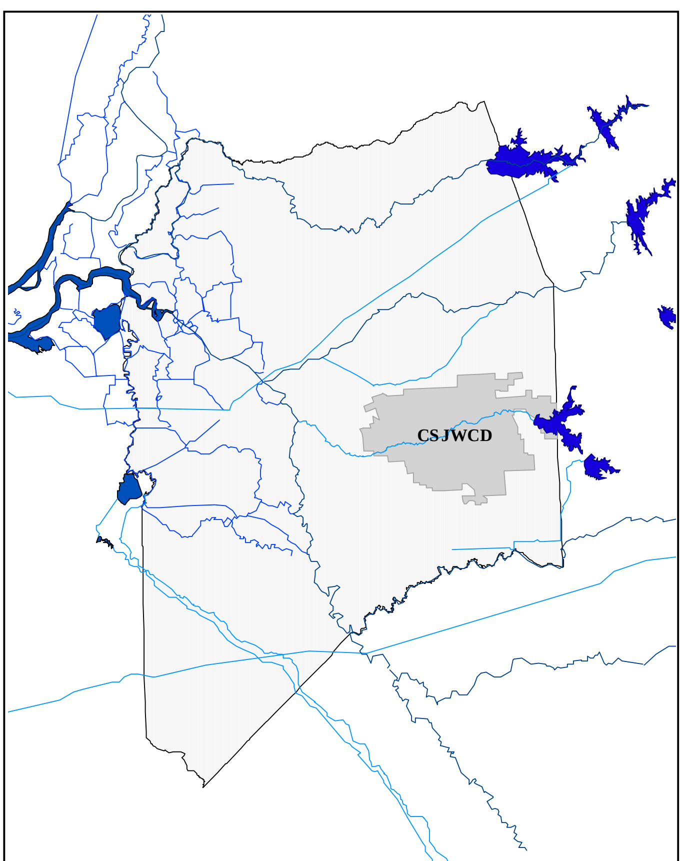
Provide additional surface water to CSJWCD to allow farmers to reduce groundwater pumping, and install infrastructure to help farmers utilize surface water.

Tier I

PRIMARY BENEFITS AND DRAWBACKS:

Benefits: In-lieu recharge is the most effective method to increase groundwater levels. In-lieu recharge in CSJWCD is potentially very effective to raise levels in the groundwater depression and slow the eastward salinity migration.

Drawbacks: In-lieu requires significant infrastructure improvements so that farmers have dual irrigation systems (both surface water and groundwater). CSJWCD has already provided surface water to their customers, so most areas with easy access and acceptable irrigation systems are already using it. The lands remaining to be converted are at potentially more difficult sites.



SCREENING CRITERIA

Criteria	*Rating*
Cost	Fair
Legal Feasibility	Good
Political Feasibility	Fair
Financial Feasibility	Fair
Environmental Impacts	Good
Water Quality	Depends on source.
Benefits	Good

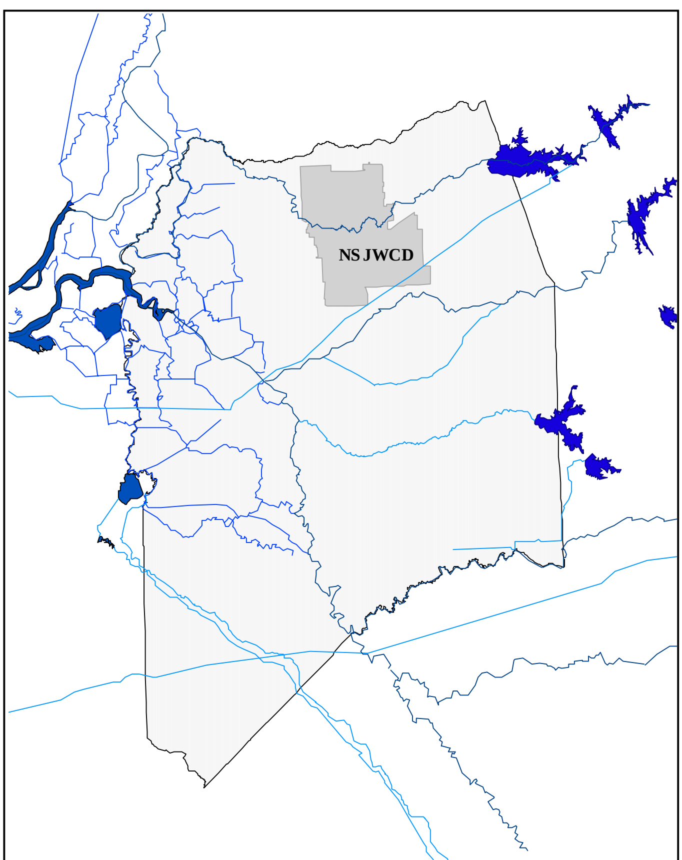
(GW10) In-lieu Recharge in NSJWCD

Average Annual Capacity: *TBD*

OPTION DESCRIPTION:
Provide additional surface water to allow farmers to reduce groundwater pumping and install infrastructure to help farmers utilize surface water.

Tier I

PRIMARY BENEFITS AND DRAWBACKS:
Benefits: In-lieu recharge is the most effective method to increase groundwater levels.
Drawbacks: In-lieu recharge requires significant infrastructure improvements so that farmers have dual irrigation systems (both surface water and groundwater). In-lieu recharge in NSJWCD is potentially less effective than other areas of East County because the groundwater depression in Sacramento County could draw water north.



SCREENING CRITERIA

Criteria	*Rating*
Cost	Fair
Legal Feasibility	Good
Political Feasibility	Fair
Financial Feasibility	Fair
Environmental Impacts	Good
Water Quality	Potential concern
Benefits	Fair

(GW11) In-lieu Recharge in SEWD

Average Annual Capacity: *TBD*

OPTION DESCRIPTION:

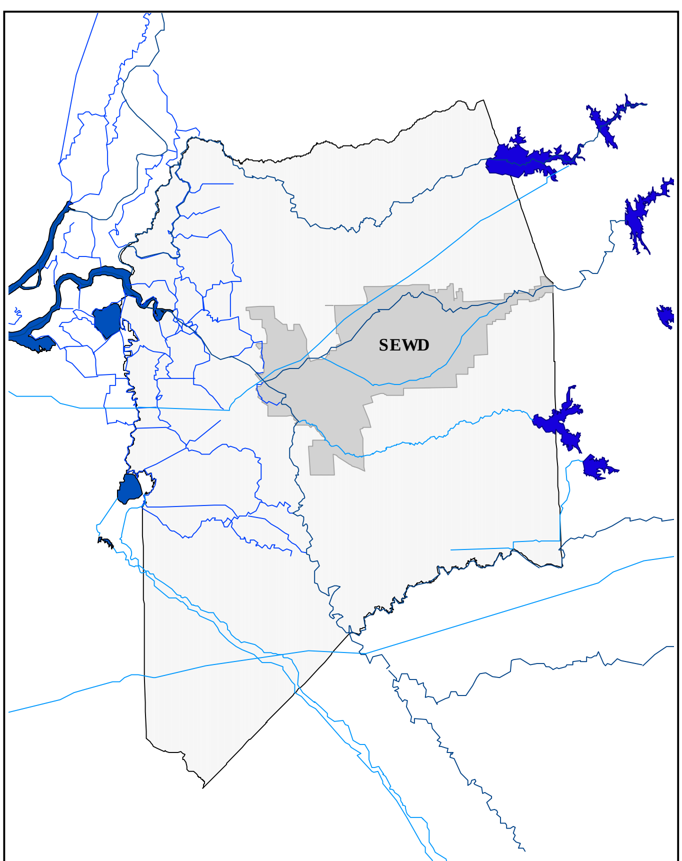
Provide additional surface water to SEWD to allow farmers to reduce groundwater pumping, and install infrastructure to help farmers utilize surface water.

Tier I

PRIMARY BENEFITS AND DRAWBACKS:.

Benefits: In-lieu recharge is the most effective method to increase groundwater levels. In-lieu recharge in SEWD is potentially very effective to raise levels in the groundwater depression and slow the eastward salinity migration.

Drawbacks: In-lieu recharge requires significant infrastructure improvements so that farmers have dual irrigation systems (both surface water and groundwater).



SCREENING CRITERIA

Criteria	*Rating*
Cost	Fair
Legal Feasibility	Good
Political Feasibility	Fair
Financial Feasibility	Fair
Environmental Impacts	Good
Water Quality	Depends on source
Benefits	Good

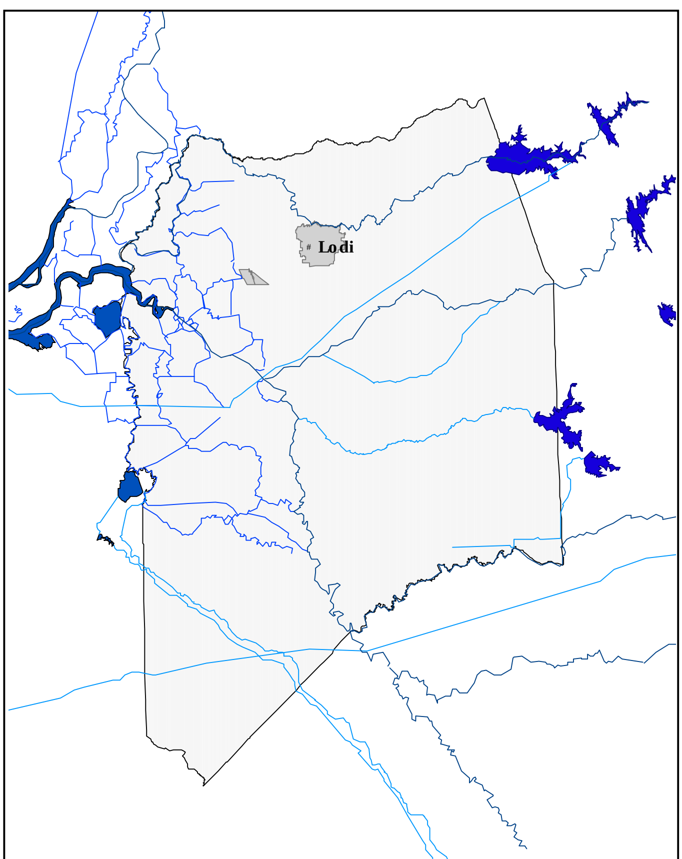
(GW12) In-lieu Recharge for the City of Lodi

Average Annual Capacity: *16.6* TAF currently;
Up to *26.4* TAF in the future

OPTION DESCRIPTION:
Provide surface water to the City of Lodi to allow it to reduce groundwater pumping.

Tier II

PRIMARY BENEFITS AND DRAWBACKS:
Benefits: In-lieu recharge is potentially the most effective way to increase groundwater levels.
Drawbacks: In-lieu recharge would require additional infrastructure to move surface water to the City, and additional water treatment facilities. The City of Lodi is north of the groundwater depression, and would be less effective in slowing the salinity migration.



SCREENING CRITERIA

Criteria	*Rating*
Cost	Fair
Legal Feasibility	Good
Political Feasibility	Fair
Financial Feasibility	Fair
Environmental Impacts	Good
Water Quality	Depends on source.
Benefits	Fair

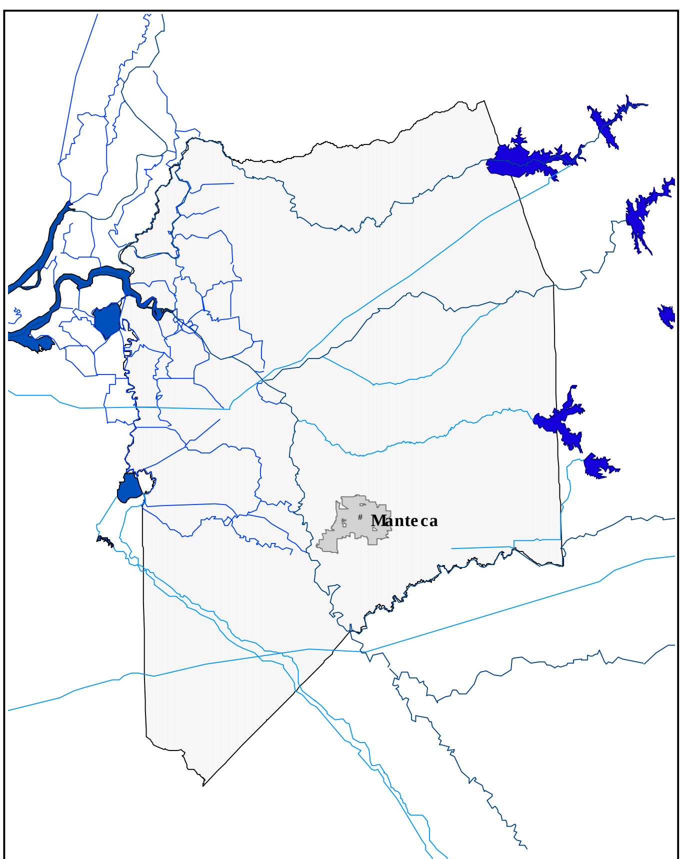
(GW13) In-lieu Recharge for the City of Manteca

Average Annual Capacity: *11.2* TAF currently;
Up to *31.3* TAF in the future

OPTION DESCRIPTION:
Provide surface water to the City of Manteca to allow it to reduce groundwater pumping.

Tier I

PRIMARY BENEFITS AND DRAWBACKS:
Benefits: In-lieu recharge is potentially the most effective way to increase groundwater levels.
Drawbacks: In-lieu recharge would require additional infrastructure to move surface water to the City and potentially new water treatment facilities. Manteca is located south of the groundwater depression, but is close to the salinity intrusion. Manteca could receive surface water as a part of the South County surface water supply project to meet half of their water demand.



SCREENING CRITERIA

Criteria	*Rating*
Cost	Fair
Legal Feasibility	Good
Political Feasibility	Fair
Financial Feasibility	Fair
Environmental Impacts	Good
Water Quality	Depends on source.
Benefits	Good

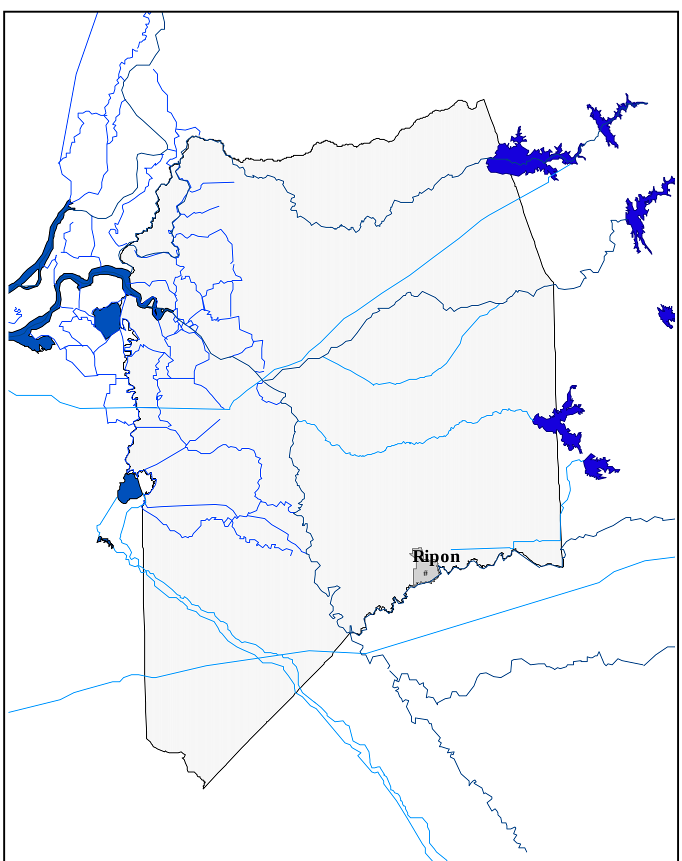
(GW14) In-lieu Recharge for the City of Ripon

Average Annual Capacity: *3.5* TAF currently;
Up to *13.2* TAF in the future

OPTION DESCRIPTION:
Provide surface water to the City of Ripon to allow it to reduce groundwater pumping.

Tier III

PRIMARY BENEFITS AND DRAWBACKS:
Benefits: In-lieu recharge is potentially the most effective way to increase groundwater levels.
Drawbacks: In-lieu recharge in Ripon would require additional infrastructure to move surface water to the City and new water treatment facilities. Ripon is southeast of the groundwater depression, and would probably not have a significant effect on the salinity migration.



SCREENING CRITERIA

Criteria	*Rating*
Cost	Fair
Legal Feasibility	Good
Political Feasibility	Fair
Financial Feasibility	Fair
Environmental Impacts	Good
Water Quality	Depends on source.
Benefits	Poor

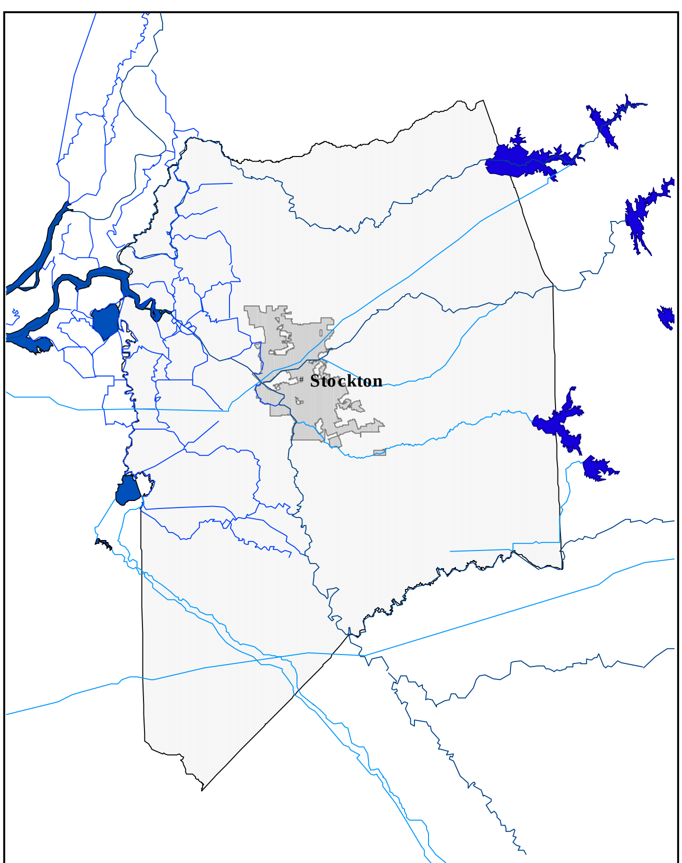
(GW15) In-lieu Recharge for the City of Stockton

Average Annual Capacity: *TBD*

OPTION DESCRIPTION:
Provide surface water to the City of Stockton to augment its current supplies and reduce groundwater pumping.

Tier I

PRIMARY BENEFITS AND DRAWBACKS:
Benefits: Stockton already has water treatment and distribution facilities, so in-lieu recharge would require fewer infrastructure improvements. Stockton is located directly over the salinity intrusion, and would therefore have a significant impact in slowing the eastward migration.
Drawbacks: Stockton has already invested approximately $65 million in in-lieu recharge facilities, which has allowed the city to utilize more surface water and increase groundwater levels in much of the city. Additional in-lieu facilities could be more difficult to finance, and the benefits will likely not be as great as the first segment of work.



SCREENING CRITERIA

Criteria	*Rating*
Cost	Good
Legal Feasibility	Good
Political Feasibility	Good
Financial Feasibility	Good
Environmental Impacts	Good
Water Quality	Depends on source.
Benefits	Good

(GW16) Additional In-lieu Recharge in WID

Average Annual Capacity: *TBD*

OPTION DESCRIPTION:

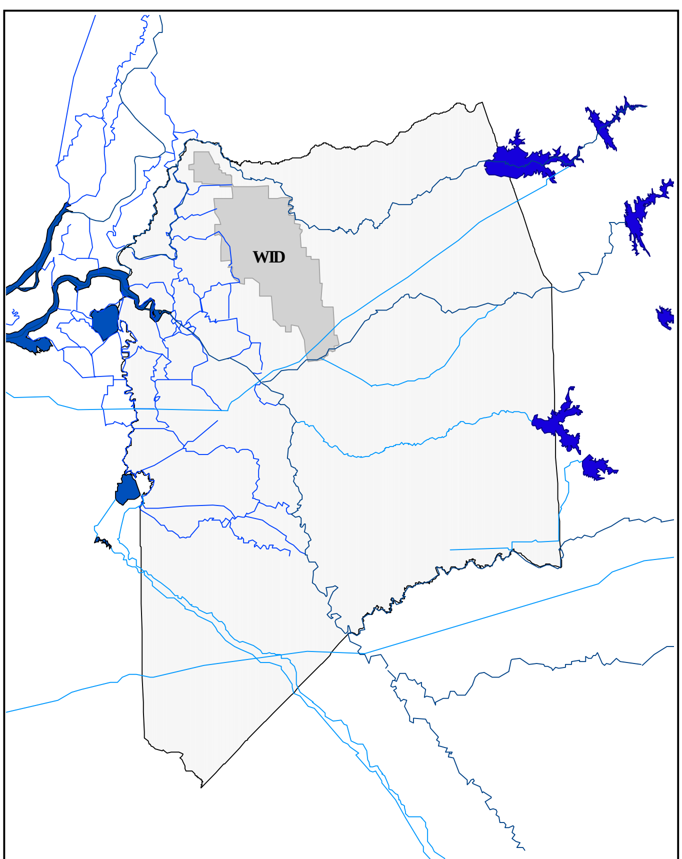
Install infrastructure to help farmers utilize WID's surface water. WID has surface water, but does not serve all farms within the district. This option would provide infrastructure to increase the number of farms within the service boundaries that utilize surface water.

Tier III

PRIMARY BENEFITS AND DRAWBACKS:

Benefits: In-lieu recharge is the most effective method to increase groundwater levels.

Drawbacks: In-lieu recharge requires significant infrastructure improvements to give farmers dual irrigation systems (both surface water and groundwater). The potential benefits from in-lieu within WID could be less than other areas because groundwater could migrate north towards the Sacramento County groundwater depression.



SCREENING CRITERIA

Criteria	*Rating*
Cost	Fair
Legal Feasibility	Good
Political Feasibility	Fair
Financial Feasibility	Fair
Environmental Impacts	Good
Water Quality	Depends on source.
Benefits	Poor

(GW17)

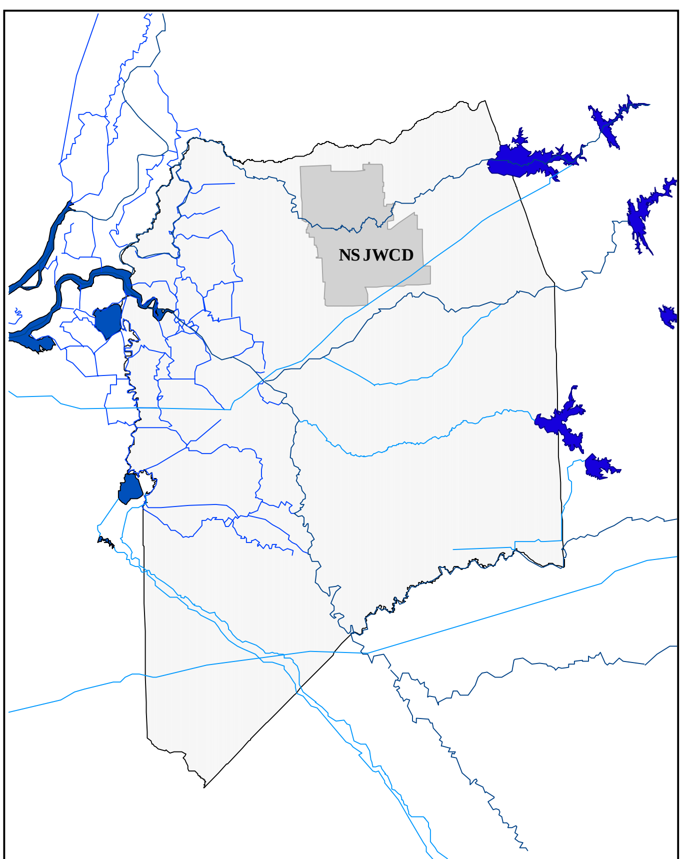
NSJWCD
Groundwater Recharge Project

Average Annual Capacity: *10* TAF

OPTION DESCRIPTION:
NSJID has been pursuing utilization of Mokelumne surface water resources for storage in the groundwater basin.

Tier II

PRIMARY BENEFITS AND DRAWBACKS:
Benefits: Enhances long-term San Joaquin County groundwater storage.
Drawbacks: Would require dual irrigation system for farmers. NSJWCD is north of the groundwater depression, so groundwater recharge would have limited effect on the saline intrusion problem.



SCREENING CRITERIA

Criteria	*Rating*
Cost	Fair
Legal Feasibility	Good
Political Feasibility	Good
Financial Feasibility	Good
Environmental Impacts	Good
Water Quality	Good
Benefits	Fair

(GW18) Unlined Flat Canal

Average Annual Capacity: *TBD*

OPTION DESCRIPTION:

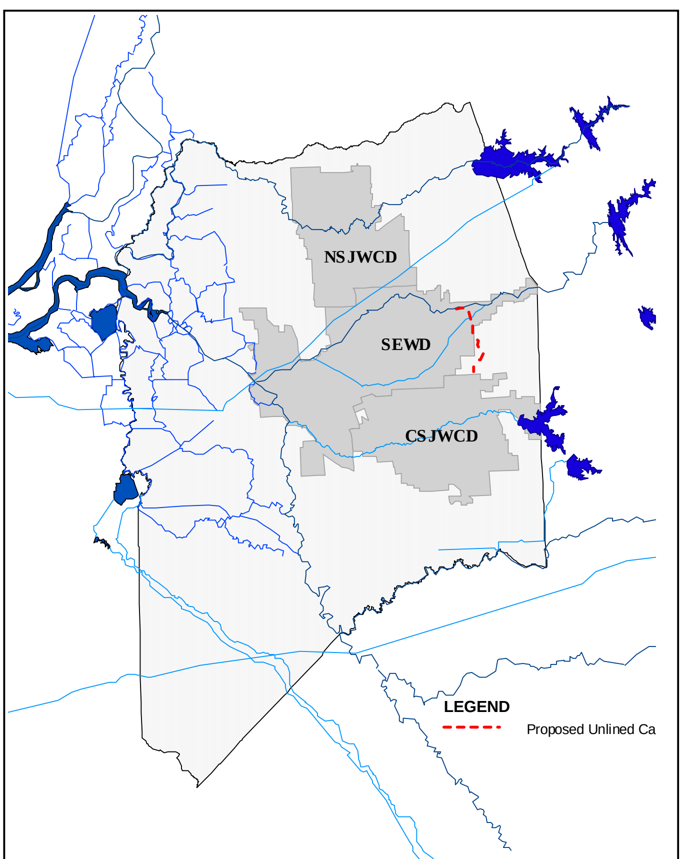
Build a delivery canal to move water within the County that can also function as a direct recharge facility.

Tier III

PRIMARY BENEFITS AND DRAWBACKS:

Benefits: The canal would provide both surface water deliveries and groundwater recharge, and could be financed as a water delivery project. Benefits would increase if the canal is used as part of a larger regional water conveyance system.

Drawbacks: The canal would require significant maintenance to remove sedimentation, and limited amounts of water would percolate into the groundwater. As a stand-alone groundwater recharge facility, this project does not result in groundwater benefits per dollar spent that are comparable with other recharge options.



SCREENING CRITERIA

Criteria	*Rating*
Cost	Poor
Legal Feasibility	Fair
Political Feasibility	Good
Financial Feasibility	Good
Environmental Impacts	Good
Water Quality	Depends on infrastructure
Benefits	Fair

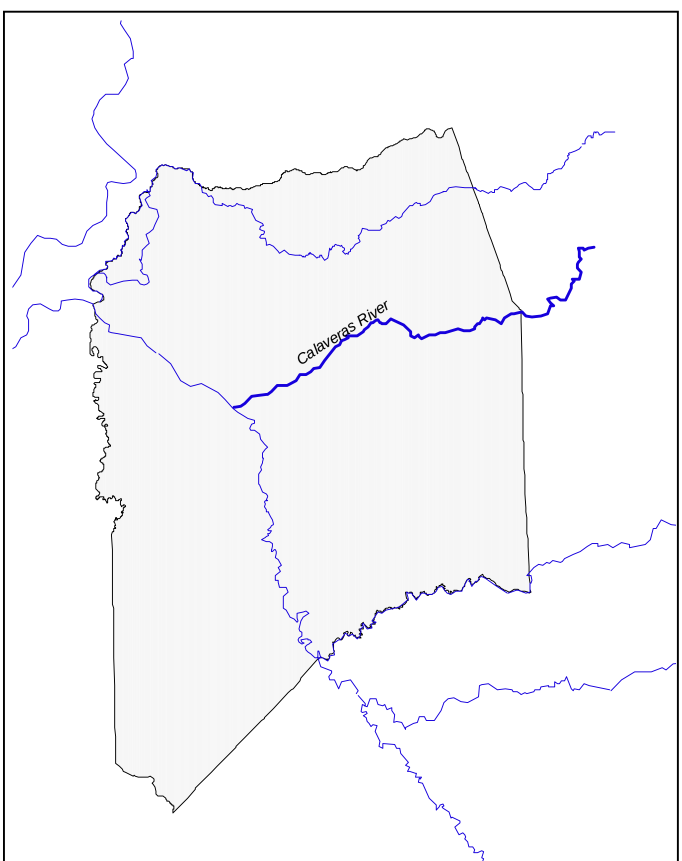
(SW1) Calaveras River Flood Flows

Average Annual Supply: *30* TAF

OPTION DESCRIPTION:
New infrastructure, regulating reservoir, to capture and utilize available flood flows from New Hogan Reservoir.

PRIMARY BENEFITS AND DRAWBACKS:
Benefits: Additional surface water supplies available to SEWD in above normal to wet years.
Drawbacks: Cost

Tier III



SCREENING CRITERIA

Criteria	*Rating*
Cost	Poor
Legal Feasibility	Fair
Political Feasibility	Poor
Financial Feasibility	Poor
Environmental Impacts	Poor
Water Quality	Good
Benefits	Good

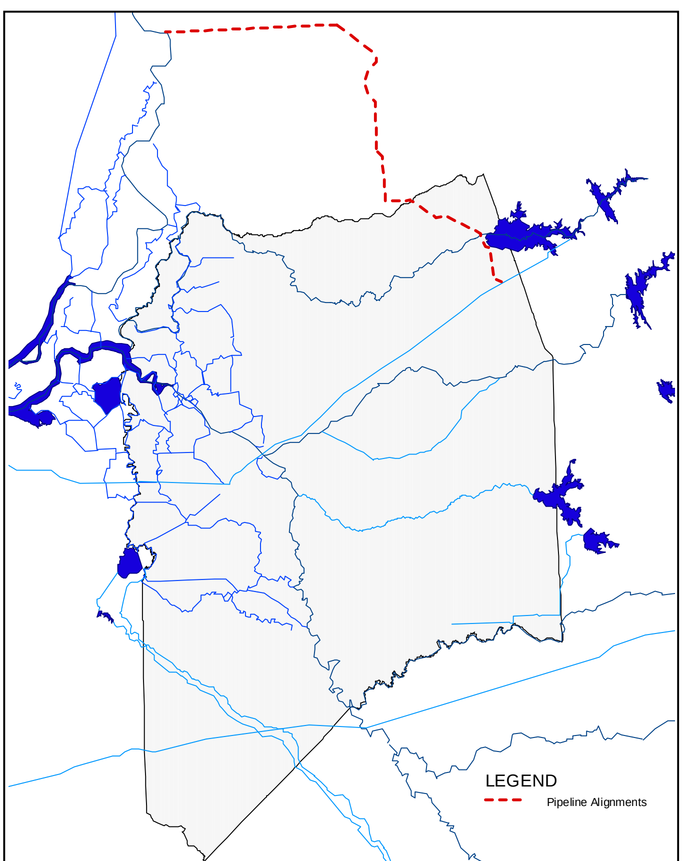
(SW2) EBMUD/Sacramento Co./San Joaquin Co.- Sacramento River Diversion Facility

Average Annual Supply: *Unknown* TAF

OPTION DESCRIPTION:
Joint Regional Planning Project (JRPP) for a new diversion facility located near Freeport on the Sacramento River.

Tier II

PRIMARY BENEFITS AND DRAWBACKS:
*Benefits***:** Potentially significant water resources to San Joaquin County entities as well as project proponents. Dependent on JRPP configuration and interconnection with San Joaquin County distribution systems. Provides access to American River and Sacramento River flood flows, access to out-of-County water transfer sources, and potential interconnection to Mokelumne River flood flows.
*Drawbacks***:** High level of coordination (and years of mistrust) associated with project. Would require extensive education/information effort to bring all parties to mutual agreement on a consensus project.



SCREENING CRITERIA

Criteria	*Rating*
Cost	Unknown, but shared with project partners.
Legal Feasibility	Fair
Political Feasibility	Fair
Financial Feasibility	Unknown
Environmental Impacts	Unknown
Water Quality	Good
Benefits	Good

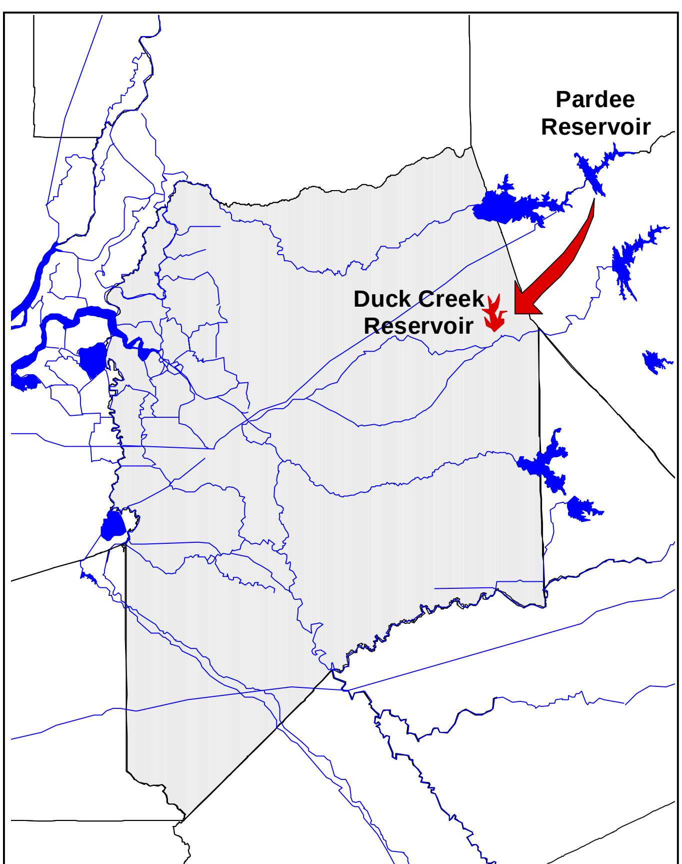
(SW3) Mokelumne River Flood Flows

Average Annual Supply: *50* TAF

OPTION DESCRIPTION:
Utilize flood flows on the Mokelumne by storing them in a new reservoir. Duck Creek Reservoir would divert water from Pardee Reservoir on the Mokelumne. Feasibility studies include a 1,000 cfs diversion facility from Pardee and a 200 TAF Duck Creek Reservoir.

Tier III

PRIMARY BENEFITS AND DRAWBACKS:
Drawbacks: High costs for infrastructure, property owner opposes project, and potential negative environmental impacts associated with new infrastructure



SCREENING CRITERIA

Criteria	*Rating*
Cost	Poor
Legal Feasibility	Poor
Political Feasibility	Poor
Financial Feasibility	Unknown
Environmental Impacts	Poor
Water Quality	Unknown
Benefits	N/A

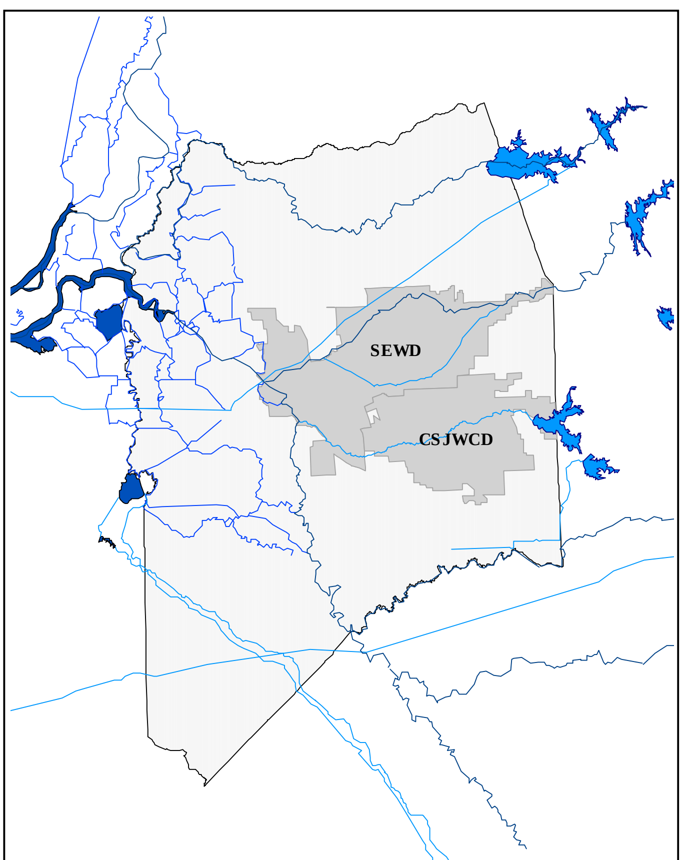
(SW4) New CVP Diversion Facility on the Lower San Joaquin River

Average Annual Supply: *70* TAF

OPTION DESCRIPTION:
New diversion facility downstream of Vernalis. Water supply would be from the CVP (New Melones Reservoir), and the option would utilize storage withdrawal releases that were first released from Goodwin Dam for fishery or water quality objective purposes. After the water meets these objectives at Vernalis, it could be diverted for use within San Joaquin County.

Tier II

PRIMARY BENEFITS AND DRAWBACKS:
Benefits: Less reliance on groundwater resources. Diverted surface water is water that would have been released from storage for non-supply purposes, but using this option, it could be utilized after fulfilling fisheries or water quality objectives.
Drawbacks: Infrastructure cost and potential water quality concerns downstream of the diversion. Water quality of diverted water would potentially be suitable only for some agricultural uses.



SCREENING CRITERIA

Criteria	*Rating*
Cost	Fair
Legal Feasibility	Good
Political Feasibility	Fair
Financial Feasibility	Fair
Environmental Impacts	Would likely restrict season of diversion to minimize fisheries concerns.
Water Quality	Fair for agriculture.
Benefits	Good

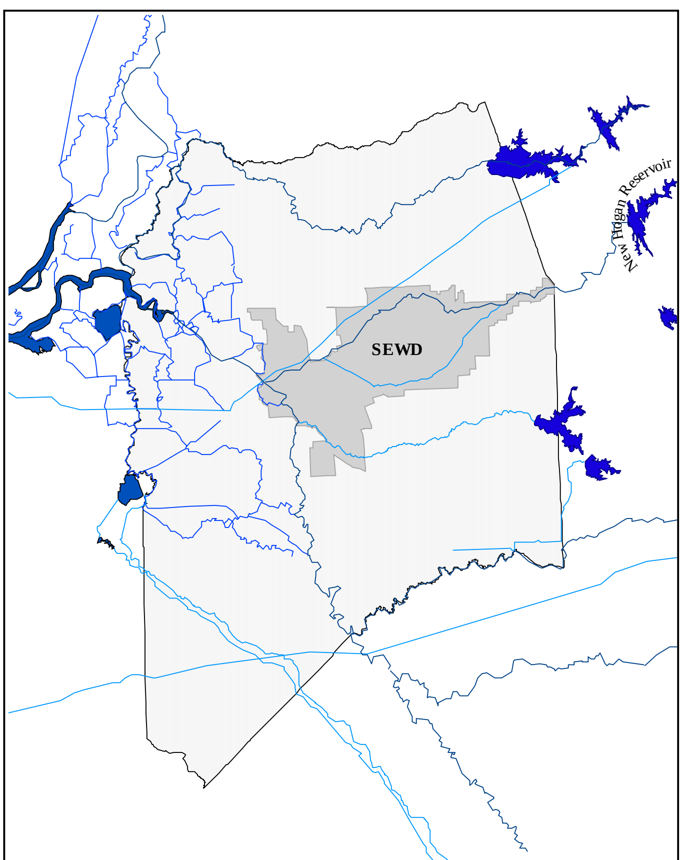
(SW5) New Hogan Reservoir Reoperation

Average Annual Supply: *25* TAF

OPTION DESCRIPTION:
Reoperate New Hogan Reservoir to increase the average annual yield potential to SEWD by allowing additional reservoir drawdown in good reservoir carryover years.

Tier I

PRIMARY BENEFITS AND DRAWBACKS:
Benefits: Increase long-term use of Calaveras River water. Reduces long-term use of SEWD groundwater resources.
Drawbacks: Potentially reduces SEWD allocation in drought conditions. Would require protection agreement for Calaveras County New Hogan supplies.



SCREENING CRITERIA

Criteria	*Rating*
Cost	Good
Legal Feasibility	Good
Political Feasibility	Good
Financial Feasibility	Good
Environmental Impacts	Good
Water Quality	Good
Benefits	Good

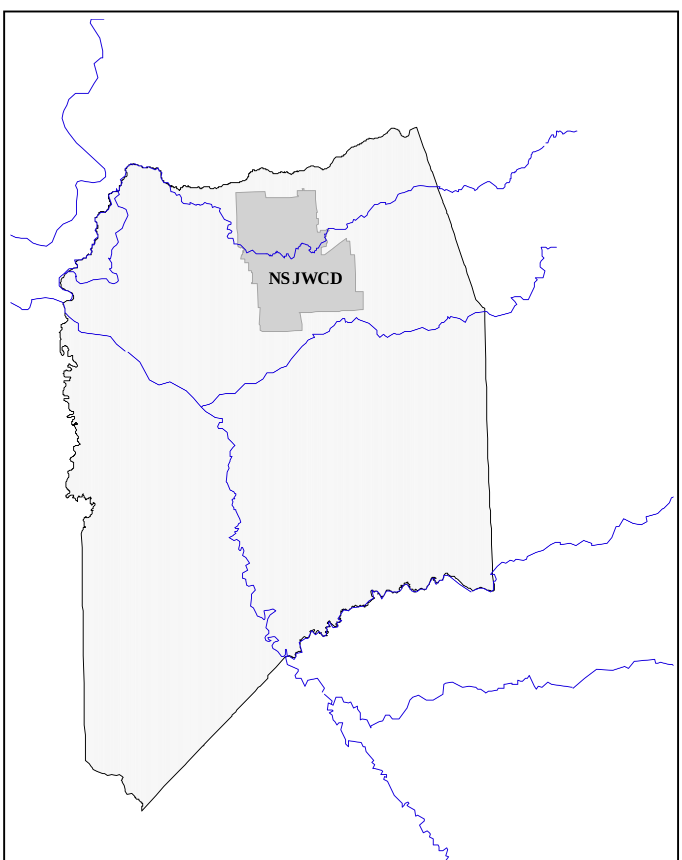
(SW6) NSJWCD-Mokelumne River Water Right and Agreement with EBMUD for Storage

Average Annual Supply: *10* TAF

OPTION DESCRIPTION:
NSJWCD has held a water right for 20 TAF of surplus Mokelumne River water with minor utilization of the surface water resource. Facilities and incentives would increase use of the surface water right.

Tier II

PRIMARY BENEFITS AND DRAWBACKS:
Benefits: Decreases reliance on groundwater resources in San Joaquin County.
Drawbacks: Cost; many farmers utilize drip systems that can inhibit use of surface water resources if the water is delivered directly to agricultural interests.



SCREENING CRITERIA

Criteria	Rating
Cost	Fair
Legal Feasibility	Good
Political Feasibility	Fair
Financial Feasibility	Fair
Environmental Impacts	Good
Water Quality	Good, but can be difficult to utilize with drip systems.
Benefits	Fair

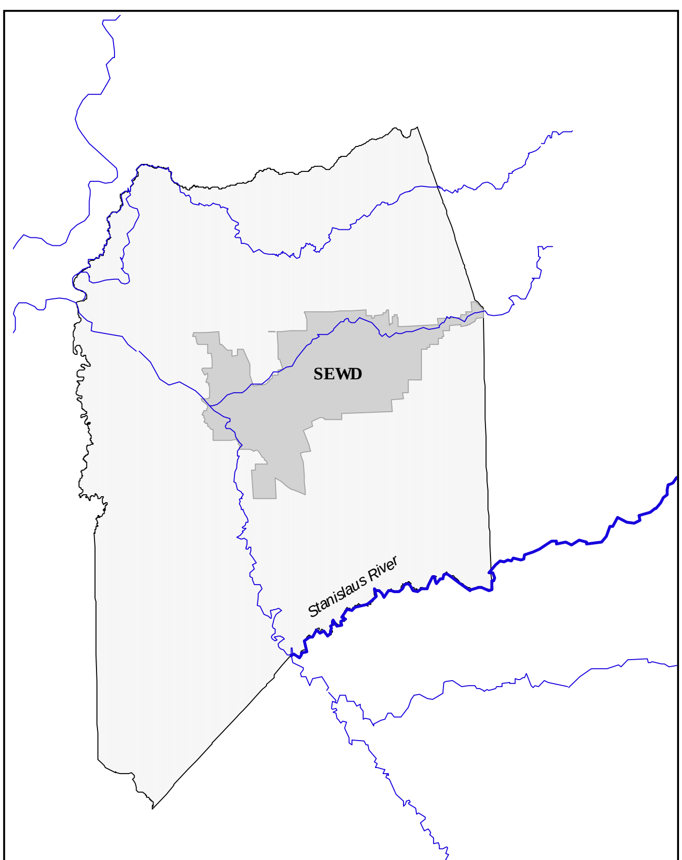
(SW7) Stanislaus River Flood Flows

Average Annual Supply: *20* TAF

OPTION DESCRIPTION:
New infrastructure and regulating reservoir to capture and utilize available flood flows from New Melones Reservoir.

PRIMARY BENEFITS AND DRAWBACKS:
Benefits: Additional surface water supplies available to SEWD in above normal to wet years.
Drawbacks: Cost

Tier III



SCREENING CRITERIA

Criteria	*Rating*
Cost	Poor
Legal Feasibility	Fair
Political Feasibility	Poor
Financial Feasibility	Poor
Environmental Impacts	Poor
Water Quality	Good
Benefits	Good

(SW8) Water Transfers Within San Joaquin County

Average Annual Supply: *Up to 64* TAF / *year*

OPTION DESCRIPTION:

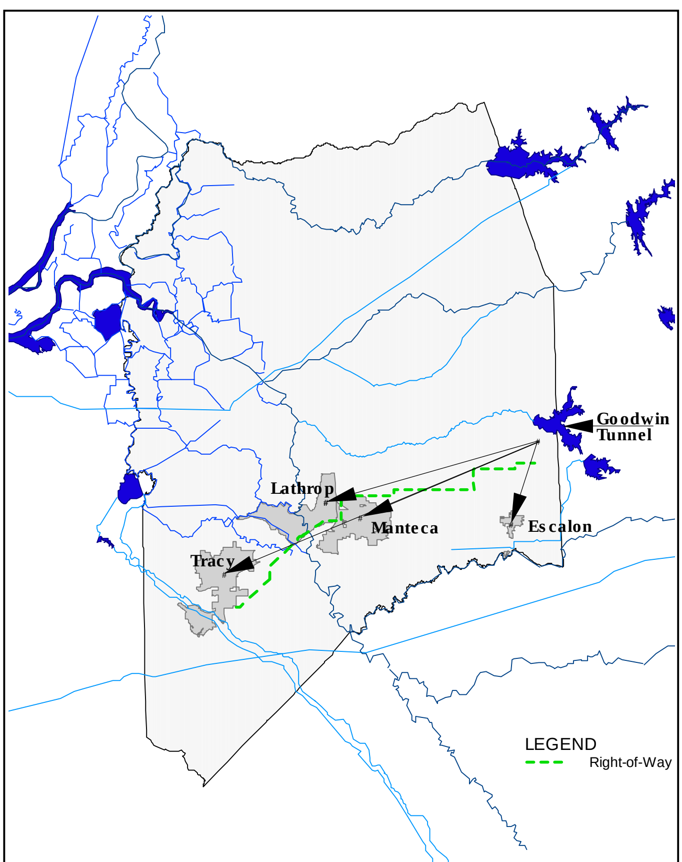
OID / SSJID / SEWD transfer (30 TAF), SSJID South County Water Supply Project (44 TAF), including 10 TAF to the City of Tracy.

Tier I

PRIMARY BENEFITS AND DRAWBACKS:

*Benefits***:** Increased surface water deliveries may allow for reduced groundwater pumping in overdrafted areas of the basin.

*Drawbacks***:** Concerns for potential harm to SDWA water quality interests.



SCREENING CRITERIA

Criteria	*Rating*
Cost	Good
Legal Feasibility	Fair
Political Feasibility	Good
Financial Feasibility	Good
Environmental Impacts	Good
Water Quality	Good for purveyors; potential incremental negative impact to SDWA water quality interests.
Benefits	Good

(SW9) WID and WWUCD Use of additional Mokelumne River Flood Flows

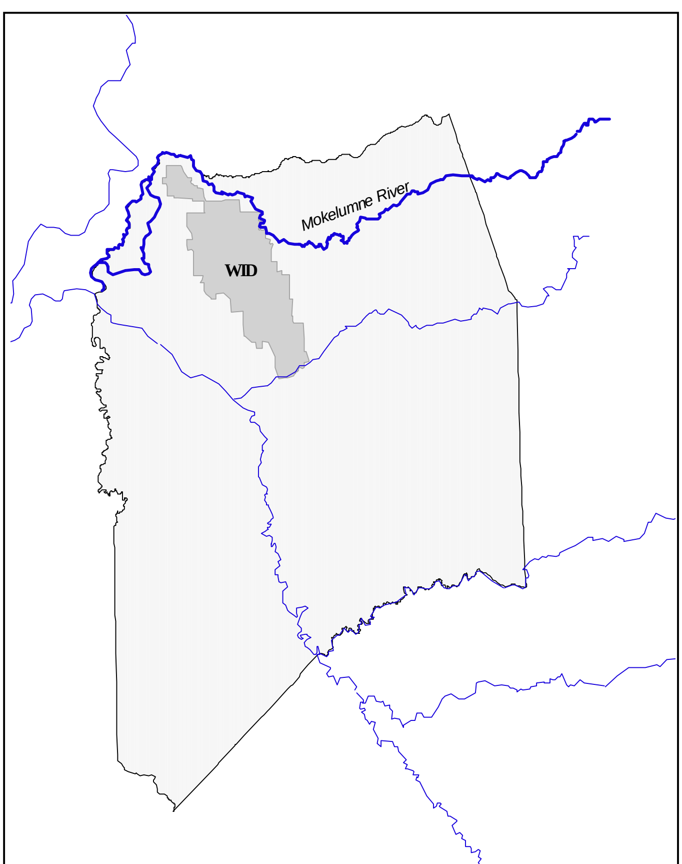
Average Annual Supply: *10-15* TAF

OPTION DESCRIPTION:
Additional diversion of Mokelumne River flood flows through WID's conveyance system to City of Stockton or direct aquifer recharge.

PRIMARY BENEFITS AND DRAWBACKS:
Benefits: Decreases reliance on groundwater resources in City of Stockton area.
Drawbacks: Potential water right limitations.

Tier II

SCREENING CRITERIA



Criteria	*Rating*
Cost	Fair
Legal Feasibility	Fair
Political Feasibility	Fair
Financial Feasibility	Good
Environmental Impacts	Fair
Water Quality	Good
Benefits	Good

(O1)

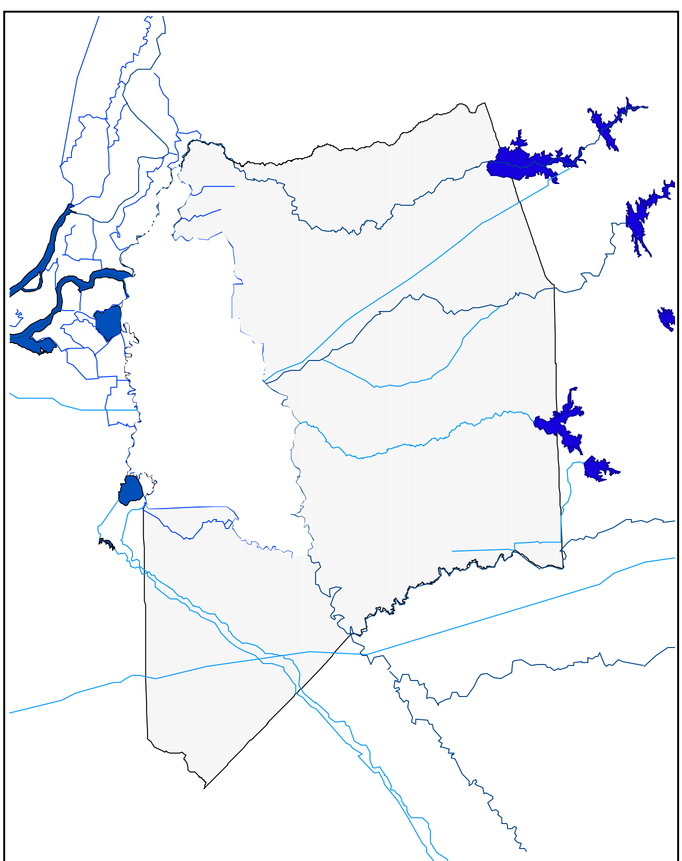
Delta Area San Joaquin County Water Supply Activities

Average Annual Supply: *N/A* TAF

OPTION DESCRIPTION:
San Joaquin County-wide political support working group or forum for activities affecting Delta Area San Joaquin County interests. Issues include: South Delta barrier implementation; support activities to improve Delta water quality and water levels; Support the technical evaluation of the DMC recirculation project; support balanced fishery and water quality operations for the Delta Cross Channel gates.

Tier I

PRIMARY BENEFITS AND DRAWBACKS:
Benefits: Although not an option for a specific project, could provide the legal, institutional and financial framework to improve water quality and supply in the Delta.
Drawbacks: Requires time and organizational commitment to be effective.



SCREENING CRITERIA

Criteria	*Rating*
Cost	Good
Legal Feasibility	Good
Political Feasibility	Good
Financial Feasibility	N/A
Environmental Impacts	N/A
Water Quality	N/A
Benefits	Good

(O2) Delta Mendota Canal Recirculation Study

Average Annual Supply: *Unknown* TAF

OPTION DESCRIPTION:

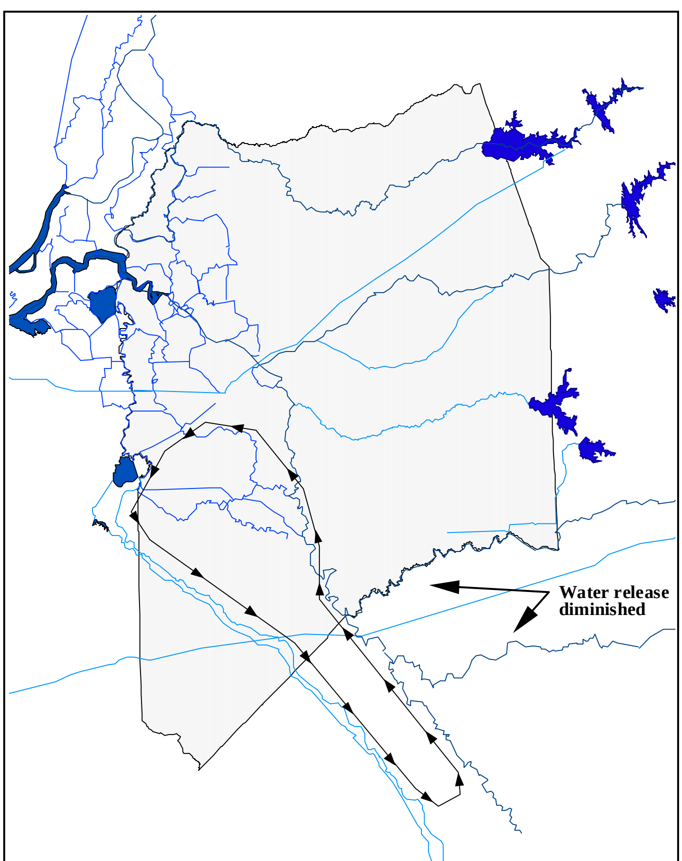
SWRCB/USBR/DWR study of utilizing DMC waterways to help provide water to meet San Joaquin River pulse flows and potentially re-export the water at the CVP-SWP export facilities.

Tier II

PRIMARY BENEFITS AND DRAWBACKS:

*Benefits***:** Reduces potential water demand from reservoirs on the eastern San Joaquin valley, especially New Melones, to meet San Joaquin River Pulse flows. The "saved" water would be available to meet other San Joaquin basin needs.

*Drawbacks***:** Project has regulatory controversies, and project must ensure that water supply to CVP-SWP export facilities will not be impacted.



SCREENING CRITERIA

Criteria	Rating
Cost	Good
Legal Feasibility	Fair
Political Feasibility	Poor
Financial Feasibility	Good
Environmental Impacts	Unknown
Water Quality	Good
Benefits	Fair

(O3)

Southwest San Joaquin County Water Supply Activities

Average Annual Supply: *N/A* TAF

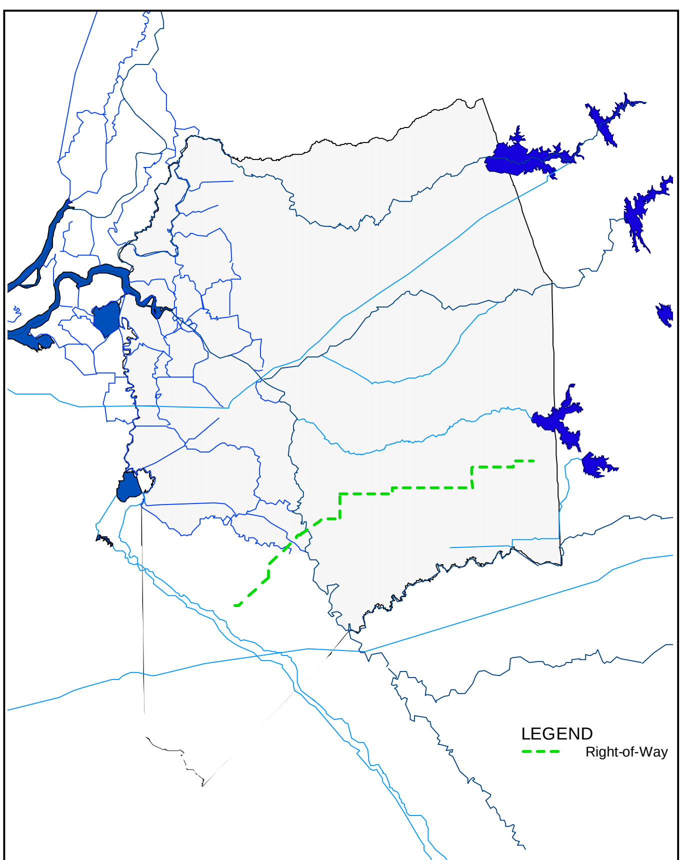
OPTION DESCRIPTION:

San Joaquin County-wide political support working group or forum for activities affecting southwestern San Joaquin County interests. Issues include: CVP water supply reliability, DMC / groundwater pump-in program, and City of Tracy water supply activities and programs.

Tier I

PRIMARY BENEFITS AND DRAWBACKS:

Benefits: Interconnection of Stanislaus River water supplies to Southwest San Joaquin County water supplies and San Joaquin River issues requires balanced management program and improvement for all San Joaquin County interests.



SCREENING CRITERIA

Criteria	*Rating*
Cost	Good
Legal Feasibility	Good
Political Feasibility	Good
Financial Feasibility	N/A
Environmental Impacts	N/A
Water Quality	N/A
Benefits	Good

(O4)

SSJID Transfers

Average Annual Supply: *N/A* TAF

OPTION DESCRIPTION:

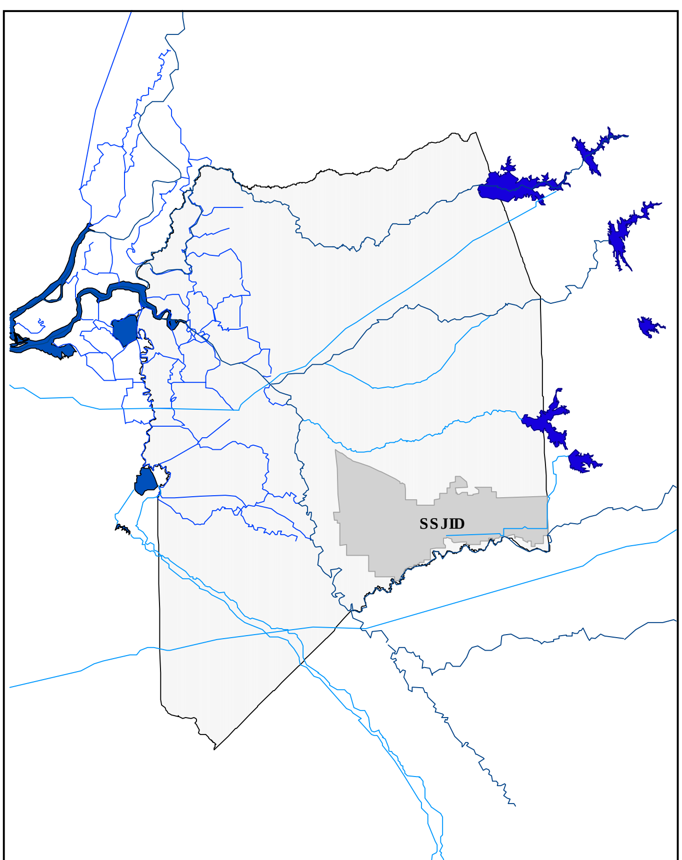
SSJID would transfer their surface water to be used in areas overlaying the groundwater depression and SSJID landowners would, instead, pump groundwater. This option would shift groundwater pumping from areas near the depression to areas with high groundwater levels.

Tier II

PRIMARY BENEFITS AND DRAWBACKS:

Benefits: Groundwater pumping would be better distributed throughout the east county.

Drawbacks: Could induce additional groundwater infiltration from the Stanislaus River, which could impact the environment downstream. This option would require a policy shift for SSJID management because they believe that they should utilize surface water before groundwater.



SCREENING CRITERIA

Criteria	*Rating*
Cost	Fair
Legal Feasibility	Fair
Political Feasibility	Poor
Financial Feasibility	Fair
Environmental Impacts	Fair
Water Quality	Good
Benefits	Fair

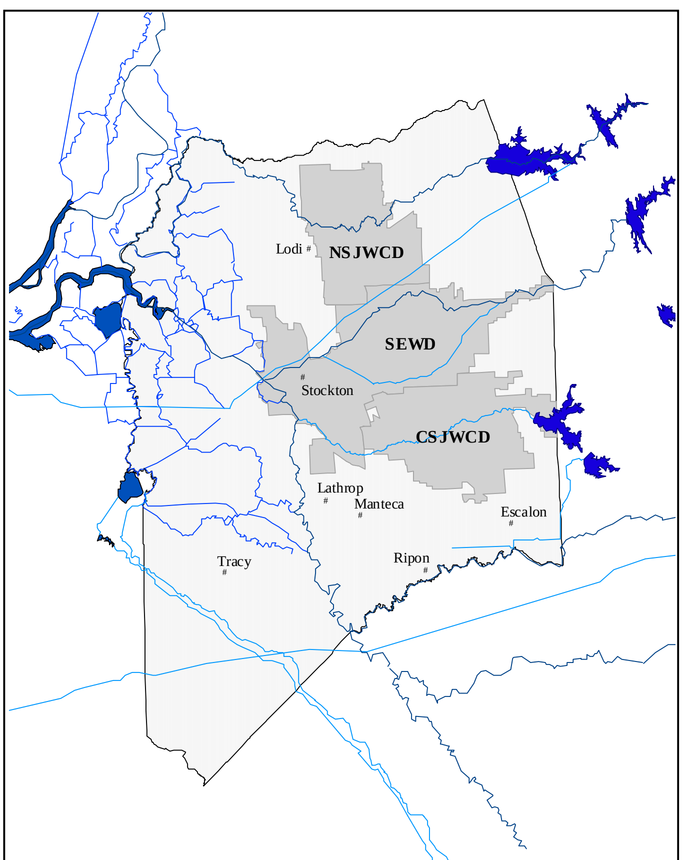
(O5) Water Conservation Improvements

Average Annual Supply: *Unknown* TAF

OPTION DESCRIPTION:
Reduce groundwater demand through development of a County-wide or region-specific water conservation program. Program would include water conservation technologies such as: drip systems; reclamation of water to golf courses, parks, etc.; urban environment low water use technologies, etc.

Tier I

PRIMARY BENEFITS AND DRAWBACKS:
Benefits: Reduces groundwater reliance.
Drawbacks: Conservation improvements tend to be site- and water use specific.



SCREENING CRITERIA

Criteria	Rating
Cost	Unknown
Legal Feasibility	Good
Political Feasibility	Good
Financial Feasibility	Water use specific
Environmental Impacts	Unknown
Water Quality	Can be a limiting factor to specific conservation efforts.
Benefits	Good

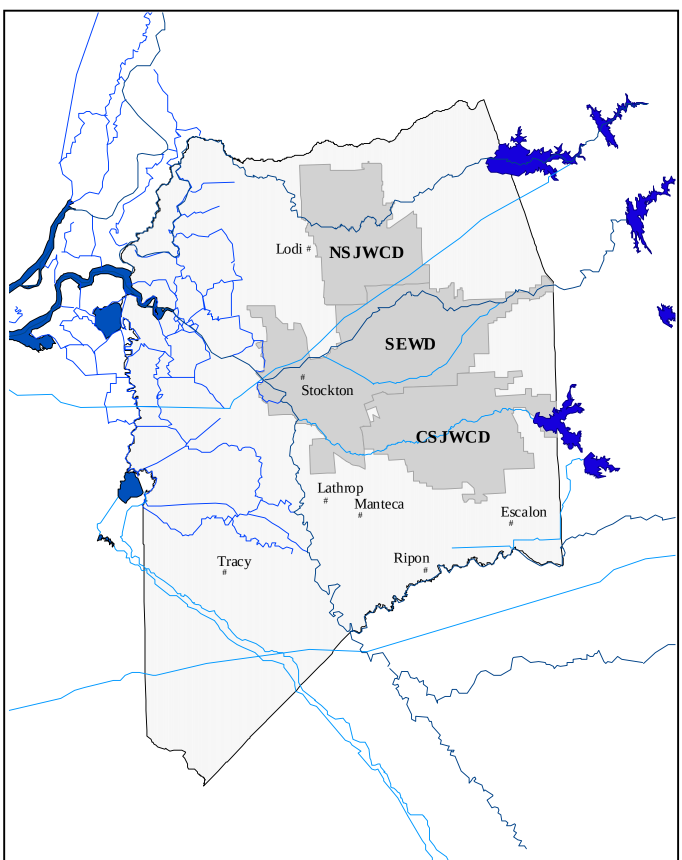
(O6) Water Conservation Improvements

Average Annual Supply: *Unknown* TAF

OPTION DESCRIPTION:
Reduce groundwater demand through development of a County-wide or region-specific water conservation program. Program would include water conservation technologies such as: drip systems; reclamation of water to golf courses, parks, etc.; urban environment low water use technologies, etc.

Tier I

PRIMARY BENEFITS AND DRAWBACKS:
Benefits: Reduces groundwater reliance.
Drawbacks: Conservation improvements tend to be site- and water use specific.



SCREENING CRITERIA

Criteria	*Rating*
Cost	Unknown
Legal Feasibility	Good
Political Feasibility	Good
Financial Feasibility	Water use specific
Environmental Impacts	Unknown
Water Quality	Can be a limiting factor to specific conservation efforts.
Benefits	Good

Appendix A
Summary of Preliminary Groundwater Modeling Work

A.1 Introduction

The preliminary analyses presented in this TM are intended to provide a reasonable basis and context for the SJCWMP option development process. They are based on a combination of previous modeling work, mass balance calculations, and on-going groundwater modeling, and will be refined as the option development and analysis proceeds.

A.2 Baseline Conditions

The term baseline condition in this context refers to the current and predicted condition of the Eastern San Joaquin County Groundwater Basin through the year 2030. The key issue is the magnitude of the overdraft and historical loss in aquifer storage volume. The overdraft is defined as the difference between the net groundwater withdrawals and natural replenishment of the basin. Based on review of previous studies and groundwater modeling, the annual overdraft between 1970 and 1993 averaged 117 TAF, resulting in an estimated loss of aquifer storage of 2.8 MAF. Based on current estimates of demands the overdraft may be as high as 160 TAF. This value does not take into account all the most recent and anticipated changes in surface water deliveries to urban and agricultural areas. For example, growth in water demand in Calaveras County may cause a reduction of available surface water supplies for San Joaquin County of approximately 40 TAF (CDM, 2001). If this were to occur the overall deficit in within the eastern county would increase to 200 TAF/year. Therefore, the estimated annual average overdraft is expected to range from 160 TAF/year to 200 TAF/year.

A.3 Saline Water Intrusion

Figure A-1 illustrates the simulated average groundwater elevations under long-term average hydrologic conditions and 1996 land use conditions. Under these conditions saline water is expected to continue to migrate from the Delta area towards the cone of depression, at a rate of 200 to 300 feet per year. This possible salinity intrusion is also illustrated on Figure A-1 by the simulated particle tracks started at the estimated location of the 300 mg/l chloride front'in the Stockton area. These particle tracks were run for 60 years. It should be noted that the salinity intrusion problem near Stockton is not well understood and the county is planning to conduct additional studies and monitoring to better characterize the source and migration pathways of the salinity problem.

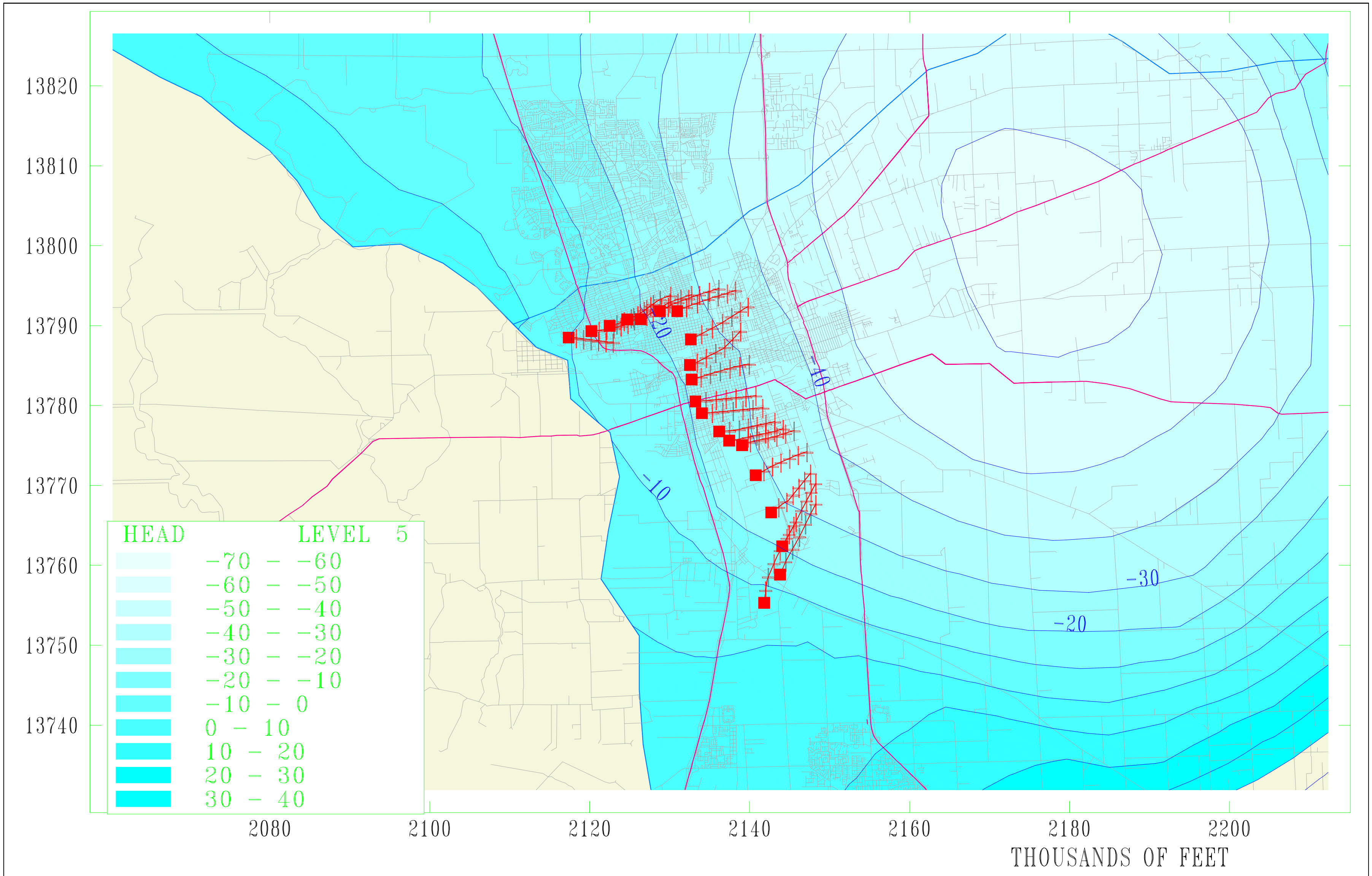
The SJCWMP strategy as described in Section 3 has two principal objectives. The first objective is to minimize and ultimately stop the degradation of groundwater quality to salinity intrusion. The second phase is to minimize groundwater overdraft and provide conjunctive use opportunities. To minimize salinity intrusion 100 TAF has been identified as the target for the development of alternatives. This 100 TAF estimate is based on:

- Preliminary steady state groundwater simulations based on long-term average hydrologic conditions which incorporate 1996 land use and water demands.
- Recharging (in-lieu or direct recharge) of 100 TAF directly over the principal cone of depression in Eastern San Joaquin County.

Figure A-2 illustrates the simulated average steady-state groundwater elevations with a hypothetical project of 100 TAF recharge in the Stockton and SEWD areas. The simulated particle tracks started at the estimated location of the 300 mg/l TDS/chloride front'in the Stockton area under the þroject'average transient conditions. This simulation showed that the rate of eastward groundwater flow into the cone of depression is slowed, and ultimately reversed during a period of 30 years. According to preliminary simulations, under average conditions it would take approximately 30 years for the groundwater table to reach this state. Figure A-3 and A-4 illustrate the average transient response at selected wells to 100 TAF of recharge in the cone of depression. Well 9 (State Well Number 01N06E23J01M) shown on Figure A-3 is located south of Stockton just east of Interstate 5, and well 10 (SWN 01N08E30M01M), shown on Figure A-4, is approximately 5 miles east of well 9.

A.4 Overdraft and Conjunctive Use

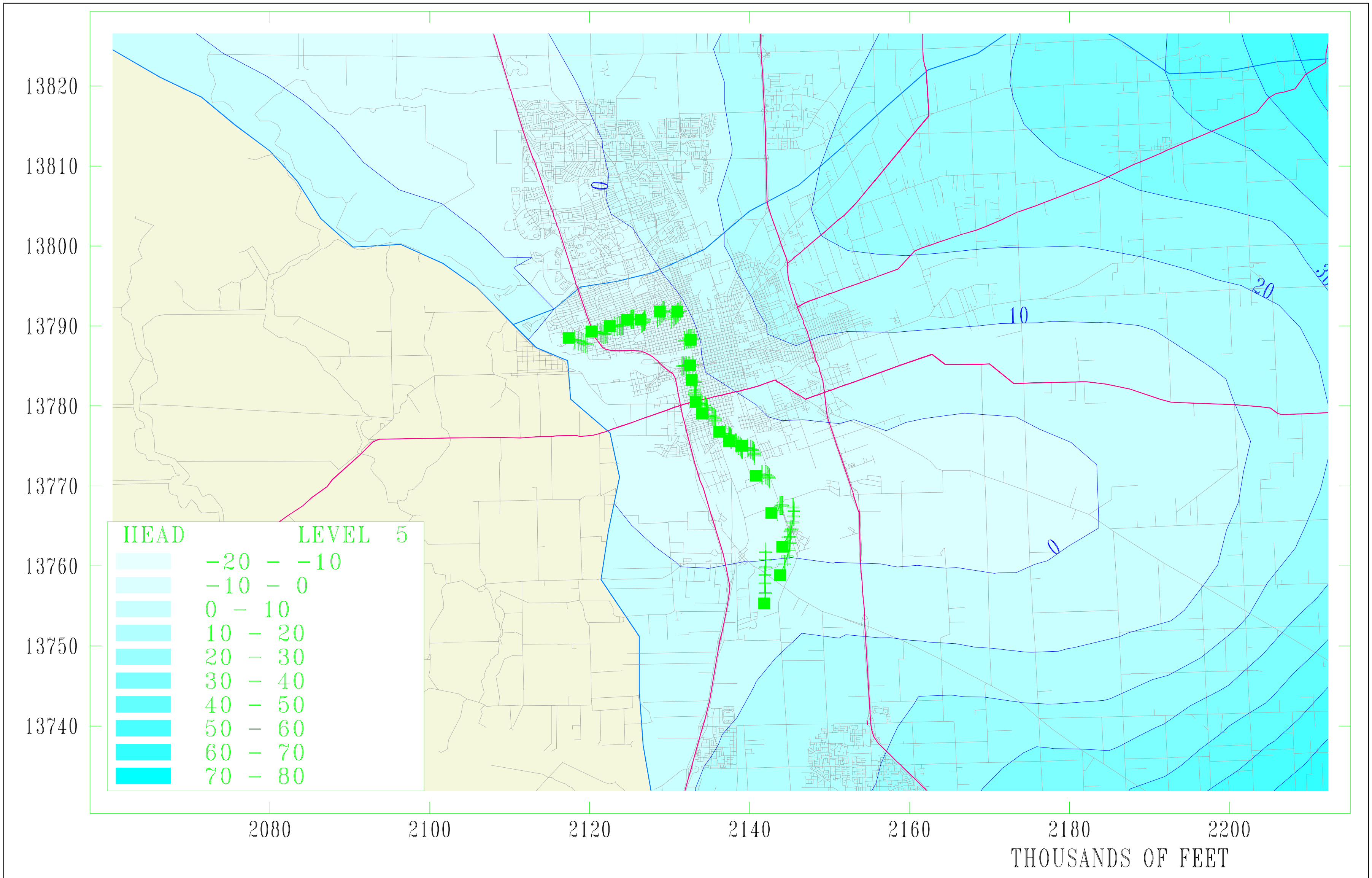
As noted earlier, our preliminary estimates show that overdraft may range from approximately 160 TAF/ year to 200 TAF/year through the year 2030. Therefore, in addition to the 100 TAF target for salinity control, at least an additional of 60 TAF/year and probably 100 TAF/year has been identified as required to minimize the overall east County overdraft and provide for conjunctive use.



consulting engineering construction operations CDM

Groundwater Levels & Simulated Particle Tracks
Representing Possible Saline Water Inflow
Based on 'Current' Average Conditions
San Joaquin County Water Management Plan

FIGURE A-1



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engineering
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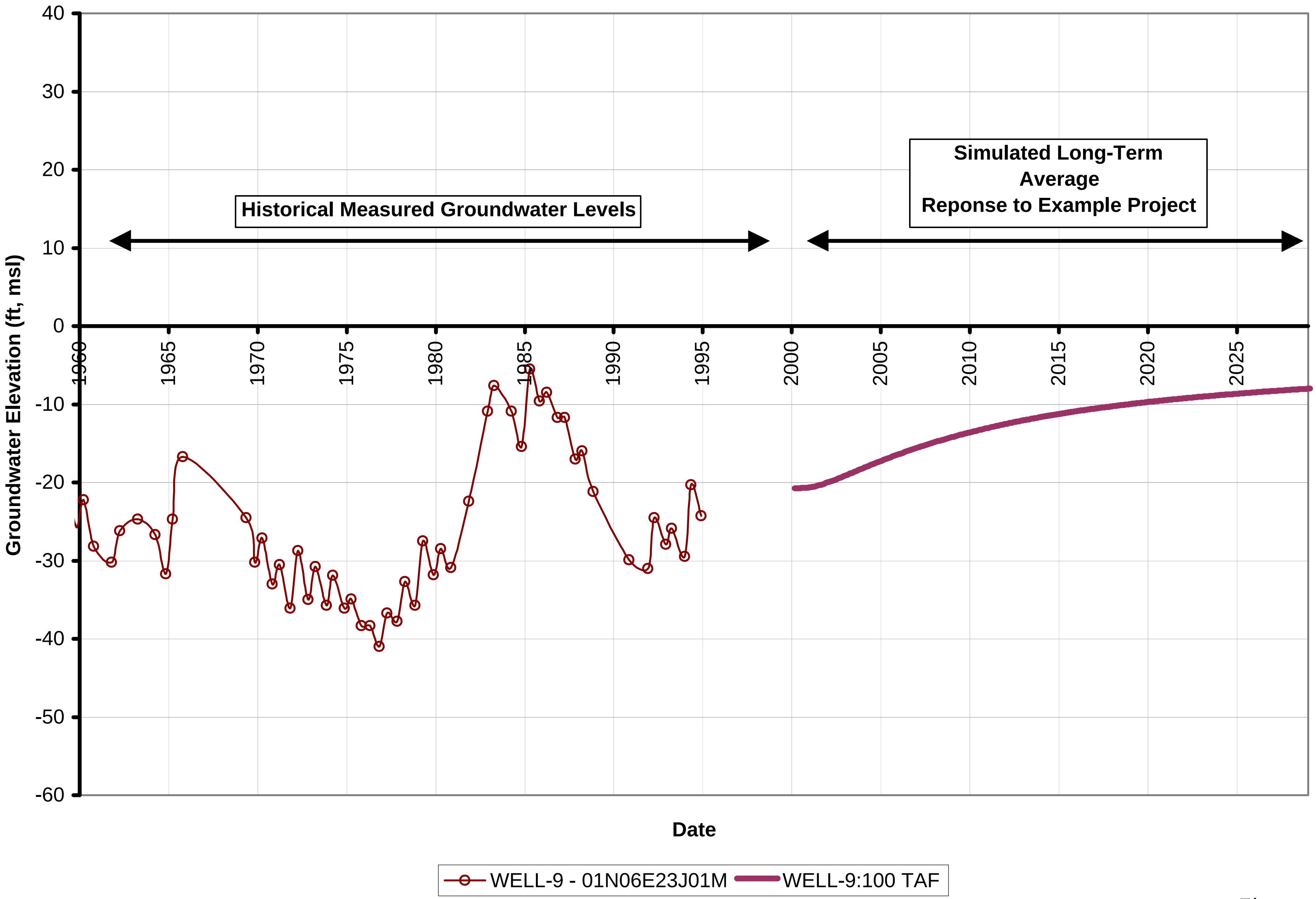
operations
CDM

Groundwater Levels & Simulated Particle Tracks
Representing Possible Saline Water Inflow
Based on Example Project Average Transient Response
San Joaquin County Water Management Plan

FIGURE
A-2

Simulated of Groundwater Levels in Response to Example 100 TAF Project
Evaluation of Baseline Conditions and East County Management Strategy

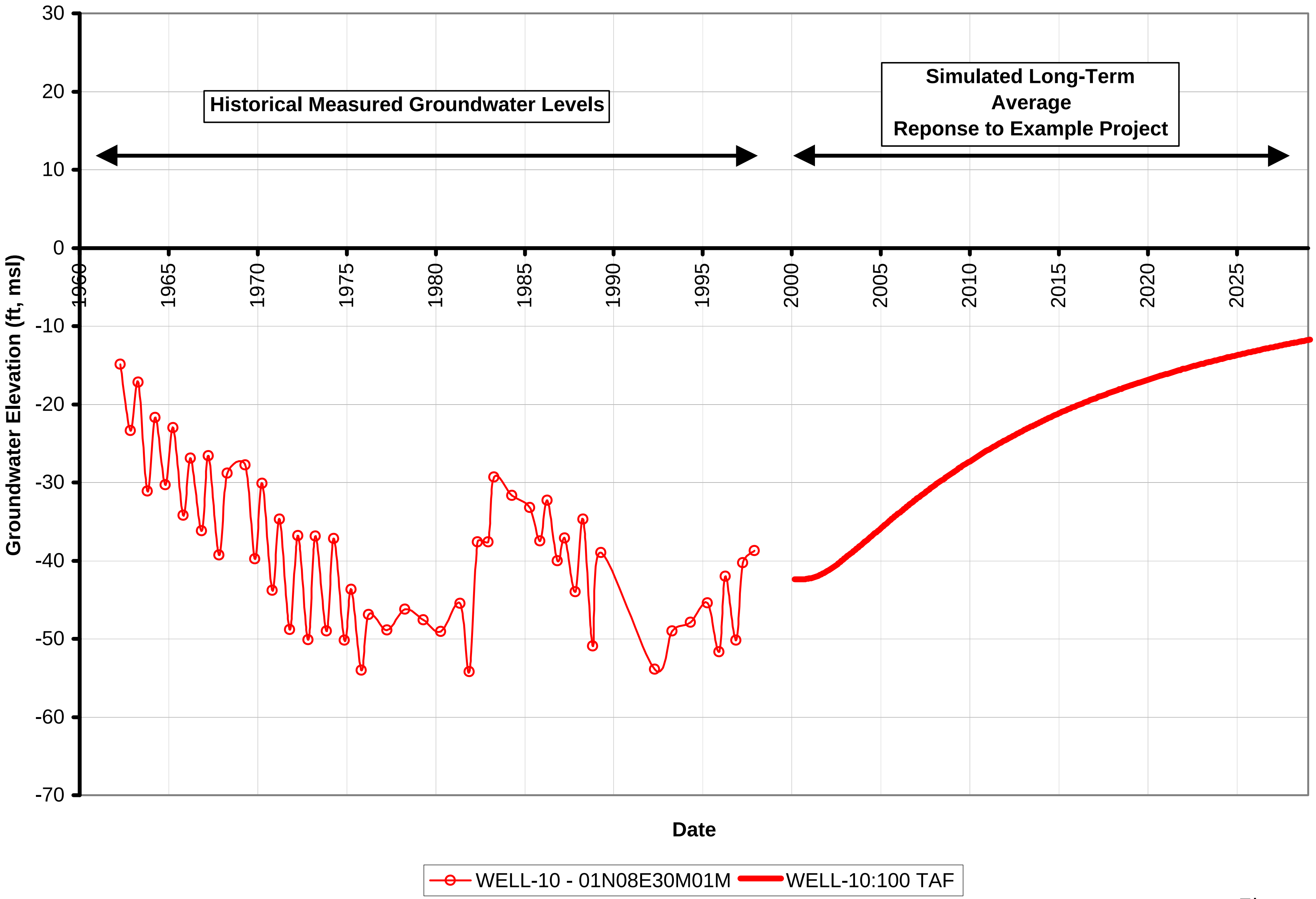


A B

Baseline Conditions2.xls-4
1/30/01

Figure A-3
Technical Memorandum 3
San Joaquin County Water Management Plan

Simulated of Groundwater Levels in Response to Example 100 TAF Project
Evaluation of Baseline Conditions and East County Management Strategy



A B

Figure A-4
Technical Memorandum 3
San Joaquin County Water Management Plan

Baseline Conditions2.xls-5
1/30/01

CDM

Camp Dresser & McKee

San Joaquin County

Flood Control and Water Conservation District

Technical Memorandum 4

Evaluation of Alternatives

August 2, 2001

Contents

Appendices

1.0 Introduction

Development of the San Joaquin County Water Management Plan (Plan) centers around the involvement of over 20 representatives of organizations with a common interest in the County's water resources. These stakeholders participated in Plan development through a process featuring interactive Steering Committee Meetings and individual meetings with the technical team members. For the Plan to succeed, it is critically important that these stakeholders agree on the course of action recommended within the plan. Without broad consensus, it is unlikely that the plan will be implemented in the future.

The purpose of this technical memorandum (TM) is to explain the process used by the Steering Committee to develop its Master Alternative. This TM describes the steps taken, in which options were grouped together and evaluated according to how well they met the water management objectives established by the stakeholders early in the planning process. The Steering Committee used this information to discuss and develop a list of projects that should be moved forward.

Technical Memorandum No. 3 described many options that could benefit the County if included in the water management plan. These options were screened for a "fatal flaw," and the options remaining were grouped into surface water options, groundwater options, and other options. Surface water options included sources of surface water and any necessary facilities to take advantage of that water (regulating reservoirs, piping, distribution facilities, etc.). Groundwater options included projects that feature recharge. Other options included options that did not fall into the first two categories, such as conservation and political support.

It was originally intended that the next step in the planning process would be to group these options into alternatives, and evaluate these alternatives. At the beginning of the plan development, the Steering Committee developed their goals and objectives for the plan. The alternatives were to be evaluated according to their ability to best meet the Steering Committee's goals and objectives.

During the process, the course changed, yet the group reached a similar endpoint. Rather than developing multiple alternatives, the options were combined into Water Management Options (WMOs). The WMOs were again screened by the Steering Committee, and then evaluated according to the goals and objectives. The final result was a "Master Alternative" that prioritized the remaining WMOs for further action.

2.0 Option Groupings

Options developed in TM 3 are not effective individually, but must be grouped together to implement an effective project. Options that provide a source of water must be paired with options that recharge that water into the groundwater aquifer. A combination of source water and groundwater recharge is referred to in this Plan as a Water Management Option (WMO). A WMO usually contains a surface water option and a groundwater option, but could also contain any fully complete option, such as providing political support for projects within a specific region. The Steering Committee determined which surface water and groundwater options should be pursued in more depth, and these options were grouped into WMOs. An example of a WMO is New Hogan Reoperation, which includes a surface water supply from reoperating the existing reservoir, and a groundwater recharge option of in-lieu recharge in SEWD. The WMOs that passed through this screening process are described in detail in Appendix A.

2.1 Alternatives Development

Three alternatives were developed to compare how different options meet the stakeholder objectives. The alternatives shared many common components. These common options that were projects that are already being implemented by smaller groups within the County, or options that stakeholders thought were outstanding. The first alternative focused on fully utilizing existing water rights or implementing water rights applications that have been filed. The second alternative emphasized conservation and reclamation, and the third alternative included floodflow projects.

These alternatives were presented to the Steering Committee for comments. The Steering Committee went through the WMOs included within the alternatives and determined which options warranted further study. By working through the list and decided if each option should proceed, the Steering Committee screened the list of WMOs. The Steering Committee also created a group of “core elements,” which were WMOs that they believed should be included in each alternative. The core elements included options that were already underway, or for which significant progress had been made prior to the formation of the Steering Committee (such as the SSJID/OID transfer of Stanislaus River water to SEWD). The core elements also included WMOs that the stakeholders believed to be exceptional when compared to the other options, including reoperating New Hogan reservoir. During the Steering Committee meeting, the list of core elements grew to five WMOs, including SSJID/OID transfer to SEWD, the Farmington project, reoperating New Hogan reservoir, SEWD and CSJWCD fully exercising their New Melones rights, and the South County Water Supply Project. Tables 2-1 to 2-3 list the options that were included in each alternative after stakeholder additions and deletions.

2.2 The Master Alternative

After the Steering Committee commented on the alternatives, number of core elements had increased, thus the alternatives had become very similar. In addition, the stakeholders went through each non-core option to determine if it should proceed to the next stage of project development (involving more detailed study). This process indicated that the stakeholders believed that each of the remaining WMOs had merit.

The original planning process called for the Technical Team to evaluate each alternative, and for the Steering Committee to then use the technical evaluation to choose an alternative to proceed to the implementation phase. All WMOs, however, had some merit to proceed to the implementation phase for additional study. Therefore, all remaining WMOs were combined into a "Master Alternative."

The Master Alternative includes viable options remaining after the screening process, and it could provide more water than the County needs if all options were implemented. The Master Alternative provides the flexibility to implement various options based upon information gathered during further study. Many evaluation parameters that could substantially change the viability of a particular project, including power cost and groundwater conjunctive use partnerships. The Master Alternative includes options that could total up to 546 TAF, so all options would not need to be implemented.

Table 2-1
Alternative 1

Water Source						How to get the water into the ground					
Option	Surface Water/Water Source	Quantity (TAF)	Tier	Cost ($/AF)	Total Annualized Cost ($ 000s)	Option	Groundwater/Delivery	Quantity (TAF)	Tier	Cost ($/AF)	Total Annualized Cost ($000s)
SW12	SSJID/OID to SEWD Transfers	30	1	40	1200	GW11	In-lieu Recharge in SEWD	30	1	40	1200
SW11	Farmington - Little John's Flood Flows	25	1	200	5000	GW4	Farmington Groundwater Recharge and Wetlands Feasibility Study	25	1	100	2500
SW5	New Hogan Reservoir Reoperation	25	1	10	250	GW11	In-lieu Recharge in SEWD	25	1	40	1000
SW10	SEWD, CSJWCD Fully Exercise New Melones Rights	45	1	10	450	GW11	In-lieu Recharge in SEWD	10	1	40	400
						GW15	In-lieu Recharge in the City of Stockton	25	1		
						GW9	In-lieu Recharge in CSJWCD	10	1	40	400
SW8	Water Transfers within San Joaquin County	44	1	-	-	GW13	In-lieu Recharge in the City of Manteca	16	1	150	2355
						GW19	In-lieu Recharge in the City of Escalon	3	1	150	480
						GW20	In-lieu Recharge in the City of Lathrop	11	1	150	1695
						O7	In-lieu Recharge in the City of Tracy	14	1	150	2100
SW9	WID and WWUCD use of additional Mokelumne River Flood Flows	10	2	10	100	GW11	In-lieu Recharge in SEWD	5	1	40	200
						GW8	In-lieu Recharge in the City of Stockton	5	1		
NEW	Utilize Stockton water right to divert water from the Delta					GW8	In-lieu Recharge in the City of Stockton				
	Totals for Water Sources	**179**			**7,000**		**Totals for Groundwater Options**	**179**			**12,330**
	Total Alternative Cost				**19,330**						

Other Options

Option	Other Option Name	Tier	Cost
O1	Delta Area San Joaquin County Water Supply Activities	1	-
O3	Southwest San Joaquin County Water Supply Activities	1	-

Table 2-2
Alternative 2

Water Source						How to get the water into the ground					
Option	Surface Water/Water Source	Quantity (TAF)	Tier	Cost ($/AF)	Total Annualized Cost ($ 000s)	Option	Groundwater/Delivery	Quantity (TAF)	Tier	Cost ($/AF)	Total Annualized Cost ($000s)
SW12	SSJID/OID to SEWD Transfers	30	1	40	1,200	GW11	In-lieu Recharge in SEWD	30	1	40	1,200
SW11	Farmington - Little John's Flood Flows	25	1	200	5,000	GW4	Farmington Groundwater Recharge and Wetlands Feasibility Study	25	1	100	2,500
SW5	New Hogan Reservoir Reoperation	25	1	10	250	GW11	In-lieu Recharge in SEWD	25	1	40	1,000
SW10	SEWD, CSJWCD Fully Exercise New Melones Rights	45	1	10	450	GW11	In-lieu Recharge in SEWD	10	1	40	400
						GW15	In-lieu Recharge in the City of Stockton	25	1		0
						GW9	In-lieu Recharge in CSJWCD	10	1	40	400
SW8	Water Transfers within San Joaquin County	44	1	-	-	GW13	In-lieu Recharge in the City of Manteca	16	1	150	2,400
						GW19	In-lieu Recharge in the City of Escalon	3	1	150	450
						GW20	In-lieu Recharge in the City of Lathrop	11	1	150	1,650
						O7	In-lieu Recharge in the City of Tracy	14	1	150	2,100
SW2	EBMUD/Sacramento County/San Joaquin County Sacramento River Diversion	25	2	?	?	GW2	Direct Recharge in SEWD	10	2	100	1,000
						GW17	NSJWCD Groundwater Recharge Project	5	2	100	500
						GW12	In-lieu Recharge in the City of Lodi	10	2	150	1,500
O6	Water Conservation Improvements	?	2	?	?						
O5	Urban Wastewater Reclamation	60	2	200	12,000	GW8	Injection Wells in the City of Stockton	60	2	300	18,000
	Totals for Water Sources	**254**			**18,900**		**Totals for Groundwater Options**	**254**			**33,100**
	Total Alternative Cost				**52,000**						

Other Options

Option	Other Option Name	Tier	Cost
O1	Delta Area San Joaquin County Water Supply Activities	1	-
O3	Southwest San Joaquin County Water Supply Activities	1	-

Table 2-3
Alternative 3

Water Source / **How to get the water into the ground**

Option	Surface Water/Water Source	Quantity (TAF)	Tier	Cost ($/AF)	Total Annualized Cost ($ 000s)	Option	Groundwater/Delivery	Quantity (TAF)	Tier	Cost ($/AF)	Total Annualized Cost ($000s)
SW12	SSJID/OID to SEWD Transfers	30	1	50	1,500	GW11	In-lieu Recharge in SEWD	30	1	40	1,200
SW11	Farmington - Little John's Flood Flows	25	1	200	5,000	GW4	Farmington Groundwater Recharge and Wetlands Feasibility Study	25	1	100	2,500
SW5	New Hogan Reservoir Reoperation	25	1	10	250	GW11	In-lieu Recharge in SEWD	25	1	40	1,000
SW10	SEWD, CSJWCD Fully Exercise New Melones Rights	45	1	10	450	GW11	In-lieu Recharge in SEWD	10	1	40	400
						GW15	In-lieu Recharge in the City of Stockton	25	1		0
						GW9	In-lieu Recharge in CSJWCD	10	1	40	400
SW8	Water Transfers within San Joaquin County	44	1	-	-	GW13	In-lieu Recharge in the City of Manteca	16	1	150	2,400
						GW19	In-lieu Recharge in the City of Escalon	3	1	150	450
						GW20	In-lieu Recharge in the City of Lathrop	11	1	150	1,650
						O7	In-lieu Recharge in the City of Tracy	14	1	150	2,100
SW6	NSJWCD-Mokelumne River water right	20	2	50	1,000	GW17	NSJWCD Groundwater Recharge Project	20	2	100	2,000
SW1	Calaveras River Flood Flows	30	3	450	13,500	GW9	In-lieu Recharge in CSJWCD	20	1	40	800
SW7	Stanislaus River Flood Flows	20	3	450	9,000	GW11	In-lieu Recharge in SEWD	30	1	40	1,200
SW3	Mokelumne River Flood Flows	50	3	450	22,500	GW11	In-lieu Recharge in SEWD	30	1	40	1,200
						GW 10	In-lieu Recharge in NSJWCD	20	1	40	800
	Totals for Water Sources	**289**			**53,200**		**Totals for Groundwater Options**	**289**			**18,100**
	Total Alternative Cost				**71,300**						

Other Options

Option	Other Option Name	Tier	Cost
O1	Delta Area San Joaquin County Water Supply Activities	1	-
O3	Southwest San Joaquin County Water Supply Activities	1	-

3.0 Evaluation Methodology

To provide direction for the technical team during the process, and to account for the variety of concerns held by these stakeholders, the group established goals and objectives for the Plan at the beginning of the process. These goals and objectives are shown in Figure 3-1. To select the WMOs that will be implemented as part of the final plan, this evaluation examined how well the WMOs meet these objectives.

In selecting a set of WMOs that may be further developed with an implementation plan, the Steering Committee prioritized the options to identify a technically feasible path for the County to follow to address water management needs. This evaluation used a tiered system to prioritize the WMOs. The tiers are described below.

- Tier I elements are those that appear to perform well according to the objectives and should be included as high priorities for implementation.
- Tier II options are those that meet some of the Plan objectives and should be included in the Plan for implementation, but are of lower priority.
- Tier III options are those that meet a few of the Plan objectives and should be considered low priority for implementation.[1]

During Steering Committee meetings, stakeholders discussed the WMO prioritization results, and options were moved among the tiers as a result of the discussions. The resulting tiered option structure illustrates implementation priority for the Plan.

To aid in comparing the WMOs, this evaluation rates the WMOs according to each objective. The “Goals” column from the objectives hierarchy (Figure 3-1) was used to compare each option at a planning level. Only those goals that are applicable to individual WMOs are included in the prioritization. Some goals, such as “Minimize community impacts,” and “Be equitable” will be more appropriate for evaluating combinations of WMOs, which have impacts and benefits throughout the County. These must be applied to a complete (Countywide) alternative to decide if the entire package meets these criteria.

The WMOs were evaluated according to each goal by using “rating criteria” for each. Rating criteria illustrate how well the option meets each objective. In general, a full circle indicates that the option meets or exceeds the objective, a half-circle indicates that the option partially meets the objective or meets the objective with

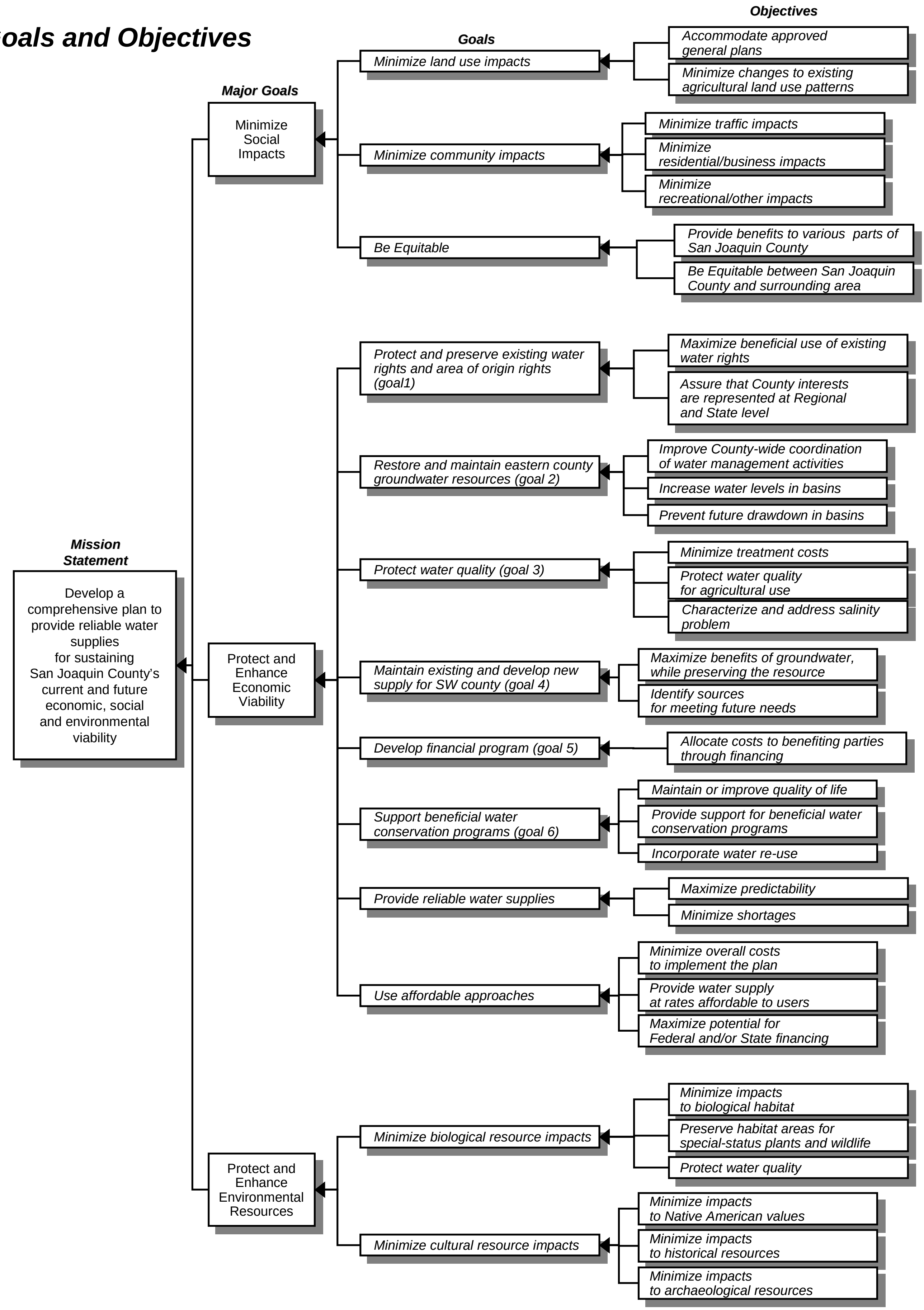
[1] These tiers are not identical to the tiers in Technical Memorandum No. 3. These new tiers indicate which options should be pursued first.

contingencies, and an empty circle illustrates that the option poorly addresses the objective. Table 3-1 shows the specific rating criteria for each objective.

Each WMO was evaluated according to the rating criteria for each goal. The results were determined from previous reports and pre-feasibility analysis completed as part of this planning process for each option. The evaluation for the groundwater goals ("increase groundwater levels" and "decrease the rate of salinity intrusion") was performed using the County groundwater model, as detailed in Appendix B.

The prioritization results are shown in Table 3-2.

Goals and Objectives



A B

Figure 3-1

Goal	Indicator	Description
Use affordable approaches	●	Estimated costs less than $100/AF
	◒	Estimated costs greater than $100/AF, but less than $300/AF
	○	Estimated costs greater than $300/AF
Minimize land use impacts	●	Negligible land use impacts (less than 0.1 acres/TAF)
	◒	Moderate land use changes (0.1 acres/TAF to 10 acres/TAF)
	○	Land use changes greater than 10 acres/TAF, or requires land that may be difficult to acquire
Protect existing water rights	●	Increase use of existing water rights
	◒	No change to use of water rights, but rights are not lost
	○	Decrease use of water rights, possibly resulting in loss of existing rights, or requires a new water right or a change in an existing water right
Increase groundwater levels	●	Groundwater levels increase by 20% or more from baseline
	◒	Groundwater levels increase by 10 to 20% from baseline
	○	Groundwater levels increase by less than 10% from baseline
Decrease the rate of salinity intrusion	●	Rate of salinity intrusion is decreased by 50% or more
	◒	Rate of salinity intrusion is decreased by 25 to 50%
	○	Rate of salinity intrusion is decreased by less than 25%
Protect water quality	●	Increased water quality delivered to County residents
	◒	No change to water quality
	○	Decreased water quality
Develop new supplies for SW County	●	New supplies available to Southwest County
	◒	No significant change to available supplies in Southwest County
	○	Diminishes or interferes with Southwest County supplies
Support water conservation programs	●	Actively creates new water conservation programs
	◒	Supports water conservation indirectly
	○	Does not increase water conservation efforts
Provide reliable water supplies	●	New water sources are available more than 80% of years
	◒	New water sources are available between 50 and 80% of years
	○	New water sources are available less than 50% of years
Minimize environmental impacts	●	Increases environmental habitat or has other beneficial environmental or cultural impacts
	◒	No biological or cultural impacts, or minimal impacts that are mitigated appropriately
	○	Extensive biological and/or cultural impacts that cannot be mitigated
Implementability	●	Project underway, or limited or no obstacles to implementation
	◒	Feasibility analysis underway or complete, and obstacles to implementation may be overcome
	○	Major technical or political obstacles to implementation

Table 3-1
Rating Criteria for Option Evaluation

Tier	Source Water	Option	Quantity	Average Cost per Acre-Foot	Use Affordable Approaches	Minimize Land Use Impacts	Protect Existing Water Rights	Groundwater Resources: Increase Groundwater Levels	Groundwater Resources: Decrease the Rate of Salinity Intrusion	Protect Water Quality	Develop New Supplies for SW County	Support Beneficial Water Conservation Programs	Provide Reliable Water Supplies	Minimize Biological and Cultural Impacts	Implementability
Tier I	Stanislaus River	Exercise Full New Melones Rights	18	$32	●	◒	●	◒	◒	◒	○	○	◒	◒	◒
	Mokelumne River	WID Transfer to SEWD	10	$35	●	●	○	○	◒	◒	◒	○	○	◒	◒
	Calaveras River	New Hogan Reoperation	25	$36	●	●	●	◒	◒	◒	◒	○	◒	◒	◒
	Littlejohn's Creek	Farmington Groundwater Recharge and Wetlands Project	25	$72	●	○	●	◒	●	◒	◒	○	◒	●	◒
	Stanislaus River	SSJID/OID Transfer to SEWD	30	$81	●	●	●	◒	◒	◒	○	○	●	◒	●
	Stanislaus River	South County Water Supply Project	44	$150	◒	◒	●	○	◒	◒	●	○	●	◒	◒
	San Joaquin River	Stockton Delta Diversion	20-126	$180	◒	●	●	◒	●	◒	○	○	●	◒	○
	Conservation	Urban Water Conservation Improvements	20	$260	◒	●	◒	◒	◒	◒	◒	●	●	●	●
	None	Delta Area Water Supply Activities				●	●	N/A	N/A	◒	●	◒	◒	◒	●
	None	Southwest County Water Supply Activities				●	●	N/A	N/A	◒	●	◒	◒	◒	●
		Total for Tier I	192-298												
Tier II	Mokelumne River	NSJWCD Groundwater Recharge Project	20	$150	◒	○	●	◒	○	◒	◒	◒	◒	●	◒
	Conservation	Agricultural Water Conservation Improvements	20-40	$250	◒	●	◒	◒	○	◒	◒	●	●	●	◒
	Sacramento	Freeport Diversion *	28	$270	○	◒	○	○	○	◒	○	○	◒	◒	◒
	Reclamation	Urban Wastewater Reclamation	60	$500	○	◒	◒	●	◒	○	○	◒	●	◒	○
	Mokelumne River	Flood Flows to Middlebar Reservoir	50	$450-$550	○	○	●	◒	◒	◒	◒	◒	○	○	◒
		Total for Tier II	**178-198**												
Tier III	Calaveras River Stanislaus River	Flood Flows to South Gulch Reservoir	30	$490	○	○	◒	◒	◒	◒	○	◒	○	○	○
	American River	American River Water Rights	20	$490	○	◒	●	◒	◒	◒	○	◒	○	○	○
		Total for Tier III	**50**												

* *Represents most recent project information from the GBA JPA Coordinating Committee.*

Table 3-2
Water Management Options Prioritization

4.0 Steering Committee Decisions

When the Steering Committee was presented with the evaluation of the WMOs on April 19, 2001, members felt that they needed several additional pieces of technical information before a final decision could be made. The Steering Committee believed that it was important to understand which options use "new" water (water that was previously unused by the County), and which options simply re-allocate water within the County. In addition, Steering Committee members wanted to further understand the infrastructure requirements for each option, especially options that use floodflows as the surface water source. After this information was presented at a Steering Committee meeting on June 14, 2001, the group agreed to the prioritization of the WMOs within the Master Alternative.

When the Steering Committee agreed to the prioritization, the members emphasized that they were not agreeing that these options should immediately be implemented, but that these options should be studied in more detail.

When the Steering Committee agreed to the prioritization, the members emphasized that they were not agreeing that these options should immediately be implemented, but that these options had the potential to benefit the County and should be studied in more detail. There are many options within the Master Alternative that need detailed technical analysis before the final decision on implementation can be made. This portion of the planning process decided which options should move forward to the next phase, where more detailed technical analysis will be performed as a part of the feasibility study.

4.1 "New" vs. "Re-allocated" Water

Several stakeholders have emphasized the importance of understanding the difference between new water and water that is re-allocated from an existing use. The following definitions explain the differences between the two, and Table 4-1 delineates which options fall into each category.

New Water. New water is defined as water that without a project would not be utilized in the County, and would either not be available to the County, flow out of the County and/or would be used by some entity outside of San Joaquin County. New water increases the total water supply available to San Joaquin County. The implication of new water is that there is higher probability that consensus can be reached between SJCWMP Stakeholders to pursue such projects.

Use of Existing Water or Re-allocation. This term refers to water that is already being used, or available to be used by some entity within San Joaquin County. Water in this category would either continue to be used in the existing manner, or would be unused without the implementation of a project. Existing water does not necessarily increase the net water supply available to the County - it changes the pattern and location of use. Implicit with this category of projects is the possibility for both positive and negative impacts to SJCWMP Stakeholders and hence, disagreement on project implementation and approach.

Table 4-1 ***New vs. Re-allocated Water***	
New Water	***Use of Existing Water or Re-allocation***
New Hogan Reoperation	Exercise Full New Melones Rights
Farmington Project	WID Exercise Full Water Rights
Stockton Delta Diversion	SSJID/OID Transfer to SEWD
NSJWCD Groundwater Recharge Project	South County Water Supply Project
Freeport Diversion	Urban Water Conservation Improvements
Urban Wastewater Reclamation	Agricultural Water Conservation Improvements
Floodflows to Middlebar Reservoir	
Floodflows to Proposed South Gulch Reservoir	
American River Water Rights	

4.2 Infrastructure Requirements

For most WMOs, an estimate of the average annual quantity that will be derived from each option is available. Listing average annual quantities resulted in some confusion because it appears that the average annual quantity would be available each year. However, average annual quantities indicate the average amount of water that each option will produce over a long period of time. During a single year, an option could range from no flow up to flow many times the average number. Therefore, the annual average flow is not a good indicator of the infrastructure that would be necessary, especially for options that utilize floodflows.

Options with floodflows will have an especially wide range of flows due to the nature of flows in the river. During dry years, no flow will be available. During wet years, large flows will be available in very short amounts of time. To capture these flows, the infrastructure required must be much larger than the average annual quantity indicates.

All options that capture floodflows have a component of storage in them. It is theoretically possible to divert floodflows from the river, and carry them to a recharge facility, however, none of the remaining WMOs use floodflows in this manner. Rather, the remaining WMOs utilize storage to capture winter floodflows and then utilize the floodflows for in-lieu recharge, primarily during the irrigation season. Using storage means that the recharge facilities will not need to handle the daily peaks in flows, but will need to have the capacity to accept the yearly peaks in flows.

Table 4-2 contains infrastructure information that was compiled for each option. The average annual quantity is listed with the maximum wet year flow to compare the two columns. Some options are essentially the same, and indicate water sources that would be available regardless of the water year type. Options that have much higher maximum flows are those that rely on floodflows as a water source, and the conveyance and groundwater recharge facilities must be sized according to the maximum year flow. The status of the conveyance system is also listed, to illustrate which options would require new conveyance facilities, or upgrades to existing facilities. The groundwater recharge infrastructure indicates the acreage that would be required to utilize the maximum year floods.

Table 4-2 illustrates that most options that would capture floodflows would require more substantial infrastructure investments. Some stakeholders were concerned that the infrastructure requirements would render a project infeasible, especially the acreage requirements for in-lieu groundwater recharge during wet years. The technical evaluation, however, found that all WMOs are feasible.

4.3 Connection of Three Rivers

Stakeholders expressed interest in the possibility of providing a conveyance system to connect the three river systems (Mokelumne, Calaveras and Stanislaus) within the County. The stakeholders requested, and the County approved, an evaluation of the feasibility of connecting the rivers and including the system as a WMO in the Water Management Plan.

The objective of a countywide transmission system would be to:

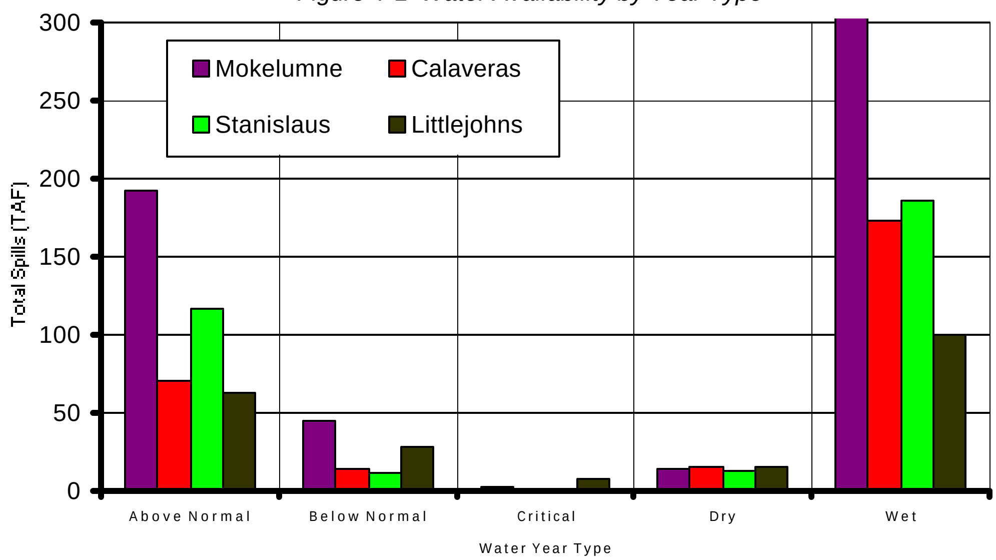
- Move available water to where it is needed the most;
- Make full use of excess storage capacity; and
- Provide groundwater recharge benefits.

A summary of CDM's presentation to the stakeholders on water availability and on the feasibility of the three-river connection is presented below.

Water Availability

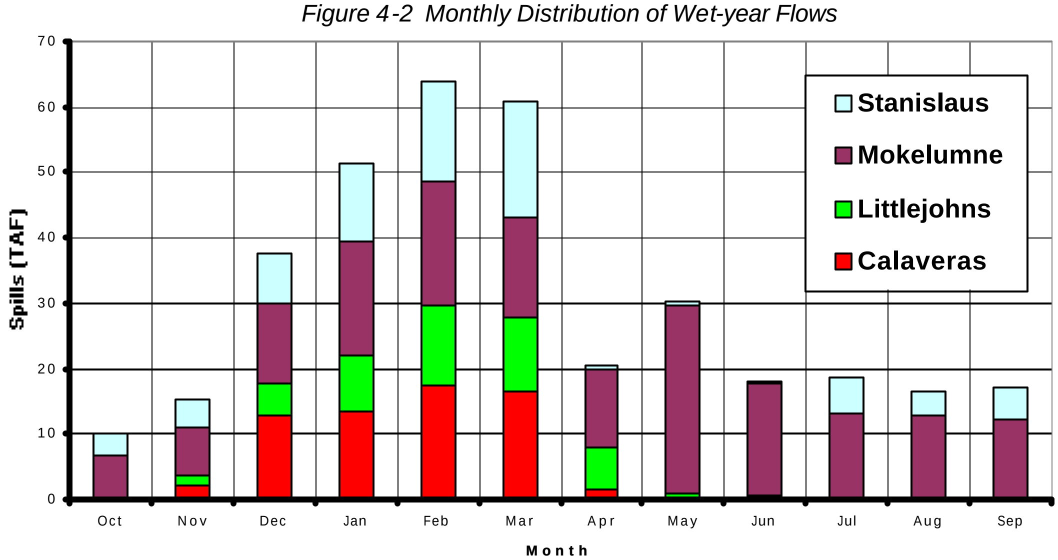
As has been discussed throughout the project, the Mokelumne, Calaveras and Stanislaus are essentially fully allocated, i.e., there is little or no firm water available to be diverted from these rivers. The only available water of significant quantity is the unallocated wet-year flows. Wet-year flows can be significant but occur relatively infrequently; in the past 20 years there have been 9 years defined as wet years. Wet years also do not have regular recurrence intervals and often occur in three to four consecutive years. For example, water years 1995 through 1998 were classified as wet years, and all but one year from 1987 to 1994 was classified as critically dry. This means the facilities designed and constructed to capture wet year flows will likely only be able to capture a small percentage of the flood flows, and will remain unused during long dry periods. The highest quantities of wet-year flows are available on the Mokelumne River. Wet-year flows are also available on the Calaveras, Littlejohns Creek and Stanislaus, but they are generally smaller. Water availability is illustrated in Figure 4-1 for each river in various year types.

Figure 4-1 Water Availability by Year Type



If the wet-years flows were available at different times during the year, then connecting the rivers would result in a higher overall yield (assuming available surface storage). However, wet-year flows are typically available at the same time on an annual basis, although the amount of monthly distribution varies from river to river. As shown in Figure 4-2, peak flows occur on all the rivers between December through April. The complete bars indicate the total wet-year flows on all four rivers. Both the Mokelumne and Stanislaus Rivers have some wet-year flow during May through November (see Figure 4-2).

Figure 4-2 Monthly Distribution of Wet-year Flows



Findings

It was found that an overall transmission system to connect the three rivers to move water from north county to south county and south county to north county was not advantageous for the following reasons:

- The rivers peak during the same years. There are not usually needs in one river watershed that would warrant the transfer of flood flows from another river watershed. For example, transferring Stanislaus river water to the Mokelumne river watershed or vise-versa is not necessary as each watershed has available floodwater that is not currently stored or utilized.

- Because the rivers peak at the same times during the year, the storage reservoirs are full and spilling at the same times. Therefore, a system to connect the three rivers would not capture and store any additional water without additional surface water storage facilities.

- Water is primarily needed in the central portion of the County (SEWD, CSJWCD) to address groundwater overdraft. Any water transferred south from the Mokelumne or north from the Stanislaus could be readily used to address this need. Currently, SEWD does not have the infrastructure to fully capture and utilize Calaveras River floodwaters.

Other important findings that that were identified as part of the three rivers evaluation included:

- Available firm and interim surface water is not fully utilized within the different watersheds and service areas. For example, Central San Joaquin Water Conservation District cannot use its firm supply of 49 TAF from the New Melones Reservoir. Distribution and conveyance systems within each district should be expanded to make full use of flood flows available within each watershed. To take full advantage of these flood flows will also require re-operation of reservoirs or additional surface water facilities. Several water management options are included in the plan to fully utilize this water.

- A conveyance system already exists to bring water to the central county from the Stanislaus River. The infrastructure to convey Stanislaus/New Melones water to CSJWCD and SEWD would need to be expanded to allow full utilization of Stanislaus River wet year flows. The expanded system needs were addressed in the Plan water management options.

- Given the availability of wet year flows on Mokelumne River, a system to regulate and move this water south for use in the north county and central county should continue to be an important element of the water management plan. Several WMOs are included in the plan to make use and distribute this available water.

In conclusion, a system that allows both transmission of water from south to north and north to south would be very costly because it would involve a large capacity canal system and may also require additional surface storage. Such a system would provide little additional benefit over a less extensive and complex transfer system that stores and moves water in each watershed with distribution to the central part of the County.

Table 4-2
Water Management Option Infrastructure

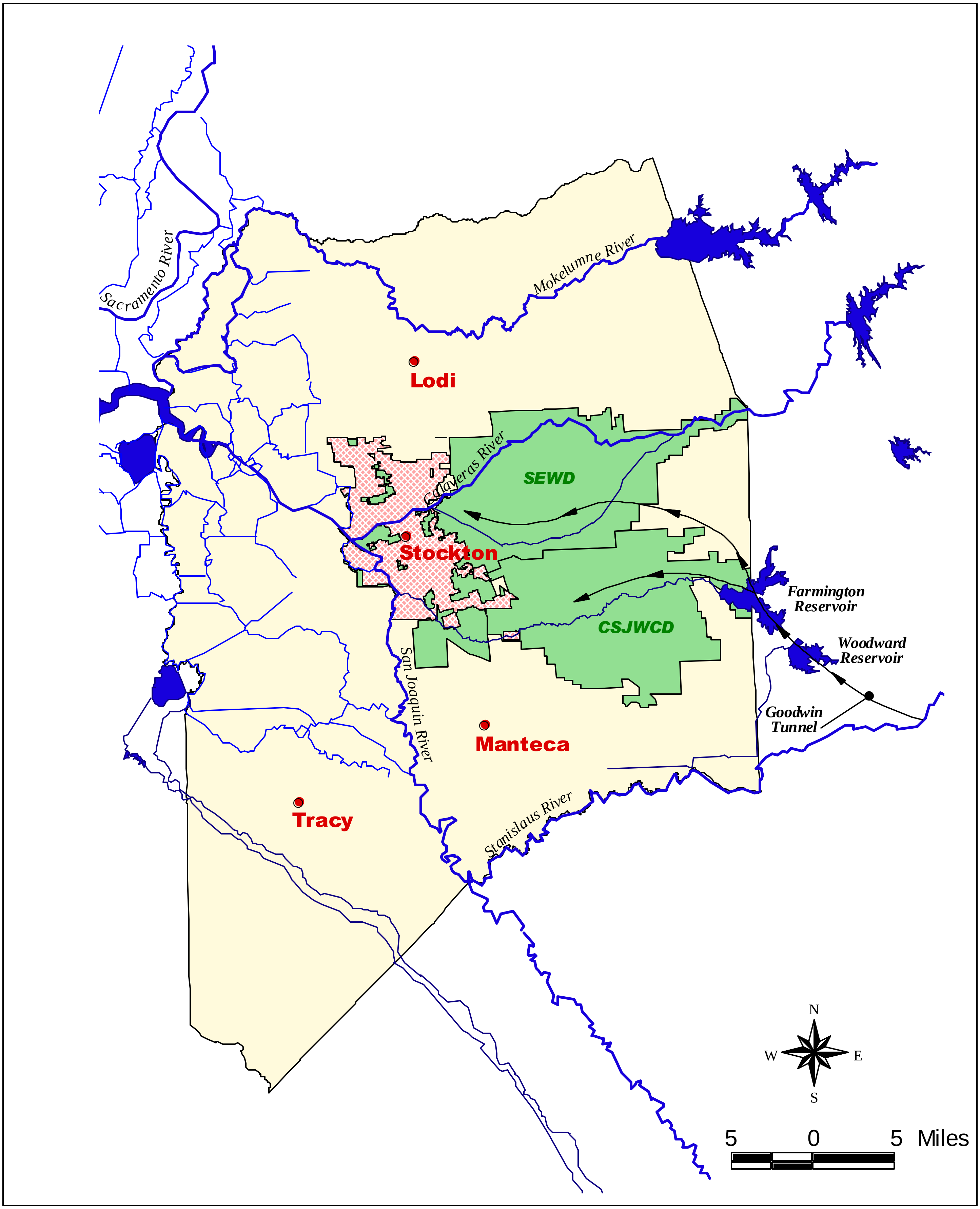
Tier	Source water	Option	Quantity (TAF)	Maximum/ Wet Year Flow (TAF)	Status of Conveyance System	Necessary Groundwater Recharge Infrastructure: Agricultural In-lieu (acres)	Urban In-lieu	Direct Recharge (acres)
Tier I	Stanislaus River	Exercise Full New Melones Rights	18	155	New	23,000	None	0
	Mokelumne River	WID Exercise Full Water Rights	10	10	Upgrade	3,500	Existing Distribution	0
	Calaveras River	New Hogan Reoperation	25	46	Existing	16,000	None	0
	Littlejohn's Creek	Farmington Groundwater Recharge and Wetlands Project	25	50	Upgrade	Unknown	None	600-1200
	Stanislaus River	SSJID/OID transfer to SEWD	30	30	Existing	0	Existing Distribution	0
	Stanislaus River	South County Water Supply Project	44	44	New	0	Existing Distribution	0
	San Joaquin River	Stockton Delta Diversion	20-126	20-126	Existing	0	Existing Distribution	0
	Conservation	Urban Water Conservation Improvements	20	20	N/A	N/A	N/A	N/A
		Total for Tier I	**192-298**					
Tier II	Mokelumne River	NSJWCD Groundwater Recharge Project	20	20	New	0	None	7,000
	Conservation	Agricultural Water Conservation Improvements	20-40	20-40	N/A	N/A	N/A	N/A
	Sacramento River	Freeport Diversion	28	93	New	7,500	None	1,800
	Reclamation	Urban Wastewater Reclamation	60	60	New	0	None	5 *
	Mokelumne River	Flood flows to proposed Duck Creek or Middlebar Reservoir, or proposed Pardee Reservoir enlargement	50	200	New	70,000	None	0
		Total for Tier II	**178-198**					
Tier III	Calaveras River Stanislaus River	Flood Flows to Proposed South Gulch Reservoir	30	120	New	42,000	None	0
	American River	American River Water Rights	20		New	0	None	0
		Total for Tier III	**50**					

* Approximately 5 acres of land needed to site 40 injection wells

Appendix A
Water Management Option Descriptions

Stanislaus River: Exercise New Melones Rights for Stockton and SEWD/CSJWCD agriculture

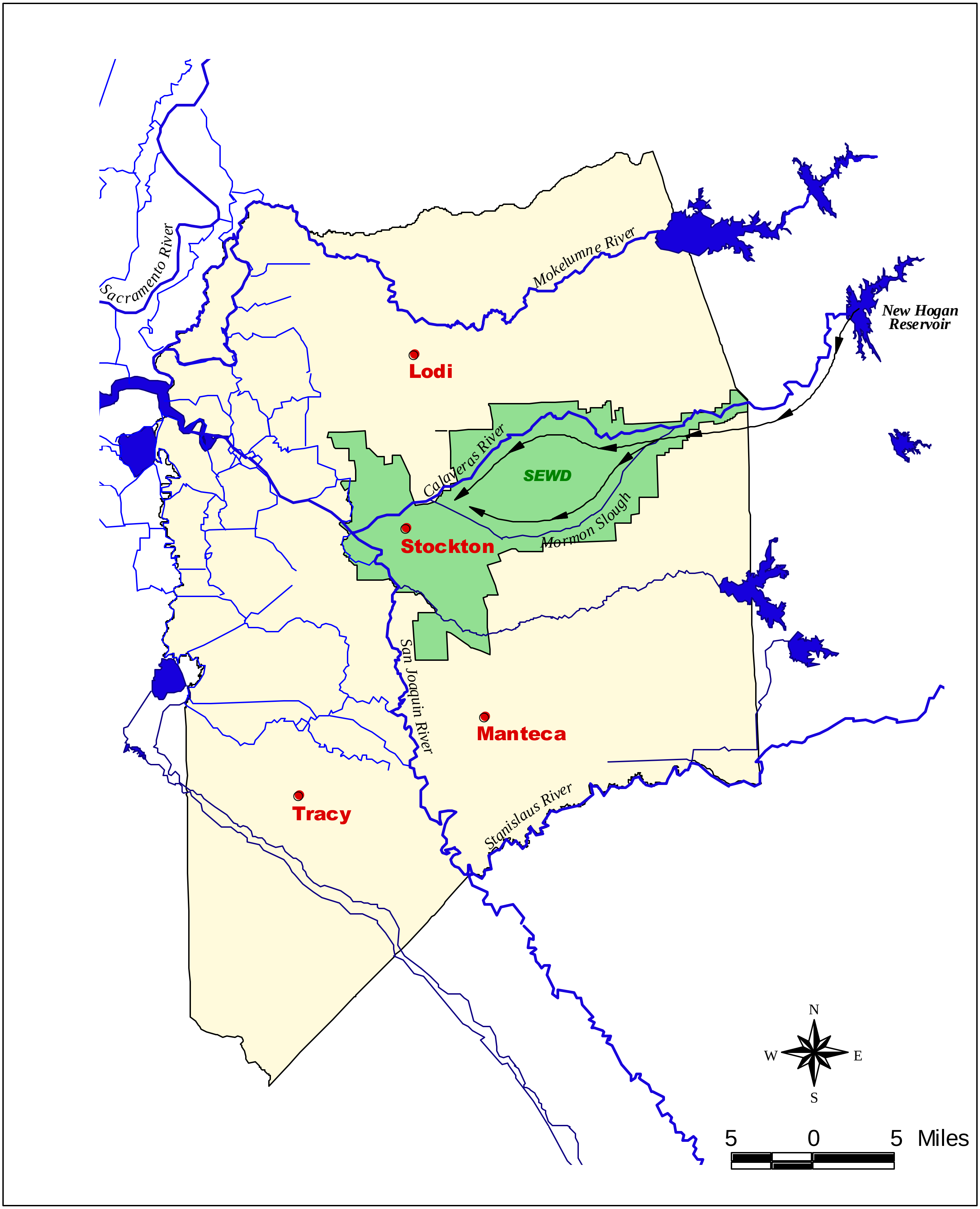
CSJWCD and SEWD together have a contractual right to 155 TAF per year for New Melones Project yield when available. Currently these districts utilize only 90 TAF per year. Increasing the two districts' ability to fully utilize their respective contract water would decrease groundwater pumping by 65 TAF in some years. To utilize this water for recharge, the districts would have to expand their existing distribution systems and provide farmers with incentive to use surface water instead of groundwater. Financial assistance would be required for distribution system expansions and also to make the price of surface water for the farmers competitive with the cost of using groundwater. The farmers would need to maintain the ability to irrigate with groundwater during dry years.



Exercise New Melones Rights for
Stockton and SEWD/SCJWCD
Agricultural, Stanislaus River

Calaveras River: New Hogan reoperation for SEWD agriculture

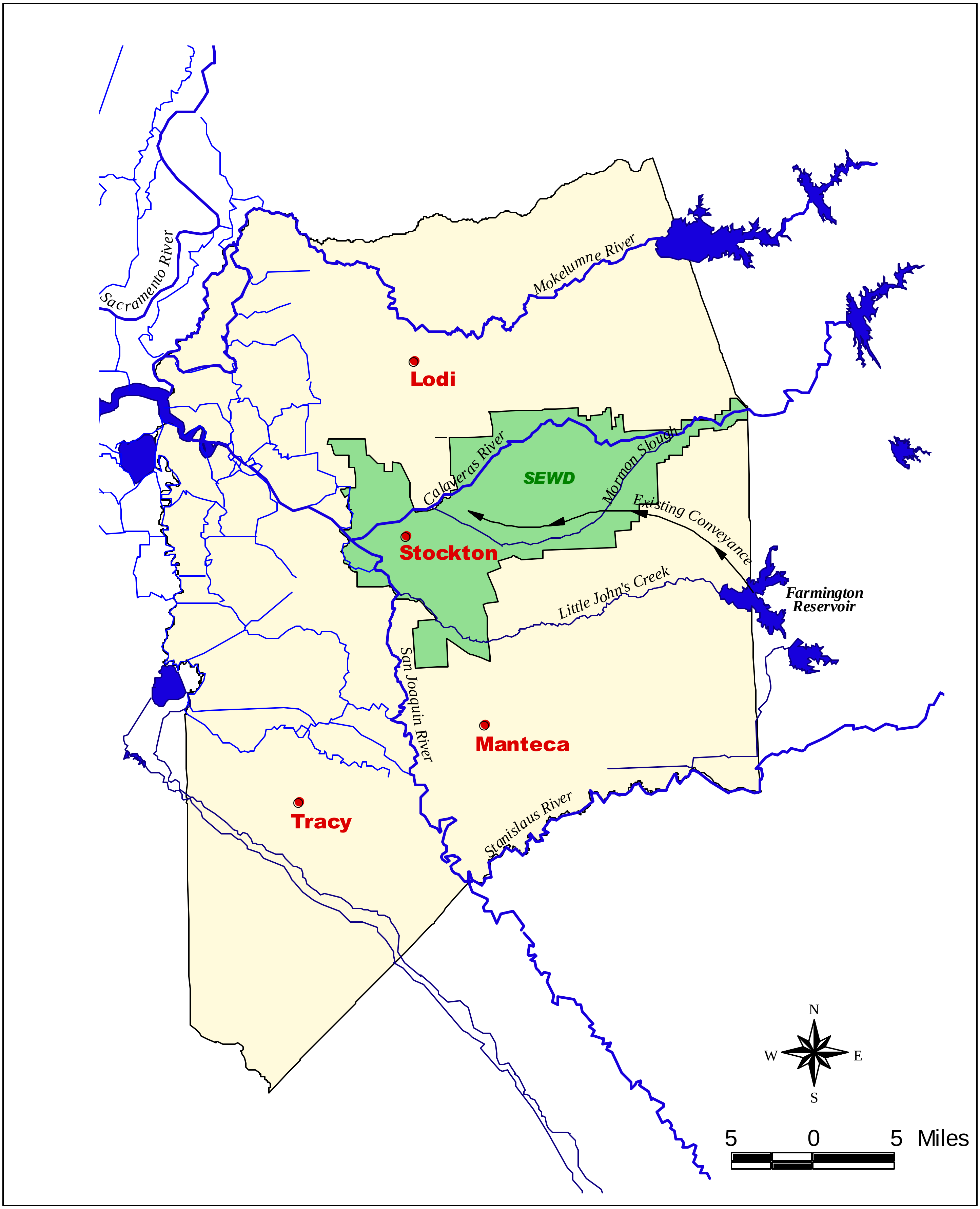
This combination of options suggests that average annual deliveries to SEWD could be increased by about 23 TAF by maximizing the available supplies from New Hogan Reservoir. The proposed action is to draw down the reservoir below the maximum required flood control reservation and deliver it to SEWD. The storage reduction would most likely be refilled the following year with water that would otherwise have been released for flood control purposes. Calaveras County Water District's water rights to the water stored in New Hogan would have to be protected under this option. No new conveyance facilities or treatment plants would need to be constructed. To facilitate in-lieu recharge in SEWD, farmers would need assistance in constructing a dual irrigation system and more water would then need to be pumped out to the irrigators. SEWD, CCWD, and COE will be involved in the realization of these proposed actions.



New Hogan Reoperation
for SEWD Agriculture,
Calaveras River

Little John's Creek: Farmington Reservoir flood flows for SEWD direct recharge

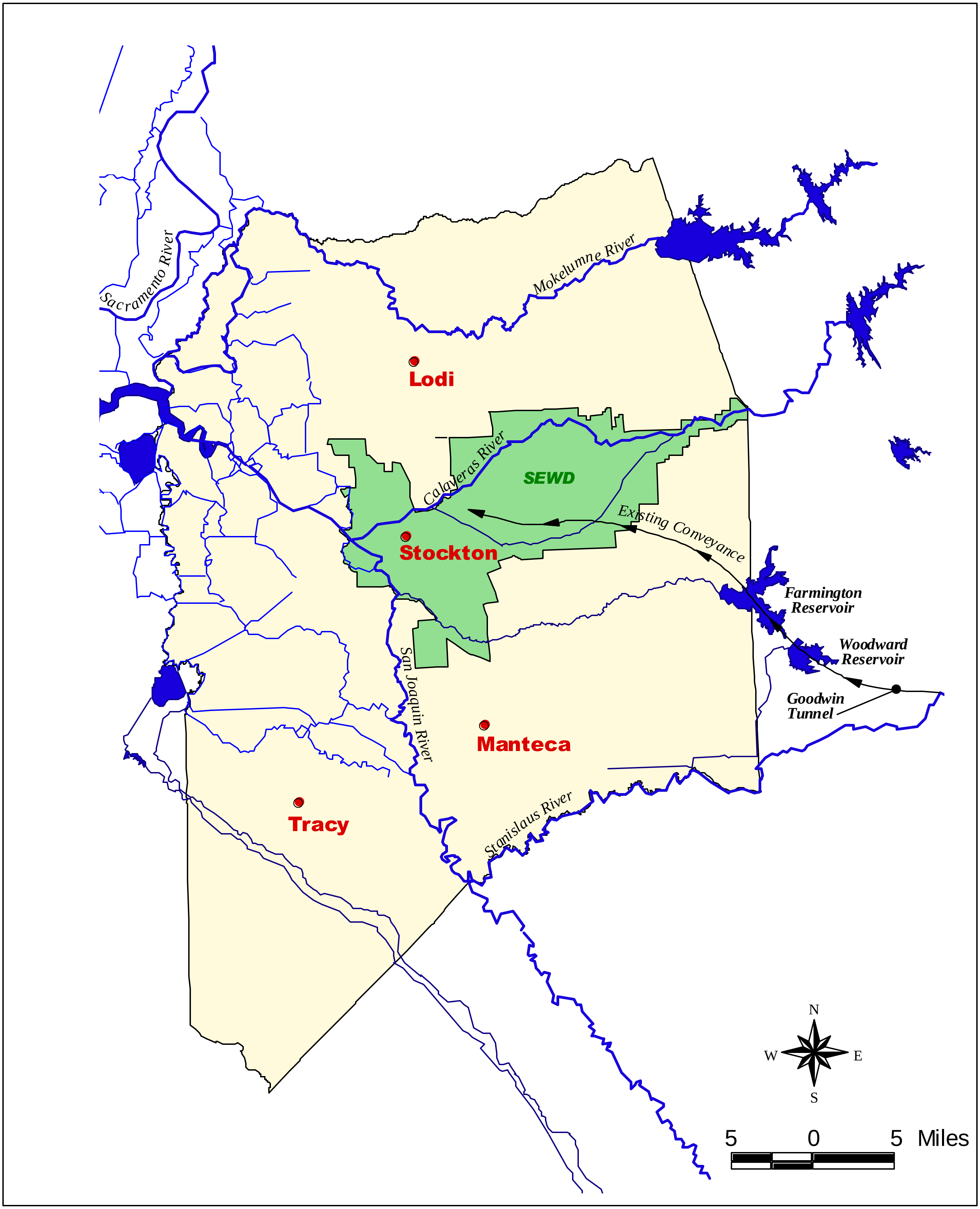
For this option, water originates from the significant flood releases made by Farmington Dam into Little John's Creek. SEWD has applied for permission from the State Water Resources Control Board to divert water from the Little John's Creek watershed. After receiving authorization, SEWD would then divert the water from several points along the creek to flood nearby fields. Flooded fields would accomplish multiple objectives, including recharging groundwater and creating seasonal wetlands. Flooded fields would provide a 10 TAF per month recharge amount, at a rate ranging from 0.25 to 0.5 ft/day. A thousand acres of agricultural land would be required to accomplish this quantity. Parties involved: SEWD, COE, CSJWCD. This project was proposed in January, 2001 by the COE in the Farmington Groundwater Recharge and Wetlands Feasibility Study.



Farmington Reservoir Flood Flows
for SEWD Direct Recharge,
Little Johns Creek

Stanislaus River: SSJID/OID transfer to SEWD

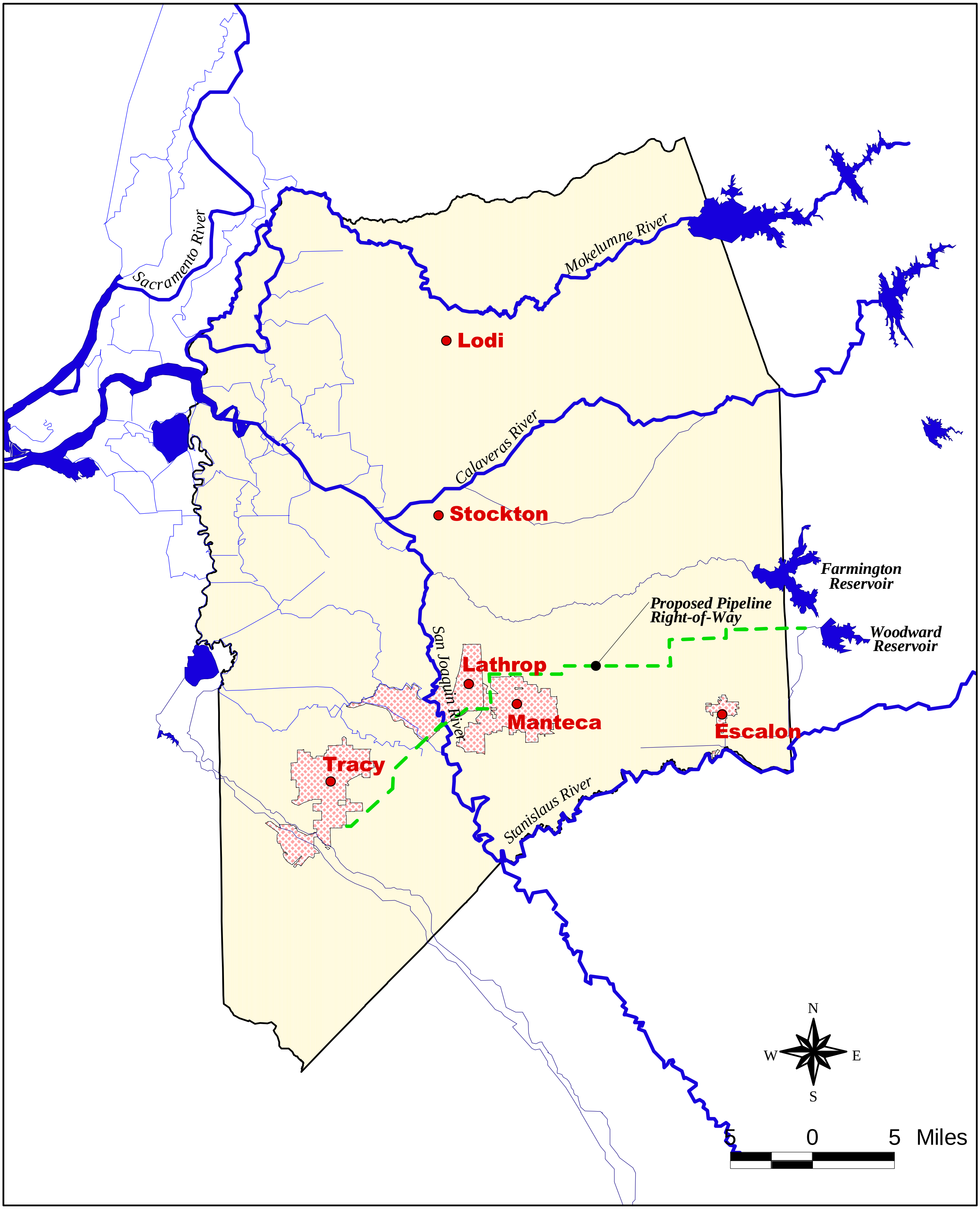
Oakdale Irrigation District (OID) and South San Joaquin Irrigation District (SSJID) have New Melones water rights of 600 TAF, from an August 30, 1988 agreement with USBR on the operation of the New Melones Project. OID and SSJID are have implemented conservation measures to allow 30 TAF to be transferred to SEWD. This transfer is already underway, and this transfer will continue for approximately ten years, when the original twenty-year agreement will expire. SEWD, OID, SSJID, and the city of Stockton are involved in this option, but the future of the transfer is uncertain. Modeling efforts have included this option for the next ten years, but it is not included in future planning after that date.



SSJID/OID Transfer to
SEWD for Supply,
Stanislaus River

Stanislaus River: South County Water Supply Project

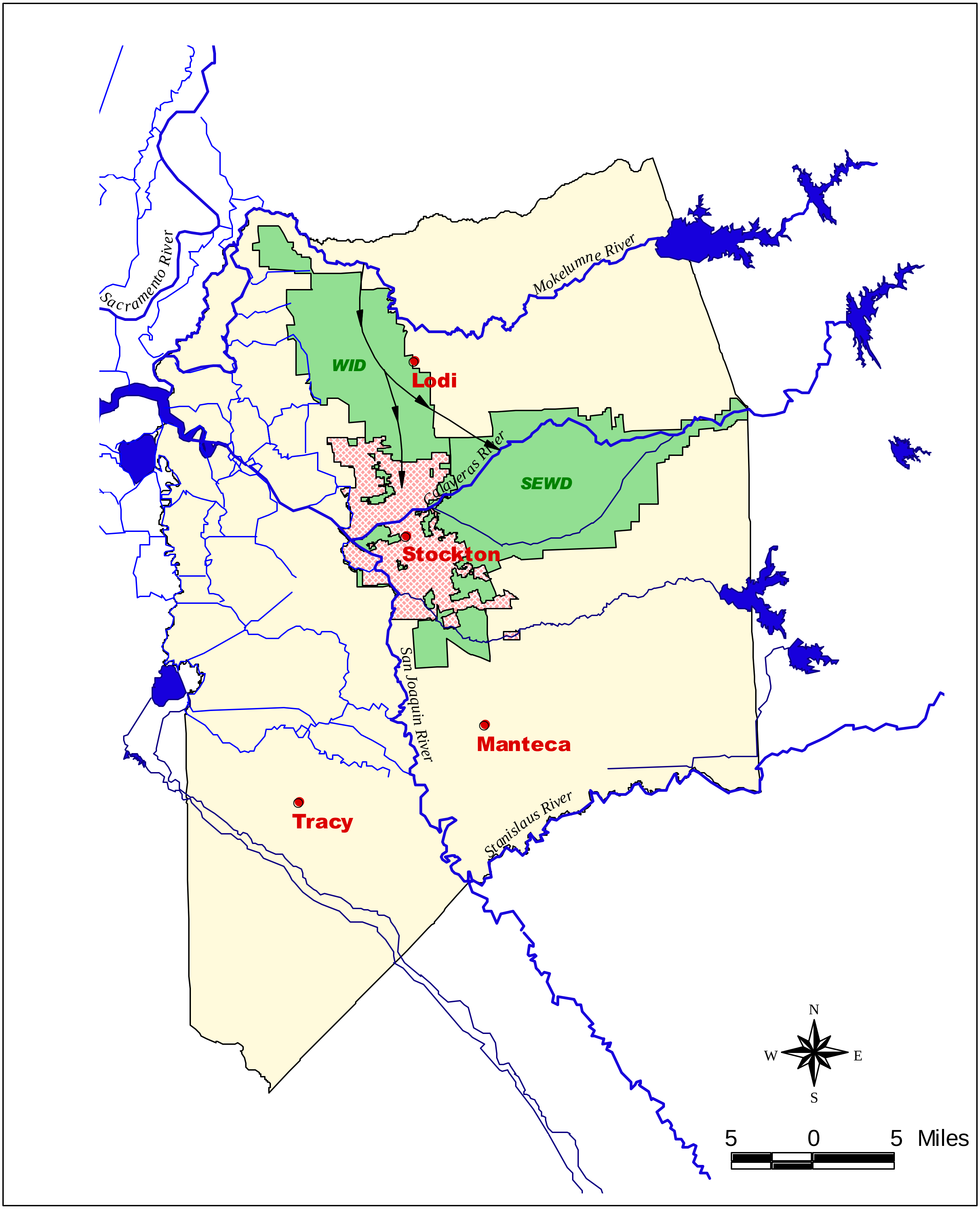
The South County Water Supply Project would transport water from the New Melones Dam on the Stanislaus River to Woodward Reservoir using existing conveyance facilities. From the Woodward Reservoir, water will be treated and pumped to four participating cities: Escalon, Lathrop, Manteca, and Tracy. The project would require a new water treatment plant near the reservoir, and new transmission pipelines and pump stations for delivery of treated water. An in-lieu program in each of the four cities would involve the increased deliveries of surface water to the four cities, thereby relaxing the strain on groundwater. This combination of options involves the cities of Manteca, Escalon, Lathrop, and Tracy and the South San Joaquin Irritation District. USBR has questioned this option, stating that SSJID cannot transfer their water rights outside of the districts' service area. USBR also questions how additional deliveries from New Melones Reservoir can be made without reducing flows available for instream flows and for South Delta Water Agency water quality improvement. These issues must be addressed before the project is operational.



South County
Water Supply Project,
Stanislaus River

Mokelumne River: WID flood flows to Stockton and SEWD agriculture

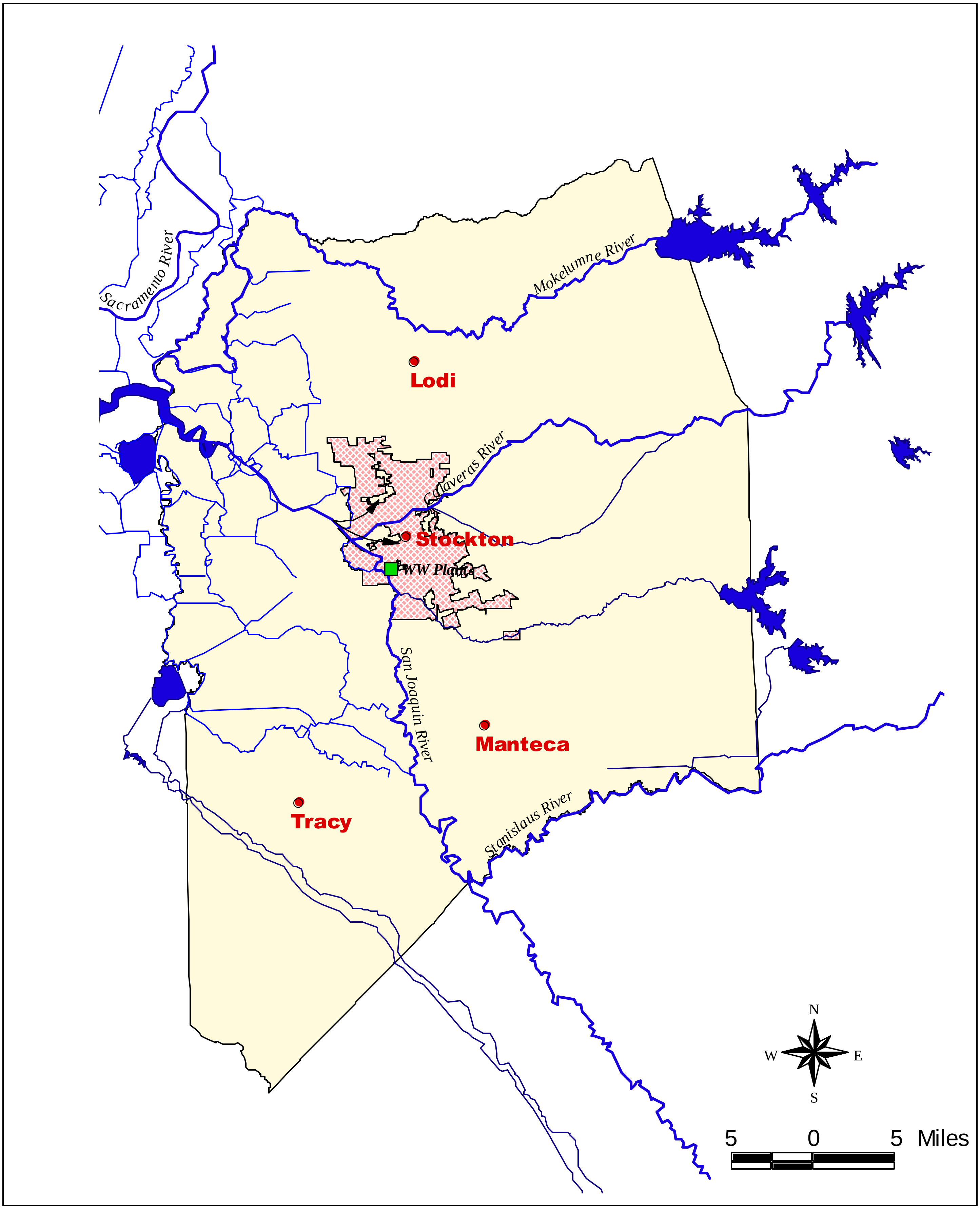
Woodbridge Irrigation District (WID) and Woodbridge Water Users Conservation District (WWUCD) have more water rights to Mokelumne River flood flows than they currently utilize. Their ability to utilize these flows has diminished significantly in the past ten years due to urbanization within their service areas and a shift from rice to crops that require less water. The ability to make use of these flows could be increased if they had the water rights to deliver water to the urban areas in their districts or move the Mokelumne River water through the districts for delivery to the City of Stockton or to groundwater recharge facilities. The agencies would have to apply to the SWRCB to expand their area of use for the water and to add these two uses to their existing permits, which are currently for irrigation uses only. Some CVP and SWP project water contractors would most likely protest this permit change due to the reduction in CVP and SWP water supplies that would occur. EBMUD might also protest the change to protect their ability to enlarge Pardee Reservoir. To facilitate in-lieu recharge in SEWD, farmers would need assistance in constructing a dual irrigation system and more water would then need to be pumped out to the irrigators and to the city.



WID Flood Flows to
Stockton Urban and SEWD for
Agriculture, Mokelumne River

San Joaquin River: Delta diversion for Stockton

In 1996, dwindling supplies caused the City of Stockton to submit a Delta Water Application that was accepted by the Division of Water Rights. Under Water Code 1485, if a city discharges wastewater into the San Joaquin River, they are entitled to divert water downstream from the point of discharge or from the Delta. They must meet wastewater discharge permit requirements, which now include tertiary treatment in the summer months. The city is now in the process of selecting a diversion point or points and deciding other important features of the project. The most likely scenario would involve the construction of one diversion structure with the capacity to take out 60 TAF per year, a pipeline, and an expandable water treatment plant with an initial capacity of 30 TAF per year. Additional water would then be treated and pumped out to the city's water users, relieving the strain on the groundwater basin.

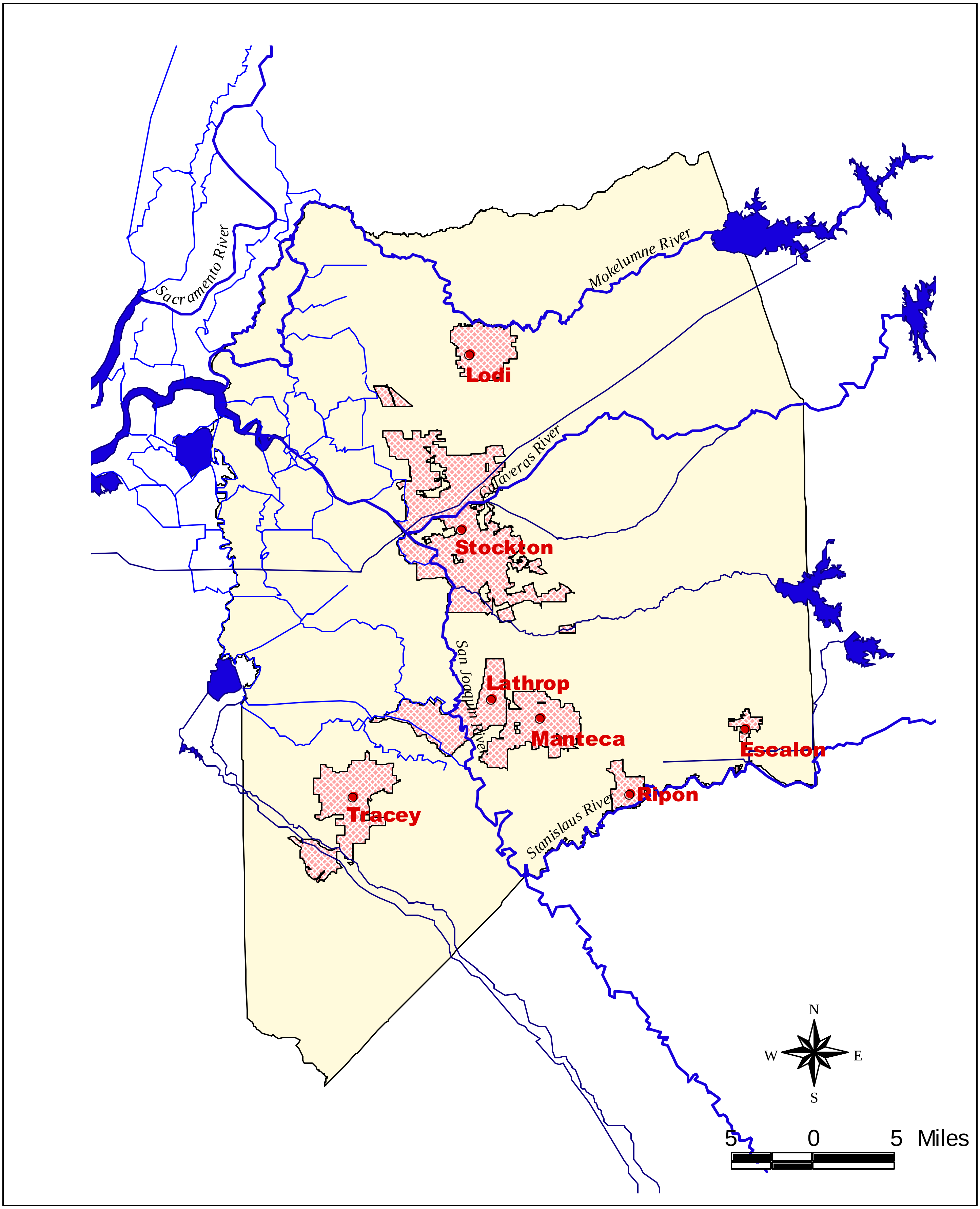


Delta Diversion for Stockton,
San Joaquin River

Urban water conservation improvements

The experience of active urban water conservation programs in California is that the potential water savings are in the order of 10 to 20% of the volume of water used. Such programs typically include distribution system leak-reduction programs, household metering, tiered pricing to discourage high use, education of school children and the public, and market-enforced transition to water saving household plumbing devices.

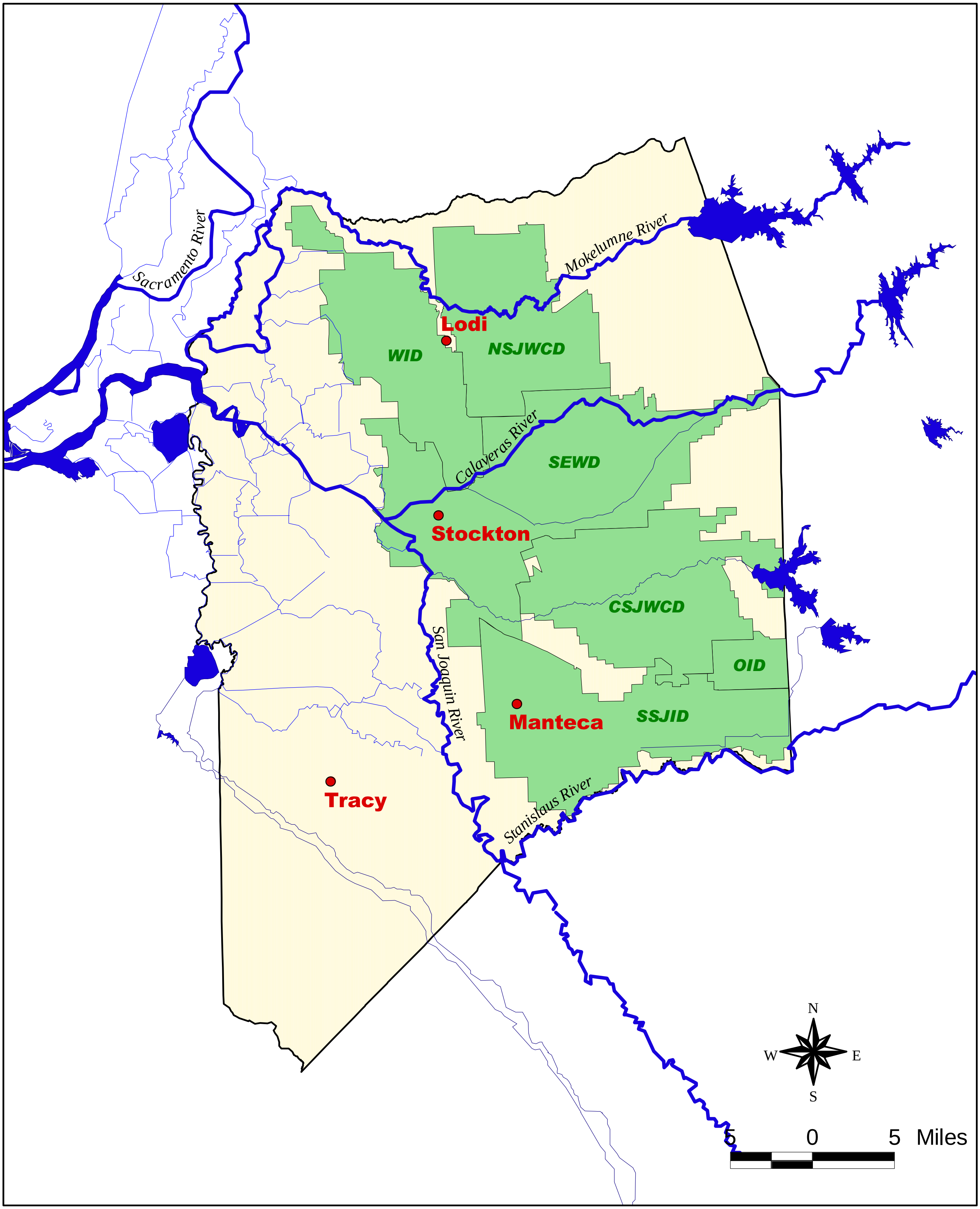
Typical costs of such programs (excluding meter installation) are in the range of $2.00 to $4.50 per capita per year in California cities. For households not already metered, the installation of a household meter typically costs about $450.



Urban Conservation Improvements

Agricultural water conservation improvements

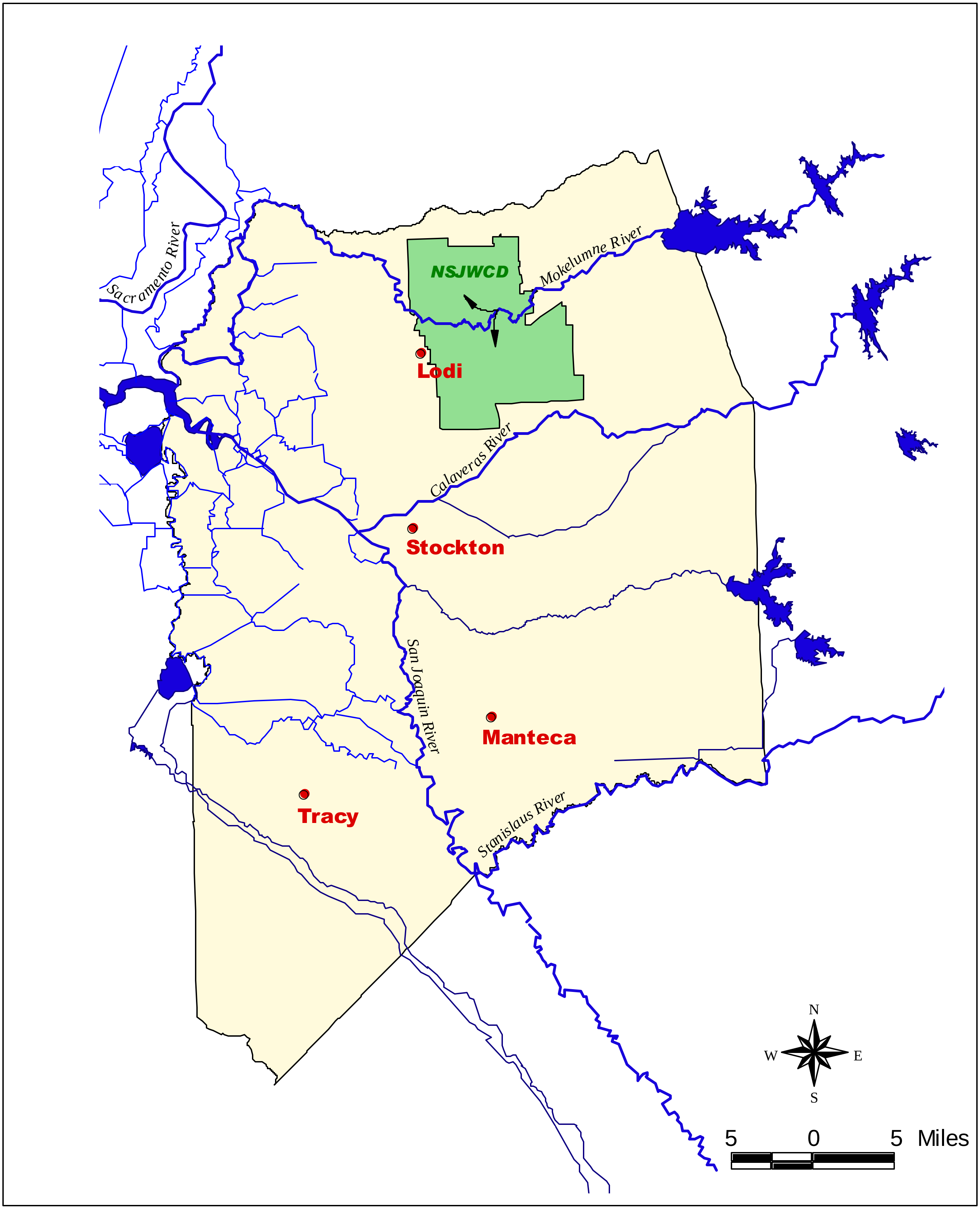
The greatest potential for agricultural water conservation relates mainly to the use of more water efficient irrigation technologies. For tree crops and viticulture, there is a potential to conserve water through the introduction of drip irrigation. However, actual use of such systems will depend upon economic drivers that still need to be quantified. Drip irrigation involves costs of pumping, filter systems at the points of use, tubing and drip facilities, and farmer education. The unit costs can be estimated on the basis of other similar programs, but the total costs and volumes of water saved are subject to economic drivers that are not easily quantified at present.



Agricultural Water
Conservation Improvements

Mokelumne River: NSJWCD water right for direct recharge

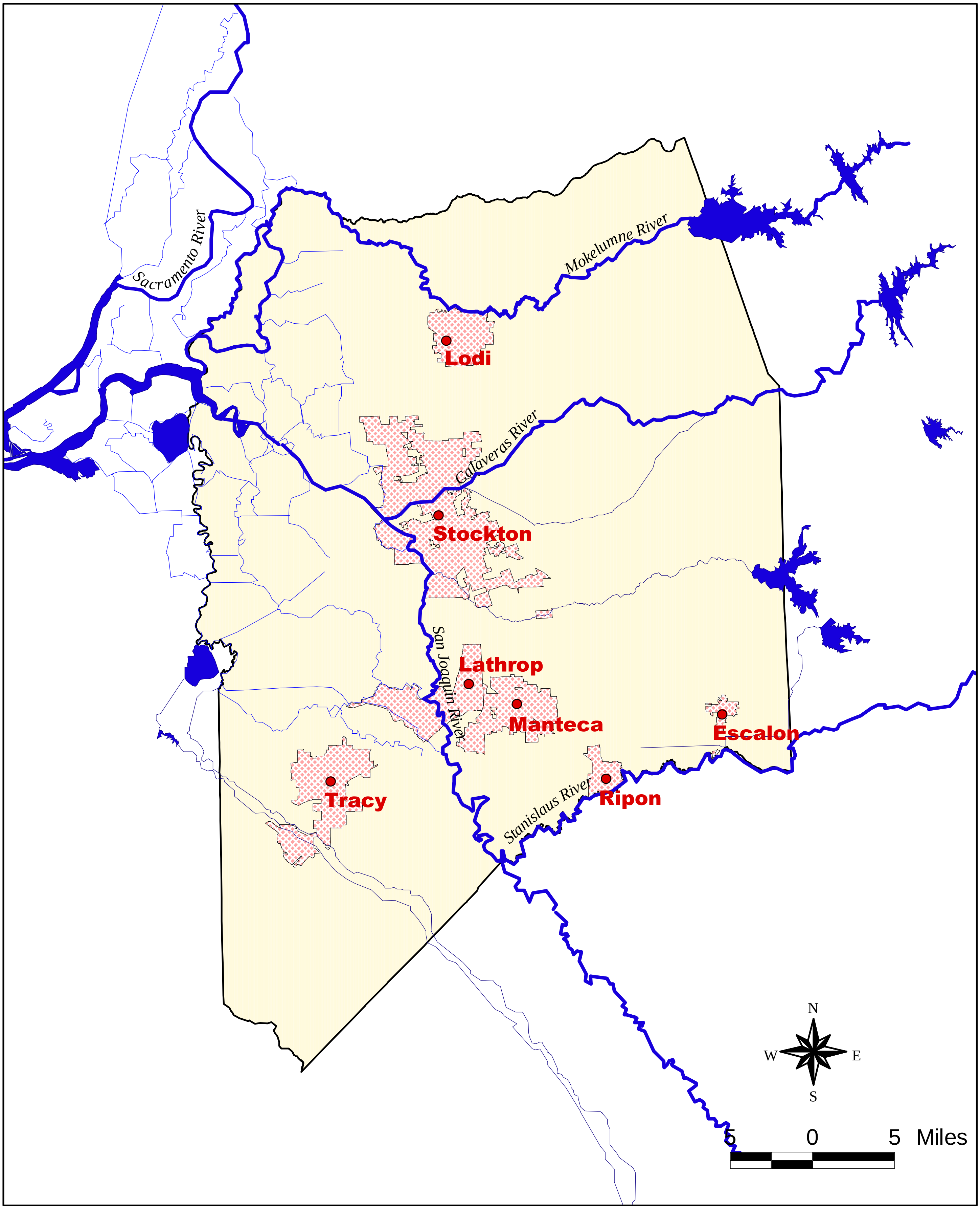
NSJWCD had a water right for up to 20 TAF per year for water from the Mokelumne River that is surplus to EBMUD's needs, but the right expired last year. The district currently uses no more than 3 TAF per year, which would leave up to 17 TAF available for recharge into the basin if the water right can be renewed. The district recently received a CALFED grant for a pilot groundwater recharge project. This project calls for ponds to be constructed within large earth berms on four acres of farmland south of the Mokelumne River in the Lockeford area of San Joaquin County. These ponds will be able to save and store about 20 TAF of water each year. NSJWCD, CALFED, and EBMUD are the parties that will be involved in the pursuance of this combination of options.



NSJWCD Water Rights
for Direct Recharge,
Mokelumne River

Urban wastewater reclamation for barrier injection in Stockton

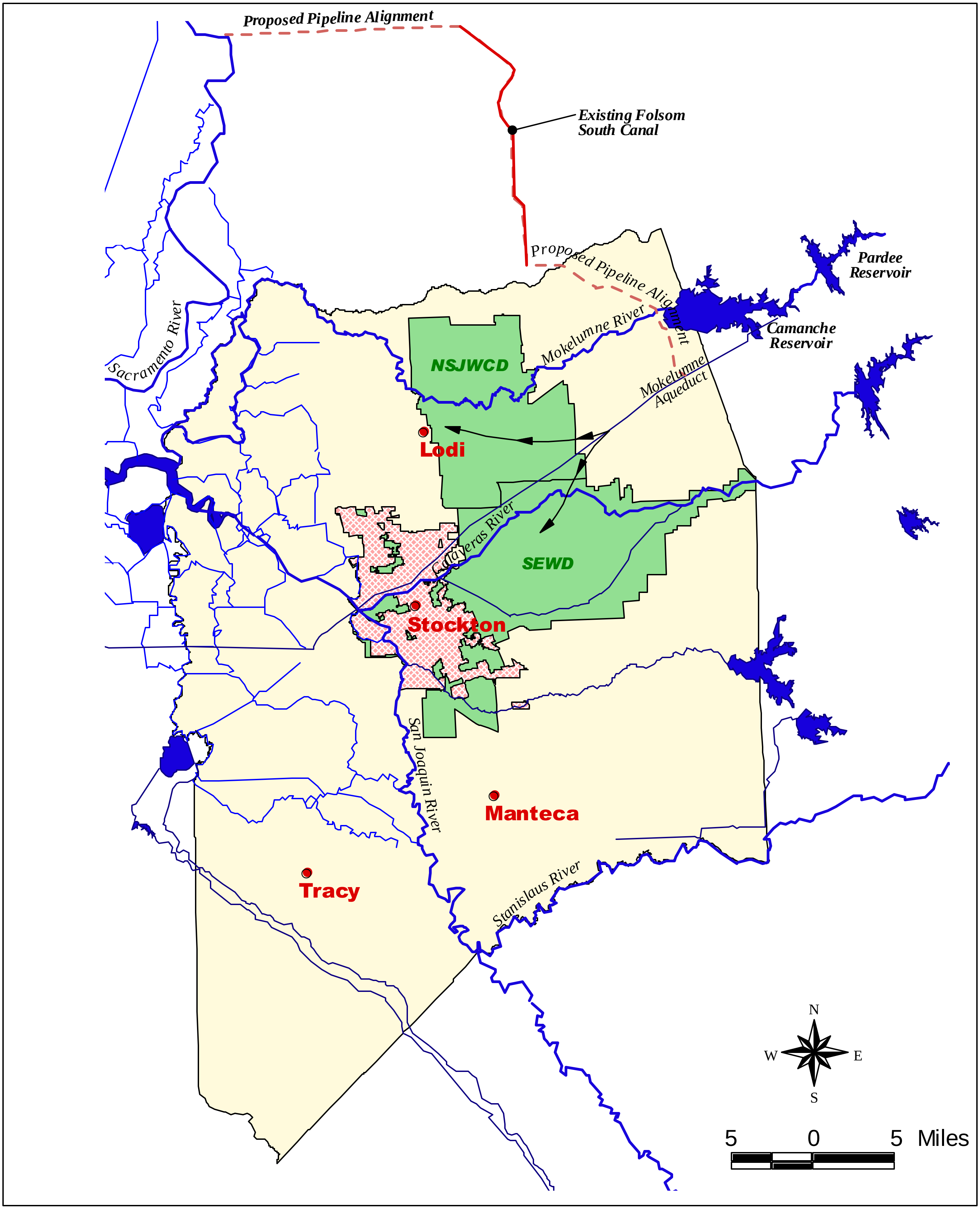
Urban wastewater from various cities within San Joaquin County can be used as groundwater recharge if it is treated to a high quality level. Facilities for additional chlorine contact, a reclamation pump station, and a distribution system must all be constructed in order to accomplish this level of treatment and prepare for recharge. Injection wells in the City of Stockton would also need to be constructed to accomplish the groundwater recharge portion of this option. Urban wastewater reclamation in Stockton could not be pursued in conjunction with Stockton's Delta Water Project because both options utilize the same water source.



Urban Wastewater Reclamation

Sacramento River: Freeport diversion

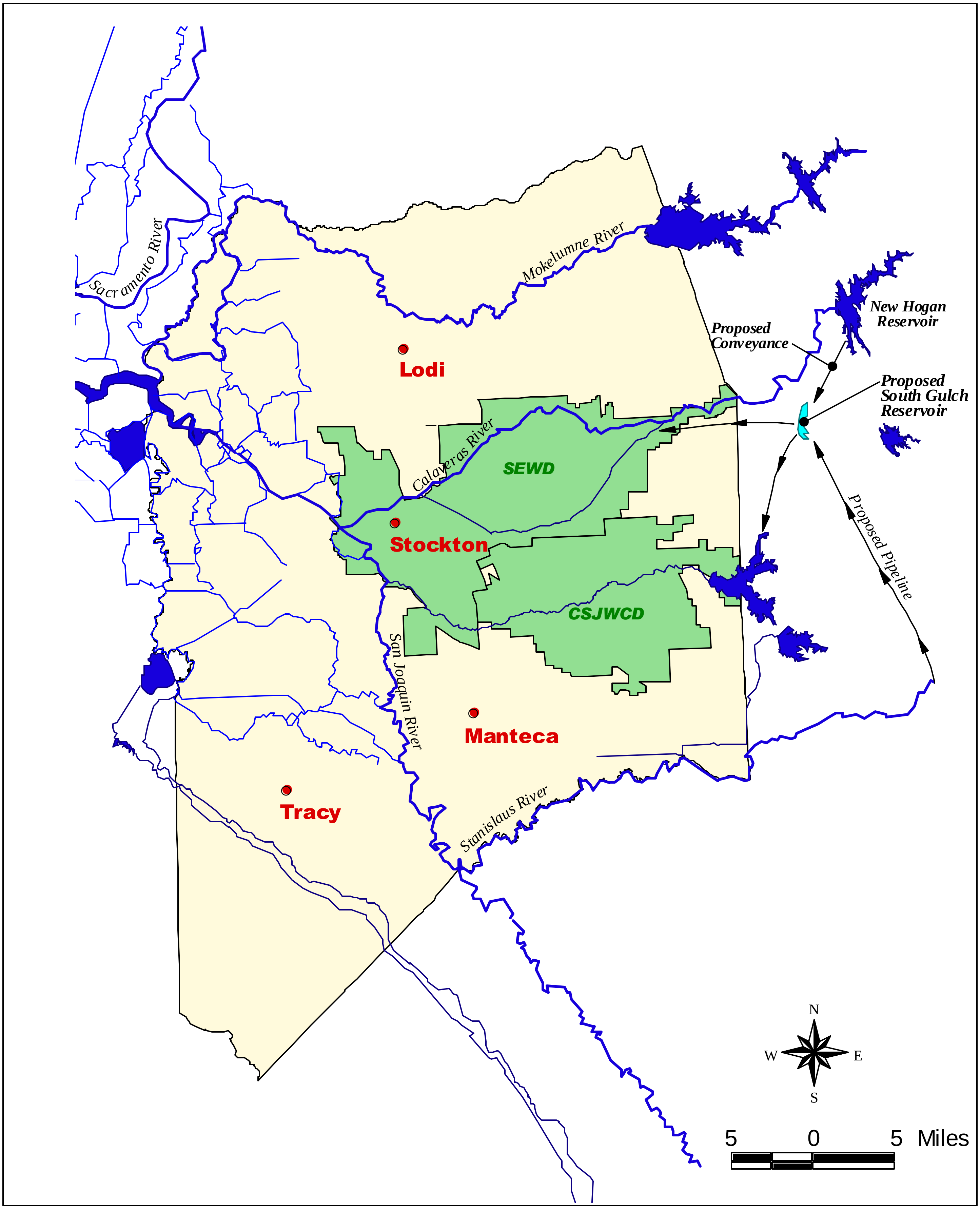
This combination of options calls for water to be diverted from the Sacramento River near the town of Freeport and transported to San Joaquin County for recharge. The project has been proposed by EBMUD as an alternative to their American River diversion, and Sacramento County is also a participant. To implement this project, a diversion structure would need to be created on the Sacramento River near Freeport and a pipeline would need to be constructed to carry water to the existing portion of the Folsom South Canal, and then from the canal to the Mokelumne Aqueduct. This project is currently under development, so available supplies, costs, and methods for groundwater recharge are under development. Involved parties: EBMUD, Sacramento County, San Joaquin County, and water agencies on the east side of the County.



Freeport Diversion,
Sacramento River

Calaveras River, Stanislaus River: Flood flows to proposed South Gulch Reservoir for SEWD and CSJWCD agriculture

The water for this combination of options comes from excess flood flows originating in the Calaveras and Stanislaus Rivers. The water from the Calaveras River will be diverted at South Gulch and pumped using a reversible pump / turbine plant to the proposed South Gulch Reservoir for storage. Both the reservoir and the pump will need to be constructed. A permit will need to be obtained from the State Water Resources Control Board (SWRCB) to divert these flows. The water coming from the Stanislaus River will be diverted above the existing Goodwin Dam and then guided to the South Gulch Reservoir using conveyance facilities that will also have to be constructed. The new facilities will consist of 2.6 initial miles of tunnel and a lined canal of varying capacity for the final 23 miles. A short tunnel will also need to be put in near the town of Milton that will convey water under the town, discharging it into a canal which will terminate in the South Gulch Reservoir. The water will be conveyed from South Gulch Reservoir to SEWD and Central San Joaquin Water Conservation District (CSJWCD) using new facilities. In order to facilitate in-lieu recharge within the districts, farmers would need assistance in constructing a dual irrigation system and more water would then need to be pumped out to the irrigators.



Flood Flows to Proposed South Gulch Reservoir
for SEWD and CSJWCD Agricultures,
Calaveras and Stanislaus River

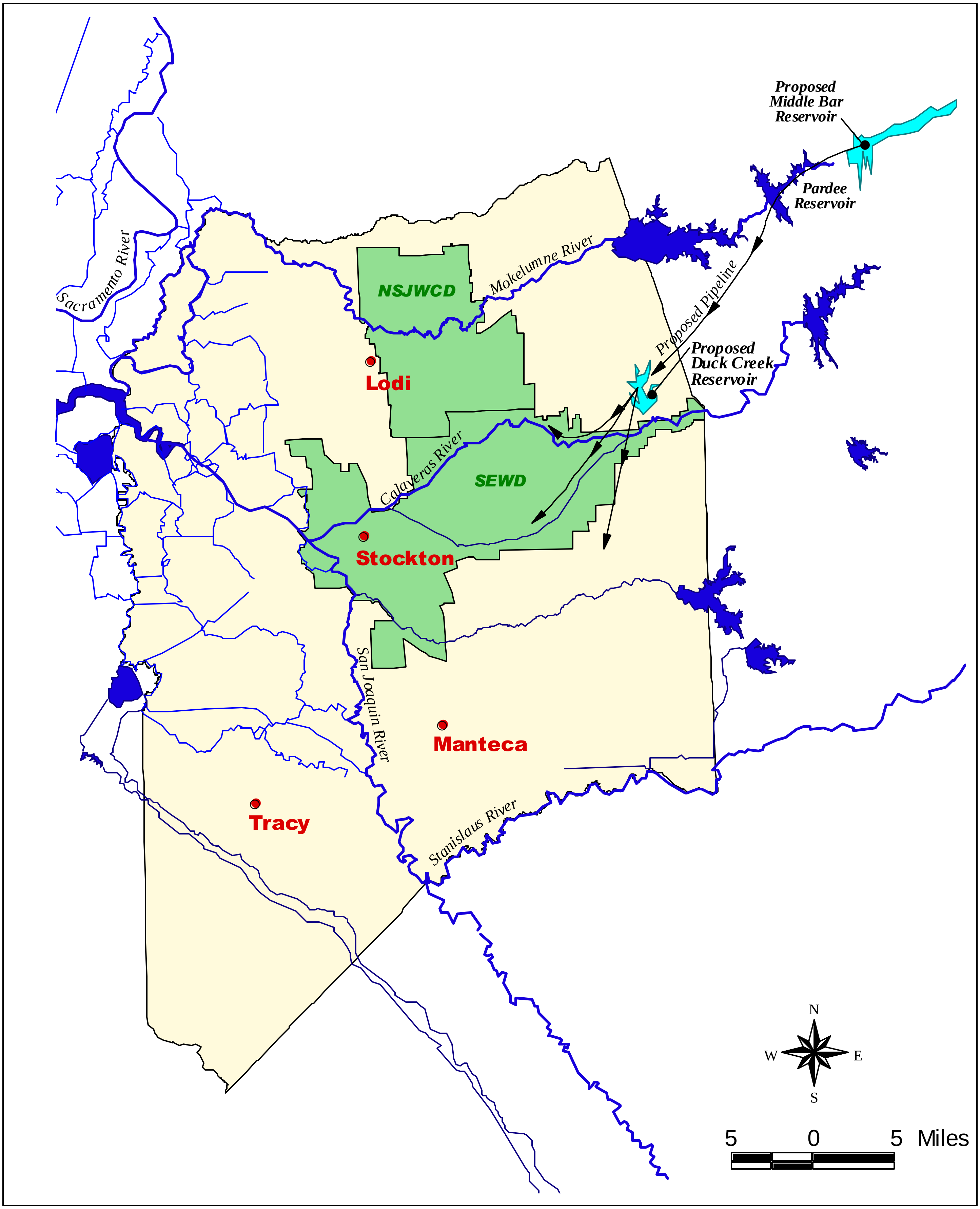
Mokelumne River: Flood flows to proposed Duck Creek or Middlebar Reservoir, or proposed Pardee enlargement for SEWD and NSJWCD agricultural supply

The Mokelumne River experiences potentially significant flood flows that could be captured with a variety of facilities, including the proposed Duck Creek Reservoir (off-stream storage), the proposed Middlebar Reservoir (on-stream storage upstream of Pardee Reservoir), or by enlarging Pardee Reservoir.

The proposed Duck Creek Reservoir would divert water from the southwest end of the existing Pardee Reservoir only when the water level is at maximum pool or higher. The water will be diverted using tunnel 10,300 feet long that will generally parallel the EBMUD Pardee Tunnel. The tunnel will discharge directly into a 57,400 foot long pipeline that will lie adjacent to the existing EBMUD Mokelumne Aqueduct for a little ways but then turn due south and discharge directly into the proposed Duck Creek Reservoir. The proposed facilities will have a total diversion capacity of 1,000 cfs. New conveyance facilities will also need to be constructed to move the water from Duck Creek Reservoir to SEWD and NSJWCD. In order to facilitate in-lieu recharge within the districts, farmers will need assistance in constructing a dual irrigation system and more water would then need to be pumped out to the irrigators from the two districts. The Duck Creek Project was strongly opposed by the landowner in 1985. In addition, the land the project will use has a Conservation Easement with the State of California. Due to the easement the California Department of Fish and Game and the California Wildlife Conservation Board may oppose the project as well.

The proposed Middlebar Reservoir was suggested by the County, and they filed for a water right with the SWRCB. The right has not been finalized, but has been kept open to see if the WMP would recommend the construction of Middlebar. Environmental concerns associated with on-stream storage could be difficult to mitigate, but the power generation associated with Middlebar could make the project more appealing.

Pardee Reservoir is owned and operated by EBMUD, who has considered expanding the reservoir. Local support from San Joaquin County would be instrumental in the expansion, and would make it more feasible. A partnership with EBMUD might allow San Joaquin County to receive water from the newly expanded reservoir.



Flood Flows to Proposed Duck Creek or
Middle Bar Reservoirs, or Proposed
Pardee Reservoir Enlargement for SEWD and
NSJWCD Agriculture, Mokelumne River

Appendix B
Modeling Results

B.1 Purpose

The purpose of the integrated groundwater and surface water model simulations was to provide a quantitative assessment of the relative benefit derived from each of the different core components of the water management plan. Additionally the overall impact of all the elements implemented under an integrated county water management plan was evaluated.

This appendix is intended to provide a brief overview the modeling results. The results will be discussed in more detail in the upcoming steering committee meeting, and additional detailed information will be provided in the San Joaquin County Water Management Plan.

B.2 Methodology

The calibrated model was first calibrated to steady-state conditions for 1970 and 1993. A transient calibration was then developed spanning the period from 1970 to 1993. The model was then applied to simulate the baseline conditions over the planning horizon of the water management plan (from 2001 to 2030).

For the simulation of the period from 2001 to 2030 the historical hydrologic record from 1970 to 2000 was used. The 1970 to 2000 period is comparable to the 1922-2000 period in-terms of an average water-year index. From 1970 to 2000 there were more wet years when compared to 1922-2000, but there were also more "critically dry" years. On average the 1970 to 2000 provides a good representation hydrologic conditions under which the water management plan can be evaluated.

Detailed information on the model and calibration will be provided in the San Joaquin County Water Management Plan.

B.3 Baseline Condition

The baseline condition refers to the current and predicted condition of the Eastern San Joaquin County Groundwater Basin through the year 2030. Under baseline conditions all water demands not met by surface water sources are met by groundwater pumping.

The average groundwater table contours for the study area for the year 2000 and 2030 are shown on Figures B-1 and B-2. Figure B-2 clearly shows the growth of the cone of depression in 2030.

B.4 Water Management Option Simulations

The following core options from the Master Water Management Alternative were simulated.

- Water Management Option 1: New Hogan Reservoir Reoperation
- Water Management Option 2: Water Transfers with San Joaquin County:
- Water Management Option 3: Farmington Project
- Water Management Option 4: SEWD / CSJWCD Fully Exercise New Melones Rights

The agreement for the transfer of 30 TAF between SSJID / OID and SEWD is incorporated into the baseline condition for the first 10 years, i.e. through 2010.

The main components of each simulation are described below.

Water Management Option 1: New Hogan Reservoir Reoperation

Preliminary studies indicate that the reoperation of New Hogan Reservoir could result in an increase in yield of 20-25 TAF, (SWRI, 2000).

For the simulation of this option, it was assumed that approximately 30 to 45 TAF of additional yield was available from New Hogan during wet or above normal years. During below normal, dry or critical no additional water was available. This resulted in an average increase for approximately 23 TAF on a yearly basis from 2000 to 2030.

Figure B-3 illustrates the resulting groundwater levels in 2030 with the implementation of this option. Groundwater levels increase by approximately 30% in the Stockton area and by 19% in the SEWD area. In general, this option significantly reduces the extent of area with groundwater levels less than 80 feet below mean sea level (feet-msl).

Water Management Option 2: Water Transfers with San Joaquin County

For the simulation of this option, it was assumed that SSJD would deliver surface to Escalon, Manteca and Lathrop as presented in the South County Surface Water Supply Project EIR, (ESA, 1999).

Figure B-4 illustrates the resulting groundwater levels in 2030 with the implementation of this option. Groundwater levels increase by approximately 14% in the Stockton area and by 3% in the SEWD area.

Water Management Option 3: Farmington Project

The Farmington Recharge Project was simulated as consisting of two principal recharge zones. A recharge zone in NSJWCD, and one in western SEWD. In the northern recharge zone, approximately 10 TAF was recharged during all years except critically dry years. In SEWD, 10 TAF was recharged in average and below normal years, and 40 TAF was recharged in wet and above normal years. On an annual average basis this resulted in approximately 25 TAF of recharge.

Figure B-5 illustrates the resulting groundwater levels in 2030 with the implementation of this option. Groundwater levels increase by approximately 12% in the Stockton area and by 10% in the SEWD area.

Water Management Option 4: SEWD/CSJWCD Fully Exercise New Melones Rights

Under baseline conditions it was assumed that SEWD / CSJWCD could on average utilize 40 TAF of water from New Melones. SEWD and CSJWCD have combined rights to 155 TAF, which would only be available in wet years. To simulate this option it was assumed that 155 TAF could only be diverted in wet years, 110 TAF in above normal years, 20 TAF in below normal years, and no water was available during dry and critical years. This resulted in an average availability of 80 TAF on an annual basis.

Figure B-6 illustrates the resulting groundwater levels in 2030 with the implementation of this option. Groundwater levels increase by approximately 12% in the Stockton area and by 18% in the SEWD area.

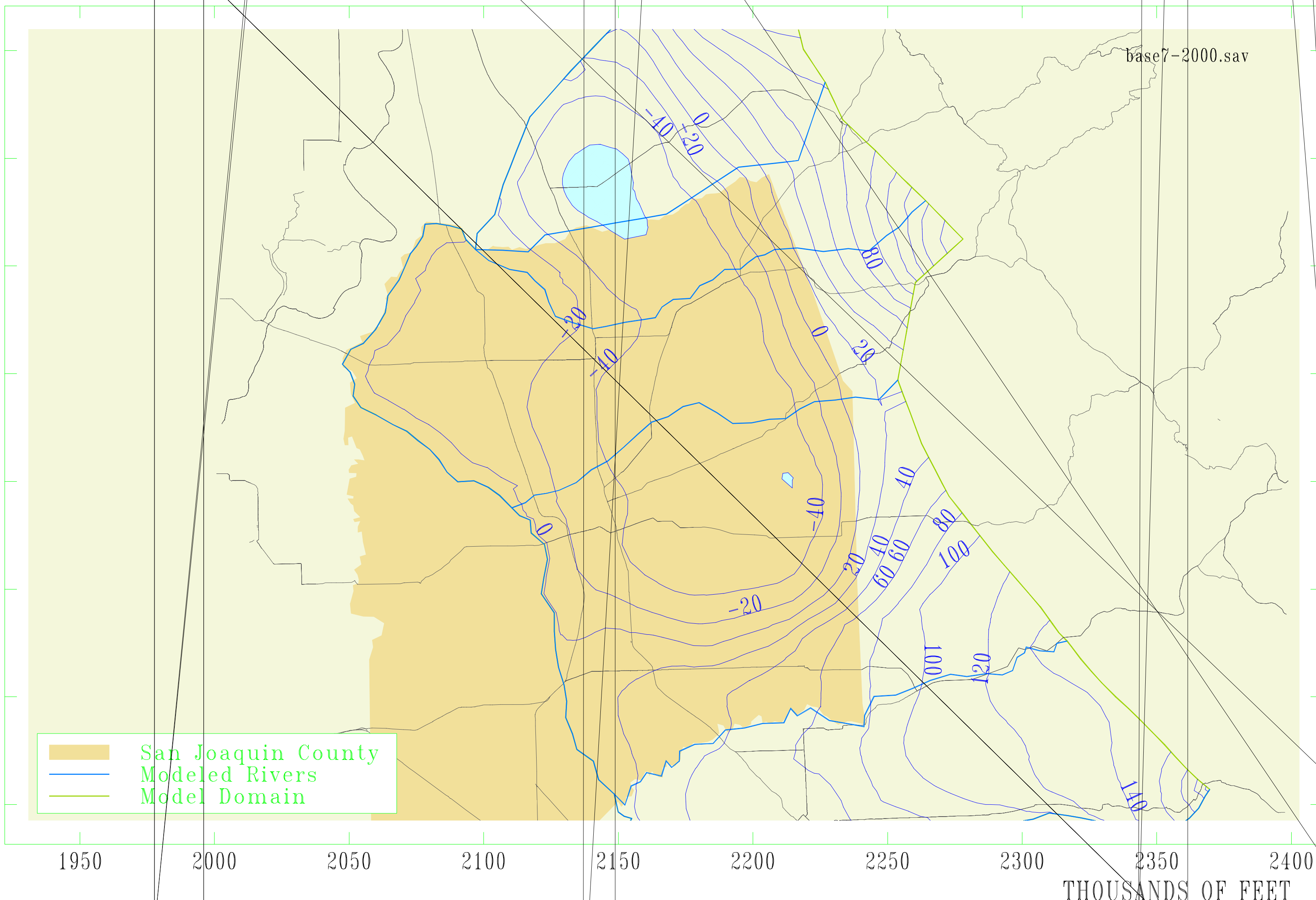
Integrated Water Management Plan

To evaluate the overall impact of the core elements, a simulation was run that incorporated all four core elements. Figure B-7 illustrates the resulting groundwater levels in 2030 with the implementation all the core options. Groundwater levels increase by approximately 48% in both Stockton the SEWD area.

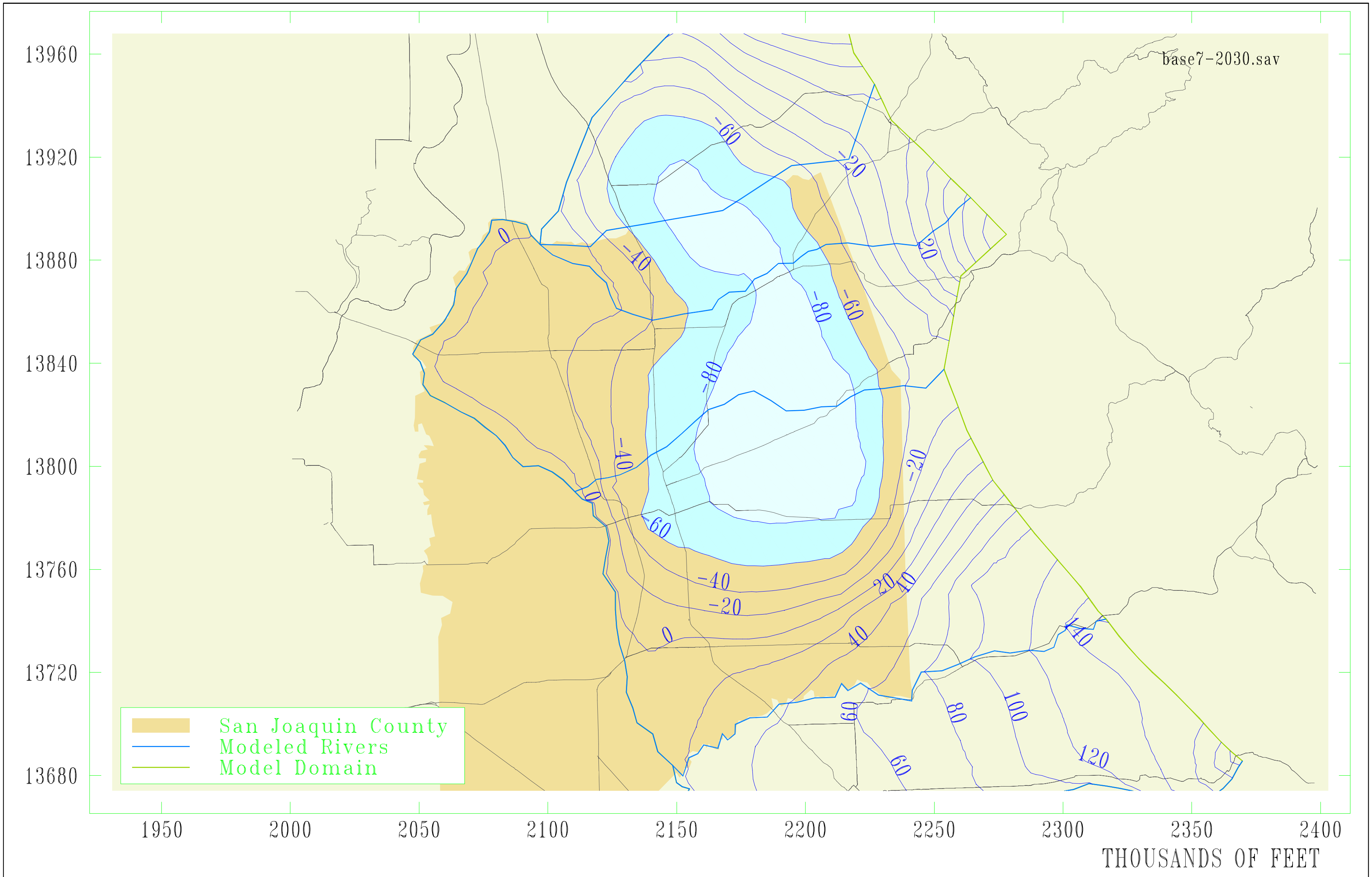
The time-varying results from this simulation are shown on figures B-8 through B-28. These figures illustrate the predicted groundwater levels under baseline conditions, and with the water management plan implemented at selected wells throughout the study area. The calibrated groundwater levels from 1970 to 2000 are also depicted. The locations of the selected wells are shown on Figure B-29.

Figure B-30 illustrates groundwater level profile along Highway 4 in Stockton and SEWD. The figure clearly illustrates the impact of the implementing the core water management options, with water levels increasing in some areas by 50 feet.

On Figure B-31 the rate of movement of a hypothetical saline water front is shown. Under baseline conditions the saline front moves towards the cone of depression at a rate of approximately 300 feet per year, or more than 1.5 miles by 2030. The rate of migration is slowed by approximately 50% with the core water management options implemented.



San Joaquin County

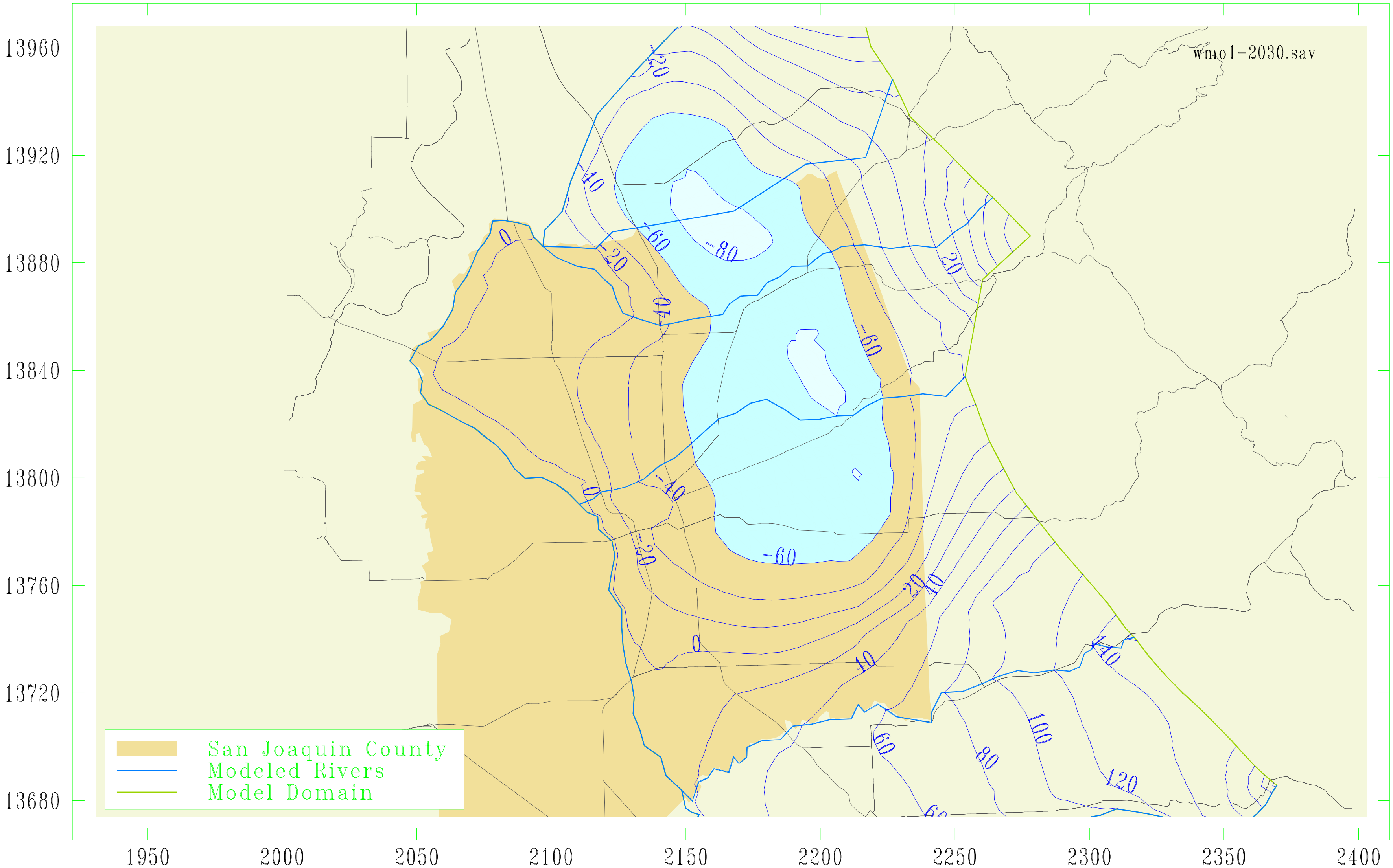


consulting engineering construction operations CDM

Simulated Groundwater Levels
Baseline Conditions: Year 2030

San Joaquin County Water Management Plan

FIGURE B-2

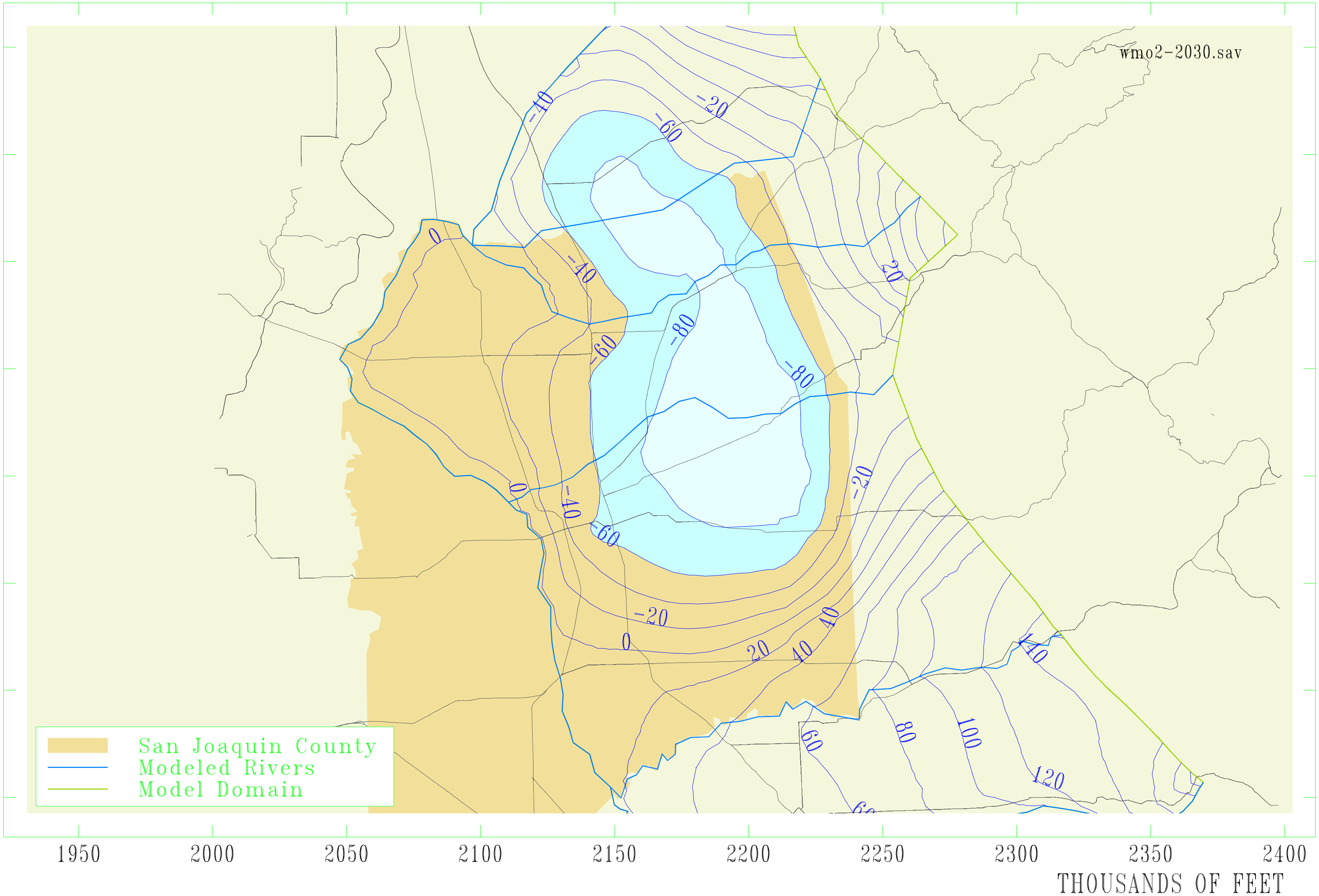


consulting engineering construction operations CDM

Simulated Groundwater Levels (Year 2030)
Water Management Plan: Core Option 1

San Joaquin County Water Management Plan

FIGURE B-3

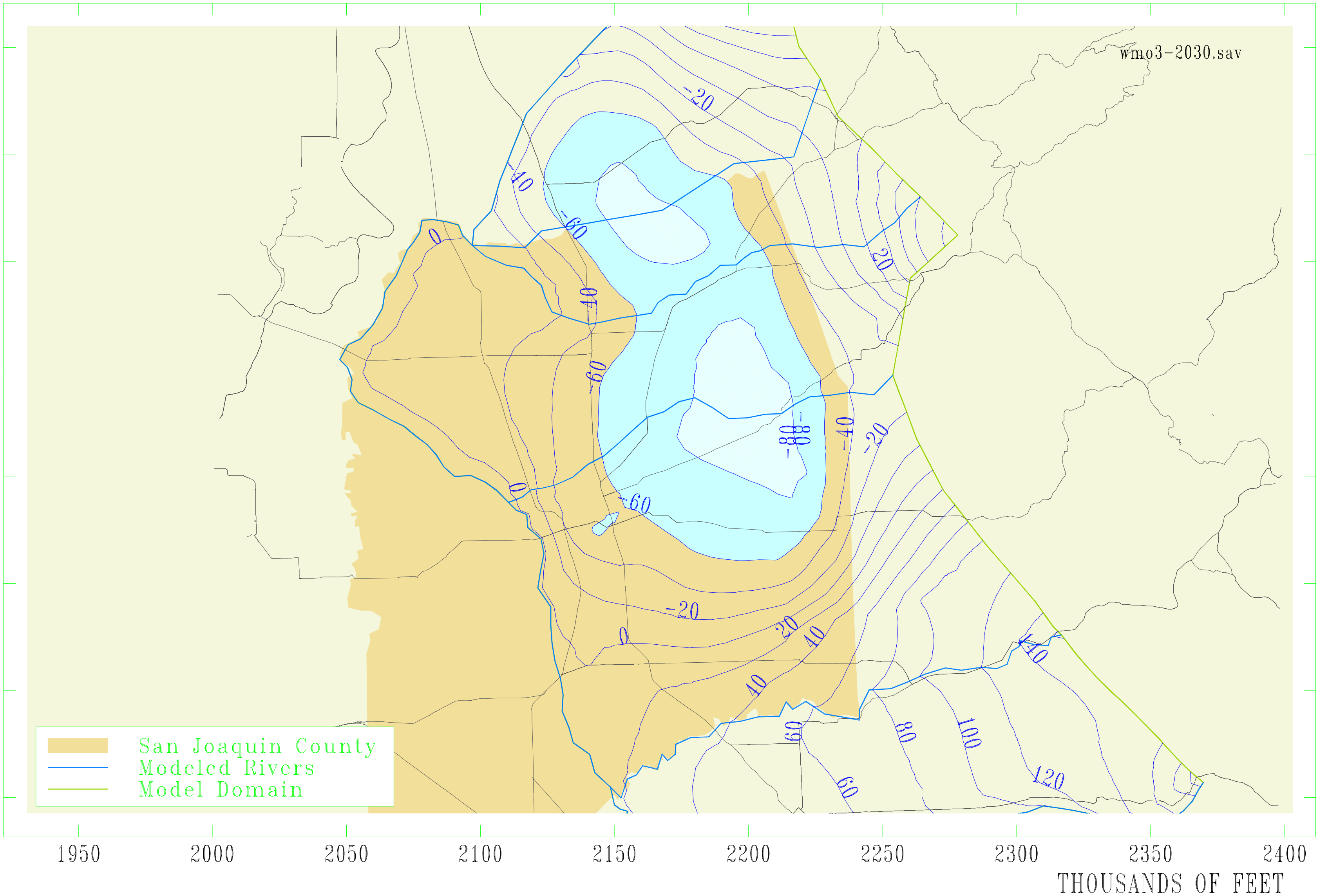


consulting engineering construction operations CDM

Simulated Groundwater Levels (Year 2030)
Water Management Plan: Core Option 2

San Joaquin County Water Management Plan

FIGURE B-4



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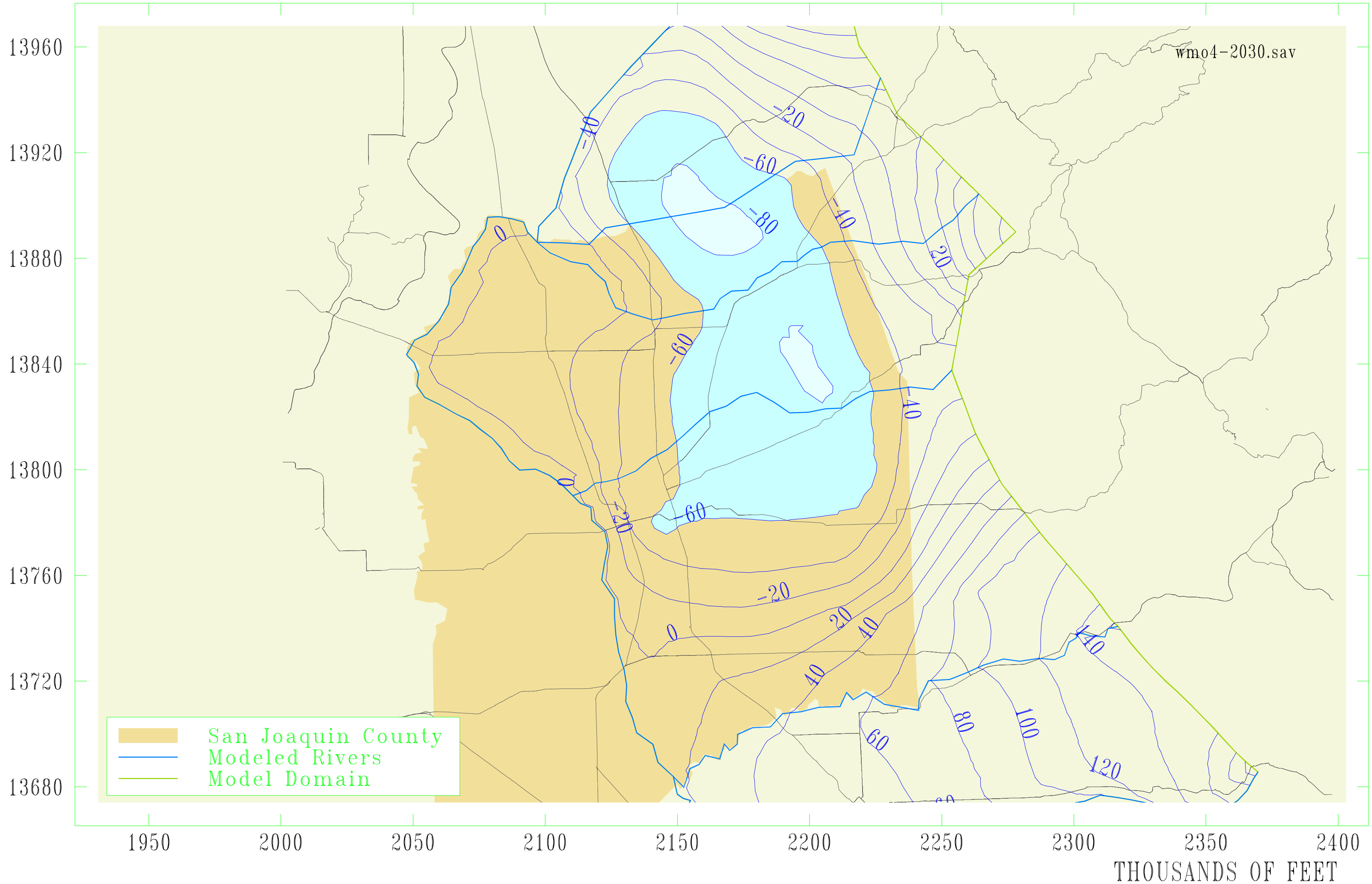
Simulated Groundwater Levels (Year 2030)
Water Management Plan: Core Option 3

San Joaquin County Water Management Plan

FIGURE
B-5

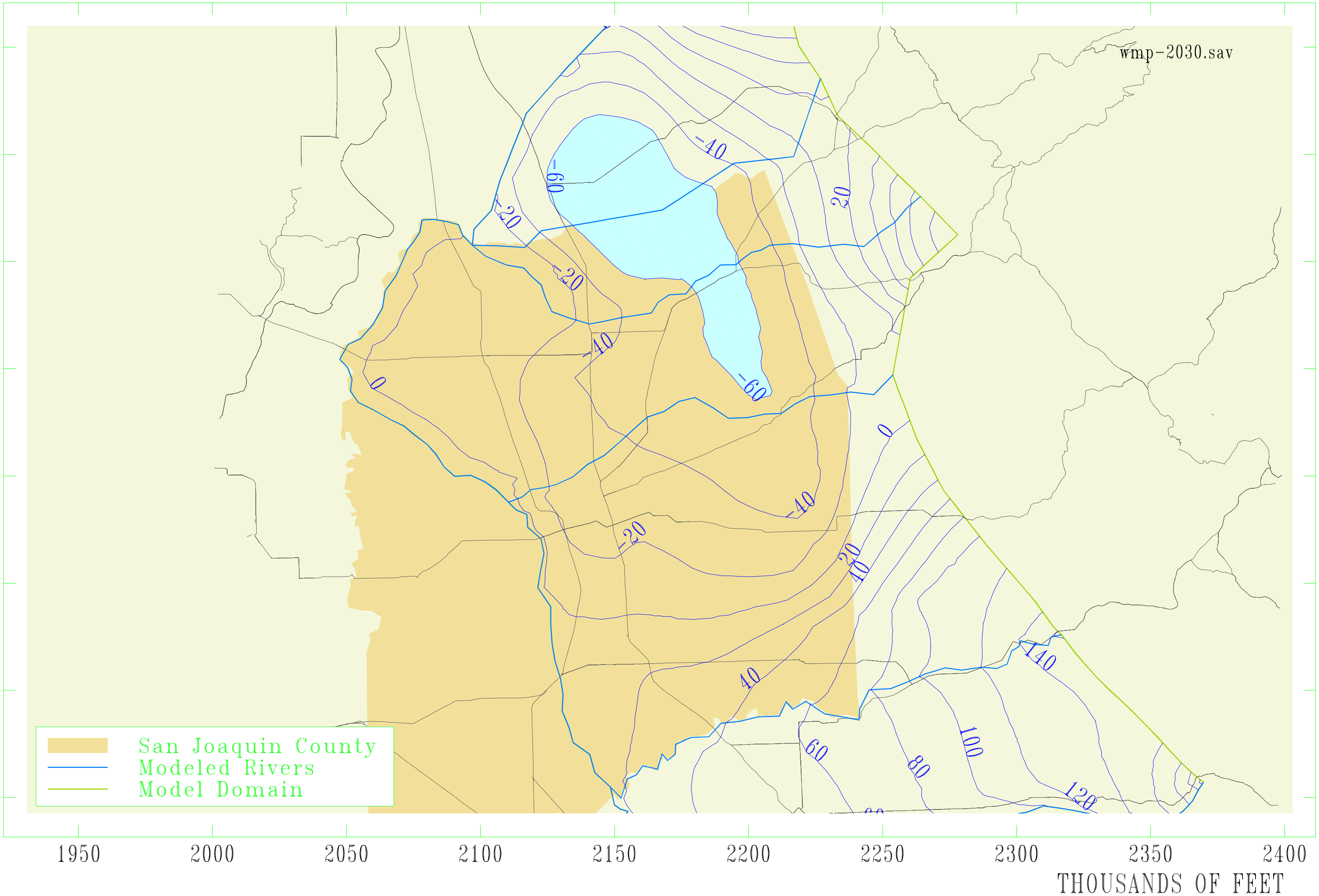


consulting engineering construction operations CDM

Simulated Groundwater Levels (Year 2030)
Water Management Plan: Core Option 4

San Joaquin County Water Management Plan

FIGURE B-6



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engineering
construction
operations

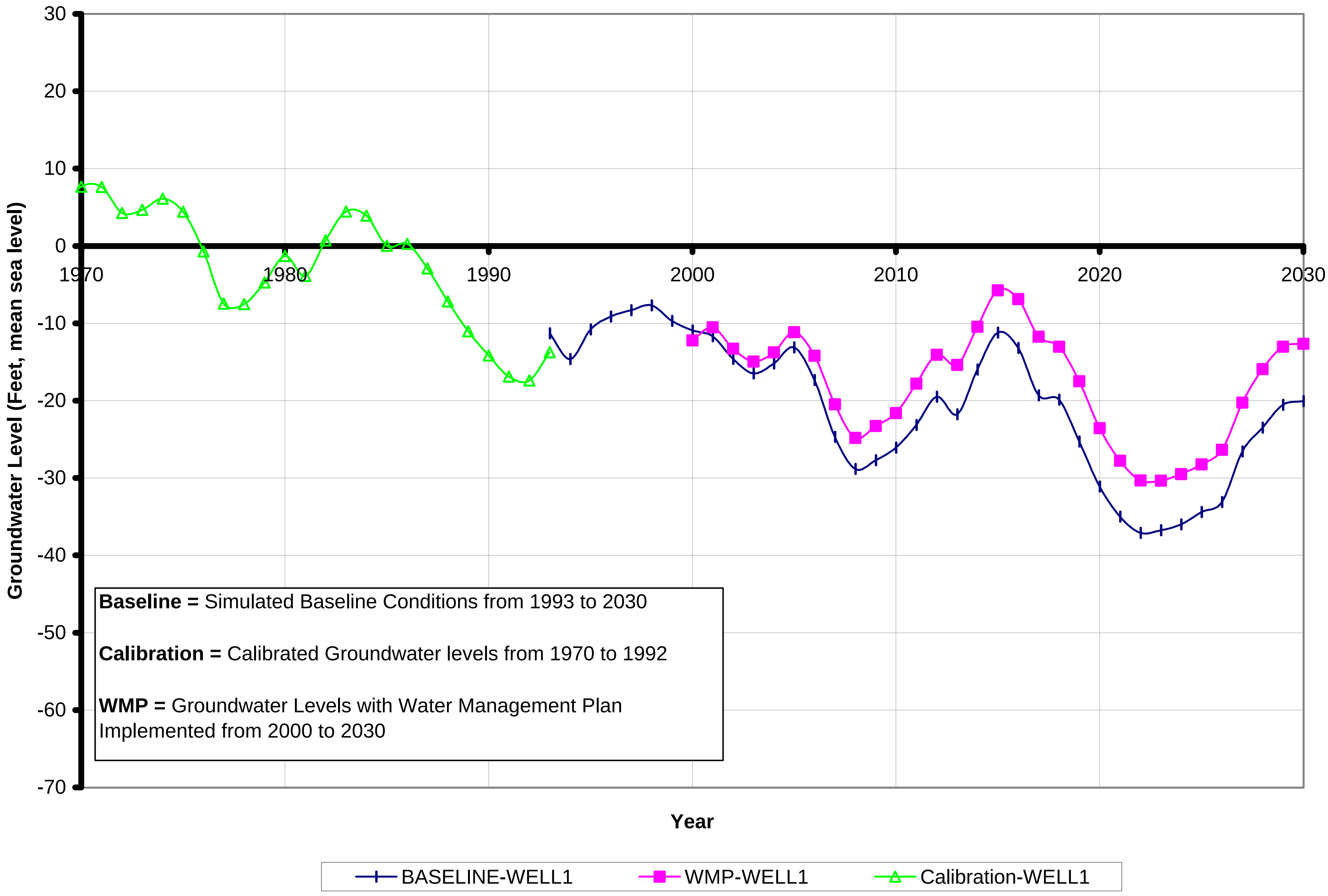
CDM

Simulated Groundwater Levels (Year 2030)
Water Management Plan: All Core Options

San Joaquin County Water Management Plan

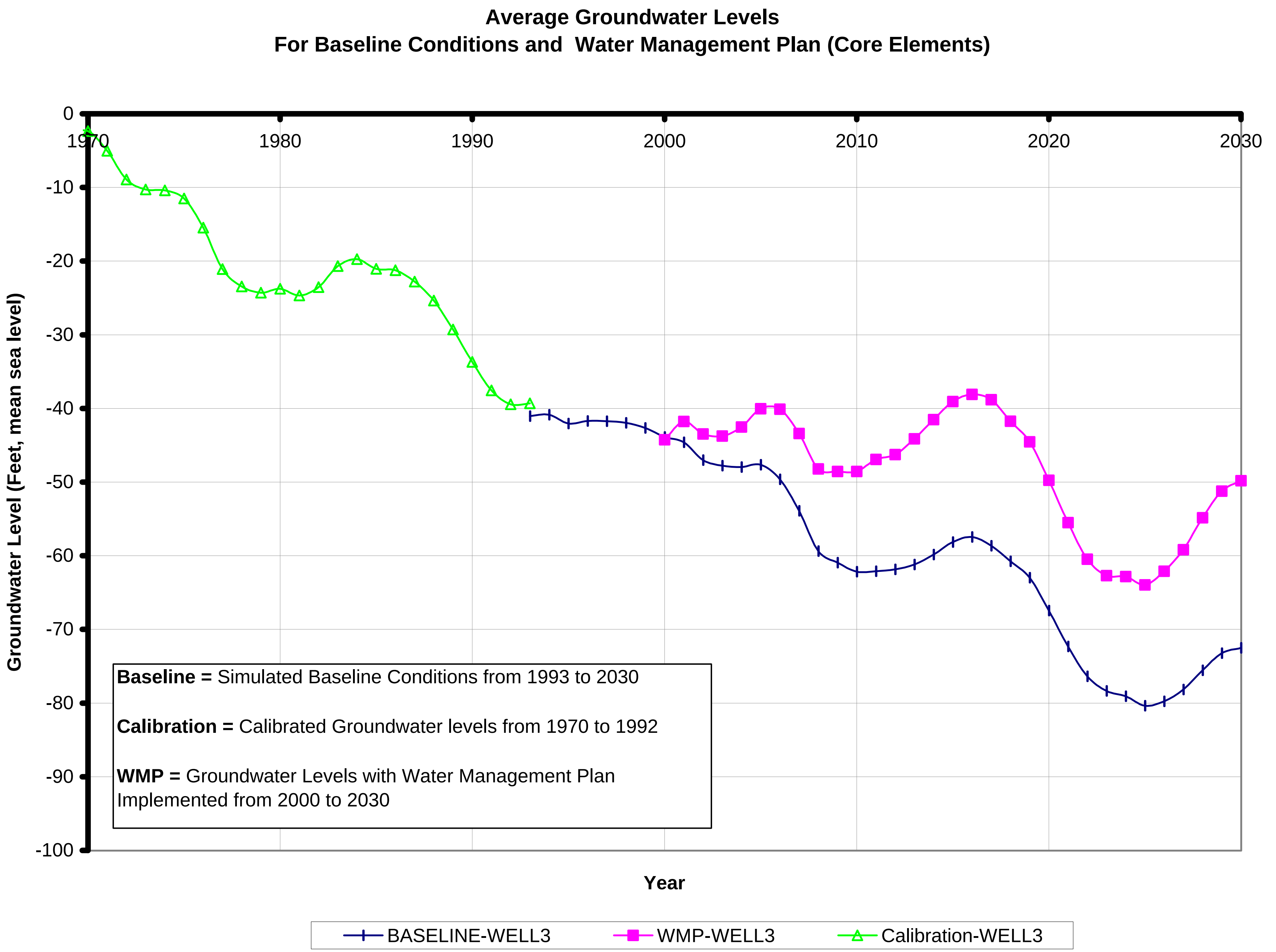
FIGURE
B-7

Average Groundwater Levels
For Baseline Conditions and Water Management Plan (Core Elements)



CDM Camp Dresser & McKee Inc.
GW Head - Average 1970-2030.xls-8

Figure 8
Simulated Groundwater Levels (1970-2030)
San Joaquin County Water Management Plan



CDM Camp Dresser & McKee Inc.
GW Head - Average 1970-2030.xls-9

Figure 9
Simulated Groundwater Levels (1970-2030)
San Joaquin County Water Management Plan

Average Groundwater Levels
For Baseline Conditions and Water Management Plan (Core Elements)

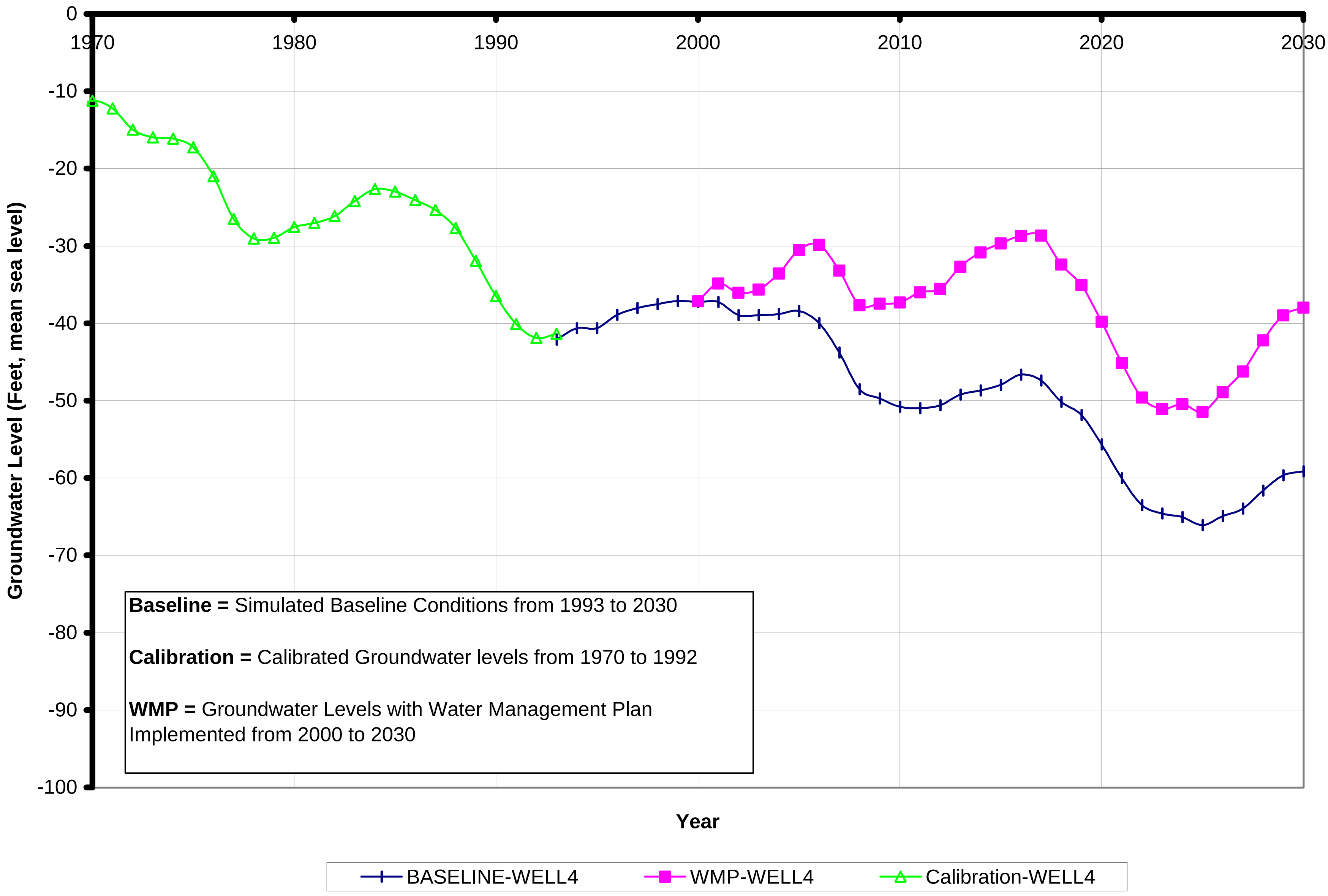


Figure 10
Simulated Groundwater Levels (1970-2030)
San Joaquin County Water Management Plan

CDM Camp Dresser & McKee Inc.
GW Head - Average 1970-2030.xls-10

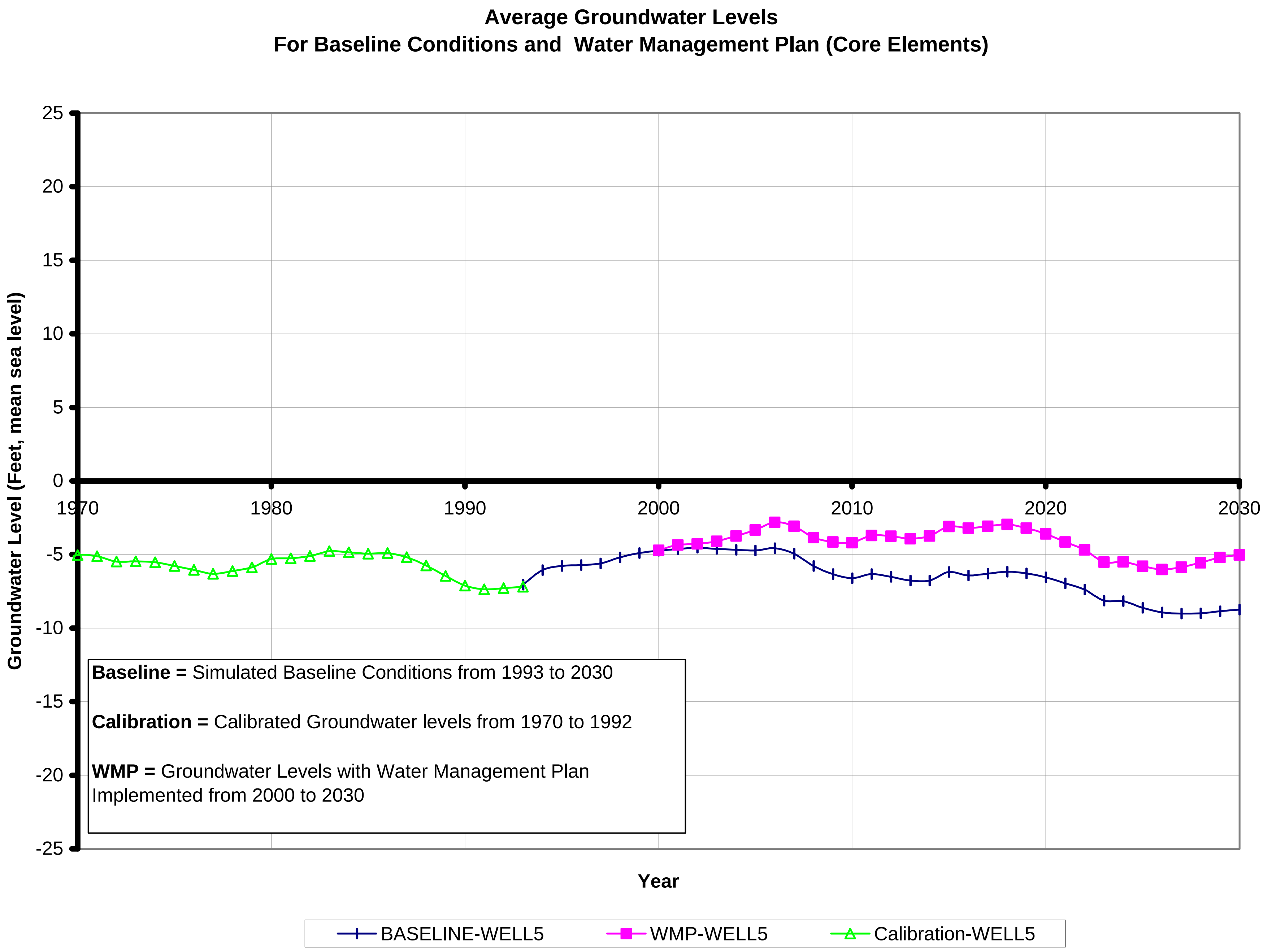


Figure 11
Simulated Groundwater Levels (1970-2030)
San Joaquin County Water Management Plan

CDM Camp Dresser & McKee Inc.
GW Head - Average 1970-2030.xls-11

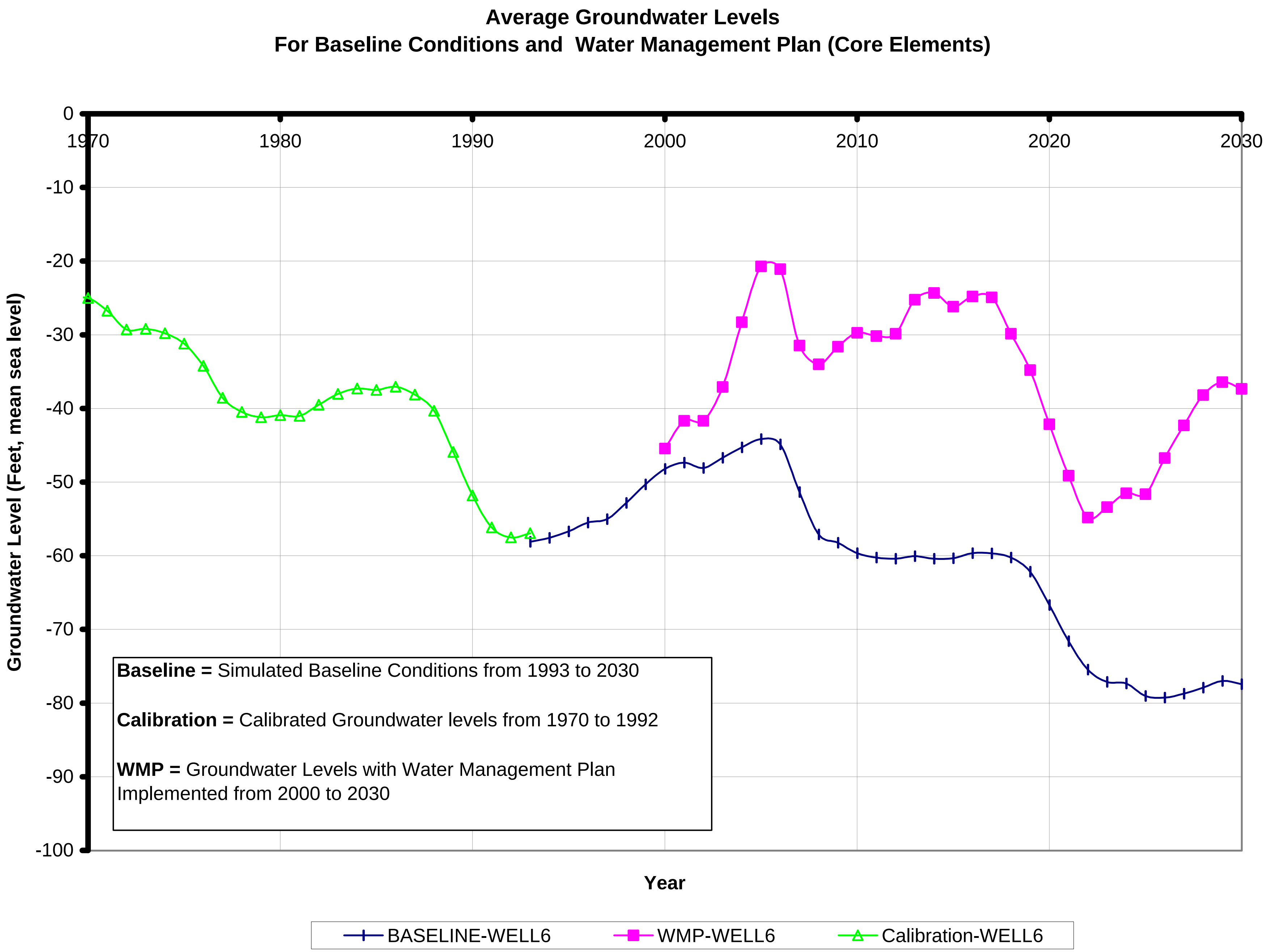
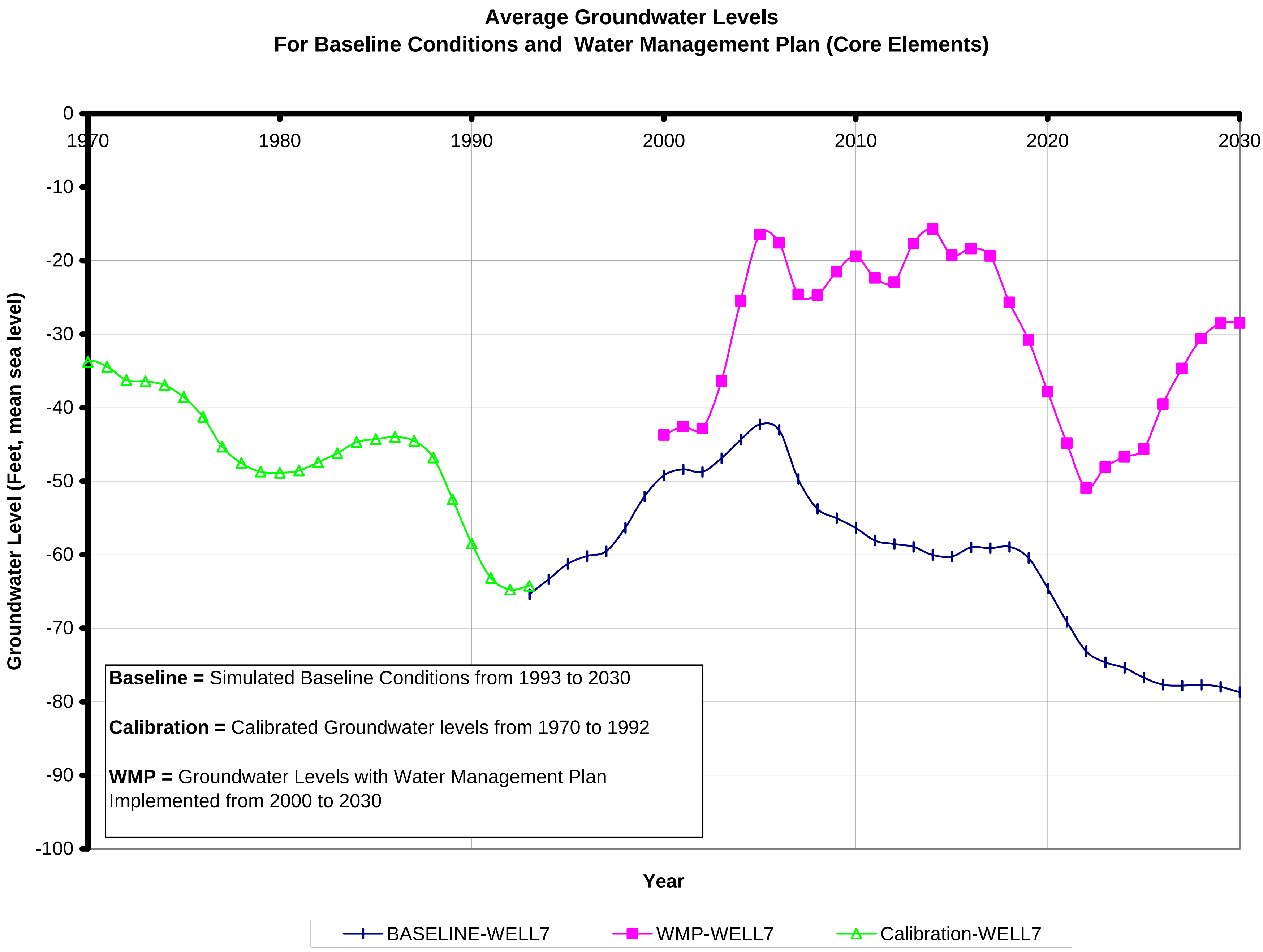


Figure 12
Simulated Groundwater Levels (1970-2030)
San Joaquin County Water Management Plan



CDM Camp Dresser & McKee Inc.
GW Head - Average 1970-2030.xls-13

Figure 13
Simulated Groundwater Levels (1970-2030)
San Joaquin County Water Management Plan

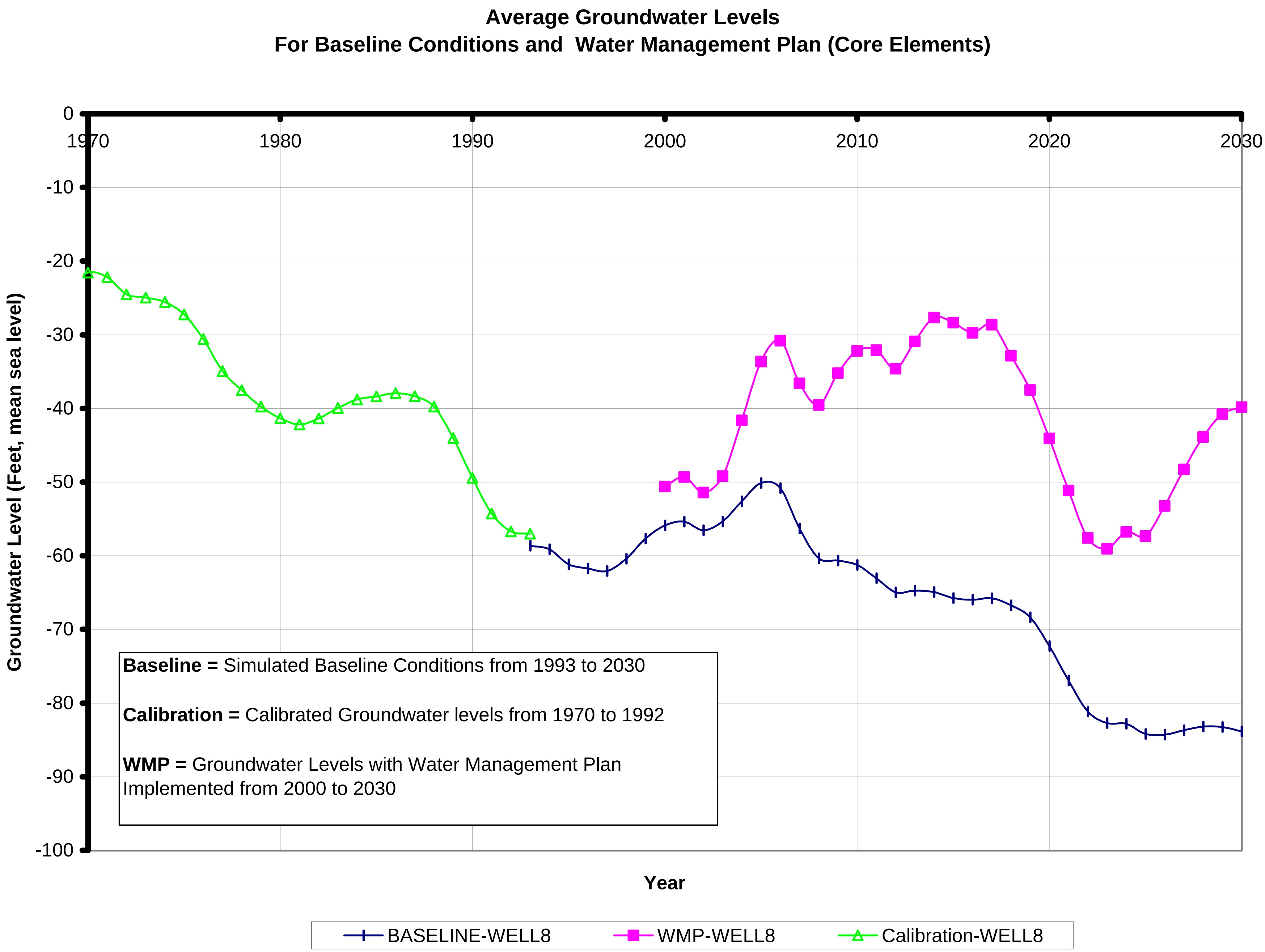
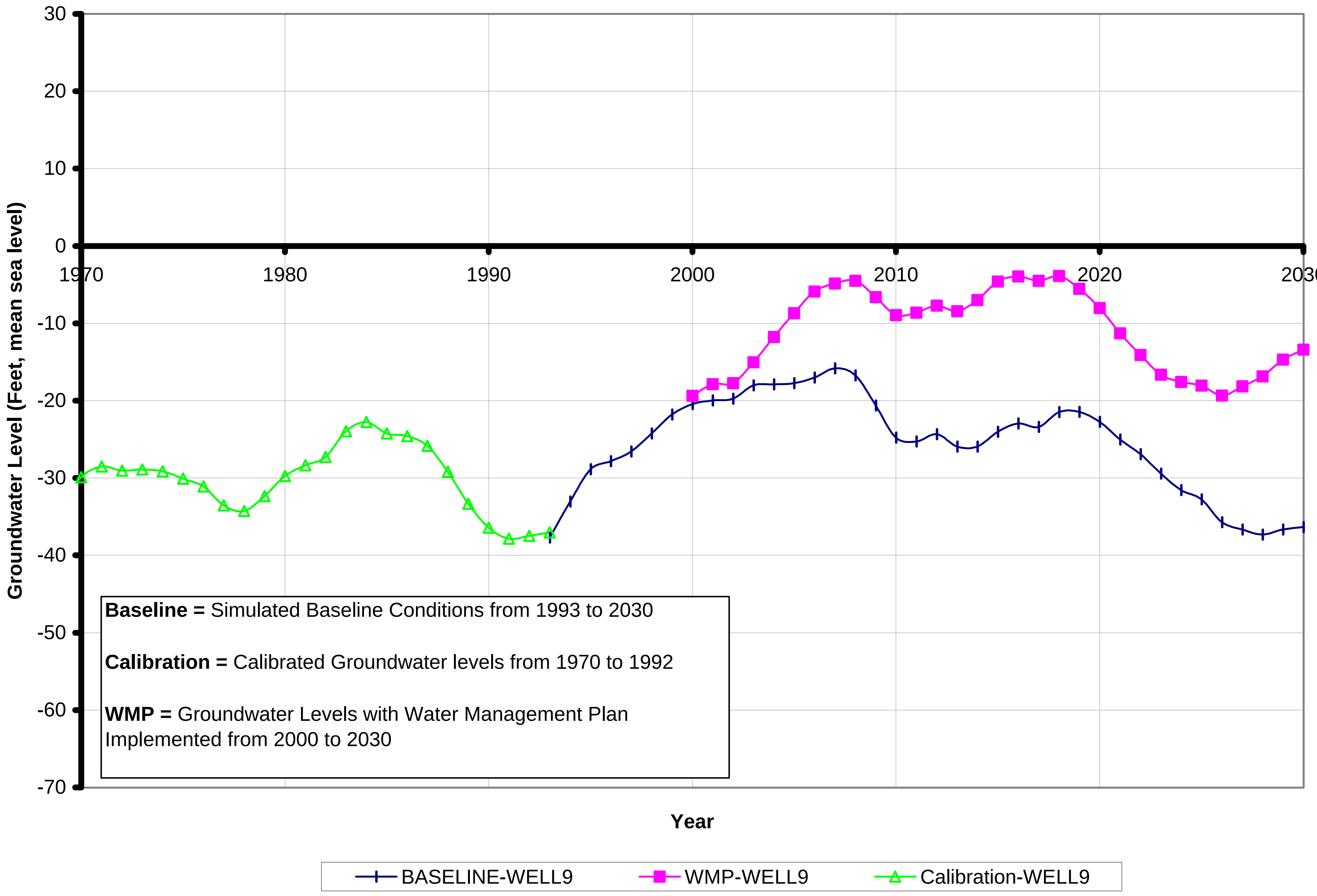


Figure 14
Simulated Groundwater Levels (1970-2030)
San Joaquin County Water Management Plan

Average Groundwater Levels
For Baseline Conditions and Water Management Plan (Core Elements)



CDM Camp Dresser & McKee Inc.
GW Head - Average 1970-2030.xls-15

Figure 15
Simulated Groundwater Levels (1970-2030)
San Joaquin County Water Management Plan

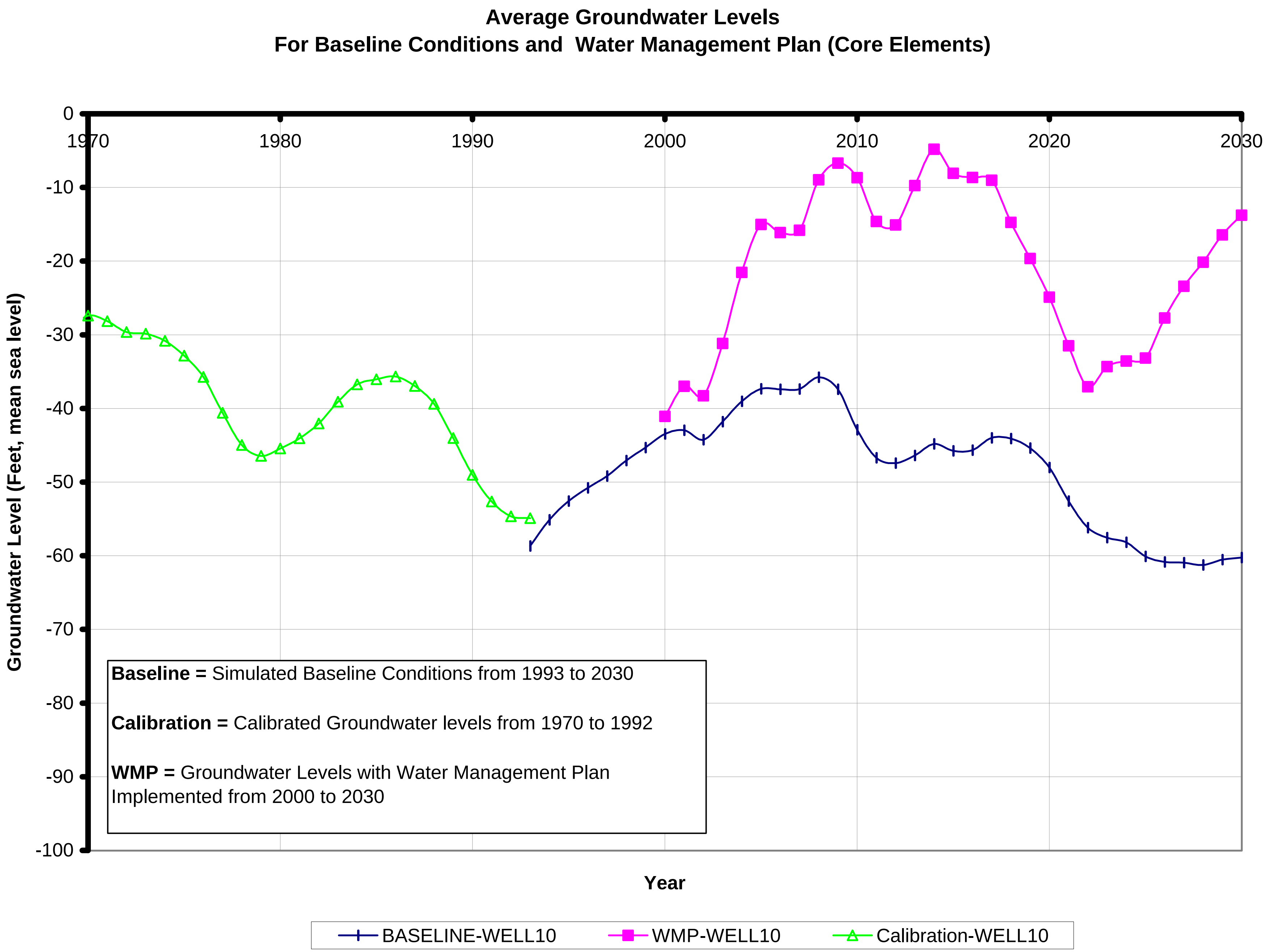


Figure 16
Simulated Groundwater Levels (1970-2030)
San Joaquin County Water Management Plan

CDM Camp Dresser & McKee Inc.
GW Head - Average 1970-2030.xls-16

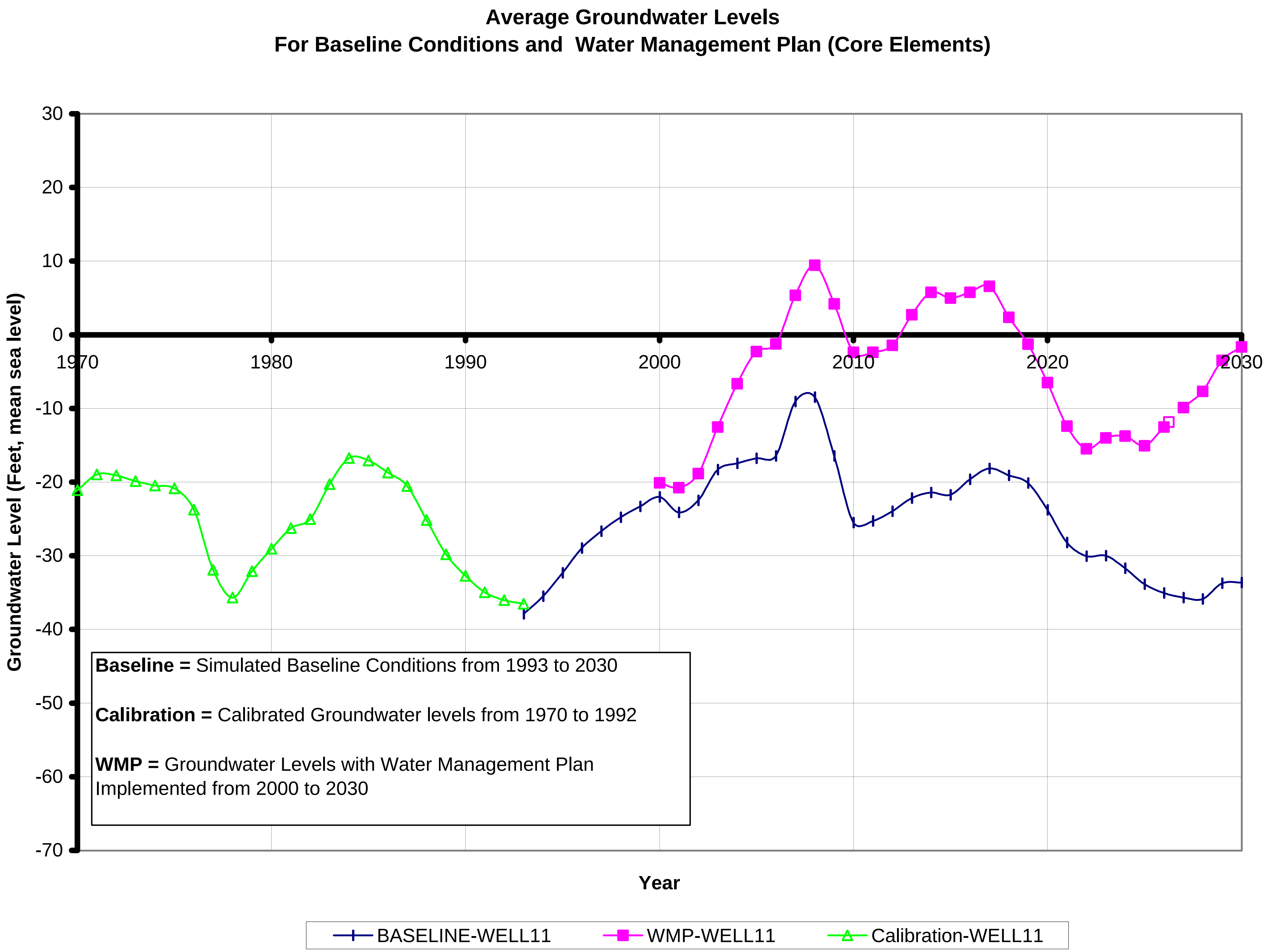


Figure 17
Simulated Groundwater Levels (1970-2030)
San Joaquin County Water Management Plan

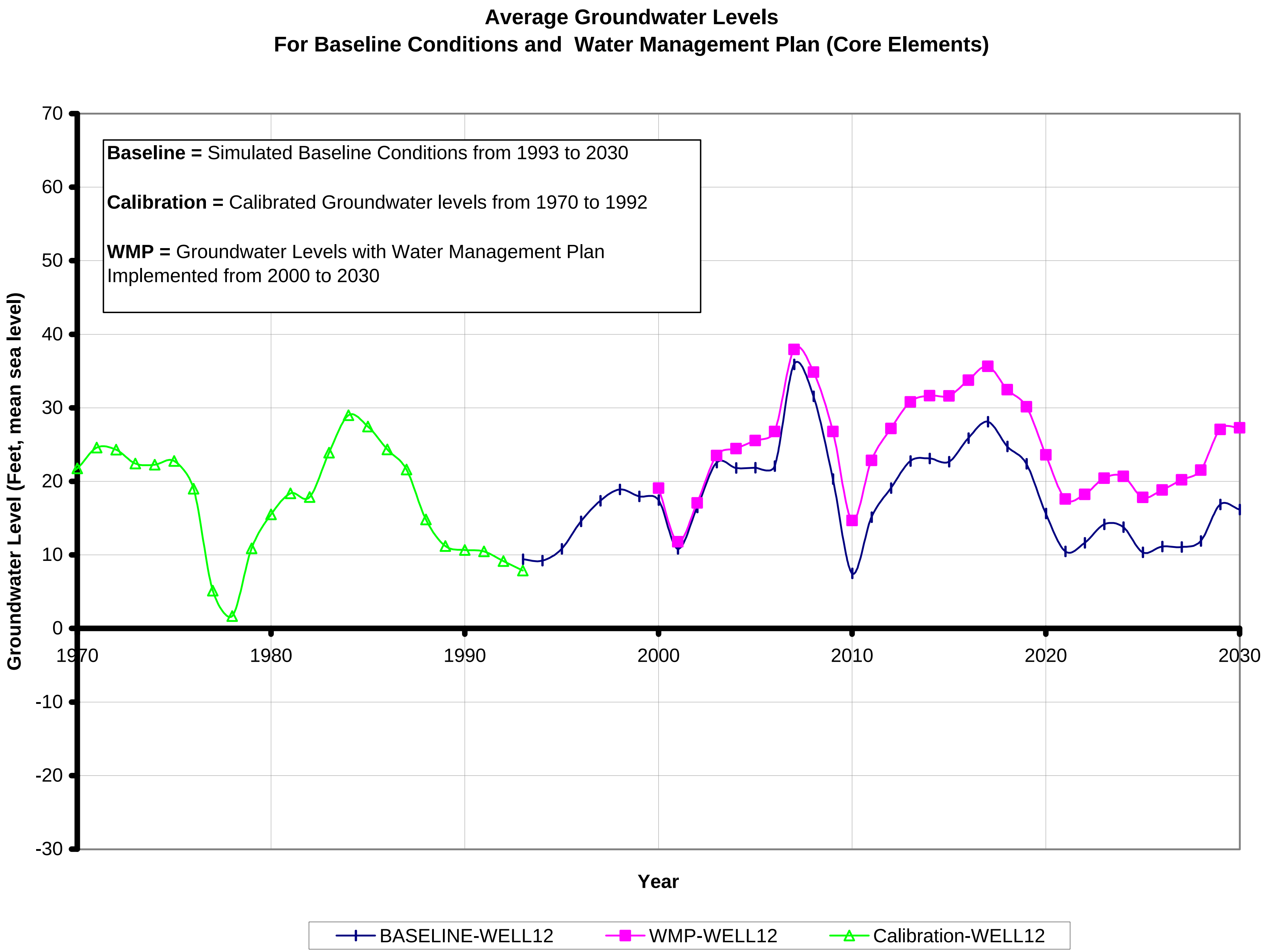


Figure 18
Simulated Groundwater Levels (1970-2030)
San Joaquin County Water Management Plan

CDM Camp Dresser & McKee Inc.
GW Head - Average 1970-2030.xls-18

Average Groundwater Levels
For Baseline Conditions and Water Management Plan (Core Elements)

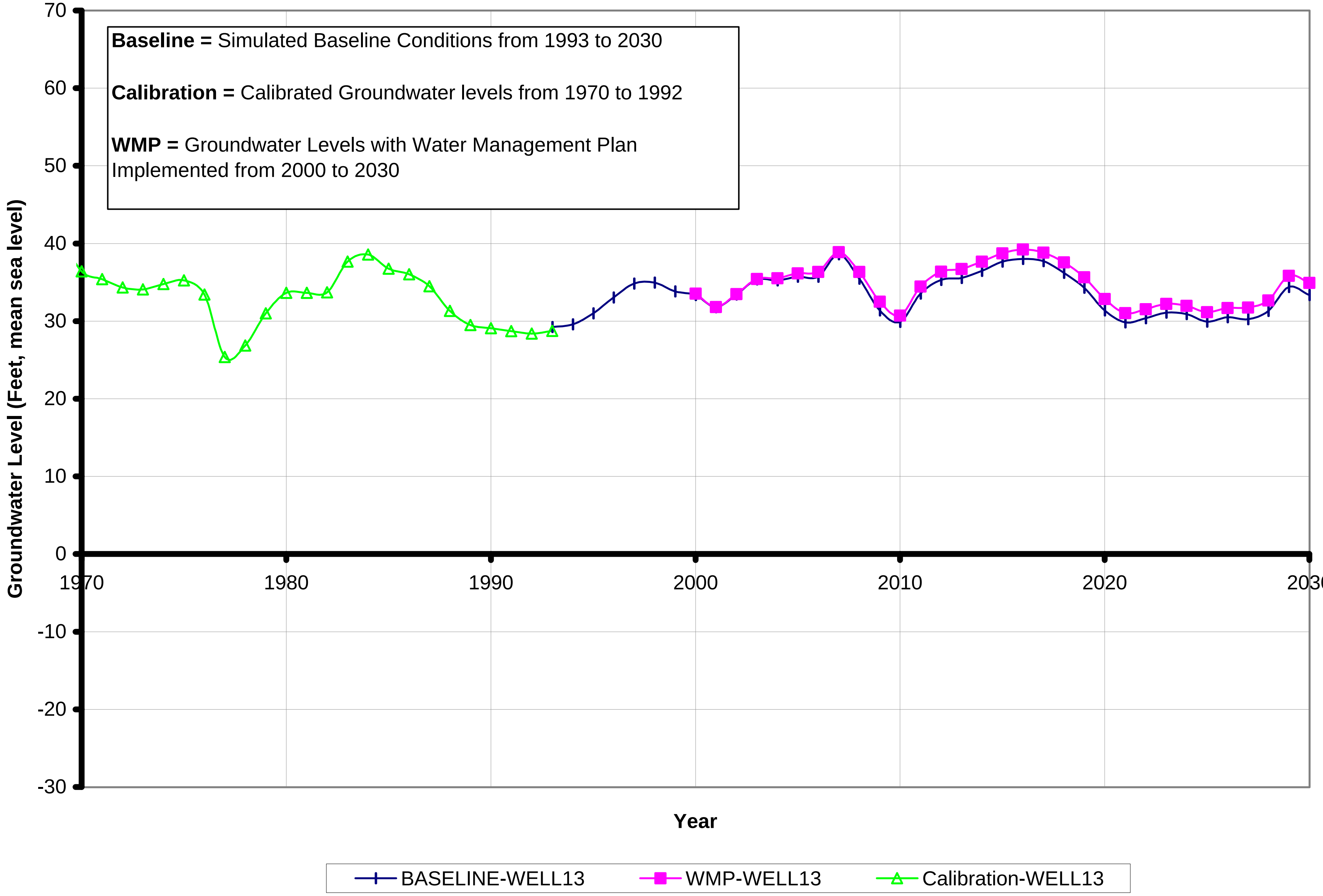


Figure 19
Simulated Groundwater Levels (1970-2030)
San Joaquin County Water Management Plan

CDM Camp Dresser & McKee Inc.
GW Head - Average 1970-2030.xls-19

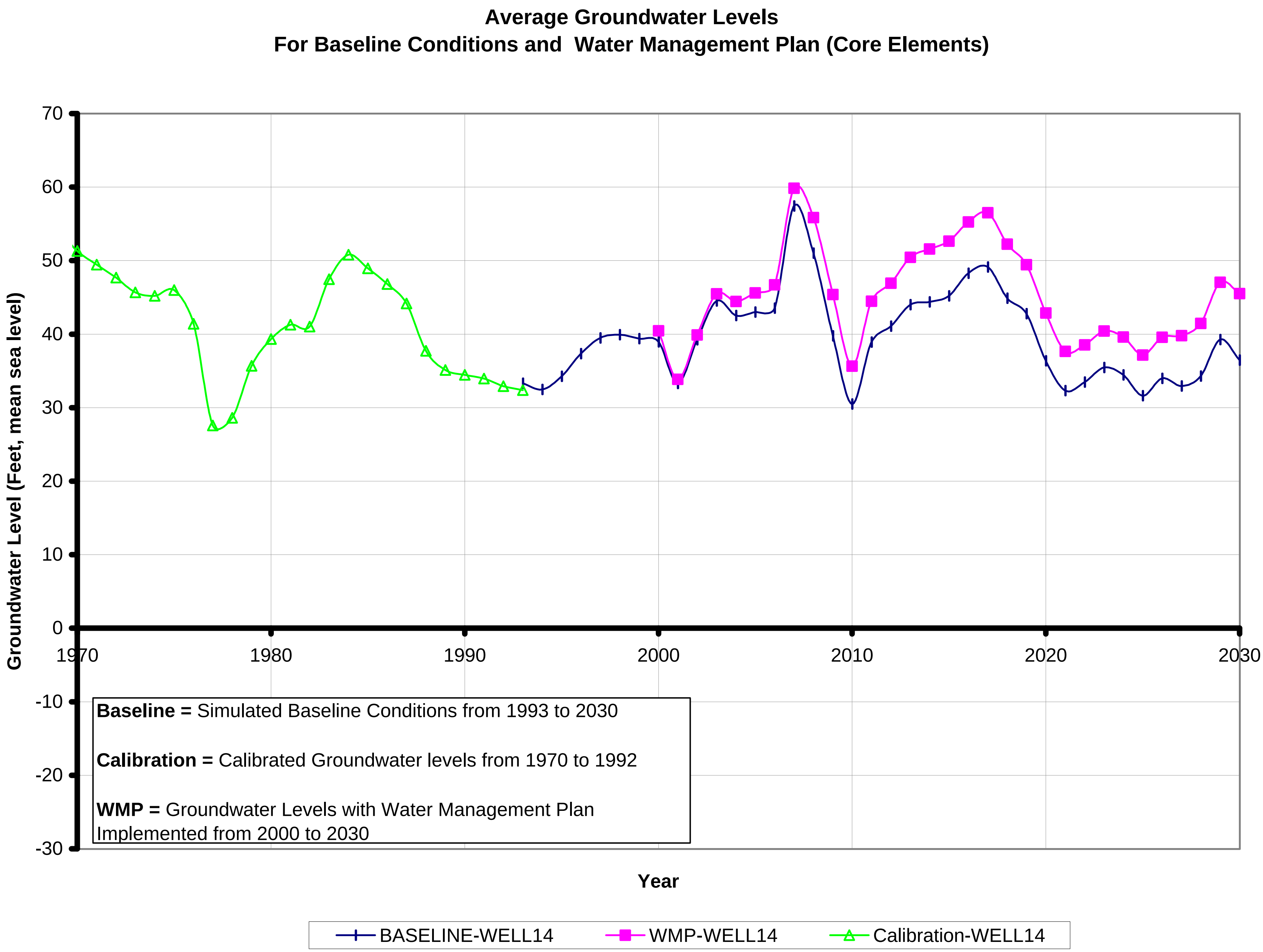


Figure 20
Simulated Groundwater Levels (1970-2030)
San Joaquin County Water Management Plan

Average Groundwater Levels
For Baseline Conditions and Water Management Plan (Core Elements)

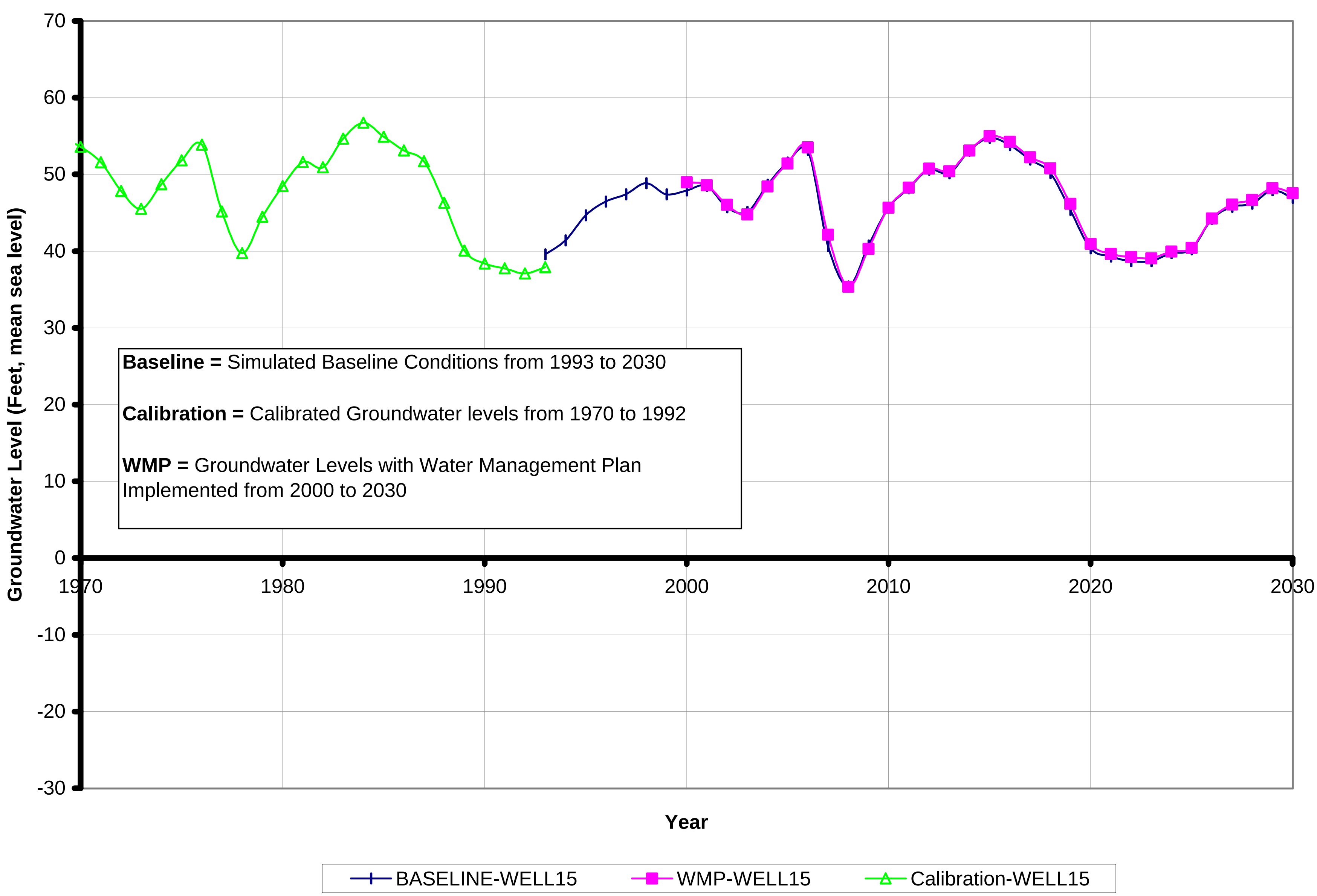


Figure 21
Simulated Groundwater Levels (1970-2030)
San Joaquin County Water Management Plan

CDM Camp Dresser & McKee Inc.
GW Head - Average 1970-2030.xls-21

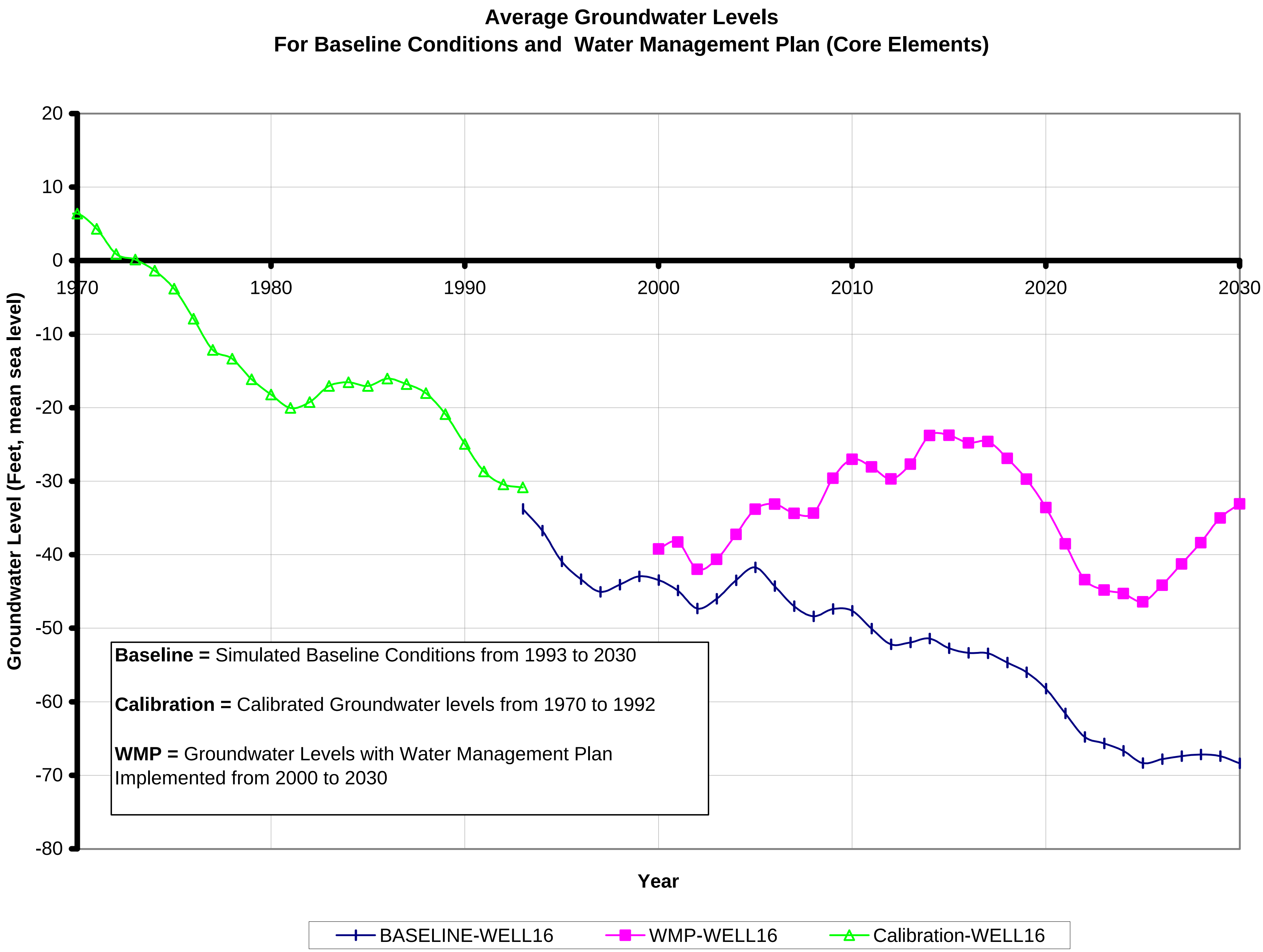


Figure 22
Simulated Groundwater Levels (1970-2030)
San Joaquin County Water Management Plan

CDM Camp Dresser & McKee Inc.
GW Head - Average 1970-2030.xls-22

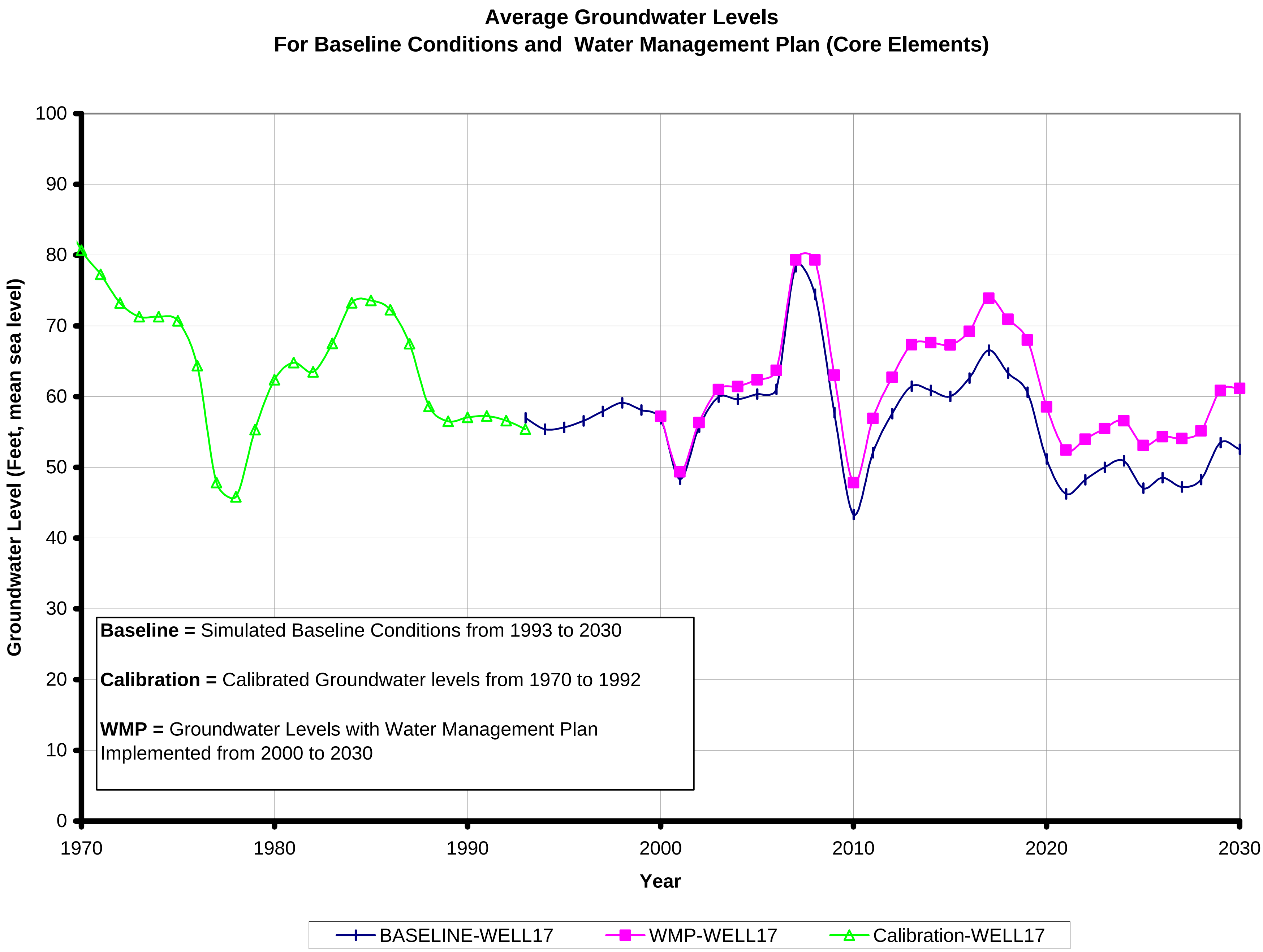


Figure 23
Simulated Groundwater Levels (1970-2030)
San Joaquin County Water Management Plan

CDM Camp Dresser & McKee Inc.
GW Head - Average 1970-2030.xls-23

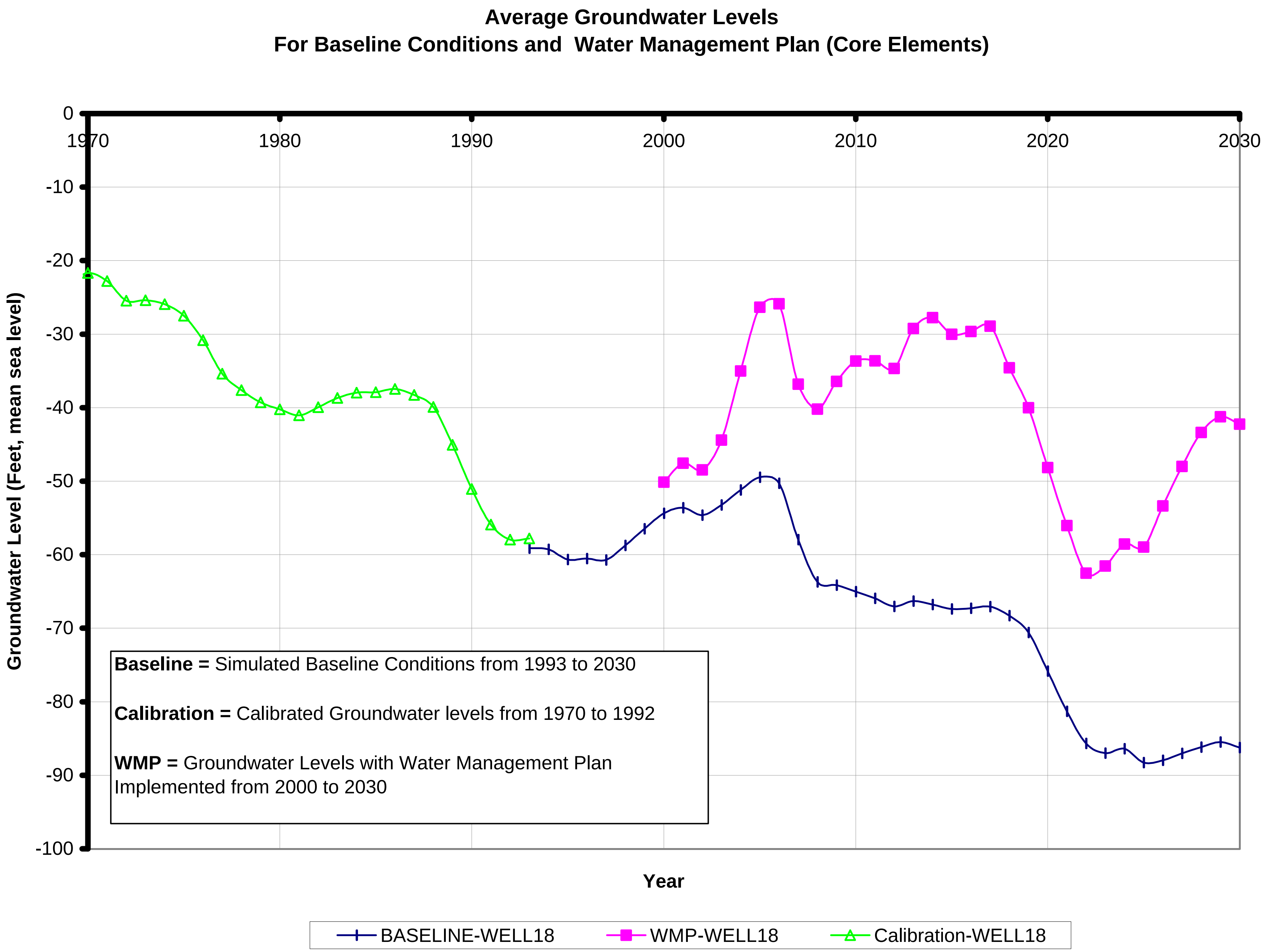


Figure 24
Simulated Groundwater Levels (1970-2030)
San Joaquin County Water Management Plan

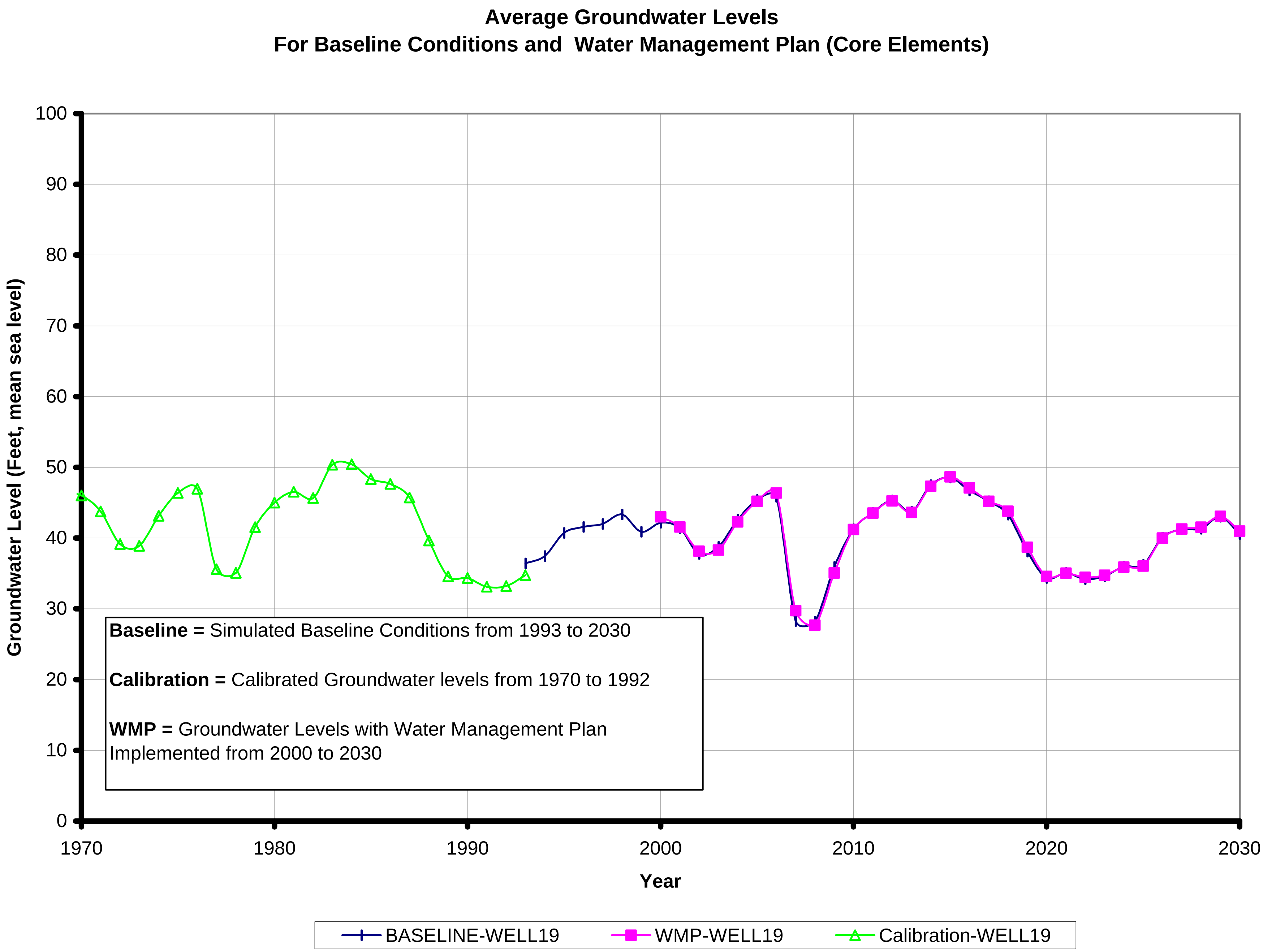


Figure 25
Simulated Groundwater Levels (1970-2030)
San Joaquin County Water Management Plan

CDM Camp Dresser & McKee Inc.
GW Head - Average 1970-2030.xls-25

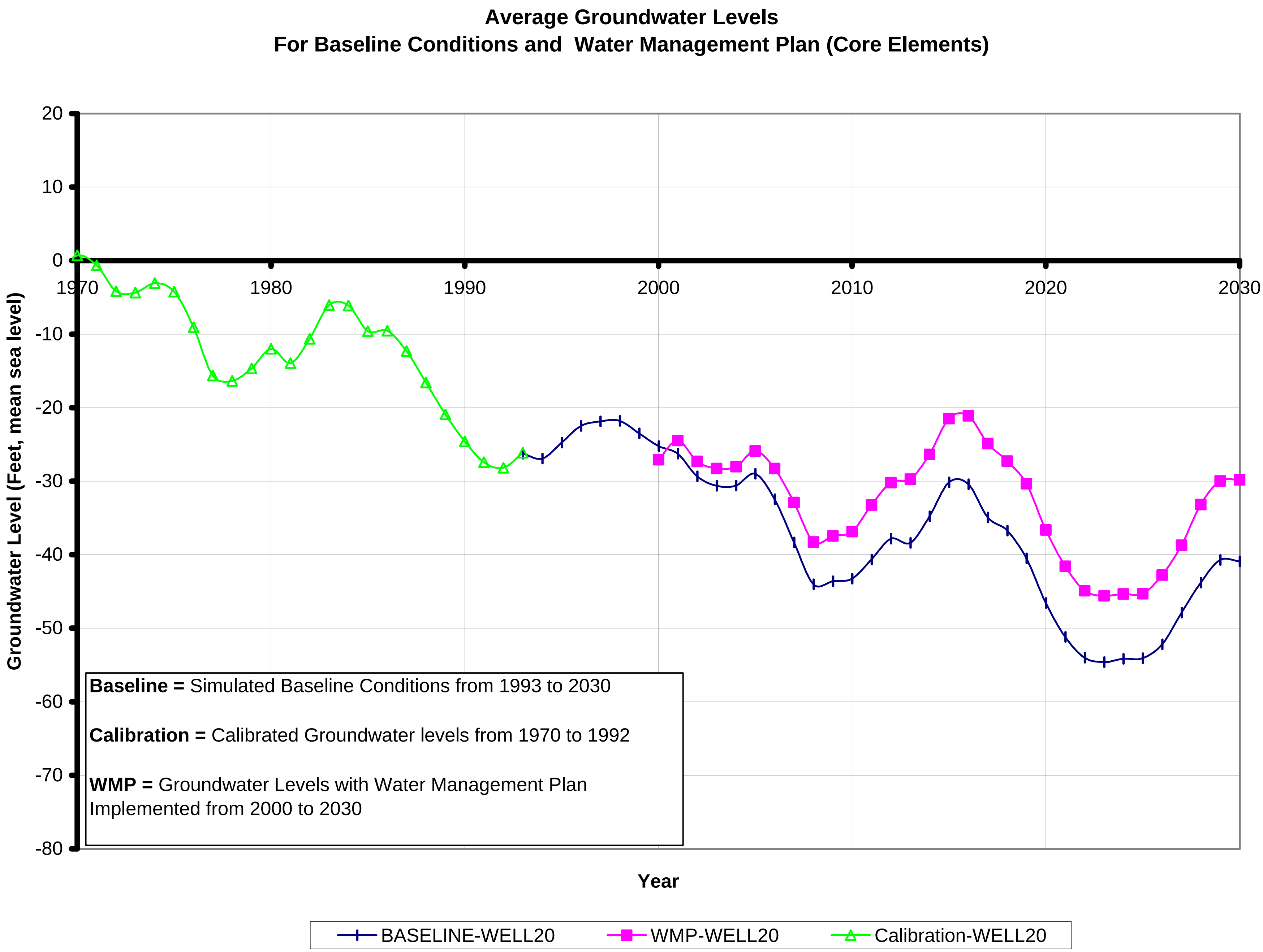
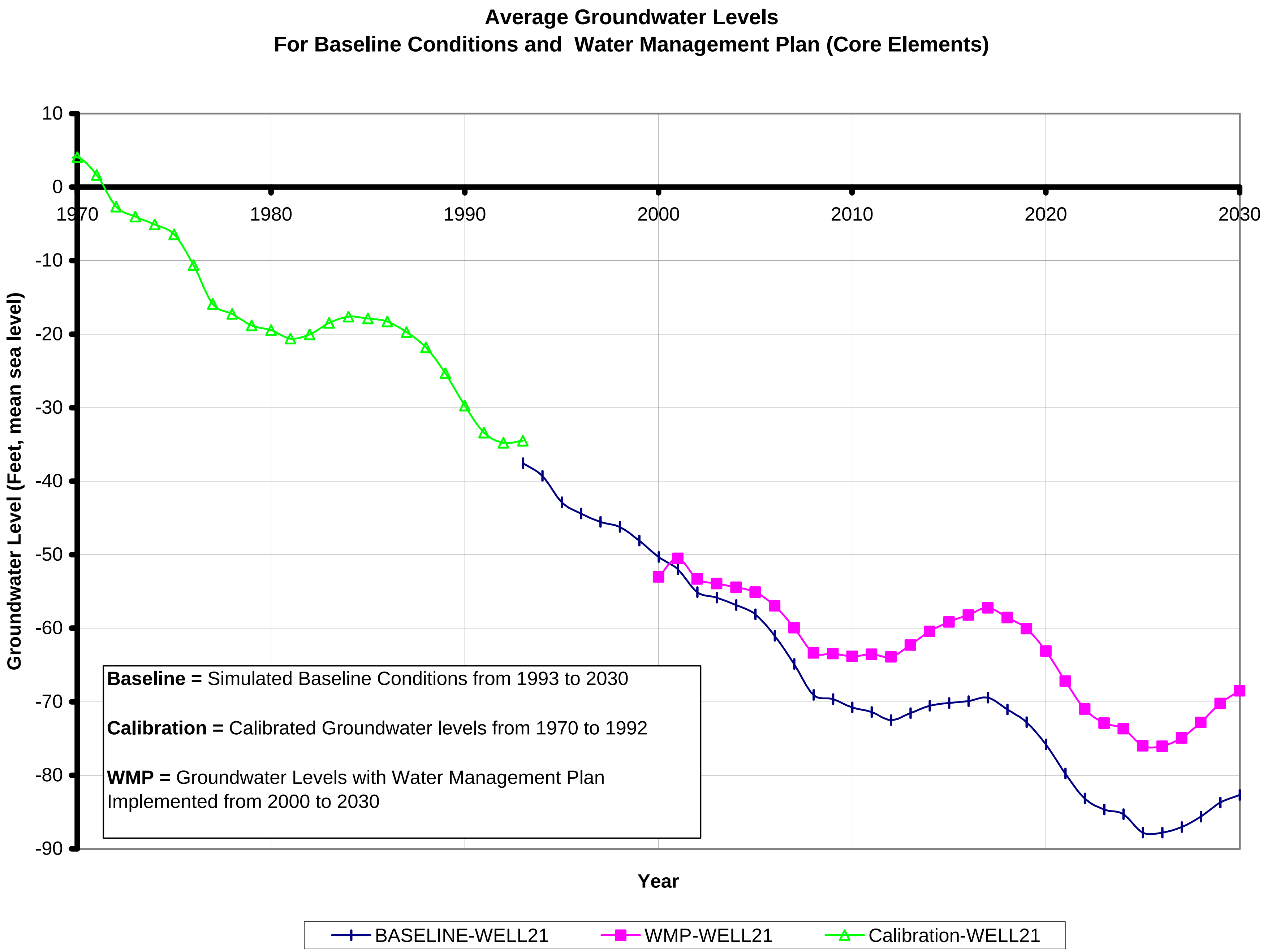


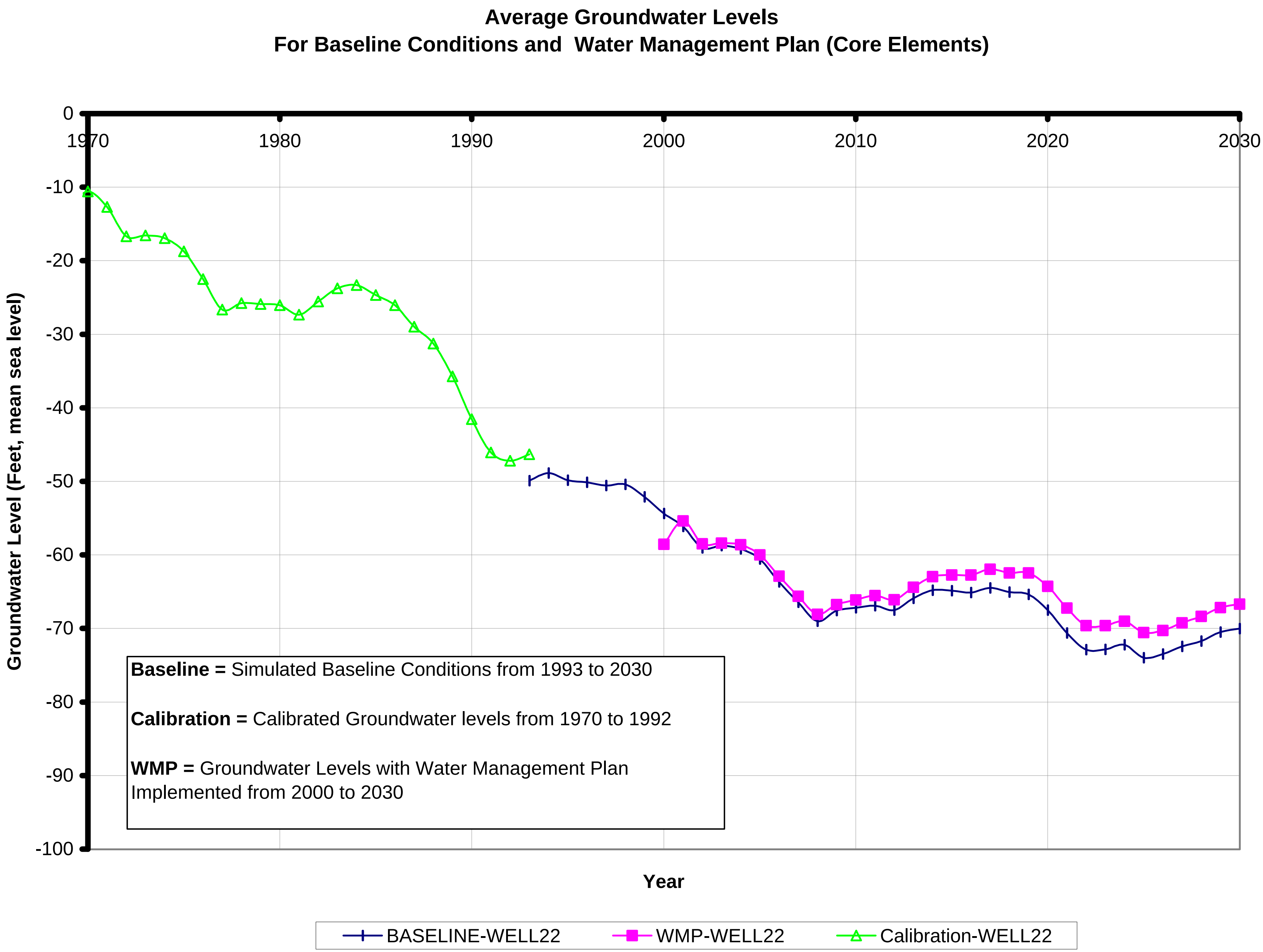
Figure 26
Simulated Groundwater Levels (1970-2030)
San Joaquin County Water Management Plan

CDM Camp Dresser & McKee Inc.
GW Head - Average 1970-2030.xls-26



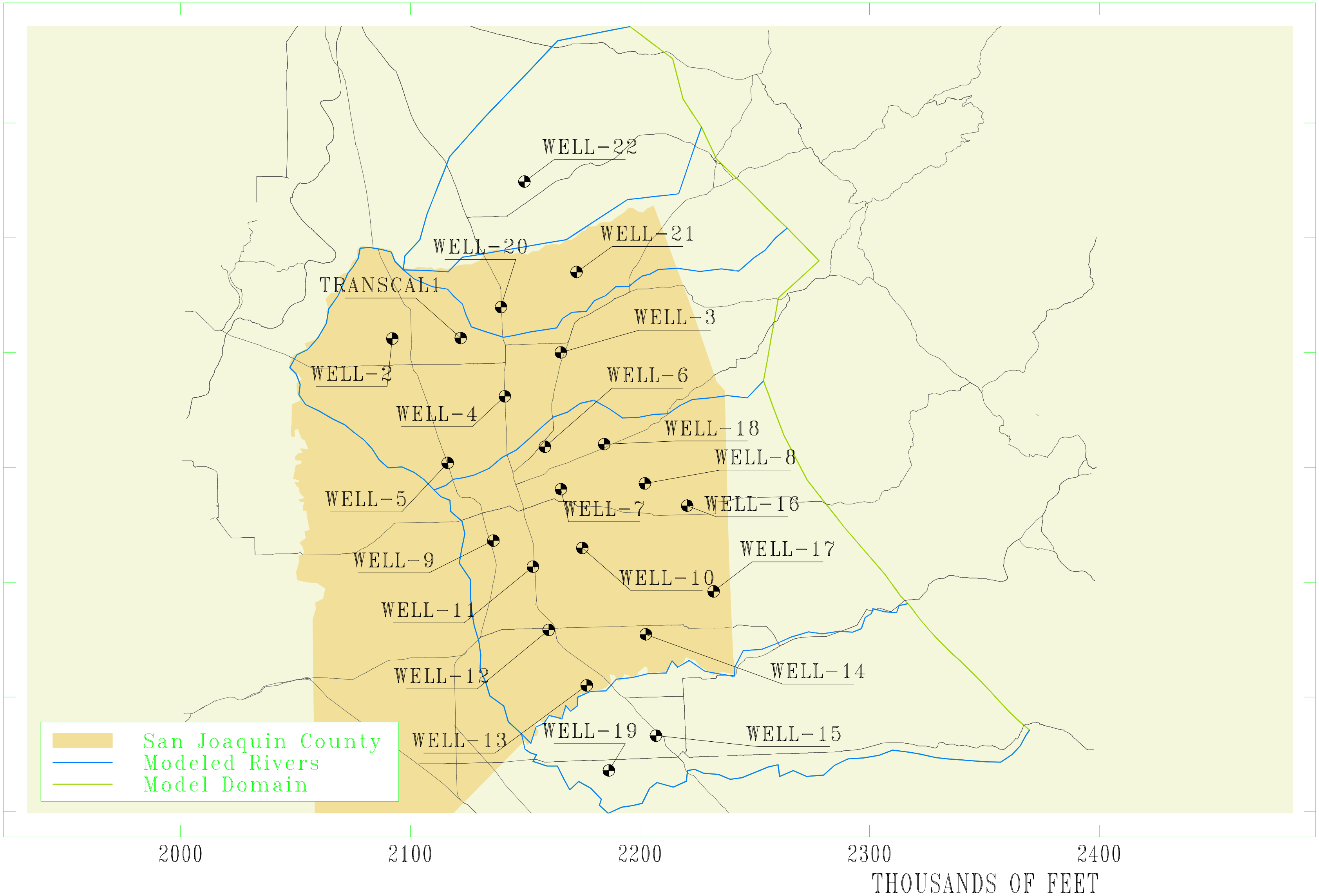
CDM Camp Dresser & McKee Inc.
GW Head - Average 1970-2030.xls-27

Figure 27
Simulated Groundwater Levels (1970-2030)
San Joaquin County Water Management Plan



CDM Camp Dresser & McKee Inc.
GW Head - Average 1970-2030.xls-28

Figure 28
Simulated Groundwater Levels (1970-2030)
San Joaquin County Water Management Plan



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Well Location Map

San Joaquin County Water Management Plan

FIGURE B-29

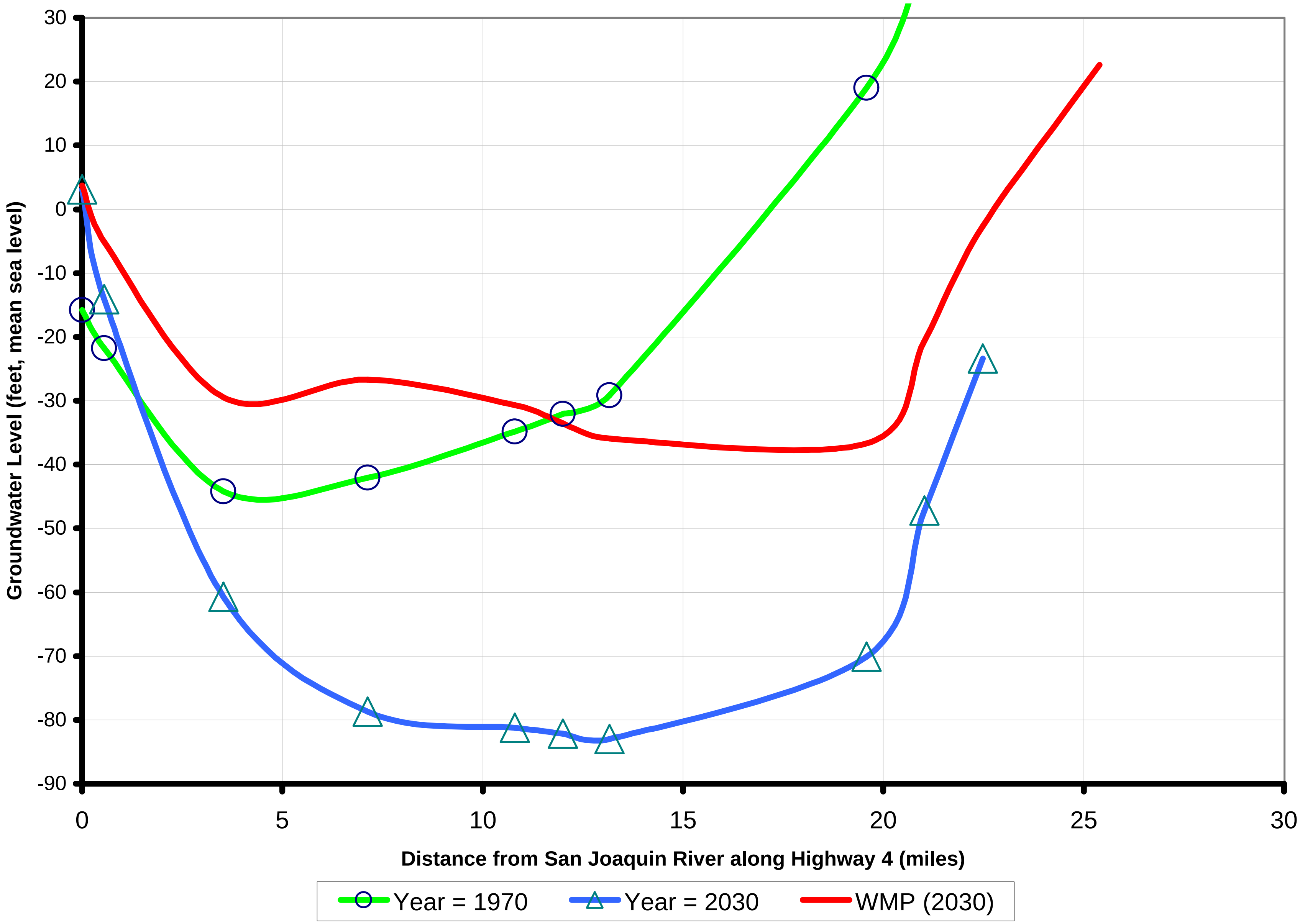
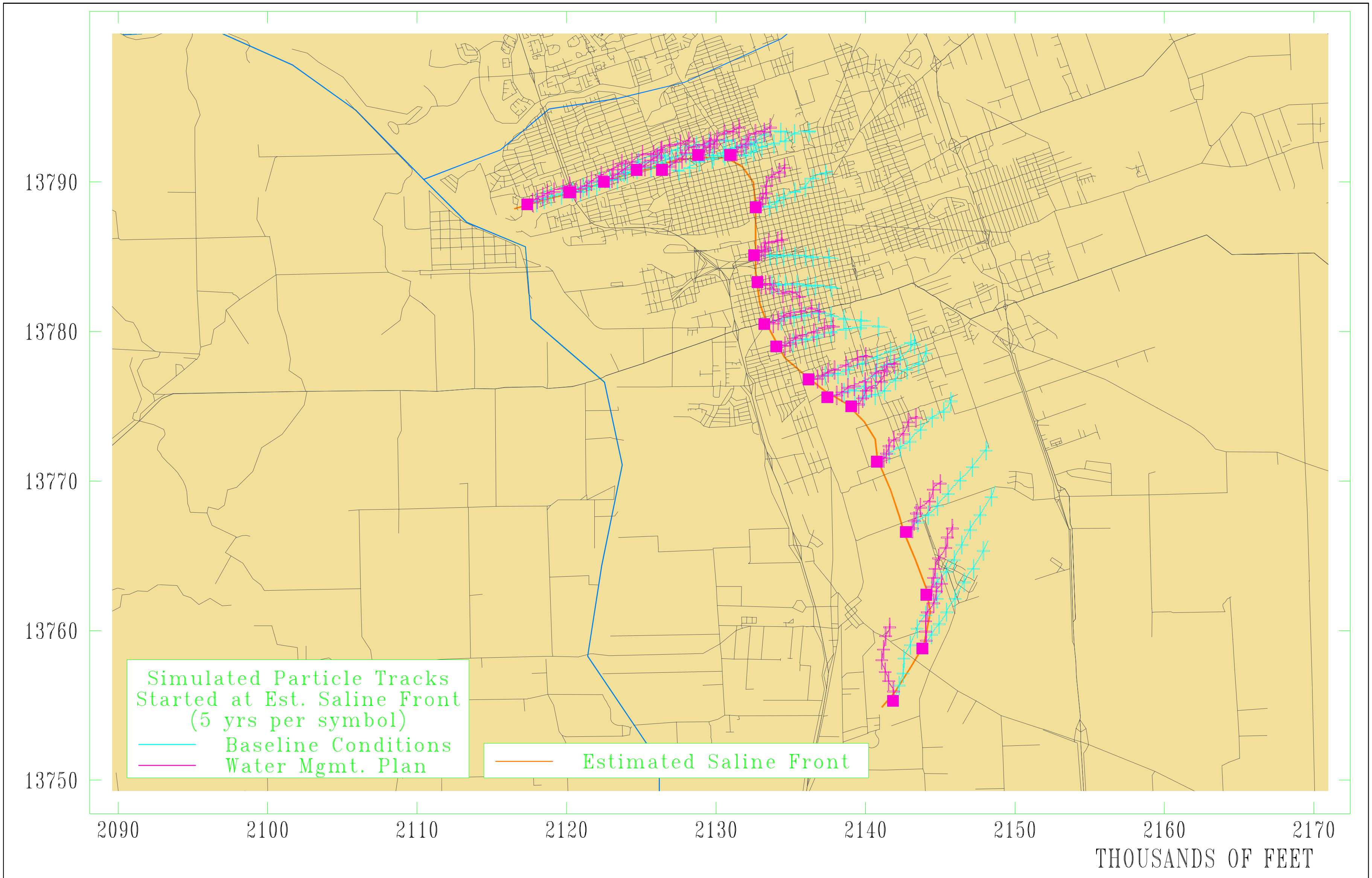


Figure 30
Groundwater Table Profile
San Joaquin County Water Management Plan



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Simulated Particle Tracks
Particles Started at Estimated Saline Front
Tracks for Baseline and Water Mgmt. Plan Conditions
San Joaquin County Water Management Plan

FIGURE
B-31

San Joaquin County Flood Control and Water Conservation District

San Joaquin County Water Management Plan Groundwater Modeling Information

September 14, 2001

Contents

Section 1
Introduction

1.1 Purpose and Scope

This document describes the integrated groundwater/surface water modeling conducted as part of the San Joaquin County Water Management Plan (SJCWMP). The document is organized into five sections. After this introduction section (Section 1), a description of the physical setting for the groundwater model is provided (Section 2). More detailed information about the physical setting is provided in Technical Memorandum 1. Section 3 provides an overview of the model inputs and calibration. The model application to the San Joaquin County Water Management Plan is described in Section 4, and Section 5 is a list of references.

1.2 Background

San Joaquin County recognizes the potential benefit in addressing its primary water management issues – supply, quality, and the groundwater basin – on a regional basis. To develop a plan for the entire County, San Joaquin County contracted CDM to:

- Gather relevant data to develop a shared understanding of County water resources;
- Develop a set of technically feasible alternatives for future water management;
- Evaluate the alternatives according to an agreed-upon method; and
- Formulate a recommended plan of action for the future.

To support these activities, CDM developed an integrated groundwater/surface water model. The model was used to:

- Develop a working understanding of the long-term behavior of the eastern San Joaquin County groundwater basin; and
- Evaluate at a screening level, the groundwater system response to potential water resources management options.

This technical appendix describes the groundwater/surface model developed and its application in support of the SJCWMP.

1.3 Modeling Approach

The modeling approach for this project consisted of the following steps:

- Data review and analysis;

- Evaluation and conversion of the existing San Joaquin County IGSM model to DYNFLOW;
- Refinement and recalibration of the model;
- Development of a baseline simulation; and
- Evaluation of Water Management Options.

1.4 Previous Modeling Work

Several models have been developed for both the San Joaquin County portion of the Central Valley and the entire Central Valley.

- USGS RASA Modeling (~ 1993) covering entire Central Valley.
- CVGSM (1990 / 1993), Montgomery Watson model of Central Valley.
- Pritchard-Long model, unknown date.
- Brown & Caldwell, 1982.
- IGSM 1993-1999, Montgomery Watson.

The modeling work conducted under the SJCWMP was based on the IGSM model for San Joaquin County. This model was the most up-to-date and rigorous model developed for the area.

1.5 Acknowledgements

CDM would like to acknowledge the assistance and information provided by DWR, City of Lodi, USBR, and San Joaquin County Flood Control and Water Conservation District. Other stakeholders and project participants also provided valuable comments and feedback on the development and application of the groundwater-surface water model.

Section 2
Physical Setting

2.1 Study Area

The study area for the SJCWMP is the entire area of San Joaquin County. San Joaquin County is in California's Central Valley, which runs north/south and is bordered by the Sierra Nevada mountain range to the east and the Coastal Range to the west. Rivers in the Central Valley flow from the north and south towards the Sacramento/San Joaquin Delta, which feeds the water through a break in the Coastal Range to the San Francisco Bay. San Joaquin County includes portions of the Delta on its western edge and the Sierra Nevada foothills on the eastern edge. The area of San Joaquin County is approximately 1,400 square miles. San Joaquin County encompasses seven urban areas, including Escalon, Lathrop, Lodi, Manteca, Stockton, Tracy, and Ripon. Urban water agencies in those areas provide water to residential, commercial, and industrial uses within their boundaries. Thirteen agricultural water agencies provide water for irrigation in other portions of the County.

2.2 Model Domain

San Joaquin County overlies the northern-most portion of the San Joaquin Valley Groundwater Basin. Within San Joaquin County, this basin is further subdivided into three sub-basins: the Eastern San Joaquin County Groundwater Basin (ESJCGB), the Cosumnes and Tracy sub-basins as shown on Figure 2-1 (at the end of the section). The groundwater/surface water model domain includes the ESJCGB, the Cosumnes sub-basin, and the Modesto sub-basin, all located on the eastside of the San Joaquin River. Figures 2-2 illustrates the model domain in relation to San Joaquin County and other surrounding counties. The southern portion of Sacramento County (from Dry Creek to the Cosumnes River), and the northern portion of Stanislaus County (from the Stanislaus River to the Tuolumne River) are also included in the model domain. The Delta and Southwest portions of the County are not included in the model but are included in the overall management plan.

2.3 Climate, Geography and Land Use

Agriculture is the primary land use within San Joaquin County. The semi-arid climate in San Joaquin County is ideal for farming, with long, warm, dry summers (May through October) and cool, rainy winters. Table 2-1 provides a summary of land use in San Joaquin County.

The average annual precipitation in the area is 14 inches, with 70% of the rain falling between December and March. In 1999, the value of agricultural production in San Joaquin County was $1.35 billion, which was the sixth largest County agricultural production in the state. Figure 2-3 illustrates the typical monthly rainfall distribution, and Figure 2-4 shows the long-term annual average rainfall at selected stations within San Joaquin County.

Table 2-1 San Joaquin County Land Use Summary				
Land Use	**1976**	**1982**	**1988**	**1996**
Urban	59,221	57,557	74,186	86,550
Orchard	87,294	96,322	102,895	107,784
Pasture, Truck, Field, & Farmstead	458,248	439,497	454,778	393,297
Rice	7,918	7,865	6,141	5,991
Vineyards	60,921	65,646	63,860	76,975
Native & Riparian Vegetation	213,922	202,073	201,133	218,056
Water Surface	17,576	27,128	22,755	22,621
TOTAL	**905,100**	**896,088**	**925,748**	**911,273**

Source: Department of Water Resources Land Surveys.

Note: San Joaquin County comprises 901,760 acres. The difference between the land use total and the area of the County is attributed to double-cropping.

2.4 Hydrology

The major rivers in this hydrologic region are the San Joaquin, Cosumnes, Mokelumne, Calaveras, Stanislaus, Tuolumne, Merced, Chowchilla, and Fresno. The Calaveras, Mokelumne, and Stanislaus Rivers flow through or border San Joaquin County and discharge directly into the Delta, or into the San Joaquin River which in turn flows into the Delta. The Delta includes areas in the west and southwest of the County. The Delta, major rivers, and the associated facilities are shown on Figure 2-5.

2.4.1 The Delta

The Sacramento-San Joaquin Delta covers more than 738,000 acres in five counties, and is comprised of many small islands within a network of canals and natural sloughs. The Sacramento and San Joaquin rivers come together in the Delta before they flow to the San Francisco Bay and out to the ocean. The Delta is the largest estuary on the west coast, and is home to over 750 plant and animal species, many of which are endangered. The Delta provides drinking water for two-thirds of all Californians, and irrigation water for over 7 million acres of highly productive farmland.

2.4.2 San Joaquin River

The San Joaquin River originates in the Sierra Nevada and enters the San Joaquin Valley at Friant. The lower San Joaquin River is the section of the river from the confluence with the Merced River north to Vernalis. The lower San Joaquin River has a drainage area of approximately 13,400 square miles. The majority of the flow in the lower San Joaquin River is derived from inflow from the Merced, Tuolumne and Stanislaus Rivers as the upper San Joaquin River contributes very little inflow.

2.4.3 Mokelumne River

The Mokelumne River has a watershed of approximately 660 square miles stretching from high in the Sierra Nevada westward towards the Delta; with snow melt comprising a large portion of the flow. The major facilities on the Mokelumne are the Salt Springs Reservoir on the North Fork of the Mokelumne and the Pardee and Camanche Reservoirs on the main stem of the river. Salt Springs Reservoir is a PG&E facility built in 1963 and is operated for hydropower. Pardee and Camanche are both owned by EBMUD. Pardee Reservoir, which is upstream of Camanche, has a capacity of 209,900 ac-ft and is operated for water supply. Pardee water is diverted into the Mokelumne River Aqueducts to the EBMUD service area. Camanche Reservoir, with a capacity of 430,000 ac-ft is operated for flood control and to meet instream flow requirements. Pardee has a 28 MW hydropower facility and Camanche has an 11 MW facility (EBMUD, Urban Water Management Plan 2000).

Water rights on the Mokelumne form a complex hierarchy, with water rights held by Woodbridge Irrigation District, Amador County, Calaveras County, EBMUD and North San Joaquin Water Conservation District. San Joaquin County has a water right application filed for floodflows as part of a Middlebar Reservoir project, which would be just upstream of Pardee Reservoir.

2.4.4 Calaveras River

The Calaveras River watershed covers 363 square miles and stretches from Stockton east into the Sierra foothills. Flow in the Calaveras is primarily rain driven, with little or no snowmelt. The US Army Corps of Engineers constructed New Hogan Dam in 1963 primarily for flood control. New Hogan Lake has a capacity of 317,000 ac-ft and New Hogan Dam is operated by SEWD. SEWD has rights to the yield from New Hogan subject to future demand in Calaveras County that has been estimated to be between 2,500 to 5,300 ac-ft/yr by the year 2040 (Calaveras County Water District, 1996).

2.4.5 Stanislaus River

The Stanislaus River drains a watershed of 904 square miles and has an unimpaired runoff of approximately 1 million ac-ft. The majority of the runoff occurs from November to July, with peak flows typically occurring in summer months. More than half the runoff is snow melt derived (USBR, Website, undated). The US Army Corps of Engineers (USACE) constructed New Melones Dam on the Stanislaus River in 1978 replacing the original structure built in 1924. New Melones Reservoir has a capacity of 2.4 million ac-ft and is operated as part of the CVP. The average runoff at New Melones for the 74 years from 1904 to 1977 was 1.12 million ac-ft.

There are an additional nine reservoirs and two diversion canals upstream of New Melones on the Stanislaus River, including Donnells and Beardsley Reservoirs (USBR, Website, undated). Tulloch Lake, located several miles downstream from New Melones, is used to re-regulate releases from New Melones. SSJID and OID divert from Goodwin Dam, located about 2 miles downstream of Tulloch Dam. Additionally, water can be pumped via Goodwin Tunnel to CSJWCD and SEWD. SSJID and OID are the principal users of Stanislaus River water in San Joaquin

County. Both SEWD and CSJWCD have CVP contracts for deliveries from New Melones.

2.4.6 Other Rivers

The other rivers in the model area, but not located in San Joaquin County are: the Tuolumne River, Cosumnes River and Dry Creek.

The Tuolumne River originates in the Sierra Nevada Mountains and is the largest tributary to the San Joaquin River. It has a watershed of approximately 1,500 square miles. The unimpaired runoff in the Tuolumne is about 1.8 million ac-ft. Flows in the lower reaches of the Tuolumne River are regulated by New Don Pedro Dam, which was constructed in 1971 and is owned by Turlock and Modesto Irrigation Districts. New Don Pedro Reservoir has a capacity of approximately 2 million ac-ft, and is operated for irrigation, hydroelectric generation, fish and wildlife protection, recreation, and flood control. Irrigation water is diverted downstream of New Don Pedro at La Grange into the Modesto Main Canal and Turlock Main Canal. The City and County of San Francisco operate several facilities in the upper watershed of the Tuolumne, namely O'Shaughnessy Dam at Hetch Hetchy Valley, Lake Eleanor and Cherry Lake. These facilities are operated for municipal and industrial supply, as wells as hydropower.

The Cosumnes River is a tributary of the Mokelumne River. It meets the Mokelumne near the town of Thorton, and has watershed area of approximately 540 miles. Flows are primarily rain/runoff derived.

Dry Creek is a relatively minor tributary to the Mokelumne River, and forms the northern boundary between San Joaquin and Sacramento Counties. The Cosumnes, Dry Creek, Mokelumne and Calaveras Rivers are collectively referred to as the Eastside Streams.

2.5 Regional Geology and Stratigraphy

The study area is set within the Central Valley, a 400-mile long and 50 mile wide northwestward trending, asymmetrical structural trough. To the east are the Sierra Nevada which are comprised of pre-Tertiary igneous and metamorphic rocks. The Coastal Range to the west is comprised of pre-Tertiary and Tertiary semi-consolidated to consolidated marine sedimentary rocks. The geologic formations within San Joaquin County cover a wide range of geologic time – from Recent to Pre-Cretaceous. Between 6 to 10 miles of sediment have been deposited within the Central Valley and include both marine and continental gravel, sand, silt and clay.

During the middle Cretaceous, parts of the Central Valley were inundated by the Pacific Ocean resulting in deposition of marine deposits. Marine conditions persisted into the middle Tertiary periods after which time the sediment deposition changed from marine to continental. The material source for the continental deposits are the Coastal Ranges and Sierra Nevada, which are composed primarily of granite, related plutonic rocks and metasedimentary and metavolcanic rocks that are from Late Jurassic to Ordovician age (Bertoldi, et al, 1991). The Central Valley has one natural surface water outlet at the Carquinez Strait located east of San Francisco Bay (USGS).

The geologic formations within the Central Valley and San Joaquin County are generally grouped as either east-side or west-side formations based on their location relative to the San Joaquin River, and the source of the sedimentary material of which they are composed. East-side formation material originated in the Sierra Nevada and west-side in the Coastal Ranges. Table 2-2 shows a generalized stratigraphic column for San Joaquin County.

The following formations have limited water-producing capabilities or contain water of marine origin (DWR Bulletin No. 146, 1967):

- Franciscan group;
- The undifferentiated Cretaceous formations west of Tracy;
- Eocene / Ione formation;
- Undifferentiated Eocene;
- Miocene eastside Valley Springs formation; and
- West side San Pablo group.

The most important east-side fresh water-bearing formations are the Mehrten, Laguna, Victor, and alluvial deposits. The principal west-side water bearing formations are the San Pablo Group, the Tulare, and alluvial deposits. They are discussed in more detail in subsequent sections.

Table 2-2
Generalised Stratigraphic Column

System	Series	Formation	Location	Thickness	Symbols	Rock Characteristics and Environment	Hydrogeological Description
Quaternary	Recent	Stream Channel Deposits	Eastside & Westside		Qk	Continental unconsolidated gravel, and coarse to medium sand deposited along present stream channels	High permeability, unimportant to groundwater except as avenue for percolation
	Recent to Late Pleistocene	Alluvial Fan Deposits	Westside	0 to 150 ±	Qal	Continental fan deposits-heterogeneous, discontinuous mixtures of gravel, sand, silt, clay.	Moderate to locally high permeability, unconfined aquifers.
		Recent Alluvium and Victor	Eastside	0 to 150 ±	Qalv	Continental fan and interfan material, locally some basin type. Lenticular gravel, sand, silt, clay.	Moderate permeabilities, unconfined aquifers.
		Flood Basin Deposits	Eastside & Westside	0 to 1400 ±	Qb	Continental basinal equivalent of Laguna, Tulare and younger fms. Clay, silt and sand, organic in part	Generally low permeabilities, saturated environmenta, unconfined to confined.
	Plio-Pleistocene	Tulare	Westside	0 to 1400 ±	QTt	Continental semi-consolidated clay, sand & gravel. Contains Corcoran Clay member.	Moderate permeabilities, genreally unconfined above Corcoran Clay, confined below.
Tertiary		Laguna	Eastside	0 to 1000 ±	QTL	Continental, semi to unconsolidated silt, sand & gravel, poorly sorted, includes Arroyo Seco Gravel pediment of Mokelumne River area.	Moderate permeability. Unconfined to locally semi-confined. Restricted perched bodies in some areas.
	Mio-Pliocene	Merhten	Eastside	0 to 600 ±	Tm	Continental andesitic derivatives of silt, sand & gravel & their indurated equivalents; tuff; Breccia; agglomerate.	Moderate to high permeability where "black sands" occur. Confined to unconfined. Saline west of Stockton
	Upper Miocene	San Pablo Group	Westside	0 to 1000 ±	Tsp	Continental to marine massive sandstone and shale. Westside equivalent of Mehrten and Valley Springs fms, in part	Low permeability. Saline in part. Essentially nonwater bearing except along fractures and joints.
	Miocene	Valley Springs	Eastside	0 to 500 ±	Tvs	Continental to marine (?) rhyolitic ash, clay, sand & gravel and their indurated equivalents	Low permeability. Saline in Stockton area. Not considered significant in groundwater studies.
	Eocene	Eocene Undifferentiated	Westside	?	Te	Marine shale, siltstone and sandstone	Contains saline waters except where flushed in outcrop areas. Unimportant to freshwater basin except as possible contaminant source.
Cretaceous	Cretaceous	Cretaceous Undifferentiated	Westside	?	K	Marine shale, siltstone and sandstone	Contains saline waters, unimportant to freshwater basin except as possible contaminant source.
Pre-Cretaceous	Jurassic	Franciscan Group, Undifferentiated	Westside	?		Marine shale, sandstone, chert metamorphics, serpentine.	Unimportant to freshwater basin except as possible contaminant source.

Source: Adapted from: San Joaquin County Ground Water Investigation, Bulletin No. 146, California Department of Water Resources.

2.6 Soil Distribution

DWR Bulletin 147 groups soils within San Joaquin County into five main categories which generally coincide with the general geology: alluvial fan and flood plain soils; organic basin soils; interfan and basin soils; lower terrace soils; higher terrace and upland soils.

The alluvial fan and flood plain soils are further classified into the Mokelumne, the Calaveras and the Stanislaus River Fans, which are moderately to highly permeable (Montgomery Watson, 1999). The organic basin soils are found in the lower Delta area of the County and have low infiltration rates (DWR, 1967). The basin and interfan soils are typically found between the Mokelumne, Calaveras and Stanislaus River Fans and have very low infiltration rates (Montgomery Watson, 1999). The lower and higher terrace soils occur along the eastern edge of the County. The lower terrace soils contain clay and claypan, while the higher terrace soils contain weathered materials originating from underlying rock formations. Both exhibit very low infiltration capacities.

2.7 Regional Hydrogeology

The groundwater in San Joaquin County is found in multiple water-bearing formations. The Eastern San Joaquin County Groundwater Basin is east of the Delta, and is comprised of multiple geologic features, including the Laguna Formation and the Mehrten Formation. The Eastern Basin is primarily unconfined, but localized soil characteristics result in semi-confined and perched conditions.

The Delta area has Flood Basin Deposits underneath, which generally contain poor quality saline water. The Tulare Formation is in the southwestern portion of the County, and is characterized by the presence of the Corcoran Clay unit that divides the aquifer into a lower confined aquifer and an upper aquifer that is locally unconfined, semi-confined, or confined. The upper aquifer in the Tulare Formation produces low quality water, but the lower aquifer produces high quality water that is used for the City of Tracy.

The regional aquifer system within the Central Valley is comprised of post-Eocene continental fluvial deposits with some interbedded lacustrine deposits and volcanic material (Bertoldi, et al, 1991). These formations overlie Tertiary and pre-Tertiary formations that generally contain saline water (Williamson et al, 1989).

Within San Joaquin County the most important east-side fresh water-bearing formations are the Mehrten, Laguna, Victor, and alluvial deposits. The east-side formations are described in more detail below.

Mehrten: The Mehrten Formation is considered the oldest significant fresh water-bearing formation within eastern San Joaquin County. It is exposed in the eastern-most portion of the county, and slopes steeply from 90 to 180 feet per mile reaching a depth of 800 to 1000 feet and a thickness of 400 to 600 feet in the Stockton area, (DWR, 1967). Consisting of stream-deposited, semi-consolidated to consolidated silt, sand, and gravel, the formation is often subdivided into upper and lower units. The upper unit is reported to contain finer grained deposits (black sands interbedded with brown-to-blue clay) and the lower unit consists of dense tuff breccia (Page, 1986). Consequently, groundwater is reported to be semi-confined in the Stockton area. The Mehrten Formation has moderate to high permeability (where black sands occur) (DWR, 1967, Brown & Caldwell, 1985).

Laguna: The Laguna Formation outcrops in the northeastern part of the County and dips at 90 feet per mile (DWR, 1967), and reaches a maximum thickness of 1,000 feet. It consists of discontinuous lenses of unconsolidated to semi-consolidated sand and silt with lesser amounts of clay and gravel. The Laguna Formation is moderately permeable with some reportedly highly permeable coarse-grained beds and generally unconfined, but semi-confined conditions probably exist locally. Some studies have suggested that Corcoran Clay (an extensive aquitard found in the westside Tulare Formation) extends into the Laguna Formation or separates the Laguna and Mehrten Formations (Brown & Caldwell, 1985).

Victor: The Victor Formation is of Holocene to Pleistocene age and consists primarily of stream deposited unconsolidated gravel, sand, silt, and clay. Coarser sand and gravel is found to the east, and sand, silt and clay towards the west. This formation is generally more permeable than underlying formations, and groundwater within it is typically unconfined.

Alluvial/Stream channel deposits: Stream channel deposits are found along major stream and river courses within the study area. Generally, they consist of unconsolidated gravel and coarse sand and have high permeability.

The western and southwestern portions of San Joaquin County are not as significant sources of groundwater as the eastern portion of the County. The principal formations in western and southwestern San Joaquin County are the San Pablo Group, Tulare , and the alluvial deposits.

San Pablo Group: The San Pablo Group is a Miocene formation (west-side equivalent of the Mehrten Formation) and consists of primarily continental to marine sandstone and shale. It is considered to have relatively low permeability and is essentially non-water bearing except in fractures and joints.

Tulare Formation: A Plio-Pleistocene age formation (west-side equivalent of the Laguna Formation) consisting of primarily continental semiconsolidated clay, sand and gravel. This formation contains the Corcoran Clay member, dividing the formation into upper and lower units. The Corcoran Clay is an impermeable confining lacustrine deposit varying in thickness from 0 to 150 feet. The eastern limit of the Corcoran Clay is the San Joaquin River (DWR, 1967). The upper section is permeable to moderately permeable and unconfined to confined. The lower section is highly to variably permeable and is generally confined.

Alluvial deposits: These deposits in the western and southern parts of San Joaquin County are really extensive but generally thin, ranging from 0 to 150 feet (DWR, 1967). They consist of unconsolidated gravel and coarse sand derived from the Coast Ranges, and are permeable to moderately permeable.

Groundwater quality in the western portion of the County is generally poor. Historically, salinity intrusion into the Delta has extended as far east and south as Roberts Island – approximately midway between Stockton and Manteca (California State Water Resources Control Board, 1978).

2.8 Aquifer Units

In general, it is difficult to define the contacts between the Victor, Laguna and Mehrten Formations because of the similar nature of their lithology (DWR, 1967). Previous studies and investigations have generally considered the Sacramento Valley as containing one unconfined aquifer and the San Joaquin Valley as containing two aquifers separated by a regional confining unit. More recent studies have proposed the concept of a single heterogeneous aquifer system spanning the thickness of the continental deposits, which has varying vertical leakance and confinement depending on fine-grained sediments (Bertoldi, et al, 1991). Existing local and regional models of the Central Valley, (CVGSM model, Sacramento and San Joaquin County IGSM models) reflect both concepts of the Central Valley aquifer systems. These are described below:

The CVGSM model has 3-layer aquifer system. The layers within the Sacramento Valley are summarized below:

- Top layer: Represents mid-Pleistocene and younger deposits such as the Alluvium and Victor formations.
- Middle Layer: Represents Pliocene and younger formations such as Laguna, and Mehrten formations. The base of layer 2 is the base of the main groundwater-pumping layer.
- Bottom layer: Represents Miocene and older formations, the base of which is the base of fresh water.
- Within the San Joaquin Valley portion of the CVGSM, a regionally extensive confining unit is modeled which represents the Corcoran Clay.

The Sacramento County IGSM model has a 3-layer system representing the Miocene Valley Springs, Pliocene Mehrten, the Pleistocene Laguna and Victor and the Holocene Alluvium formations. A regionally extensive aquitard is also represented.

The San Joaquin County IGSM model has a 3-layer system with no explicit confining unit, but with variable vertical leakance in the 3 layers. The model represents essentially a two-aquifer system, a shallow alluvial type aquifer and a deeper Laguna/Mehrten aquifer. A third layer is modeled but represents an unusable high TDS and/or marine water bearing formation, representing the Miocene Valley Springs Formation.

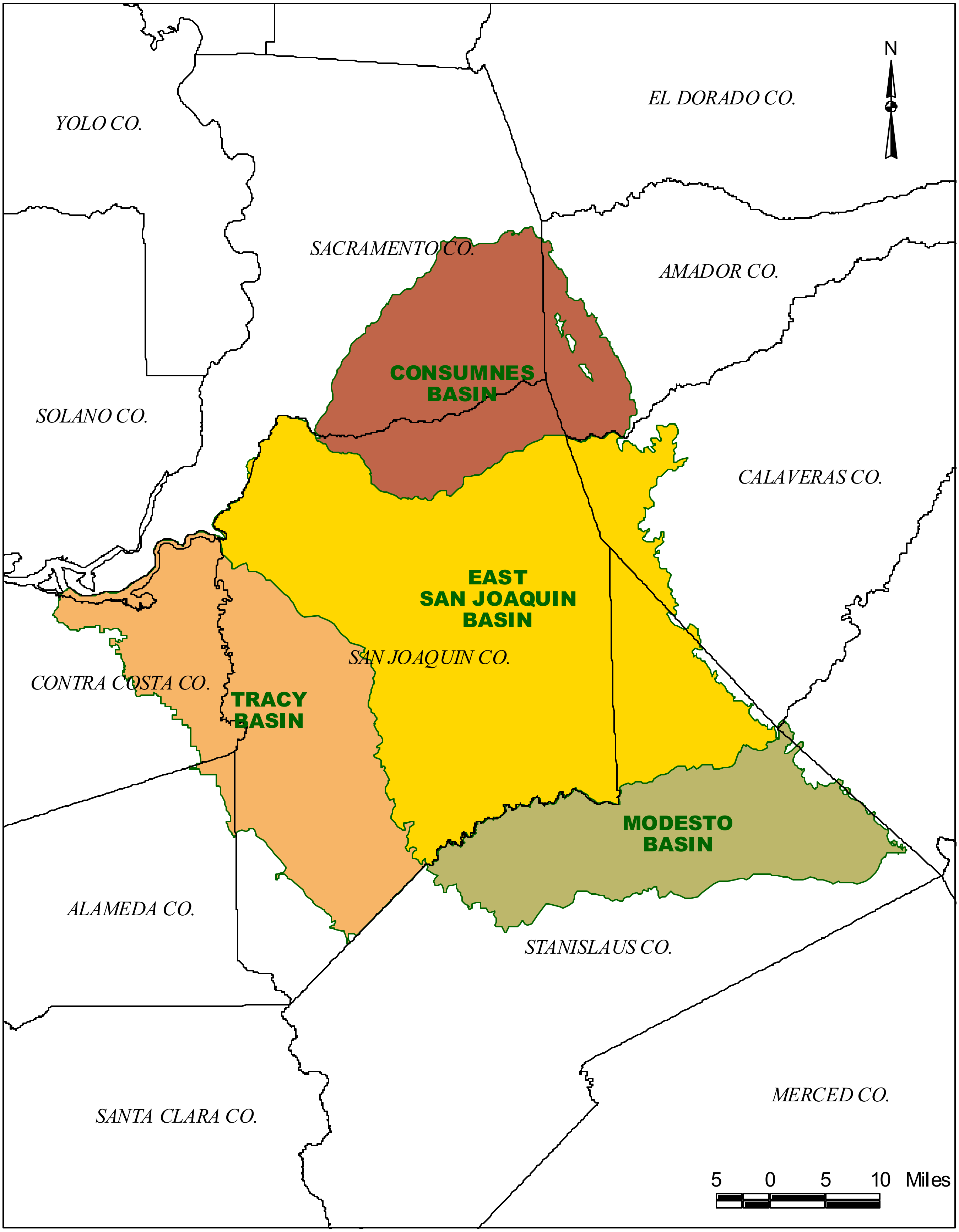
Brown and Caldwell developed a model of the Eastern San Joaquin Groundwater Basin in 1985. This model represented the aquifer system within San Joaquin County as a 2-aquifer (3 layer) system. The upper aquifer was comprised of the Victor and Laguna formations, and a confined lower aquifer was comprised of the Mehrten.

2.9 Aquifer Hydraulic Properties

Existing data on aquifer properties (e.g., transmissivities, hydraulic conductivities, storage coefficients, etc.) are primarily based on specific capacity data from installed wells. Aquifer heterogeneity is reflected in the large range of parameter values that have been used in various modeling efforts, summarized below.

Under the USGS Regional Aquifer-System Analysis (RASA) modeling of the Central Valley, an average horizontal hydraulic conductivity of 6 feet per day was reported based on the model calibration (Williamson et al, 1989). Within the Eastern San Joaquin Basin values of horizontal hydraulic conductivity ranged from 1 to 13 feet per day. The San Joaquin IGSM model has been calibrated with a wide range of aquifer permeability's, but they are typically much higher than the USGS model. Horizontal hydraulic conductivity ranges from 5 to 300 feet per day.

Analyses conducted on unconsolidated sediments in the Central Valley (Bertoldi, et al, 1991) showed hydraulic conductivities to be range from less than 1 to 14 feet per day. Measured porosity typically ranged from 30 to 40 percent.



Source: California Department of Water Resources

SAN JOAQUIN COUNTY
WATER MANAGEMENT PLAN

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Figure 2-1
GROUNDWATER BASINS MAP

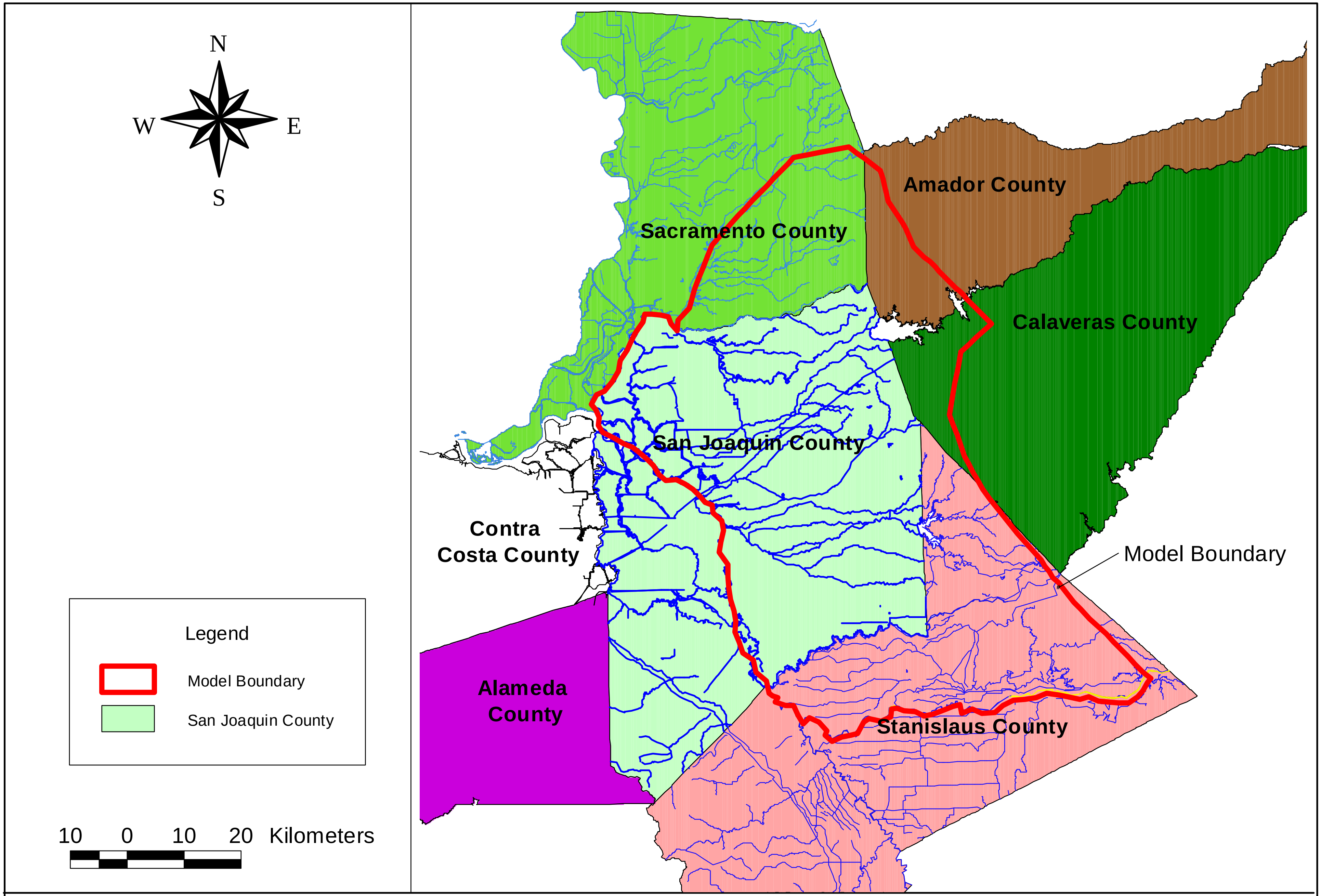

Figure 2-2 - Location Map and Model Domain
San Joaquin Water Management Plan

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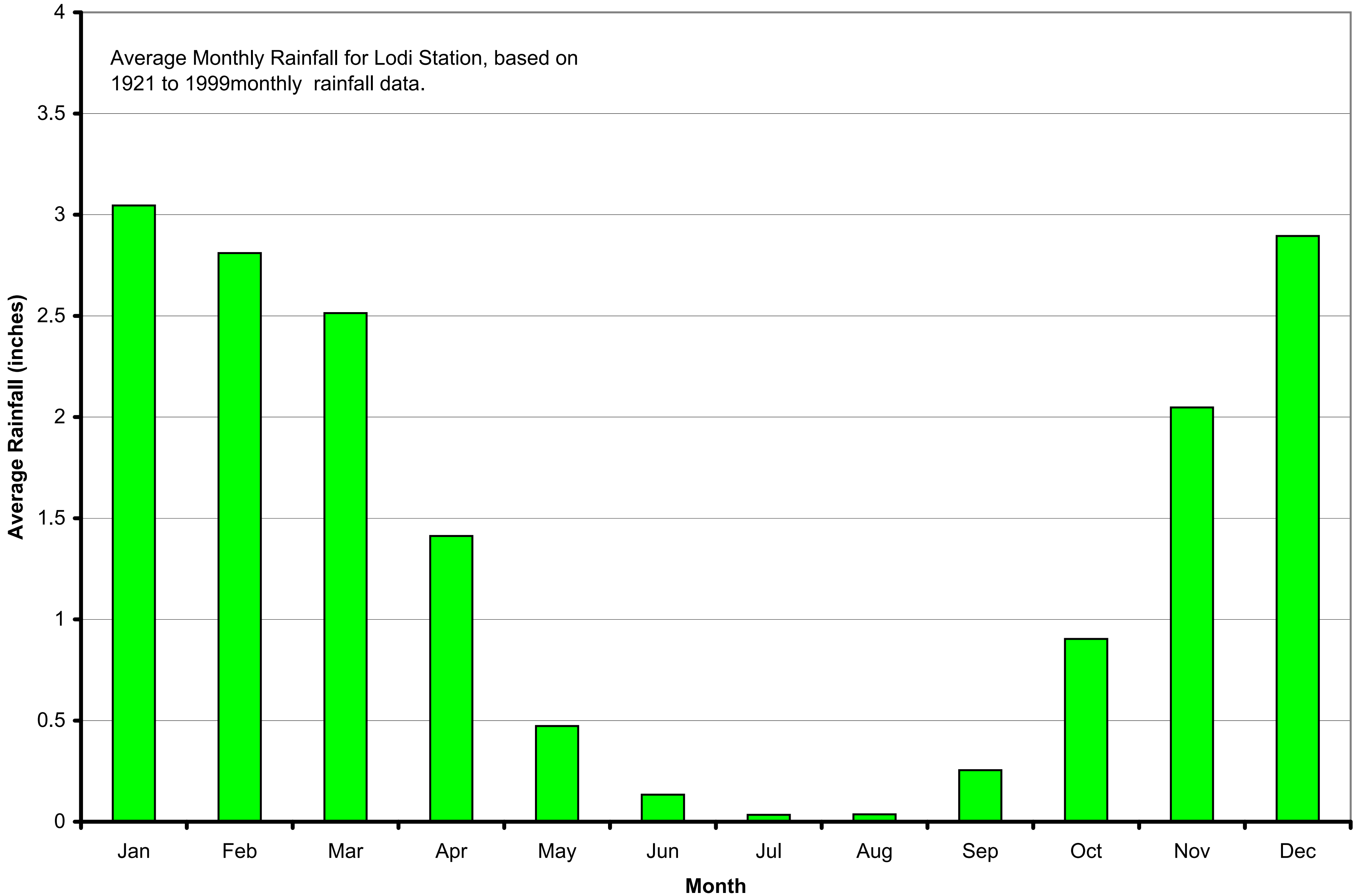


Figure 2-3
Long-Term Annual Average Rainfall - Lodi Station
San Joaquin County Water Management Plan

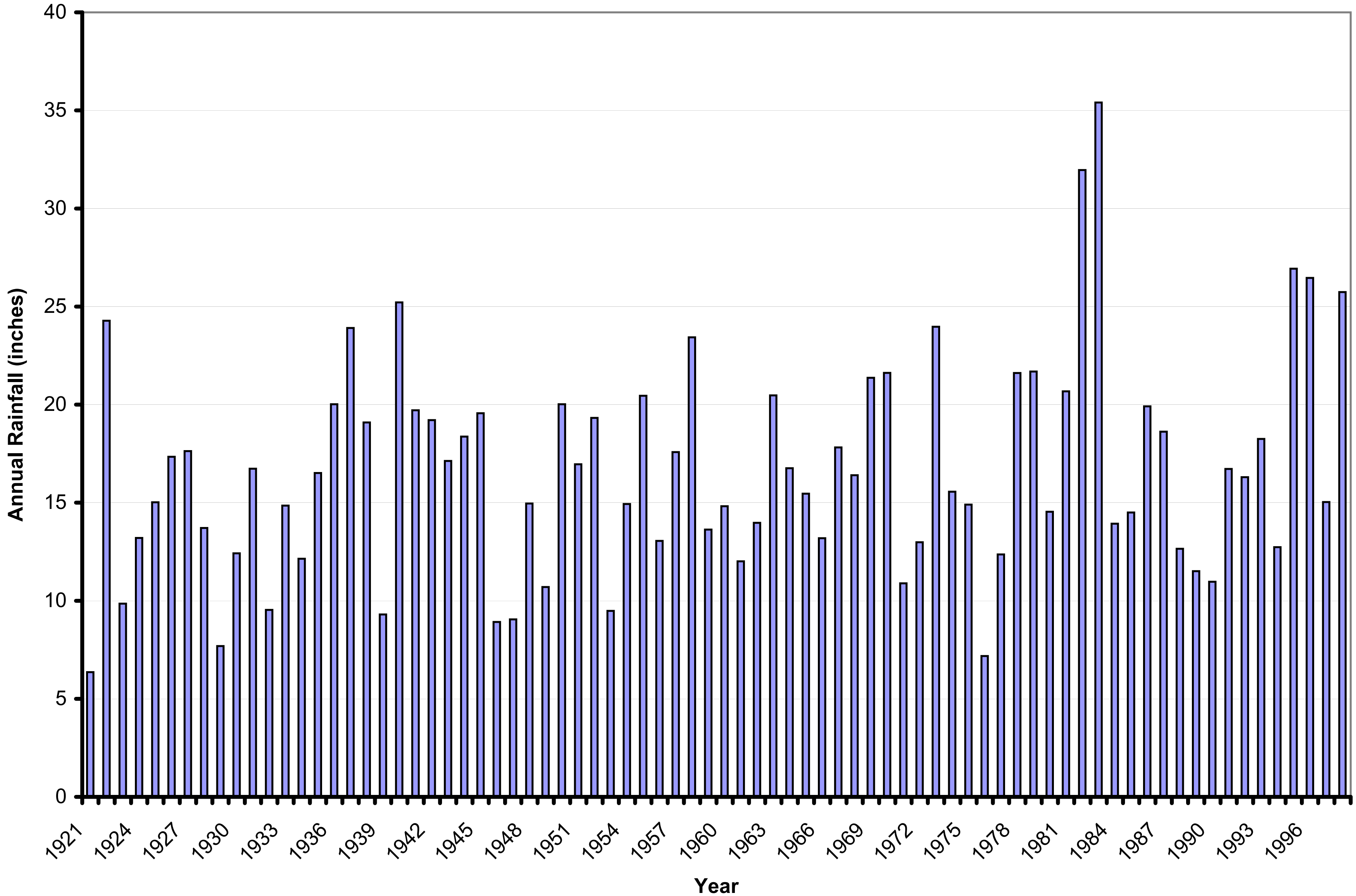
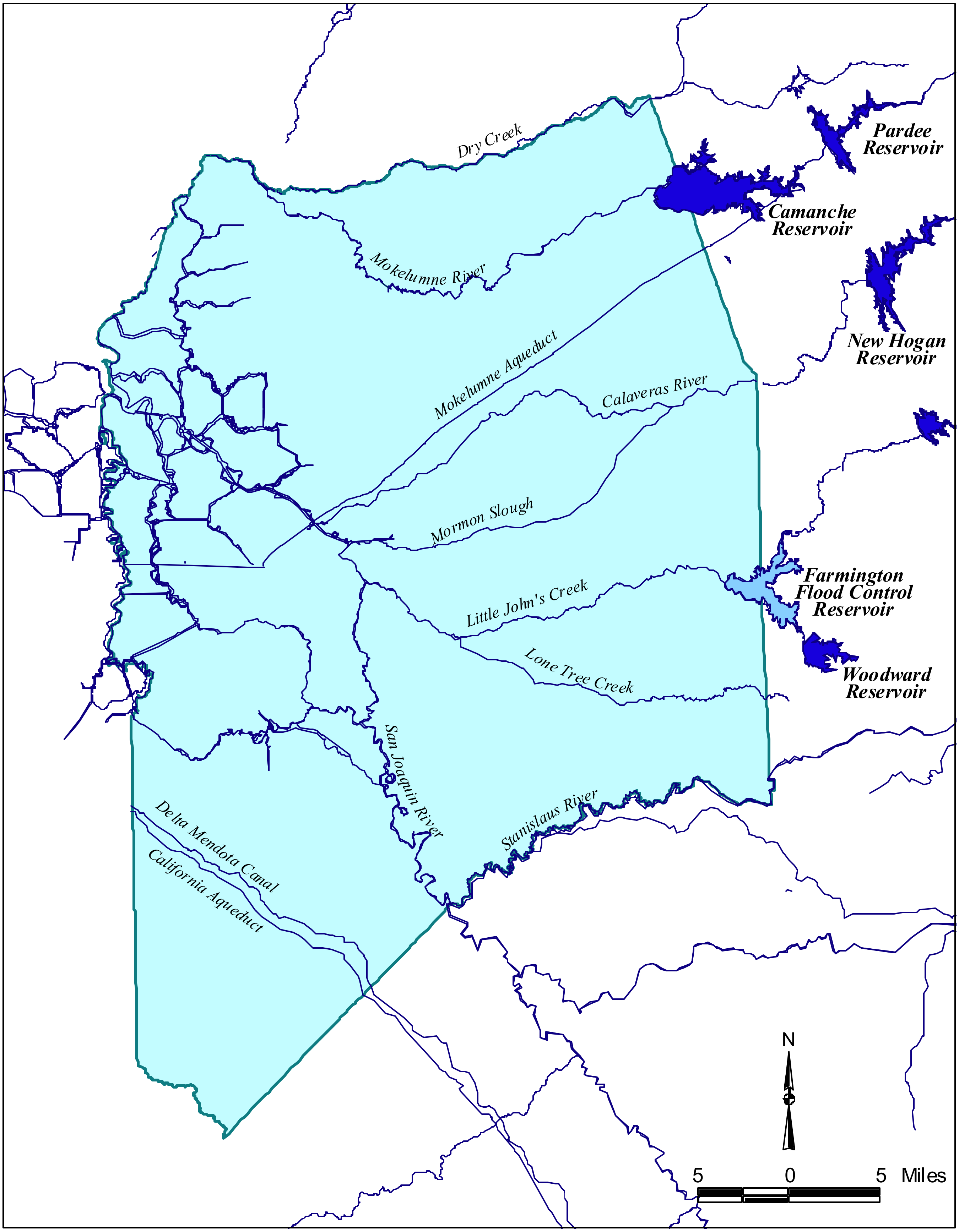


Figure 2-4
Long-Term Annual Average Rainfall - Lodi Station
San Joaquin County Water Management Plan



Source: California Department of Water Resources

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WATER MANAGEMENT PLAN

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Figure 2-5
MAJOR COUNTY RIVERS AND RESERVOIRS

Section 3
Groundwater and Surface Water Model Development

3.1 Model Code

The modeling software utilized in this study included DYNFLOW (single phase groundwater flow), and DYNTRACK (solute transport).

3.1.1 DYNFLOW

The groundwater flow computer code used in this study is the fully three-dimensional, finite element groundwater flow model, DYNFLOW. This model has been developed over the past 18 years by CDM engineering staff, and is in general use for large scale basin modeling projects and site specific remedial design investigations. It has been applied to over 150 modeling studies in the United States.

The governing equation for three-dimensional groundwater flow that is solved by DYNFLOW is:

$$S_s \frac{\partial f}{\partial t} = \frac{\partial}{\partial x_i} K_{ij} \frac{\partial f}{\partial x_j} \; ; i, j = 1,2,3$$

where the state variable ö represents the potentiometric head [L]; K_{ij} represents the hydraulic conductivity [LT 1] tensor; S_s is the specific storativity (volume/volume/length), [L 1]; x_j is a Cartesian coordinate and t is time.

DYNFLOW uses a grid built with a large number of tetrahedral elements. These elements are triangular in plan view, and give a wide flexibility in grid variation over the area of study. An identical grid is used for each level of the model, but the thickness of each model layer (the vertical distance between levels in the model) can vary at each point in the grid. In addition, 2-dimensional elements can be inserted into the basic 3-dimensional grid to simulate thin features such as faults. One-dimensional elements can be used to simulate the performance of wells which are perforated in several model layers.

DYNFLOW accepts various types of boundary conditions on the groundwater flow system including:

- Specified head boundaries (where the piezometric head is known, such as at rivers, lakes, or other points of known head);

- Specified flux boundaries (such as rainfall infiltration, well pumpage, and no-flow "streamline" boundaries);

- Rising water boundaries; these are hybrid boundaries (specified head or specified flux boundary) depending on the system status at any given time; and

- Head-dependent flux (3rd type) boundaries including "River" and "General Head" boundary conditions.

The DYNFLOW code has been reviewed and tested by the International Groundwater Modeling Center (IGWMC) (van der Heijde 1985). The code has been extensively tested and documented by CDM.

3.1.2 DYNTRACK

The solute transport code used in this study is DYNTRACK. DYNTRACK uses the random-walk technique to solve the advection-dispersion equation. DYNTRACK has been developed over the past 15 years by CDM engineering staff. The partial differential equation describing transport of conservative solutes in a groundwater flow field is:

$$n_e \frac{\partial C}{\partial t} = \frac{\partial}{\partial x_i} n_e D_{ij} \frac{dC}{dx_j} - q_i \frac{dC}{dx_i}; i, j = 1, 2, 3$$

where C is the concentration at any x_i location, n_e is the effective porosity, q_i is the specific discharge vector, and D_{ij} is the dispersion tensor. The first term on the right hand side if the equation represents the dispersive flux as embodied by Fick's Law; the second term represents the advective flux of solute mass.

DYNTRACK uses a Langrangian approach to approximate the solution of the partial differential equation of transport. This process uses a random walk method to track a statistically significant number of particles, wherein each particle is advected with the mean velocity within a grid element and then randomly dispersed according to specified dispersion parameters.

In DYNTRACK, a solute source can be represented as an instantaneous input of solute mass (represented by a fixed number of particles), as a continuous source on which particles are input at a constant rate, or as a specified concentration at a node. The concentration within a particular zone of interest is represented by the total number of particles that are present within the zone multiplied by their associated solute mass, divided by the volume of water within the zone. DYNTRACK has also been reviewed and tested by the IGWMC (van der Heijde 1985).

3.2 Model Domain and Finite Element Grid

The model domain and finite element grid are illustrated in Figure 3-1. As already discussed the model covers portions of Sacramento, Stanislaus, and Calaveras Counties, and does not include the portion of San Joaquin County west of the San

Joaquin River. The finite element grid for the model consists of 1892 triangular elements, and 3520 nodes per level. The finite element grid discretization is essentially the same as that of the IGSM model. The only difference is that the quadrilateral elements from IGSM (IGSM uses both triangular and quadrilateral elements) were split into two triangular elements.

3.3 Model Stratigraphy

The model consists of 4 layers and 5 levels, and is based on the IGSM model. As already mentioned, there is no clear definition of the contacts between the Victor, Laguna and Merhten formations, and therefore the correlation between model layers and geologic formation is very general. Table 3-1 provides description of the model layering and stratigraphy.

Table 3-1
Model Stratigraphy

Model Layer	Description
4	Represents the shallow alluvial and Victor formation deposits. Fresh water, moderately permeable, generally unconfined. Model layer varies from 15 to 190 feet thick.
3	Represents Laguna and Merhten Formations. Generally fresh water bearing and moderately too highly permeable. Model layer varies from 130 to 1500 feet thick.
2	Represents Valley Springs Formation. Considered to be saline in the west/Stockton area. Low permeability. Model layer varies from 0 to 1400 feet thick.
1	Inactive model layer.

Figures 3-2 through 3-6 illustrate cross-sections through the model. Three west to east cross sections show model stratigraphy. Figure 3-2 shows a cross section through model starting at the western boundary of the model, the San Joaquin River along the Mokelumne River to the eastern edge of the model, the San Joaquin County boundary. Figure 3-3 shows a cross section through model starting at the San Joaquin River along the Calaveras River to the San Joaquin County boundary. Figure 3-4 shows a cross section starting at the San Joaquin River along the Stanislaus River to the San Joaquin County boundary. Figures 3-5 and 3-6 show model stratigraphy along north to south cross sections. Figure 3-5 shows a cross section along the San Joaquin River, along the length of San Joaquin County, and Figure 3-6 shows a cross section along Highway 99.

3.4 Model Aquifer Properties

The distribution of aquifer hydraulic properties was primarily determined by calibration. The aquifer hydraulic properties of each layer are described below:

- Layer 4, which is the top layer of the model, is shown on Figure 3-7. It illustrates the distribution of the main aquifer properties for the layer. This layer, representing the alluvium and Victor formations, has horizontal hydraulic conductivity varying from 10 to 150 feet per day. The vertical hydraulic conductivity various from 0.1 to 1.5 feet per day (horizontal to vertical anisotropy of 1:100). In general, the hydraulic conductivity increases from east to west.

- Layer 3 is shown on Figure 3-8. It illustrates the distribution of the main aquifer properties for the layer. This layer, representing the Laguna and Merhten formations, has horizontal hydraulic conductivity varying from 10 to 100 feet per day. The vertical hydraulic conductivity various from 0.1 to 2 feet per day (horizontal to vertical anisotropy of 1:100). In general, the hydraulic conductivity increases from east to west.

- Layer 2 is shown on Figure 3-9. It illustrates the distribution of the main aquifer properties for the layer. This layer, representing the Valley Springs formations, has horizontal hydraulic conductivity varying from 1 to 40 feet per day. The vertical hydraulic conductivity varies from 0.1 to 0.4 feet per day (horizontal to vertical anisotropy of 1:100). The thickness of layer 2 increases from east to west.

- Layer 1 is essentially an inactive layer, and is included to improve the numerical stability of the model.

3.5 Boundary Conditions

The major boundary conditions used for the model are:

- General head;

- Fixed Head;

- No flow;

- Third type / rising head; and

- River / variable head.

The general head boundaries are used along the south, west and north-west boundaries of the model. The fixed head boundaries are used along the northern boundary, and the no flow is used along the entire eastern edge of the model. The top level of the model, i.e., ground surface, is set to a third-type or rising head boundary condition. This boundary allows the water table to reach the ground level, at which point water is discharged to the surface. The major rivers modeled are: San Joaquin, Tuolume, Stanislaus, Calaveras, Mokelumne, Consumnes and Dry Creek. The surface water features are discussed in more detailed in the following section.

3.6 Rivers

Six rivers are modeled explicitly. They are the San Joaquin, Tuolume, Stanislaus, Calaveras, Mokelumne, Consumnes and Dry Creek. The rivers are specified as a series of linked river reaches, shown on Figure 3-10. For each river reach, a property set is defined, that includes river bed width, bank angle, Manning's n, maximum flow depth, tortuosity, river bed thickness and vertical hydraulic conductivity. For each system within the model domain, the user specifies the downstream river stage, inflows, and diversions. DYNFLOW calculates the flow in or out of the stream to the groundwater under saturated and unsaturated conditions. Runoff from rainfall or irrigation activities is also calculated and added to the flow. Detailed information on the input parameters is available from the model input file.

3.7 Land Use

Three types of land uses are input into the model; urban; agricultural and native. They are discussed below.

3.7.1 Urban

Historical urban areas were imported from the IGSM model. For future conditions, urban areas were determined urban spheres of influence, assuming a linear rate of growth from 2000 to 2030. By 2030 it was assumed that the areas contained by the urban spheres of influence is fully urbanized. The input for DYNFLOW is the percent of each finite element that is urbanized. Figure 3-11 shows the model input for urban land use for years 1958 and 1988.

3.7.2 Agricultural

Historical land use was imported from the IGSM model. For predictive simulations DWR land use data for 1996 was incorporated into the model, with agricultural areas within the urban spheres of influence reduced on a linear basis through the year 2030. By the year 2030, agricultural land use within urban spheres of influence was completely converted to urban land use. The actual data that is imported into the model is the evapotranspiration of each model element based on the different crop types and areas linked to that element through the use of a GIS system. Figure 3-12 shows the model input for agricultural land use for years 1958 and 1988.

3.7.3 Native

Native areas were assumed to have a constant evapotranspiration. Figure 3-13 shows the model input for native land use for years 1958 and 1988.

3.8 Applied Hydraulic Stresses

3.8.1 Groundwater Discharge

Municipal, Industrial and Domestic Pumping

Municipal, industrial and domestic groundwater pumping for the historic period from 1970 to 1993 was based on the data in the IGSM model. For 1993 to 2000 and predictive simulations the pumping was updated based on more recent data, and projected urban demands documented in TM1. Urban pumping outside San Joaquin County was assumed to increase at a rate of 3% per year in the post 1993 and predictive simulations.

Agricultural Pumping

Agricultural pumping for the historic period from 1970 to 1993 was primarily based on the data in the IGSM model. Modifications were made based on new information and calibration to factors that affect the groundwater pumping, such as: evapotranspiration rates for different crop types; agricultural irrigation efficiency; conveyance losses; soil runoff characteristics; surface water irrigation rates and locations, etc.

Figure 3-14 shows the simulated historical and predicted groundwater pumping for the entire model domain, which includes the southern portion of Sacramento County and the northern portion of Stanislaus County. Groundwater pumping within San Joaquin County is estimated to have averaged approximately 867,000 ac-ft per year from 1970 to 2000.

3.8.2 Groundwater Recharge

Deep Percolation

Deep percolation is the recharge from rainfall, irrigation and recharge activities. Deep percolation is calculated by the model based on rainfall and runoff parameters including land use, crop patterns, irrigation and related parameters. For the predictive simulation period of 2000 to 2030, the 1970 to 2000 hydrologic record was used as input for rainfall and stream hydrology. Figure 3-15 shows the simulated historical and predicted deep percolation the entire model domain, which includes the southern portion of Sacramento County and the northern portion of Stanislaus County. Deep percolation within San Joaquin County is estimated to have averaged between 470,000 to 590,000 ac-ft per year from 1970 to 2000.

3.8.3 Surface Water Interaction

As already noted, the San Joaquin, Tuolume, Stanislaus, Calaveras, Mokelumne, Consumnes and Dry Creek are modeled explicitly. Depending on the stream parameters and local groundwater conditions, these streams will either be losing streams (i.e., have a net discharge to the groundwater system) or gaining streams (have a net recharge from the groundwater system). Table 3-2 summarizes the average stream gains and losses to groundwater.

Table 3-2
Summary of Groundwater Loss/Gain by River

River	Gain from Groundwater	Loss to Groundwater	Net
Dry Creek	0	2,611	2,611
Calaveras	1	20,957	20,957
Stanislaus	51,379	38,416	-12,963
Mokelumne	35	102,772	102,737
San Joaquin River	57,483	33,413	-24,069
San Joaquin County Only	108,989	198,170	89,272

3.8.4 Surface Water Irrigation

Irrigation of crops with surface water is also simulated. The main data inputs for this component are points of diversion, diversion rates, and area irrigated. The points of diversion were taken from the IGSM model, as were the majority of the diversion rates. Some modifications were made based on more recent data. The areas irrigated were completely revised based on the infrastructure maps developed for the SJCWMP, and based on DWR land use information.

3.9 Flow Model Calibration

Model calibration is the process of modifying model input parameters until the output from the model reasonably matches a set of measured data and the observed transient behavior of the ground water flow system (e.g., seasonal head changes). Good calibration is required to reliably apply the model in predictive mode, such as forecasting the impacts of water management actions on the ESJCGB.

The objectives of calibration of regional aquifer systems and regional models such as the ESJCGB model are very different from calibration of local-scale models. With a regional scale model, the objective is to achieve a representation of the basic hydrogeological characteristics and controls of the ground water flow system, and small-scale aquifer heterogeneities are represented by bulk properties, or ‘averages’, for larger volumes of aquifer material. In local-scale models, small-scale heterogeneities may be important to represent in greater detail.

3.9.1 Steady-State Calibration

During calibration, measured and model-computed heads (water levels) are compared, and the difference is referred to as the residual:

Residual = Measured water level – computed water level

In terms of quantifying the calibration, and defining an 'acceptable' calibration, a set of basic 'standards' were followed since interpretations of calibration results between modelers / reviewers can be subjective:

- There should be no systematic head bias across the model domain. The spatial correlation of residuals should be random.
- Greater emphasis was placed on calibration of the area of detailed study (i.e., San Joaquin County) than the areas to the north and south.
- The standard deviation of residuals should be within 10-15% of the total measured head gradient across the model domain.
- The mean and absolute mean differences of the residuals should be close to zero.

Steady state calibration was performed for water year 1970. After an acceptable calibration was obtained for this period, the transient calibration was performed. Figure 3-16 shows the calibrated groundwater table for 1970, with the calibration statistics. Figure 3-17 shows a graph of the calculated versus observed groundwater heads. The closer to a straight line fit the points are, the better the calibration, indicating no spatial basis in the residuals. Water balance for average conditions is presented in Table 3-3. The numbers in the table are based on (1970 to 2000) average values.

Table 3-3
Simplified Groundwater Balance for Current Conditions

Groundwater Flow Component	Average Value	Explanation
Inflows (acre-feet per year)		
Deep Percolation/Recharge	608,400	Net infiltration from rainfall, irrigation, canal leakage etc.
Gain from Streams	198,170	Net inflow from streams to groundwater system
Lateral Inflow	98,000	Subsurface inflows
Total Inflows	**904,577**	
Outflows		
Groundwater Pumping	867,600	Net agricultural, municipal and industrial pumping
Loss to Streams	108,898	Net outflow from groundwater system to streams
Lateral Outflow	35,300	Subsurface Outflows
Total Outflows	**1,011,815**	
Groundwater Overdraft		
Groundwater from Aquifer Storage	107,238	Total Inflows – Total Outflows
Estimated Saline Water Intrusion	42,000	Lateral Inflow in the Stockton Area
Estimate Total Gr oundwater Overdraft	**150,700**	Aquifer Storage Loss + Saline Water Intrusion

3.9.2 Transient Calibration

After an acceptable steady state calibration was achieved, a transient calibration was performed. The transient calibration was performed for the period of 1970 to 1993, using a monthly time step. Stream flows, diversions, pumping, and boundary conditions were varied on a monthly basis. Land use and crop patterns were changed every five years. Figures 3-18 through 3-39 show the transient calibration hydrographs for 1970 to 1993.

In terms of the head comparison, emphasis was placed on the subsequent simulated response - i.e., whether the model reproduces the observed trends in water levels. Trends are expressions of regional features, and if they are captured by the model, this provides added confidence that the model can be applied for predictive purposes. As demonstrated by Figures 3-18 through 3-39, reasonable simulated responses were achieved for the transient period in different parts of the model. A location map showing the transient well calibration targets is provided on Figure 3-40.

The ESJCGB integrated groundwater-surface water model is a fully 3-dimensional model. It has been constructed and calibrated to address regional water management issues that involve the interaction of complex surface water and groundwater operations. The main objective behind the calibration effort was to represent the flow characteristics and general hydraulic behavior of the aquifer system. The calibration and verification results are acceptable for the current level of planning and are capable of supporting the simulations of future water management options. Additional information is required in order to update land use information, urban pumping and agricultural diversion data.

The ESJCGB model is a regional-scale flow model and as such incorporates ‘regional’ features. Local-scale models typically incorporate features that have little or no impact on overall aquifer assessment, but may be important for site-specific studies/problems such as assessing the performance or impact of a recharge basin. For more detailed engineering and design, local hydrogeological and hydraulic features need to be incorporated.

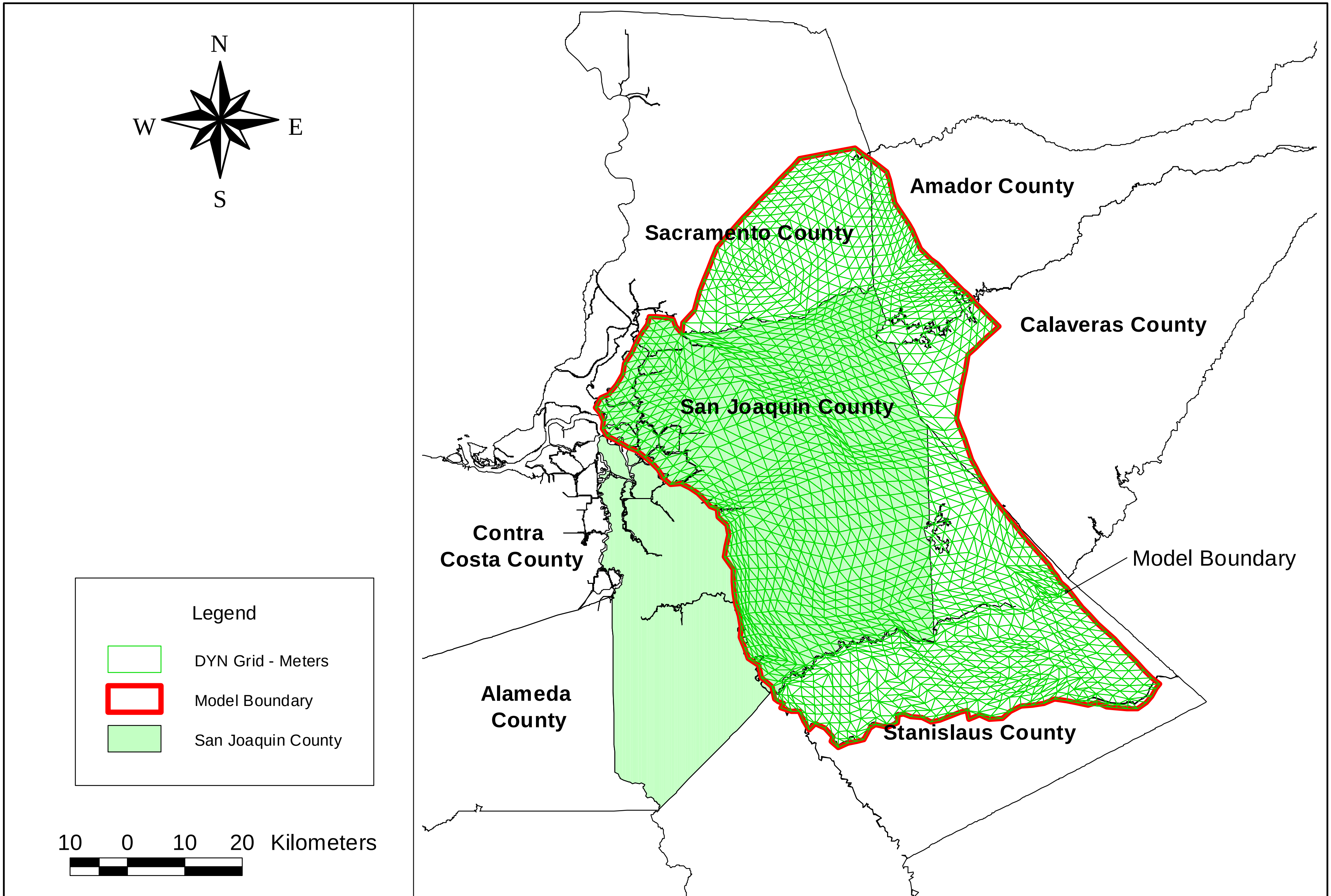

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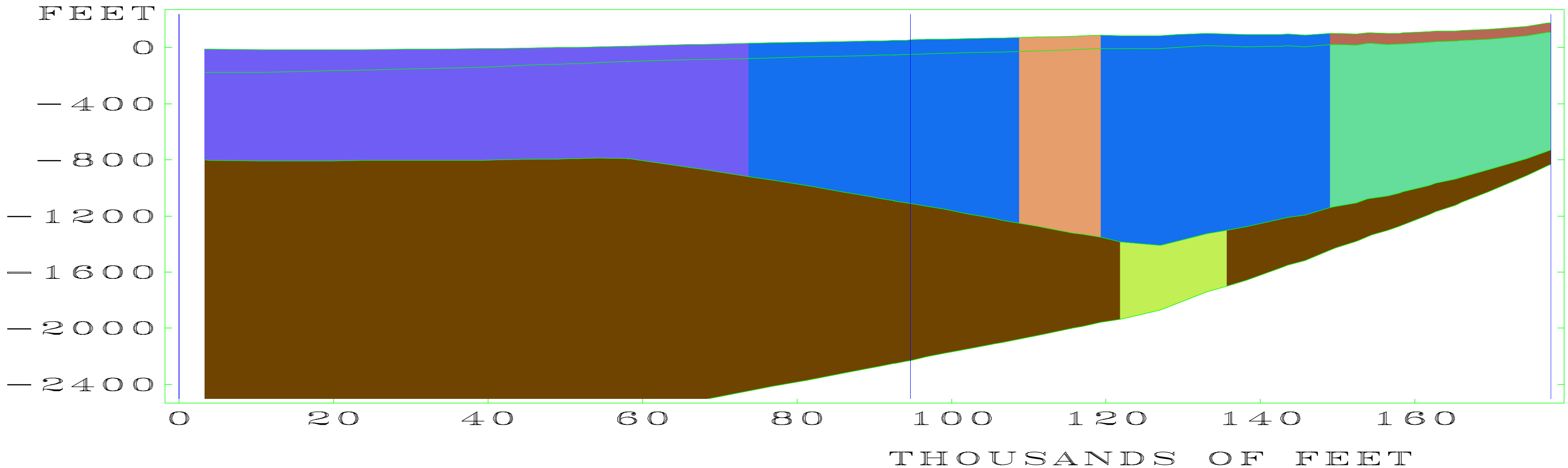
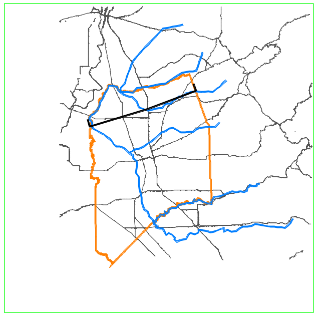
Figure 3-1 - Model Finite Element Grid
San Joaquin Water Management Plan



MATERIALS CROSS-SECTION AA

- K = 10.0 ft/day
- K = 20.0 ft/day
- K = 40.0 ft/day
- K = 30.0 ft/day
- K = 200.0 ft/day
- K = 100.0 ft/day
- K = 5.0 ft/day
- Inactive Layer

CROSS SECTION AA



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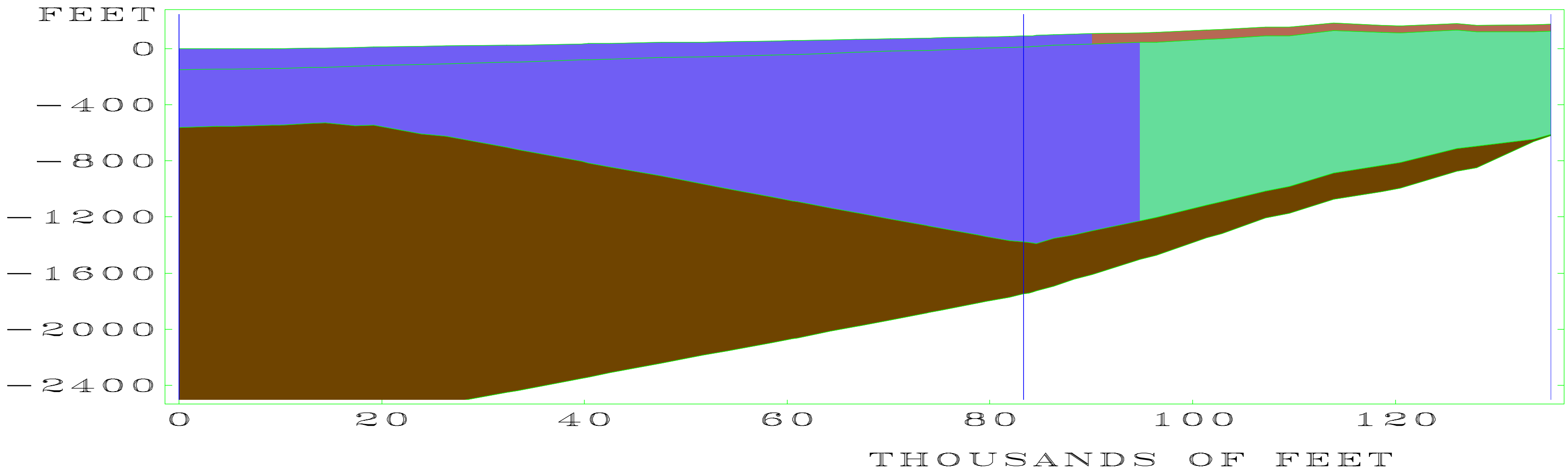
Cross Section Through Model
Wsst to East: From Delta Along Mokelumne River
to Eastern Border of San Joaquin County
San Joaquin County Water Management Plan

FIGURE
3-2



MATERIALS CROSS-SECTION BB

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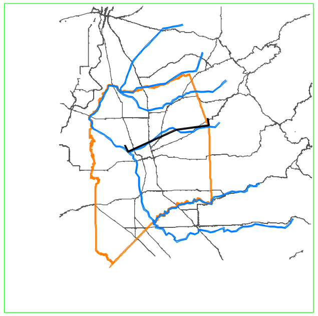
K = 10.0 ft/day
K = 100.0 ft/day
K = 5.0 ft/day
Inactive Layer

CROSS SECTION BB



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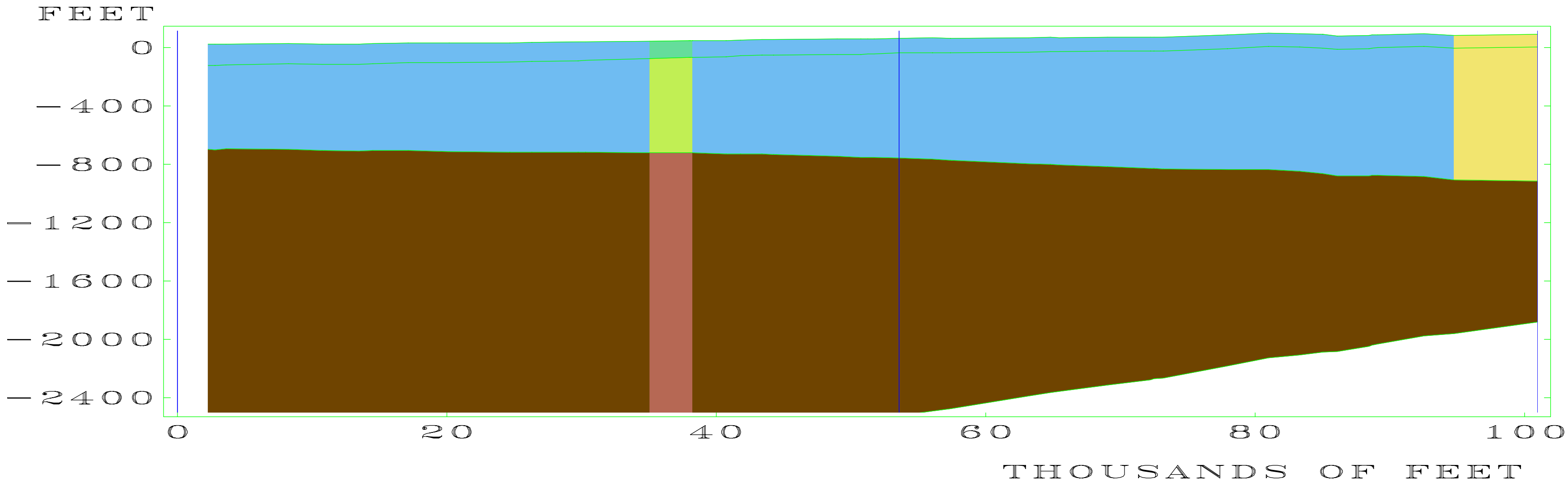
Cross Section Through Model: West to East
From San Joaquin River Along Calaveras River
to Eastern Border of San Joaquin County
San Joaquin County Water Management Plan

FIGURE
3-3



MATERIALS CROSS-SECTION CC

- K = 75.0 ft/day
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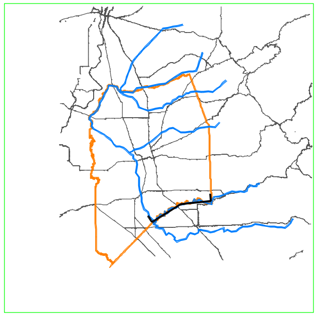
CROSS SECTION CC



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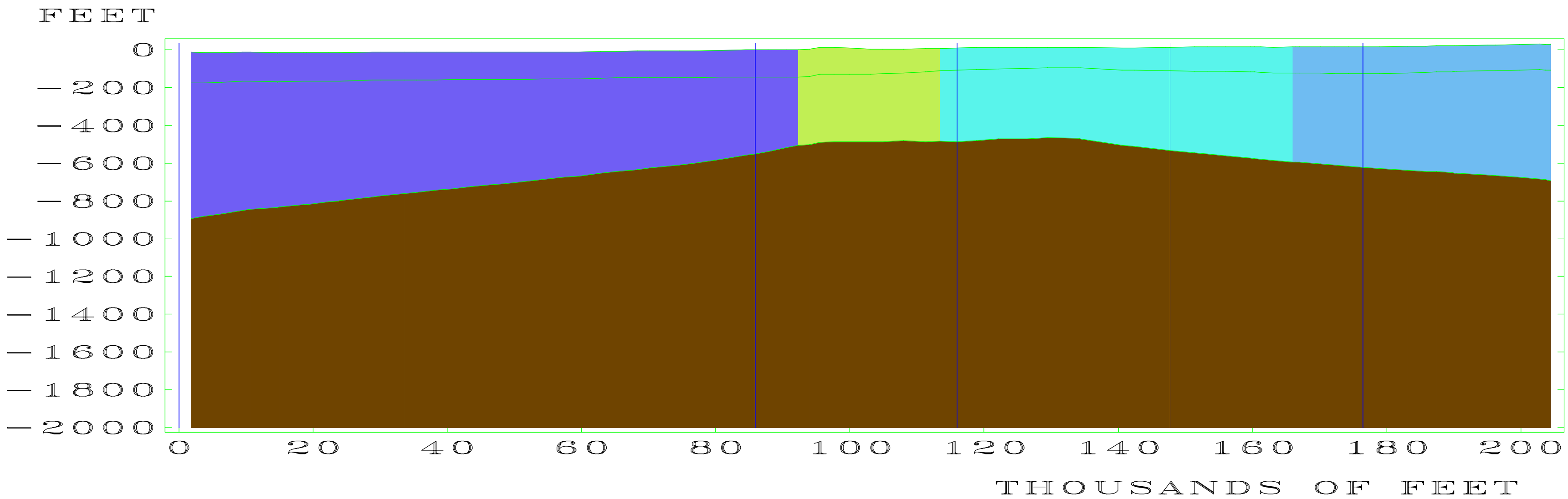
Model Through Cross Section: West to East
From San Joaquin River Along Stanislaus River
to Eastern Border of San Joaquin County
San Joaquin County Water Management Plan

FIGURE
3-4



MATERIALS CROSS-SECTION EE

- K = 150.0 ft/day
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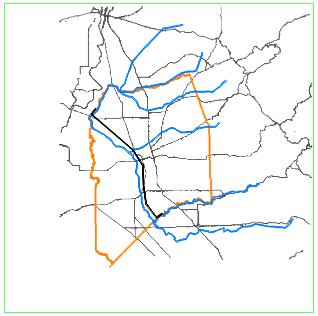
- K = 40.0 ft/day
- K = 100.0 ft/day
- K = 5.0 ft/day
- Inactive Layer

CROSS SECTION EE



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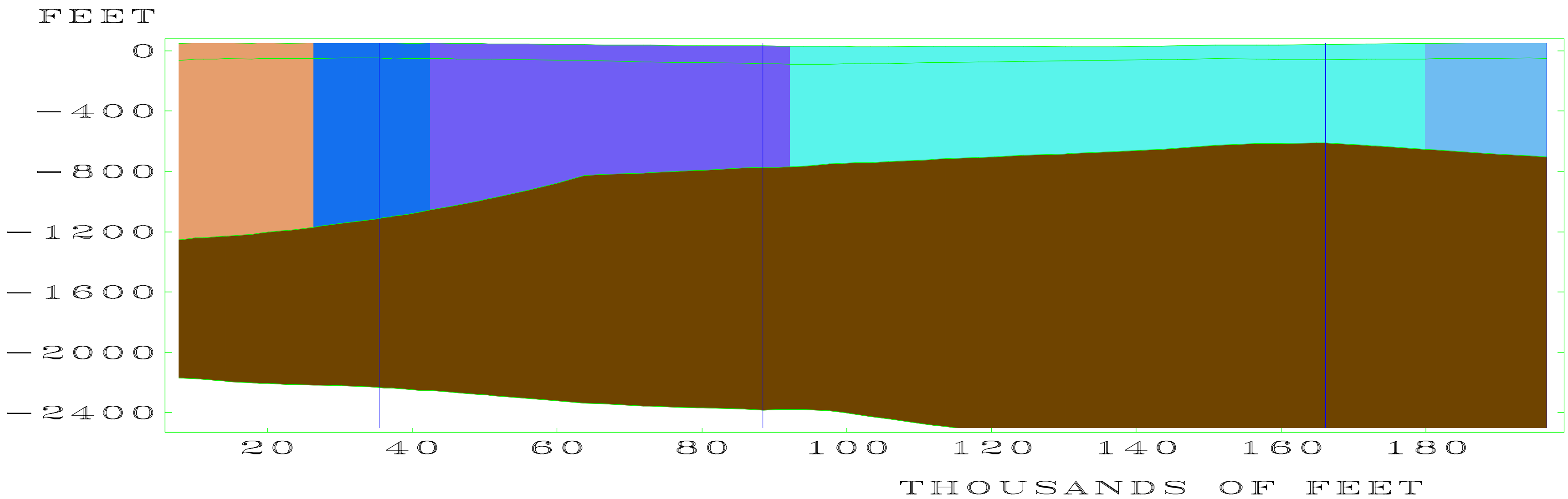
Model Cross Section: North to South
From Mokelumne to Stanislaus River
Along San Joaquin River
San Joaquin County Water Management Plan

FIGURE
3-5



MATERIALS CROSS-SECTION FF

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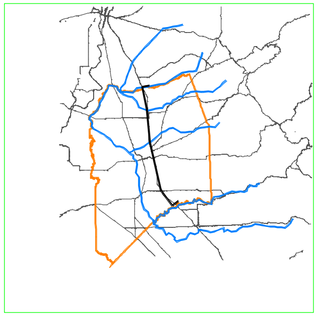
- K = 60.0 ft/day
- K = 100.0 ft/day
- K = 200.0 ft/day
- K = 30.0 ft/day
- K = 5.0 ft/day
- Inactive Layer

CROSS SECTION FF



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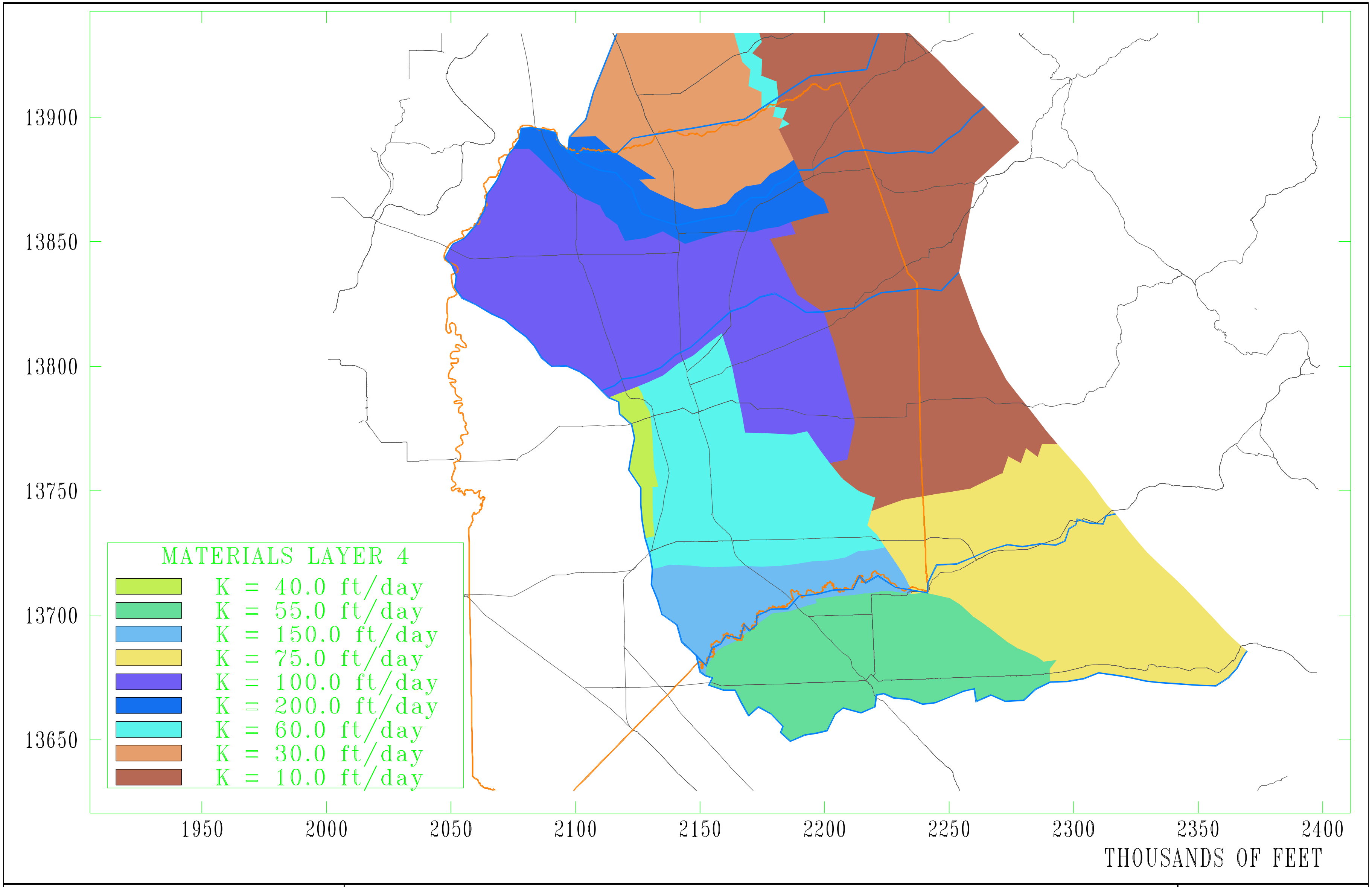
Cross Section through Model: North to South
From Dry Creek to Stanislaus
Along Highway 99
San Joaquin County Water Management Plan

FIGURE 3-6

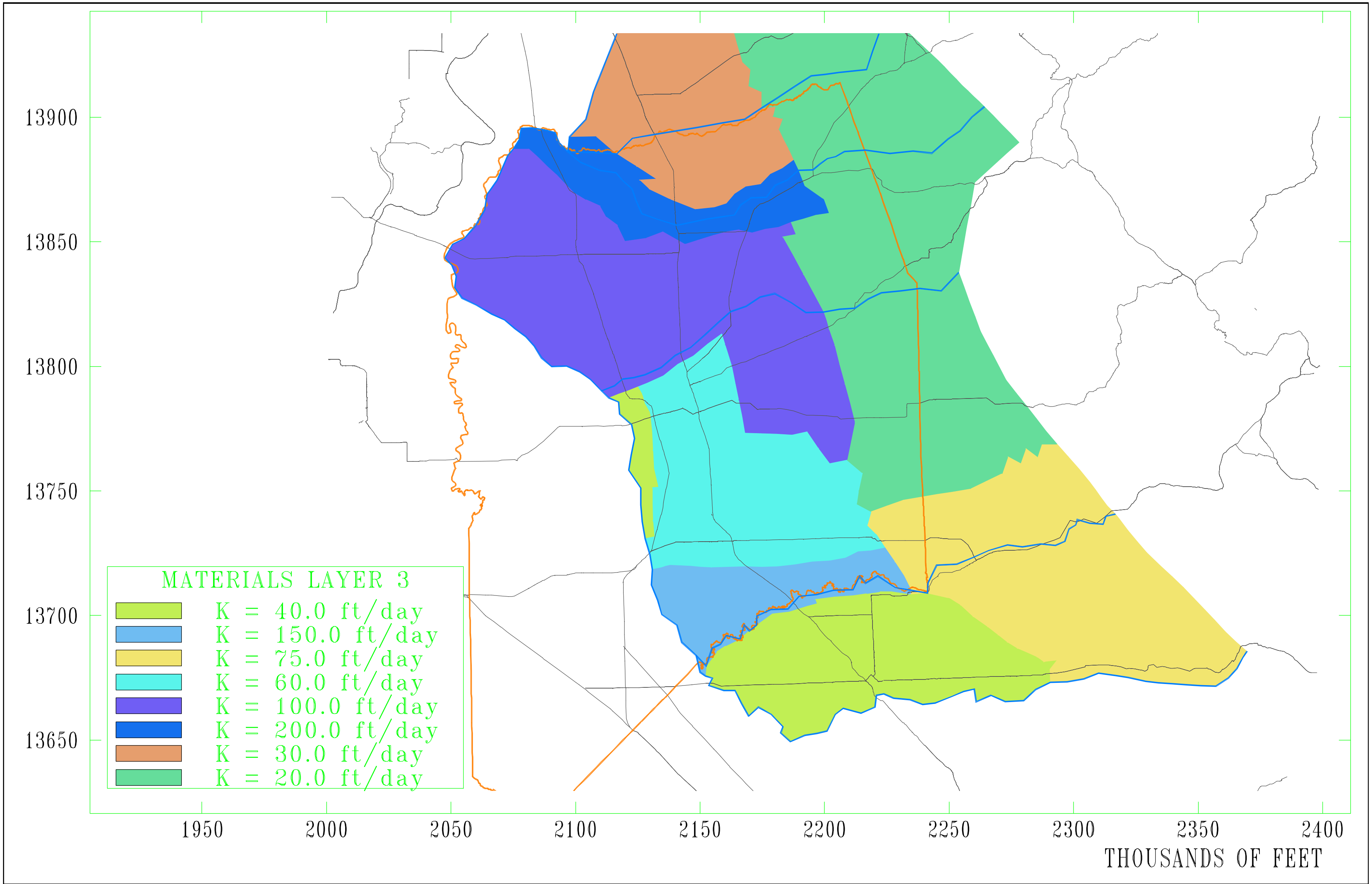


consulting engineering construction operations CDM

Model Hydraulic Property Distribution
Layer 4: Alluvium and Victor Formation

San Joaquin County Water Management Plan

FIGURE 3-7



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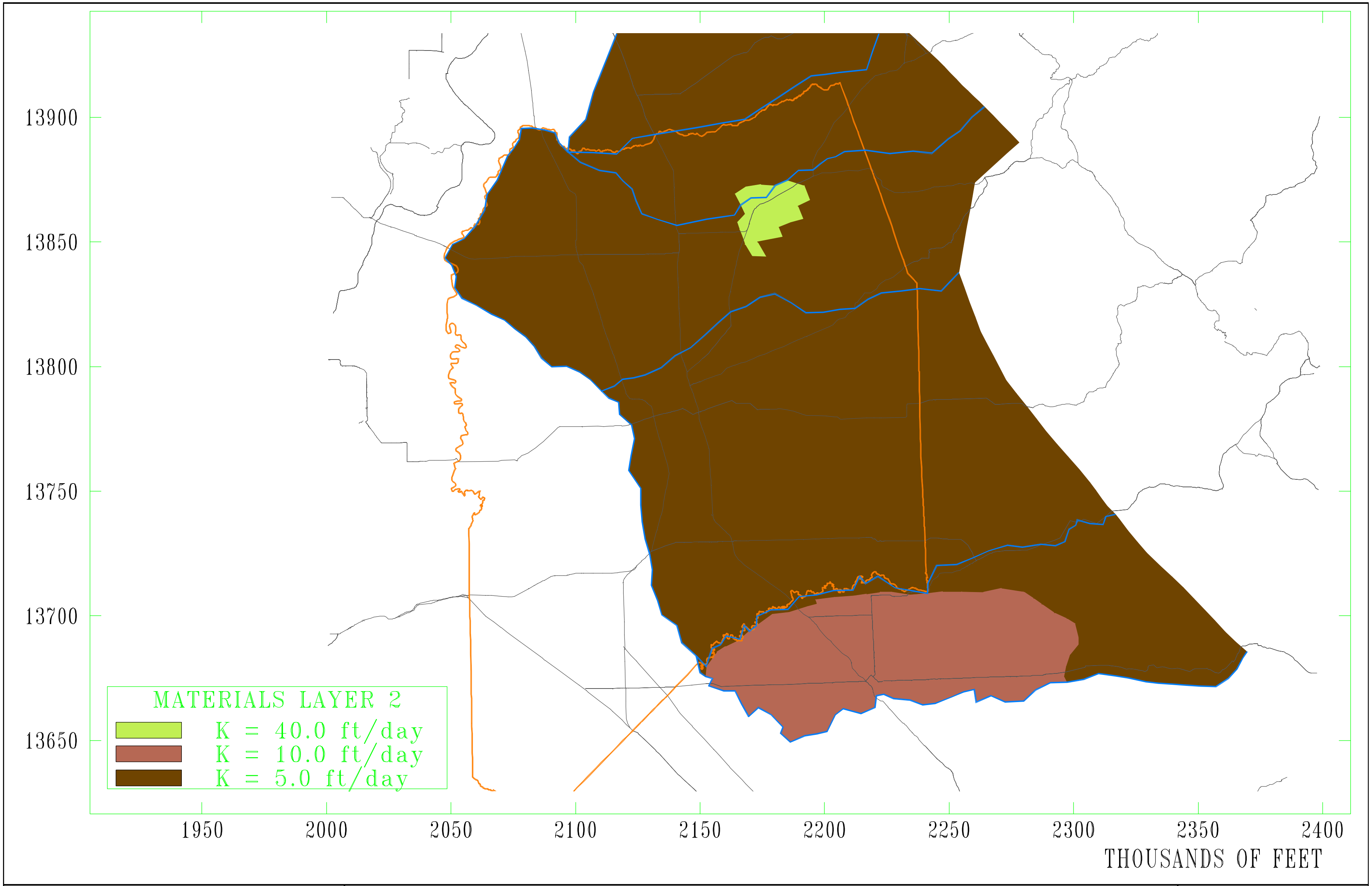
Model Hydraulic Property Distribution
Layer 3: Laguna and Merhten Formations

San Joaquin County Water Management Plan

FIGURE 3-8



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Model Hydraulic Property Distribution
Model Layer 2: Valley Springs Formation

San Joaquin County Water Management Plan

FIGURE
3-9

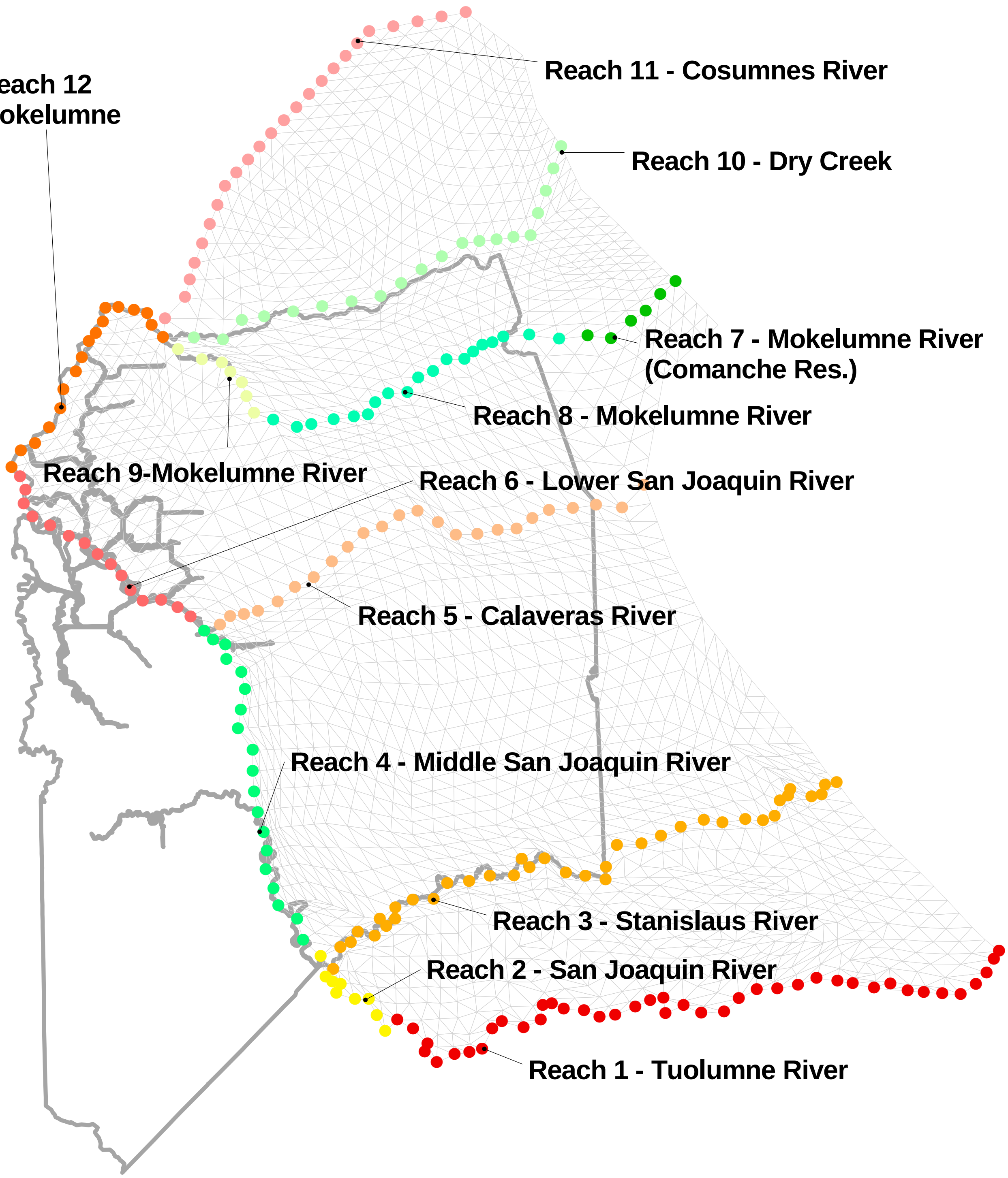


Figure 3-10
Location of Major Rivers/Streams in the
Groundwater / Surface Water Model
San Joaquin County Water Management Plan

CDM Camp Dresser & McKee Inc.

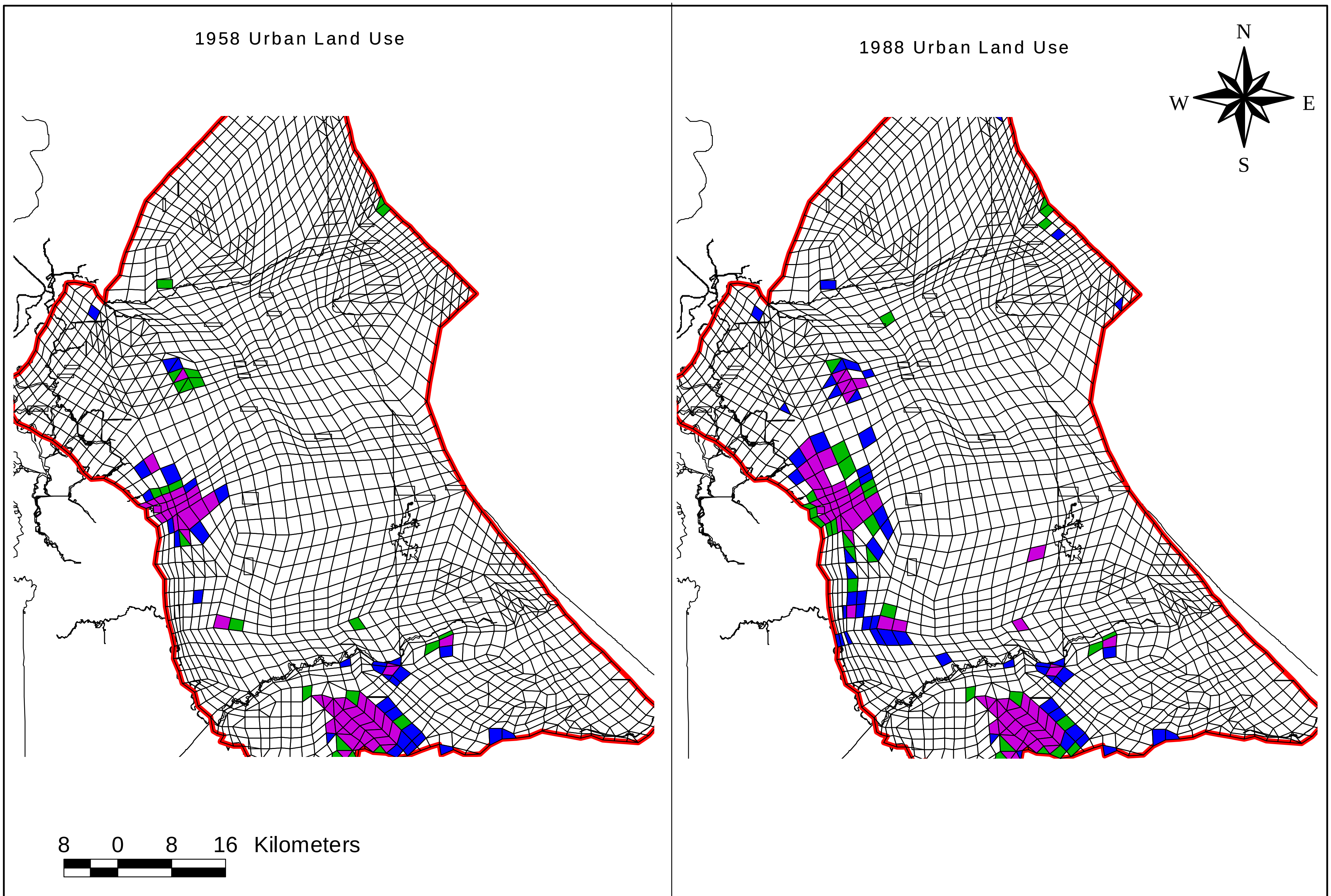


Figure 3-11
Urban Land Use Distribution
San Joaquin Water Management Plan

CDM Camp Dresser & McKee Inc.

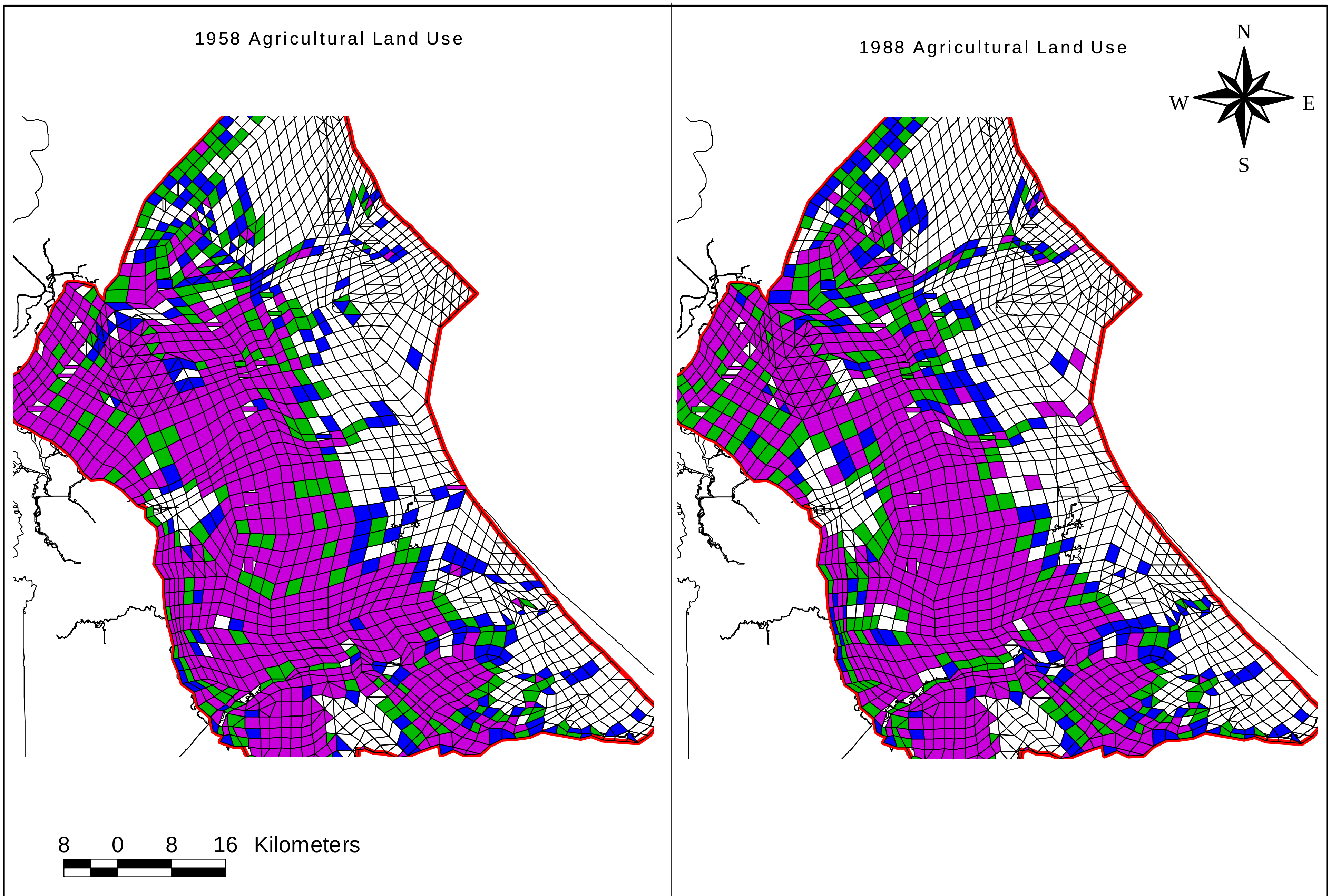


Figure 3-12
Agricultural Land Use Distribution
San Joaquin Water Management Plan

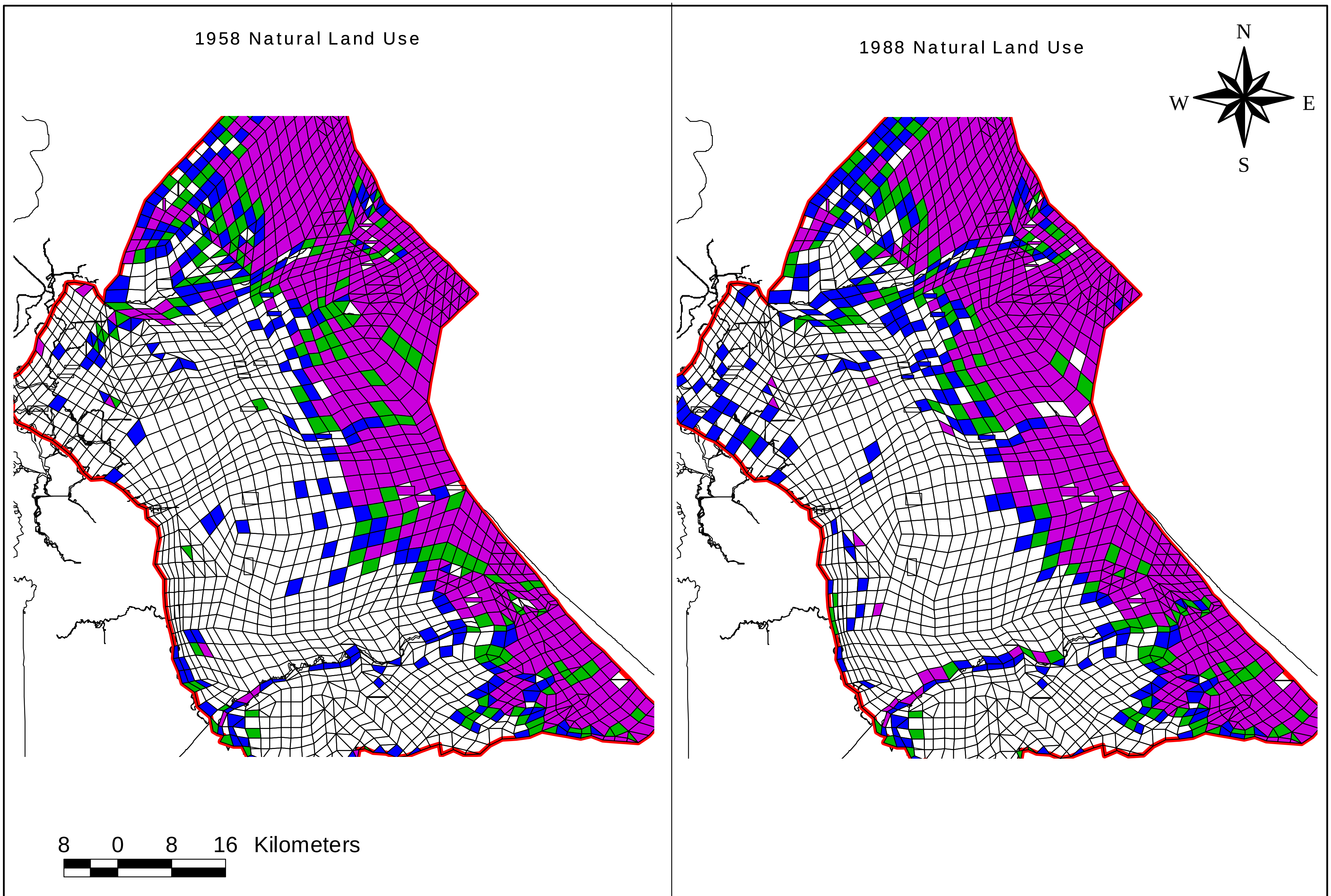


Figure 3-13
Natural Land Use Distrubtion
San Joaquin Water Management Plan

CDM Camp Dresser & McKee Inc.

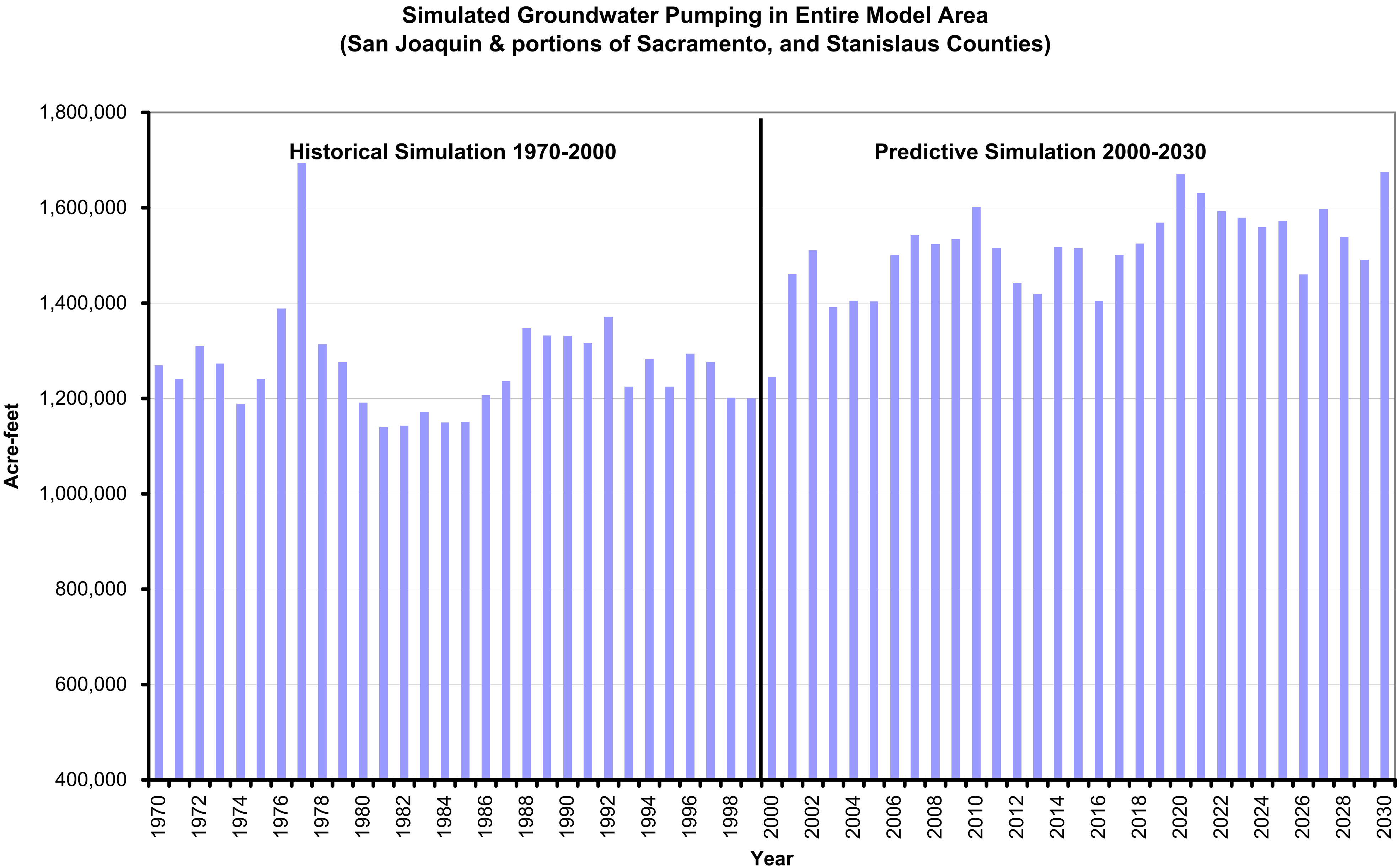


Figure 3-14
San Joaquin County Water Management Plan

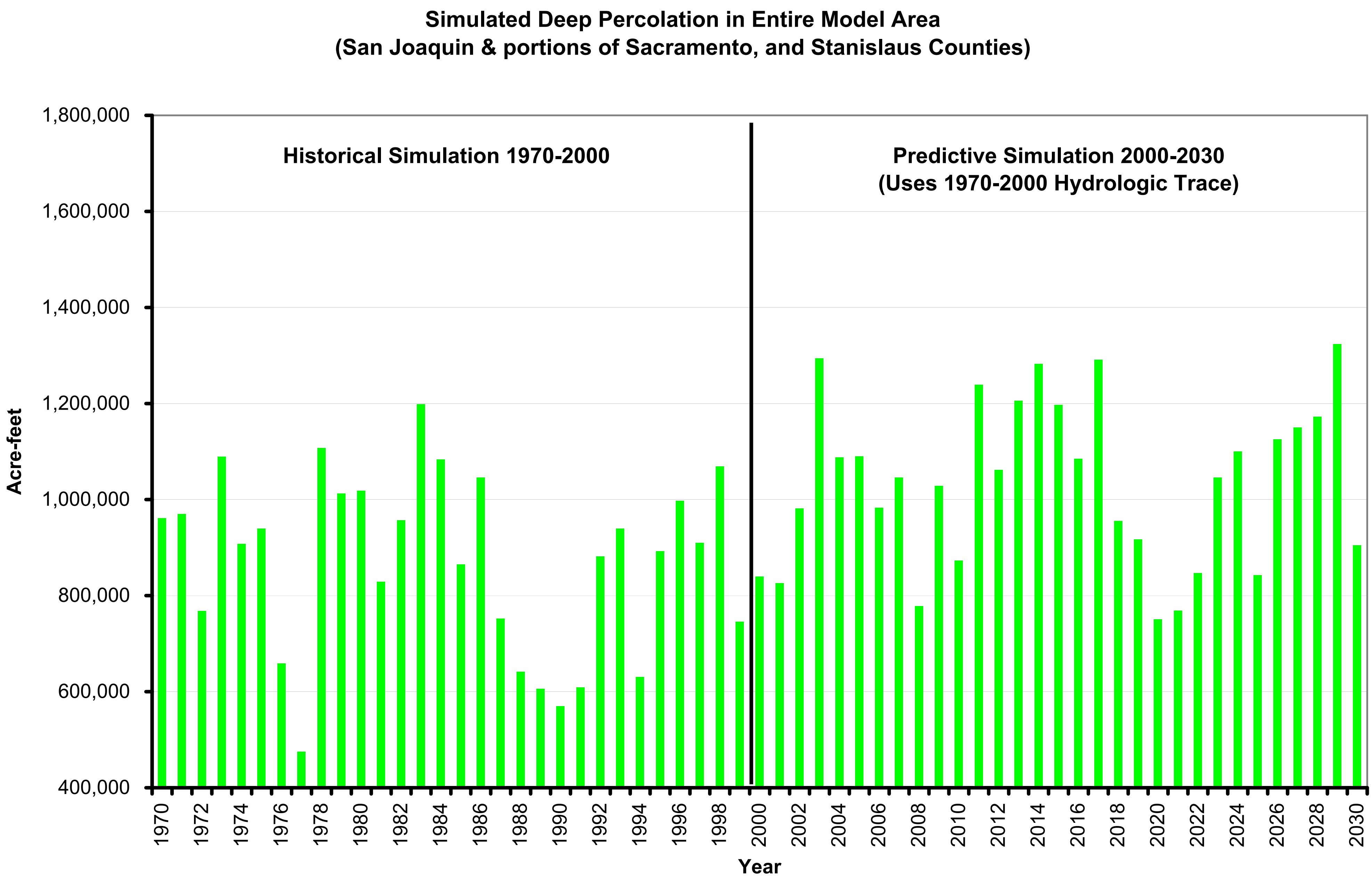
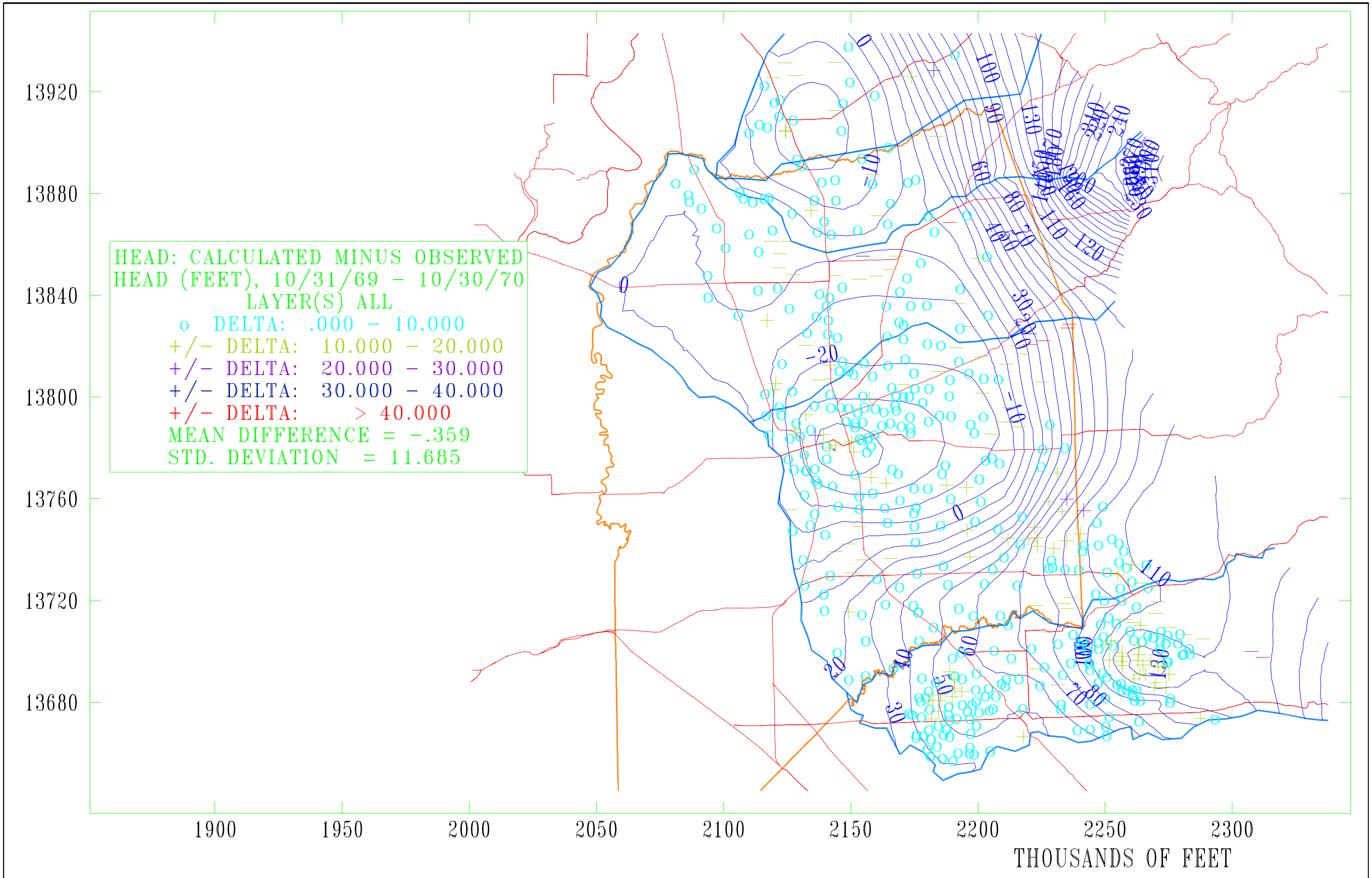


Figure 3-15
San Joaquin County Water Management Plan



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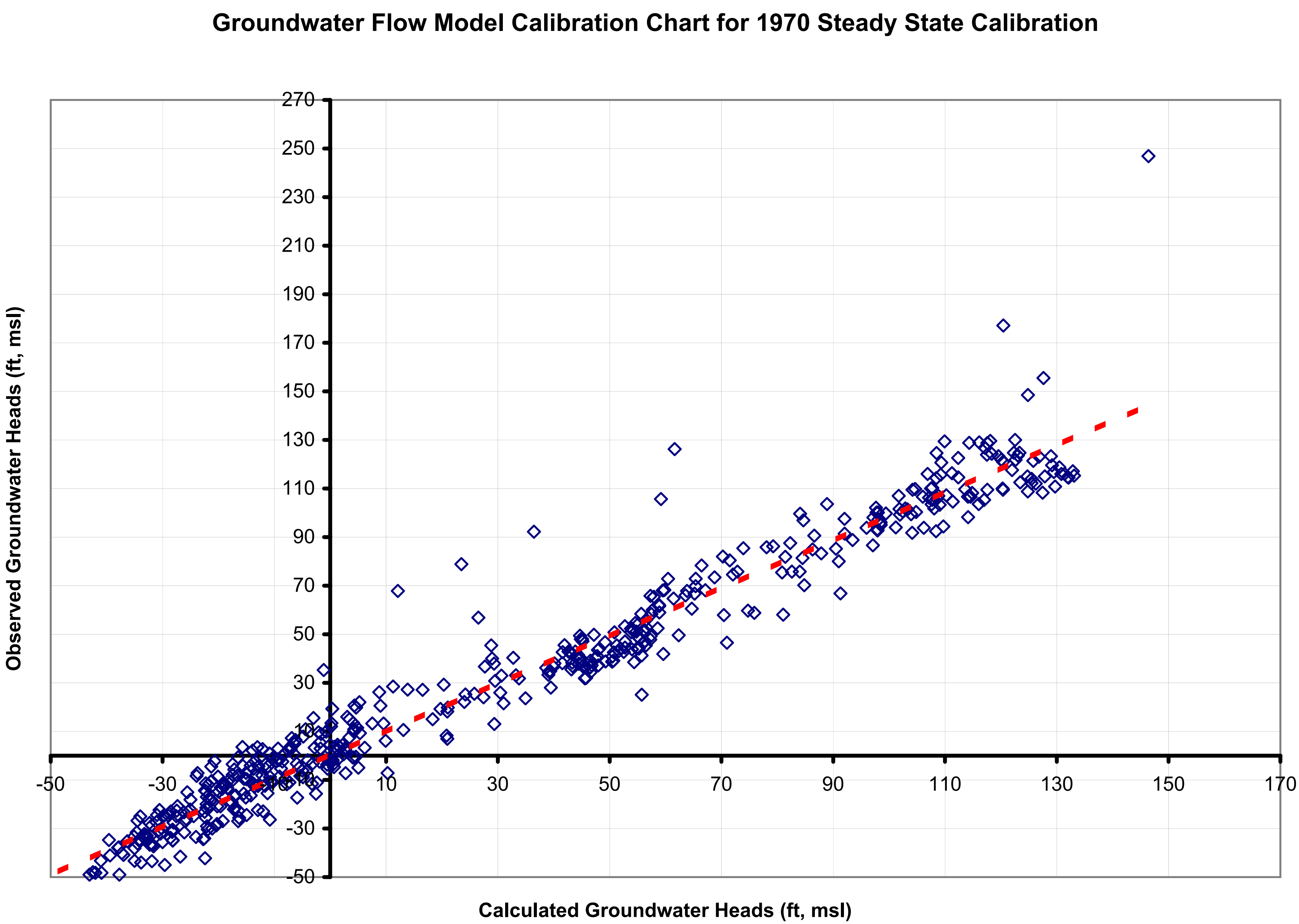
Steady State Calibration Results
Year 1970

San Joaquin County Water Management Plan

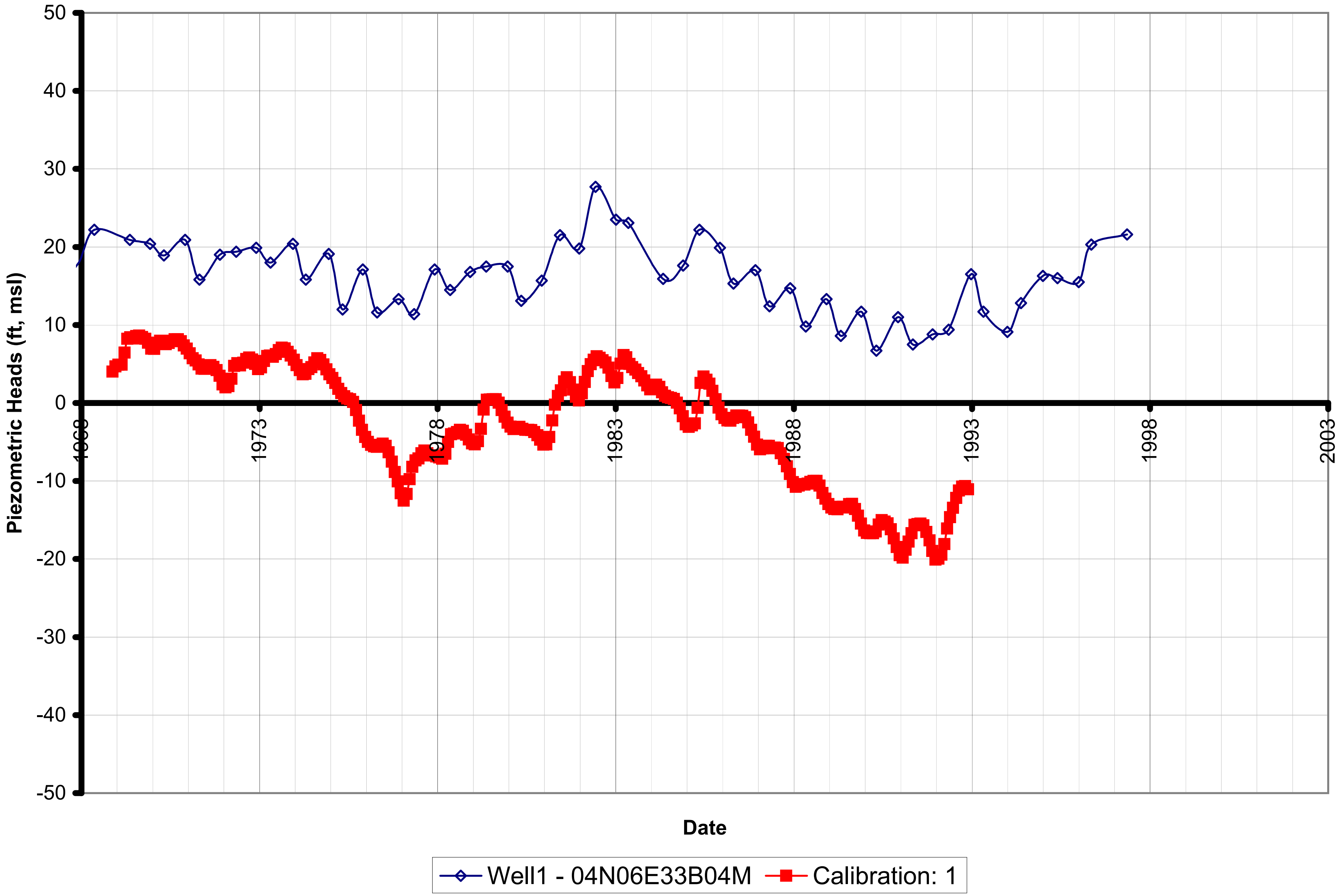
FIGURE
3-16



CDM Camp Dresser & McKee Inc.
ss1970-60.xls-Chart1

Figure 3-17
San Joaquin County Water Management Plan

Comparison of Observed Simulated Water Levels



CDM Camp Dresser & McKee Inc.

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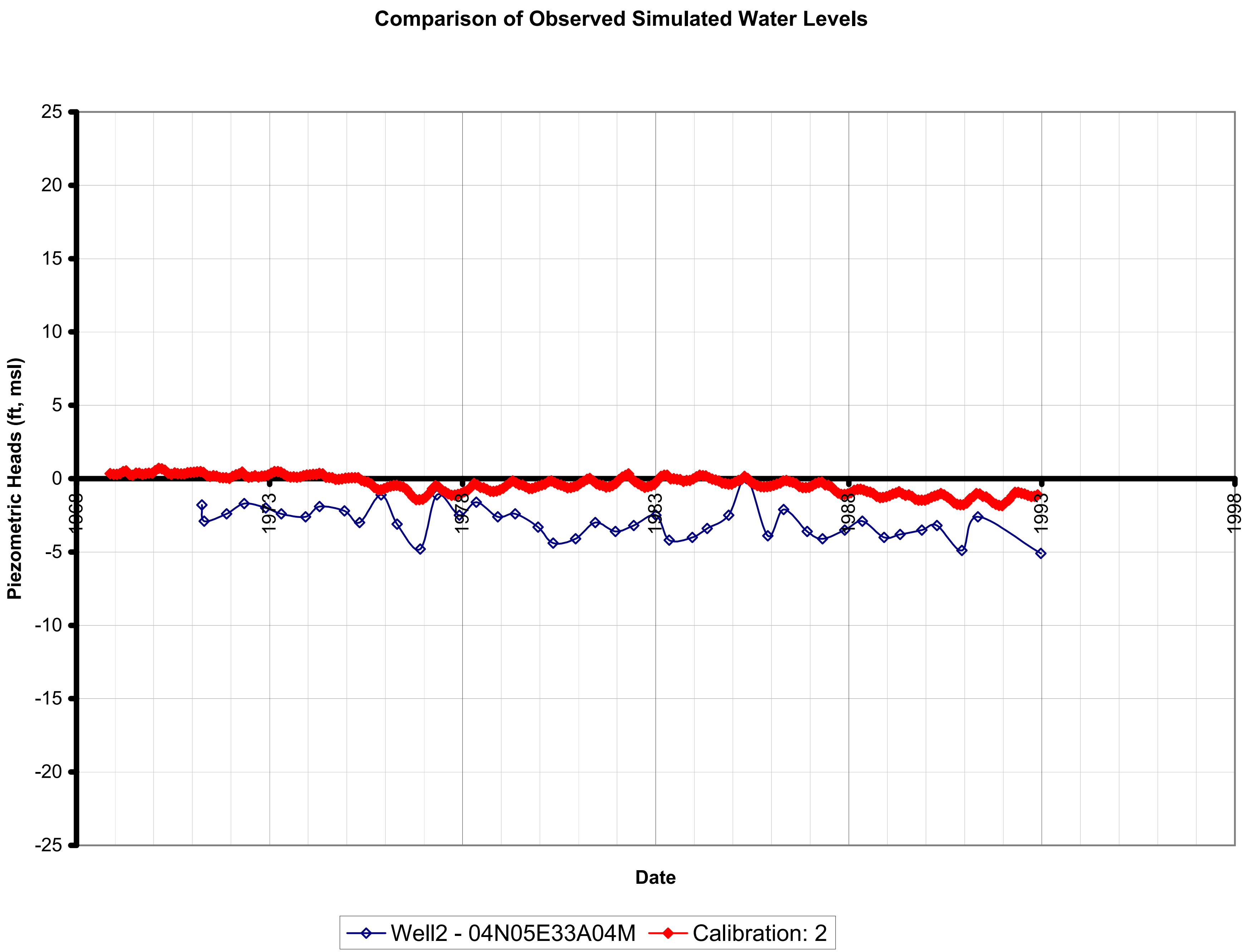
9/14/2001

Figure 3-18
San Joaquin County Water Management Plan



CDM Camp Dresser & McKee Inc.

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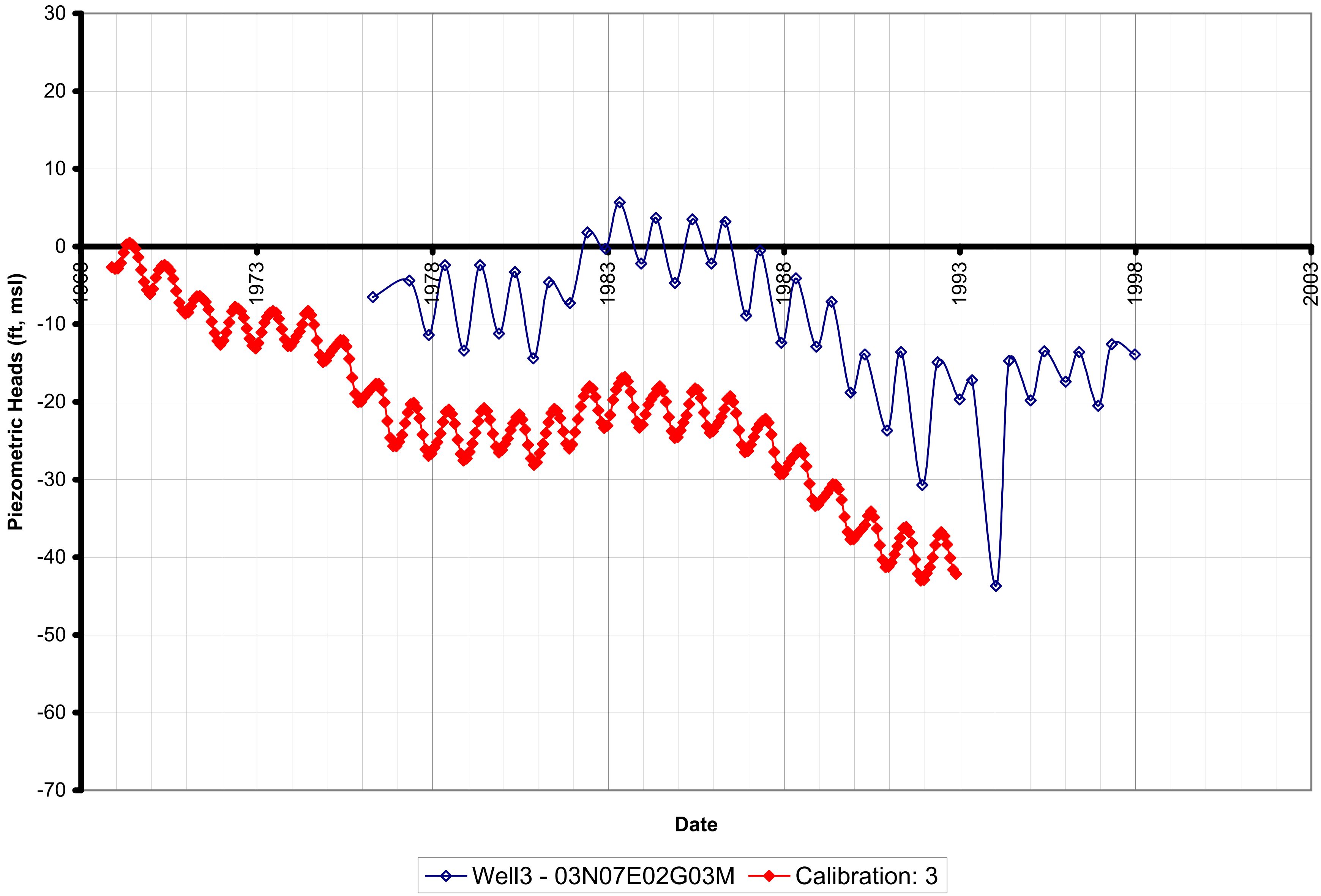
Figure 3-19
San Joaquin County Water Management Plan

Comparison of Observed Simulated Water Levels



CDM Camp Dresser & McKee Inc.

Figure 3-20
San Joaquin County Water Management Plan

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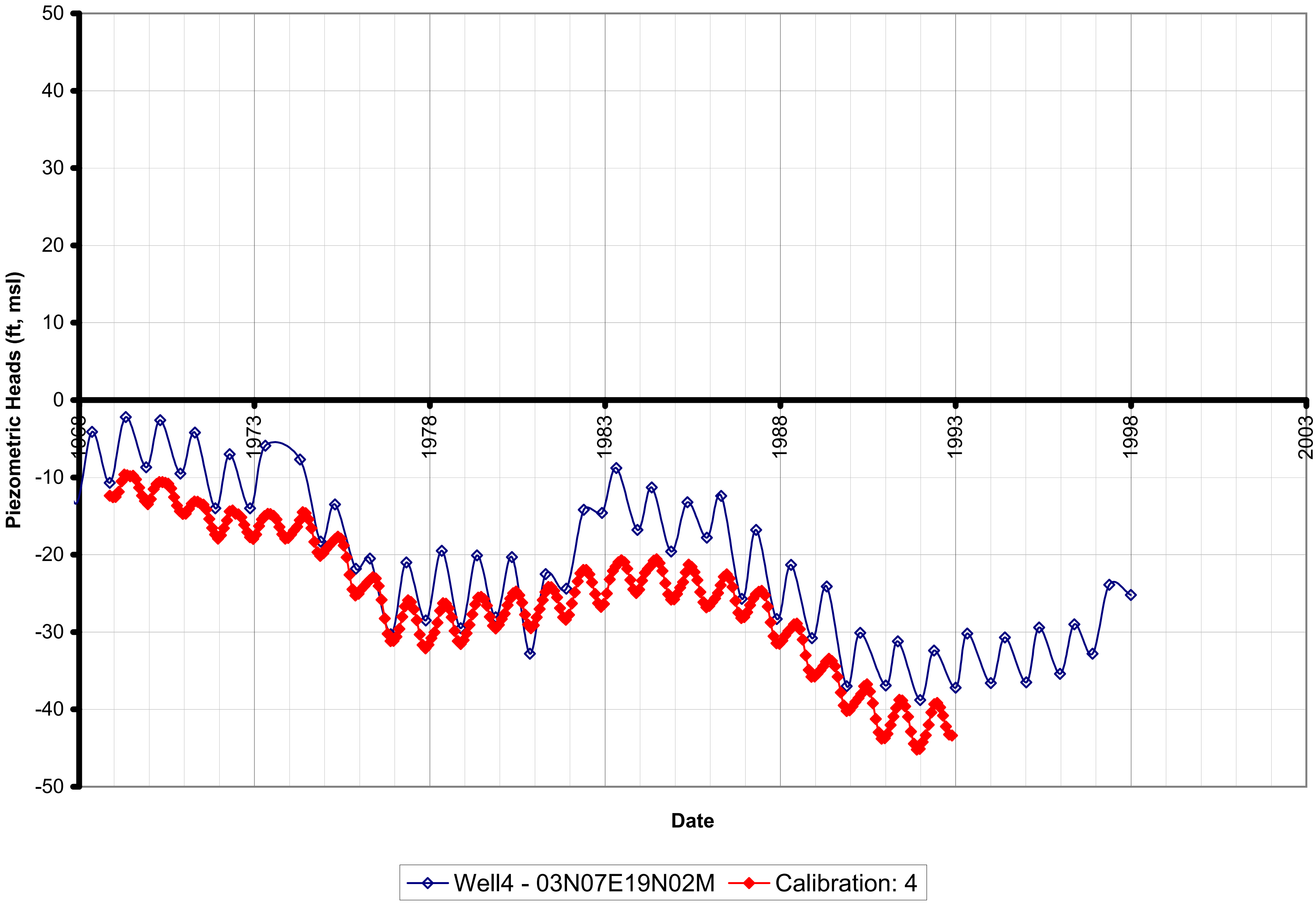
9/14/2001

Comparison of Observed Simulated Water Levels



CDM Camp Dresser & McKee Inc.

Figure 3-21
San Joaquin County Water Management Plan

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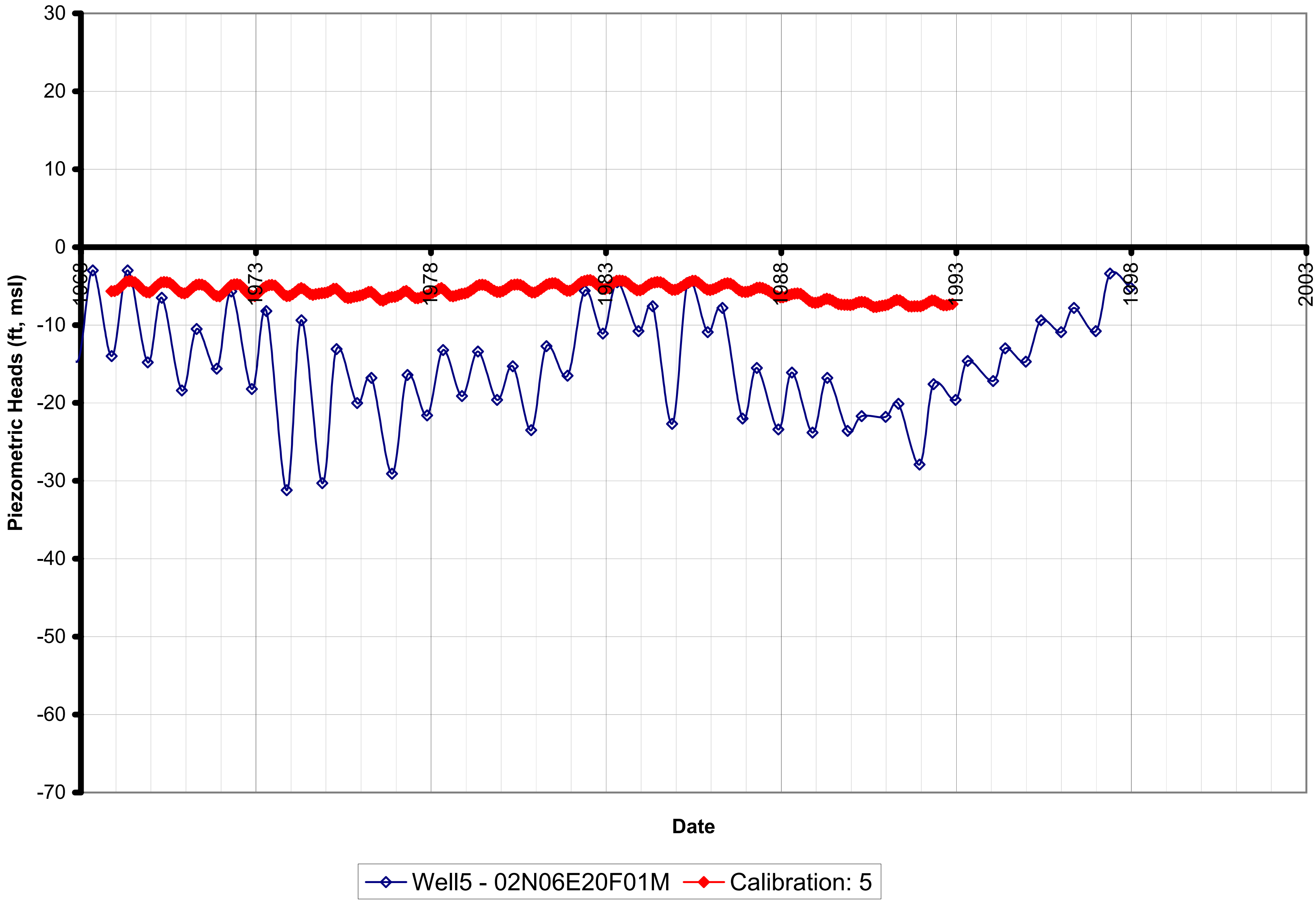
9/14/2001

Comparison of Observed Simulated Water Levels



CDM Camp Dresser & McKee Inc.

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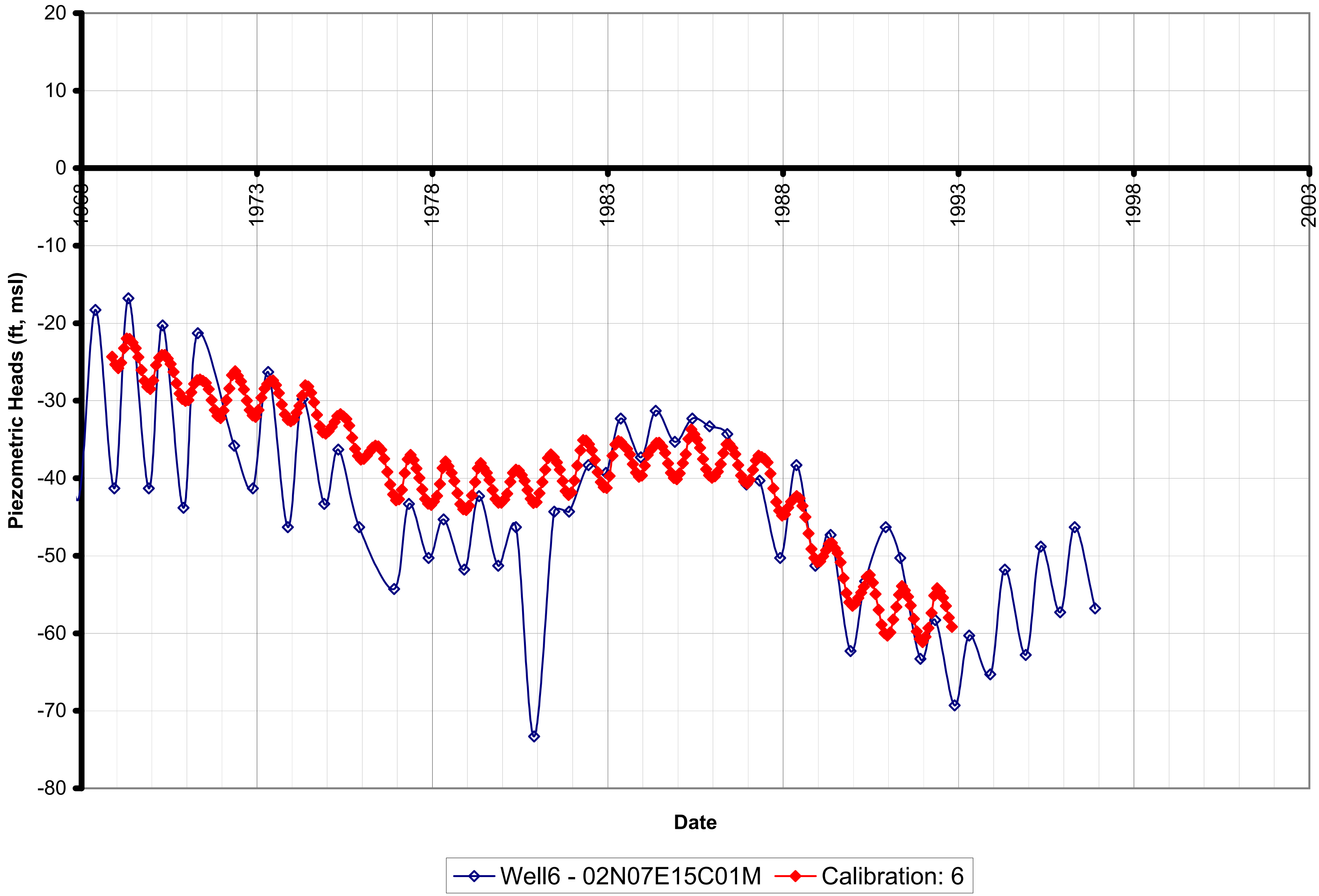
9/14/2001

Figure 3-22
San Joaquin County Water Management Plan

Comparison of Observed Simulated Water Levels



CDM Camp Dresser & McKee Inc.

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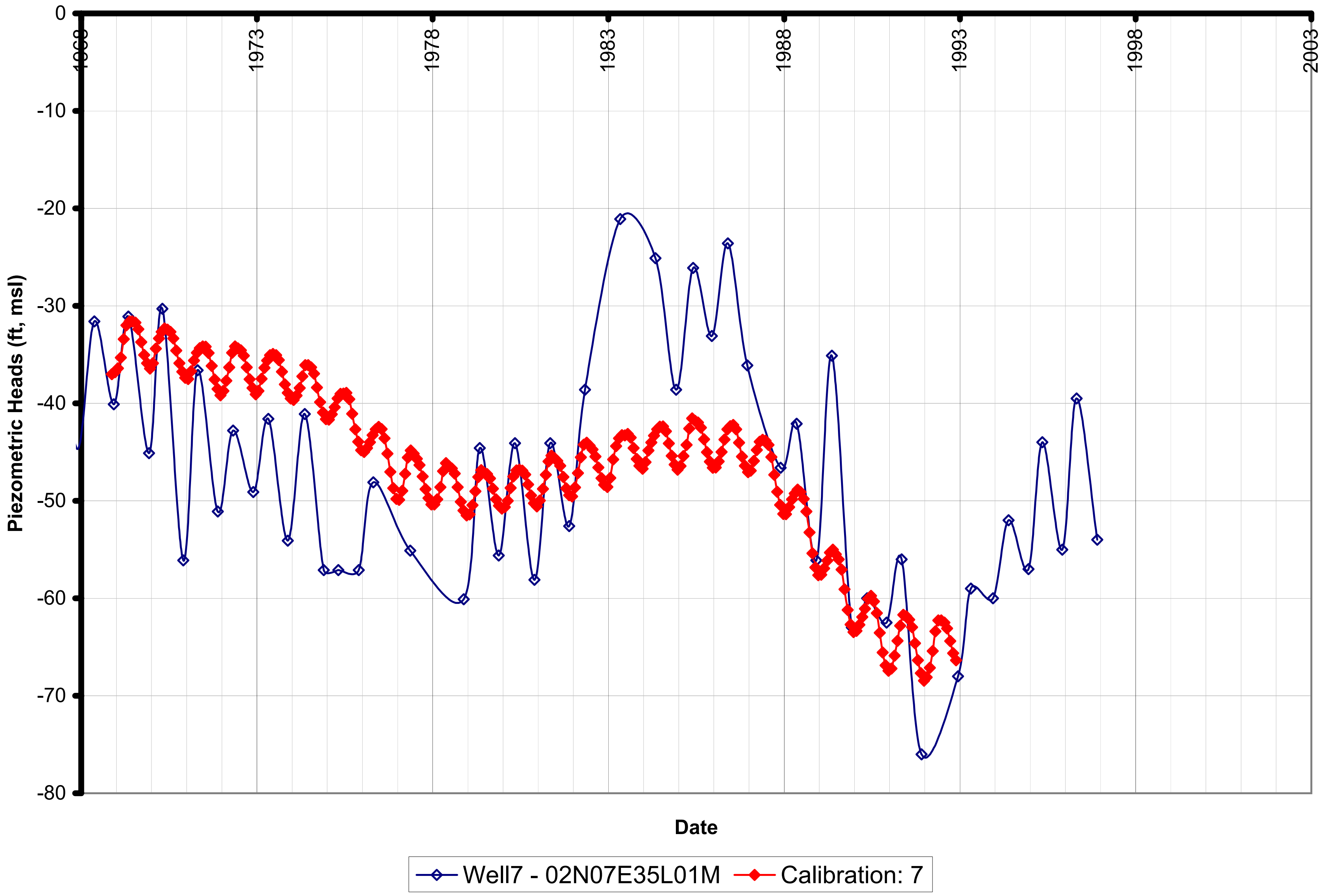
9/14/2001

Figure 3-23
San Joaquin County Water Management Plan

Comparison of Observed Simulated Water Levels



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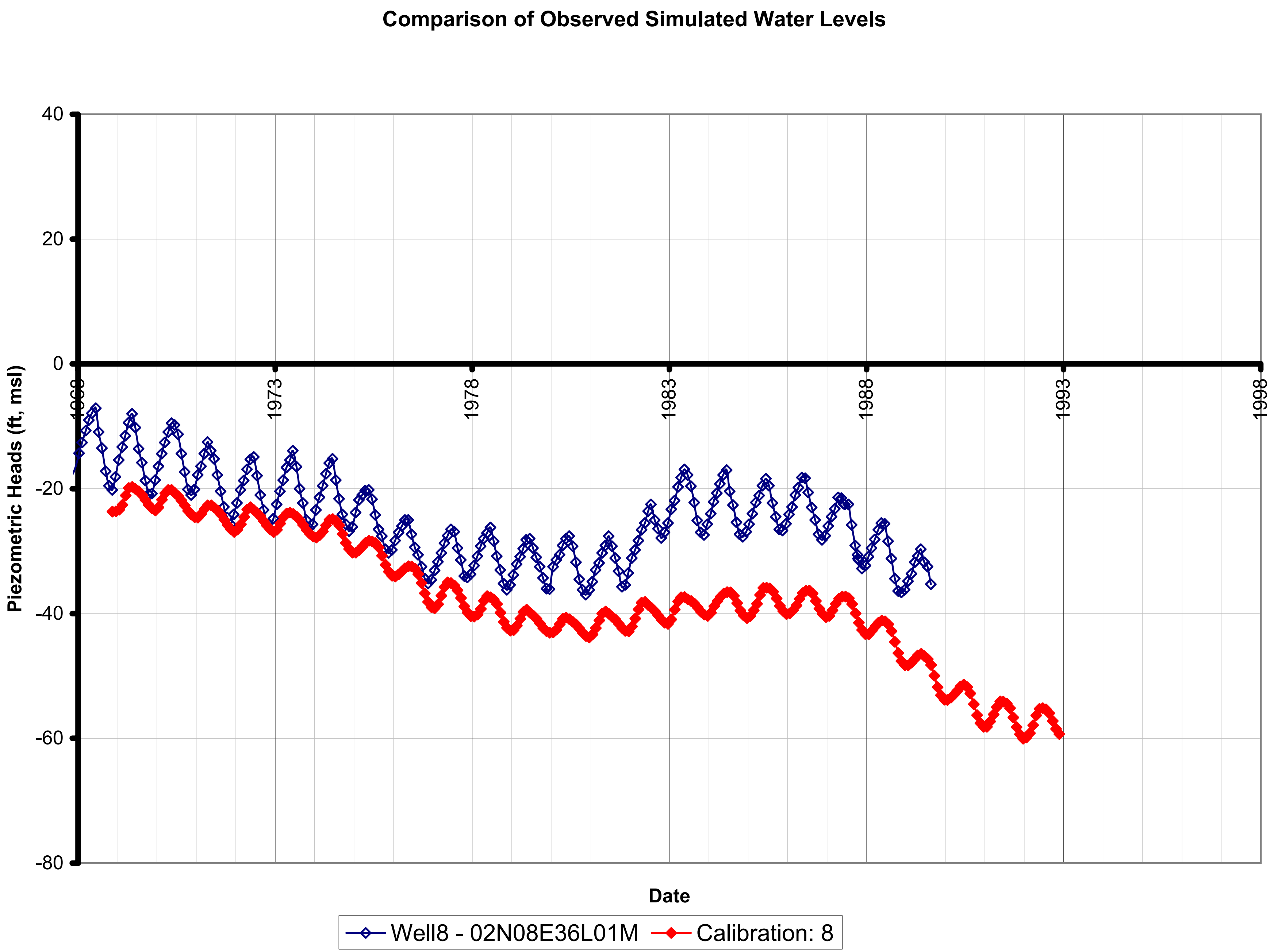
9/14/2001

Figure 3-24
San Joaquin County Water Management Plan



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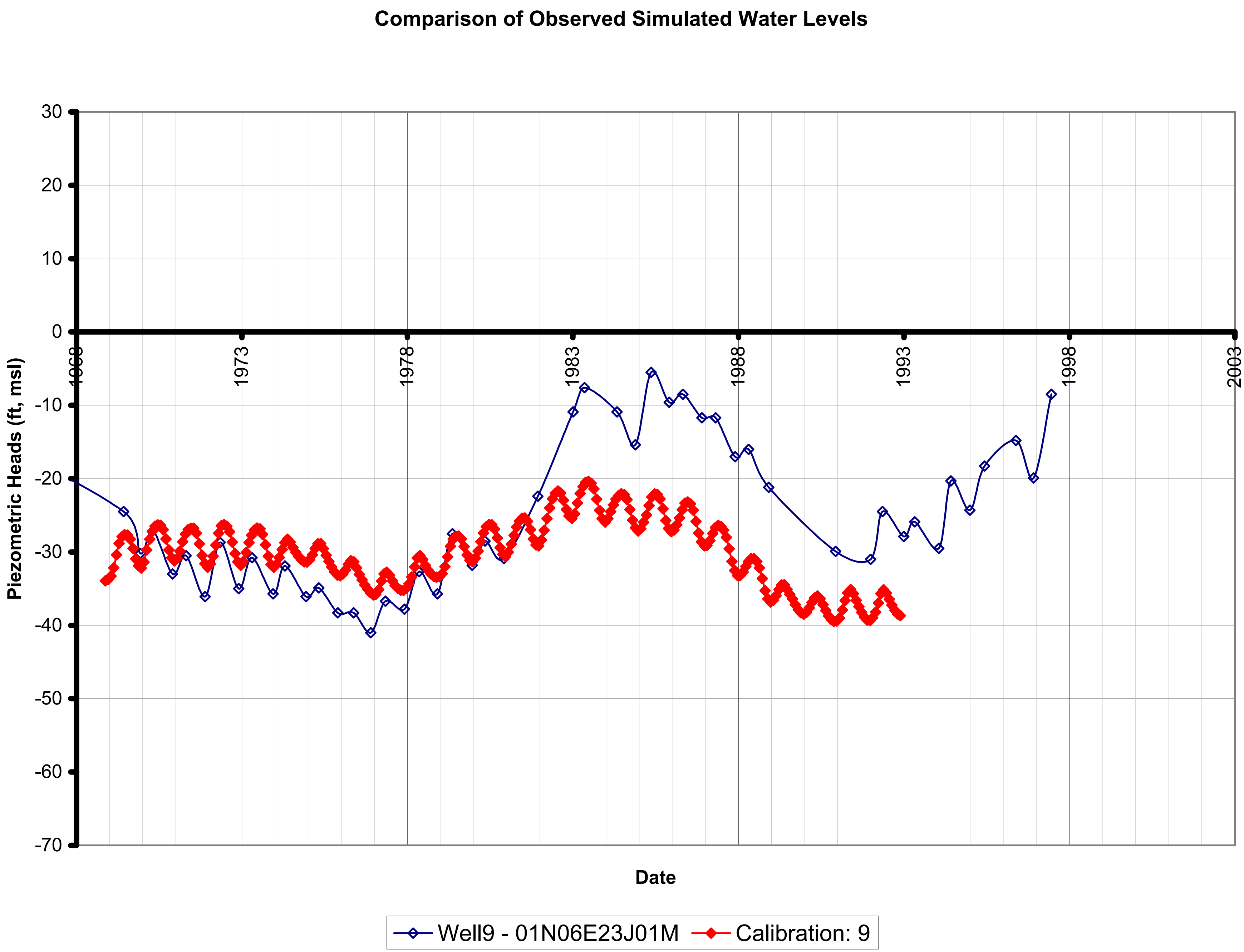
9/14/2001

Figure 3-25
San Joaquin County Water Management Plan



CDM Camp Dresser & McKee Inc.

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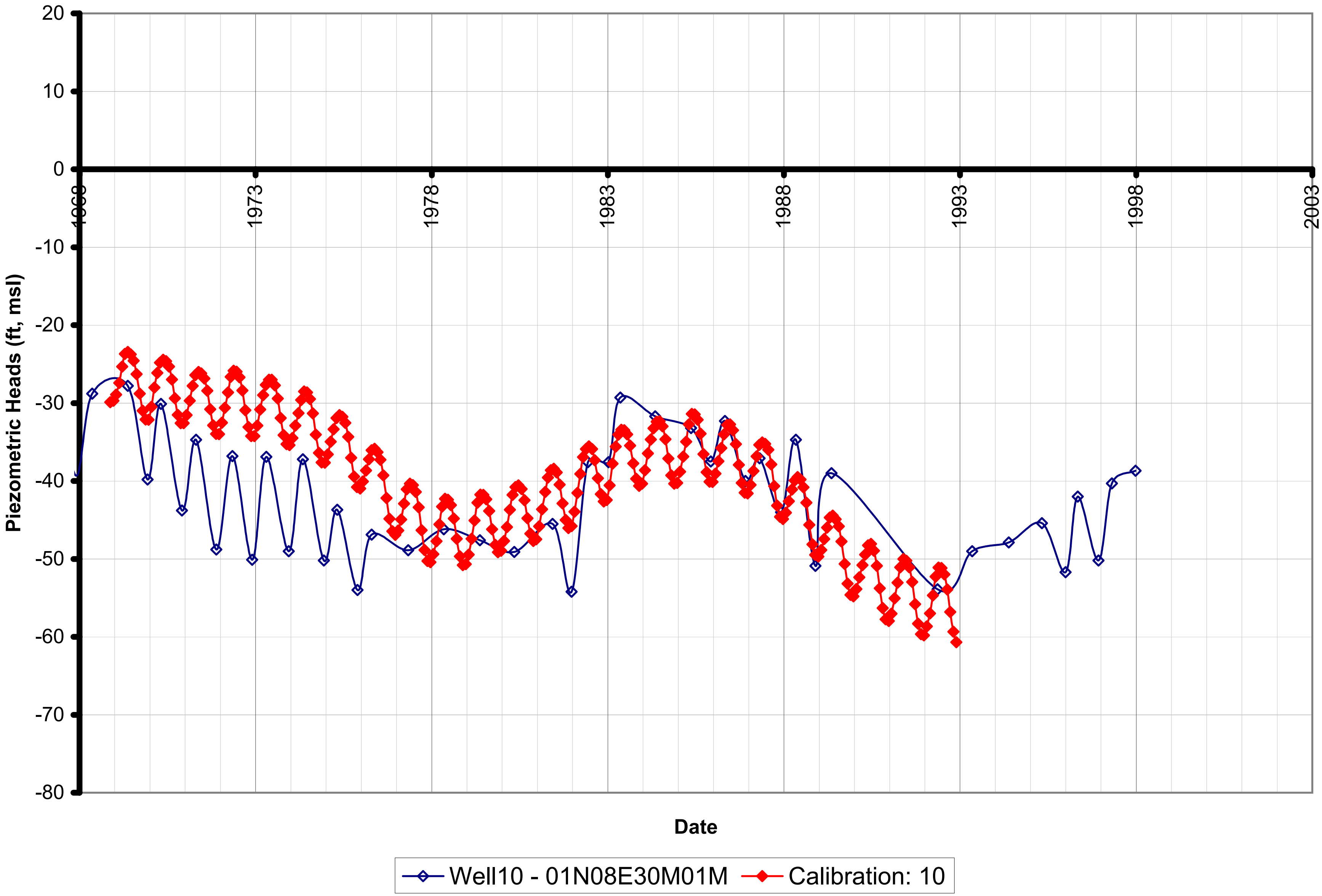
9/14/2001

Figure 3-26
San Joaquin County Water Management Plan

Comparison of Observed Simulated Water Levels



CDM Camp Dresser & McKee Inc.

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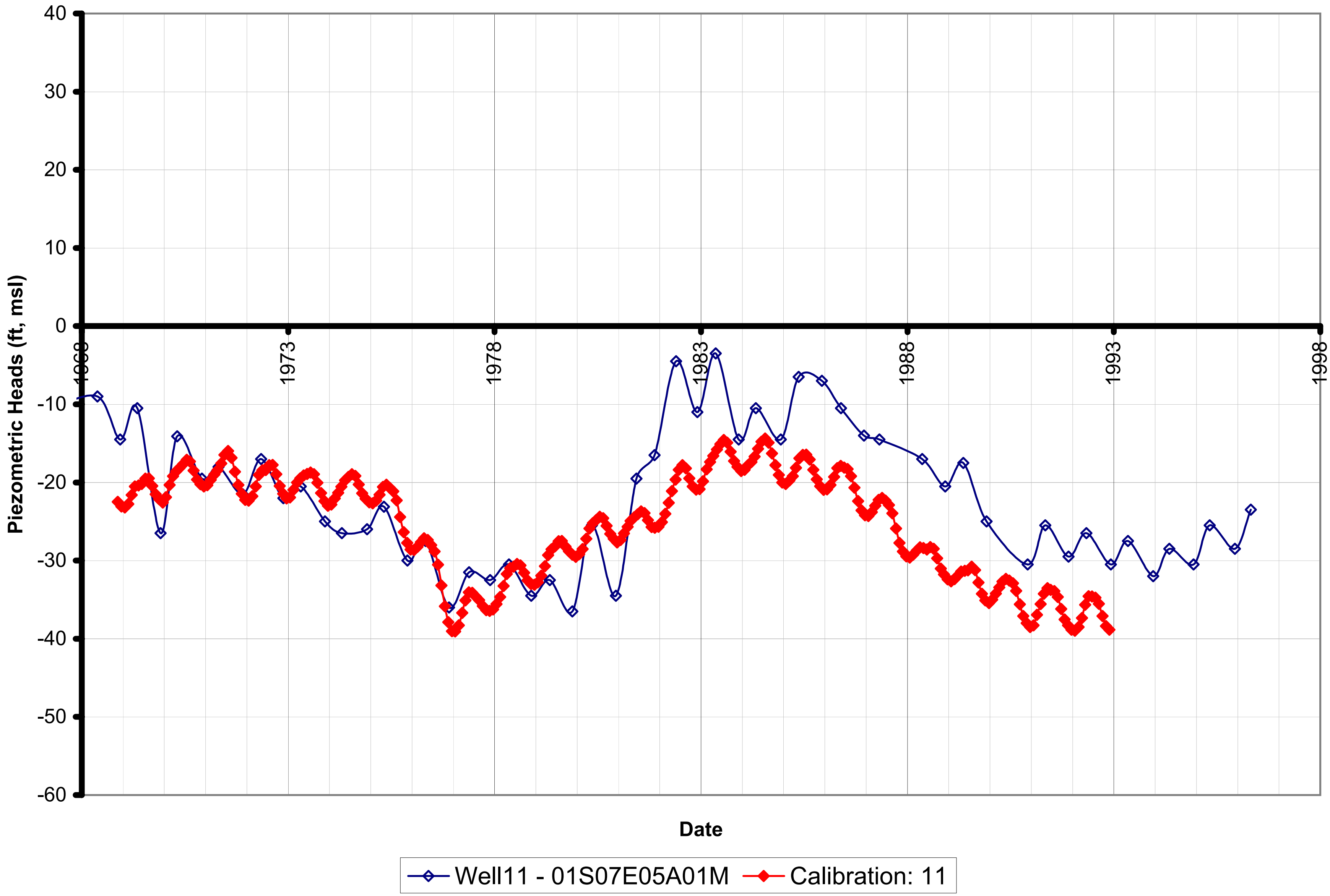
9/14/2001

Figure 3-27
San Joaquin County Water Management Plan

Comparison of Observed Simulated Water Levels



CDM Camp Dresser & McKee Inc.

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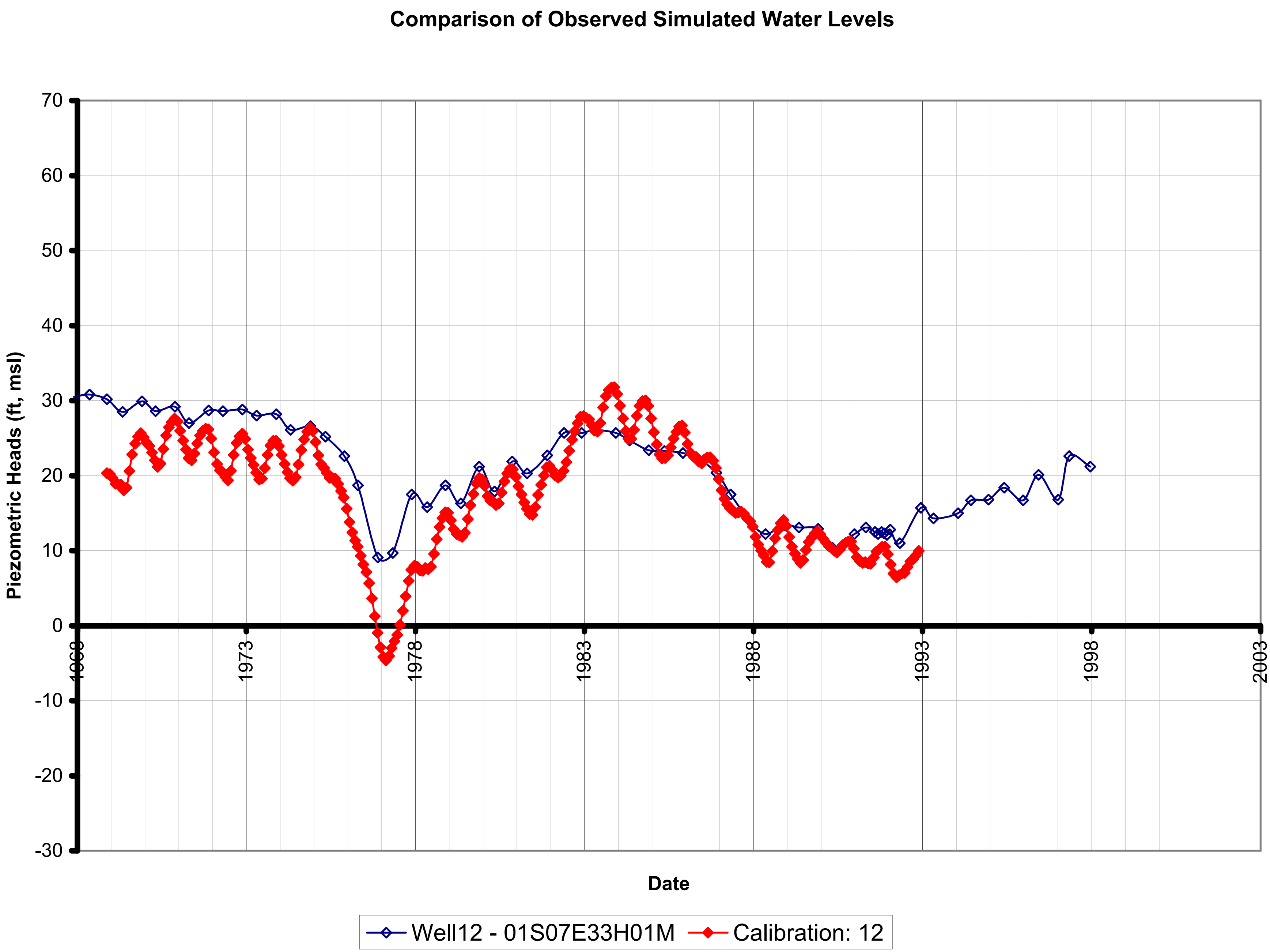
9/14/2001

Figure 3-28
San Joaquin County Water Management Plan



CDM Camp Dresser & McKee Inc.

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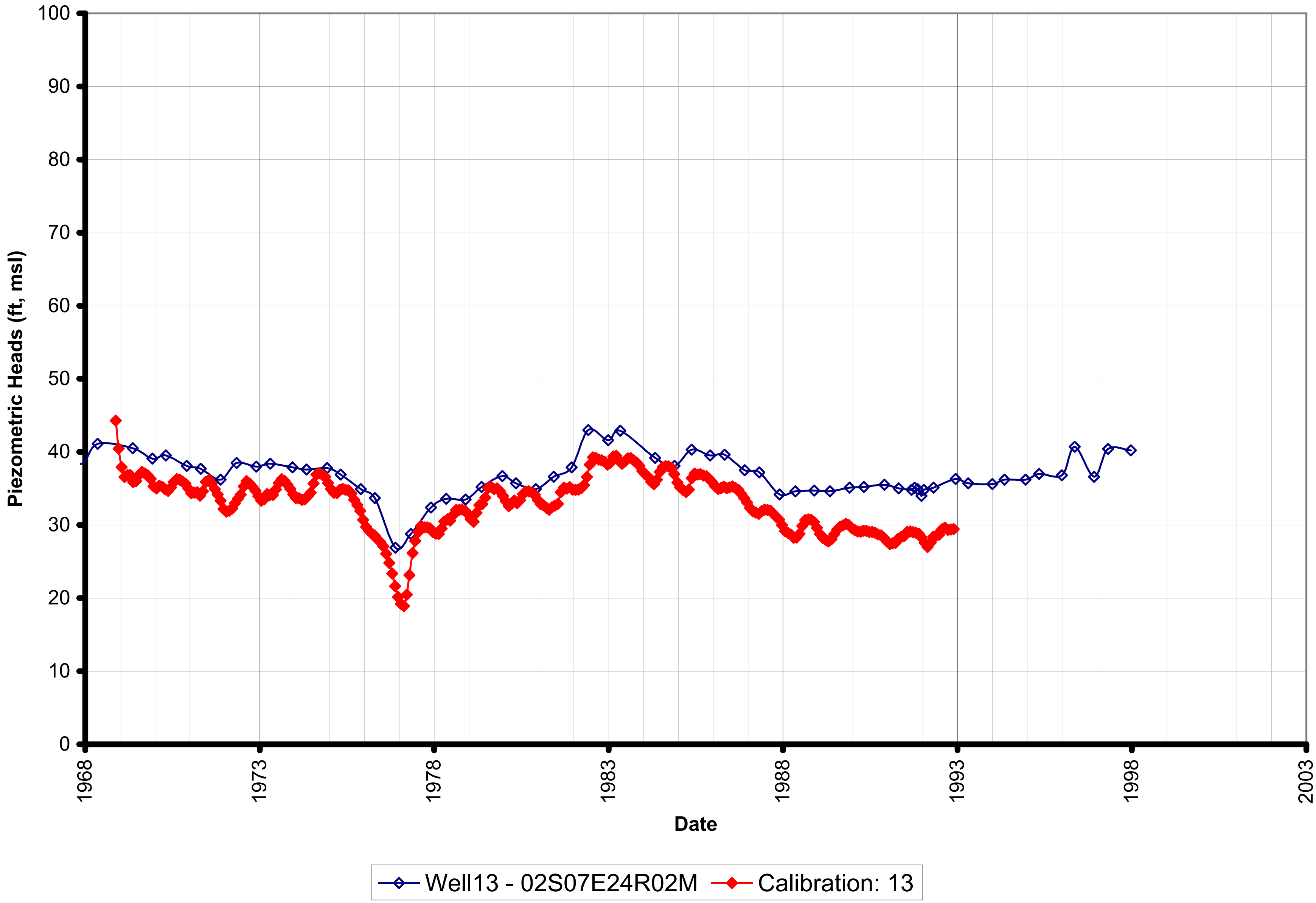
9/14/2001

Figure 3-29
San Joaquin County Water Management Plan

Comparison of Observed Simulated Water Levels



CDM Camp Dresser & McKee Inc.

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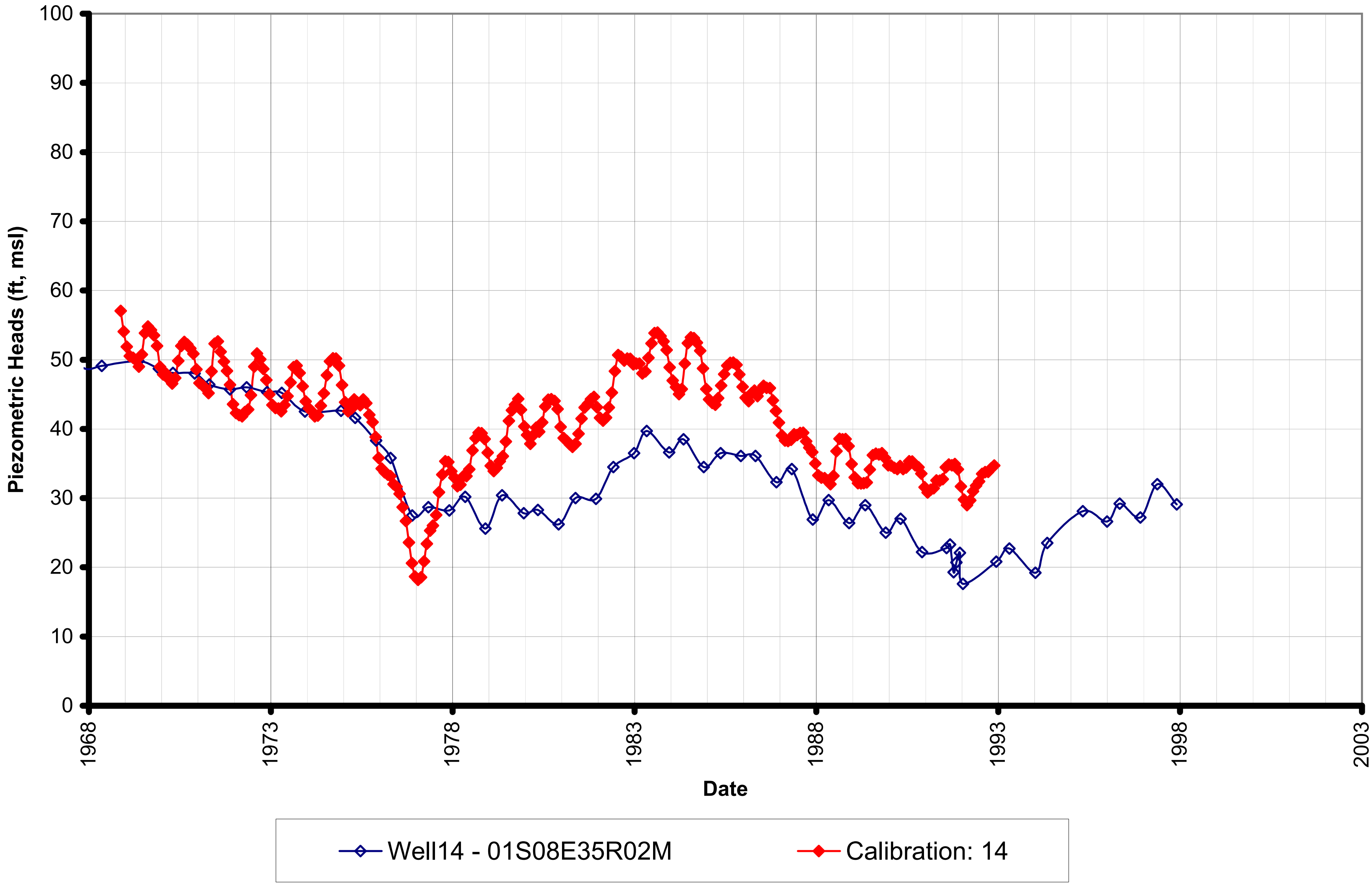
9/14/2001

Figure 3-30
San Joaquin County Water Management Plan

Comparison of Observed Simulated Water Levels

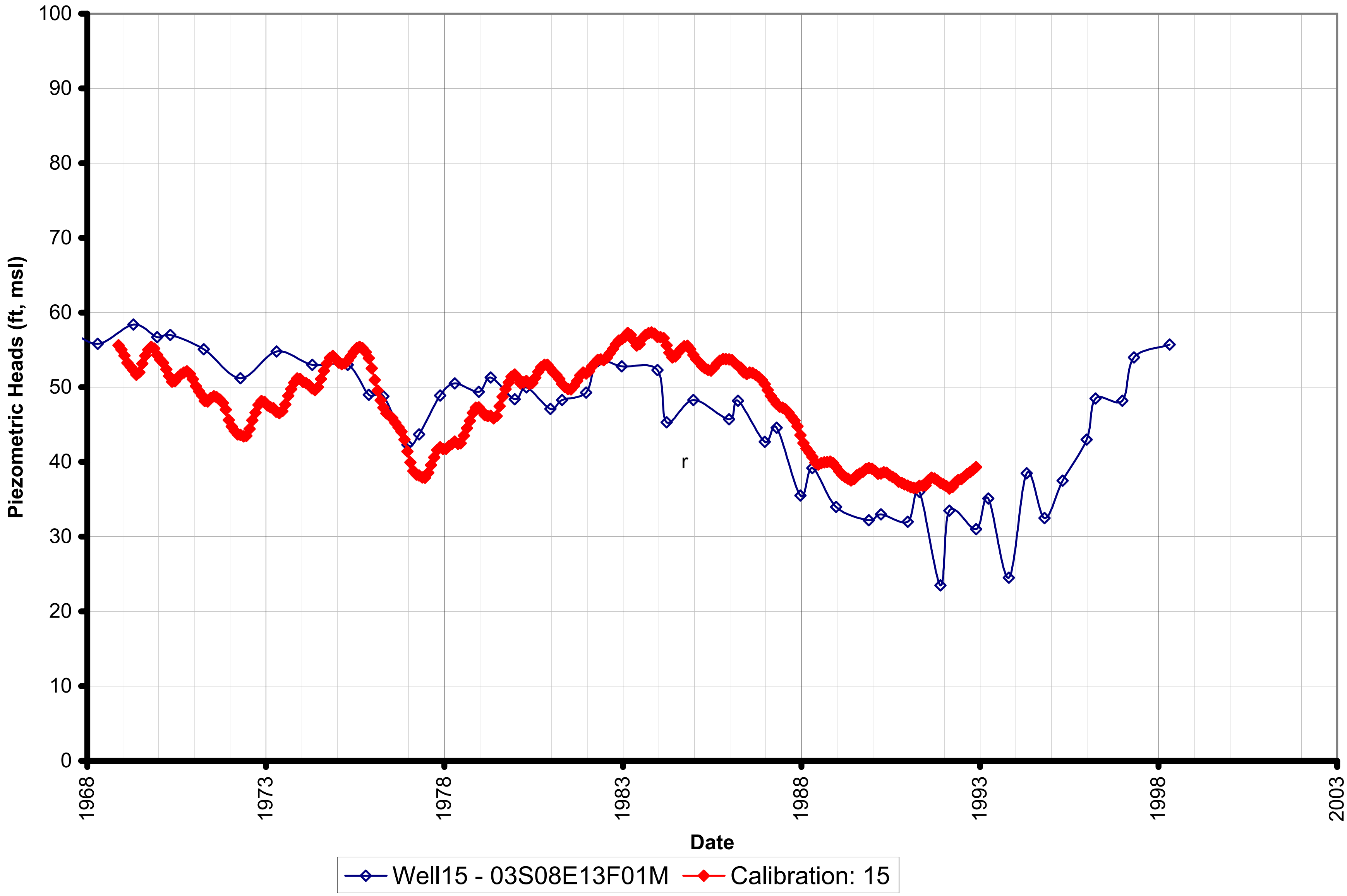


CDM Camp Dresser & McKee Inc.

TransCal-58.xls-31
9/14/2001

Figure 3-31
San Joaquin County Water Management Plan

Comparison of Observed Simulated Water Levels

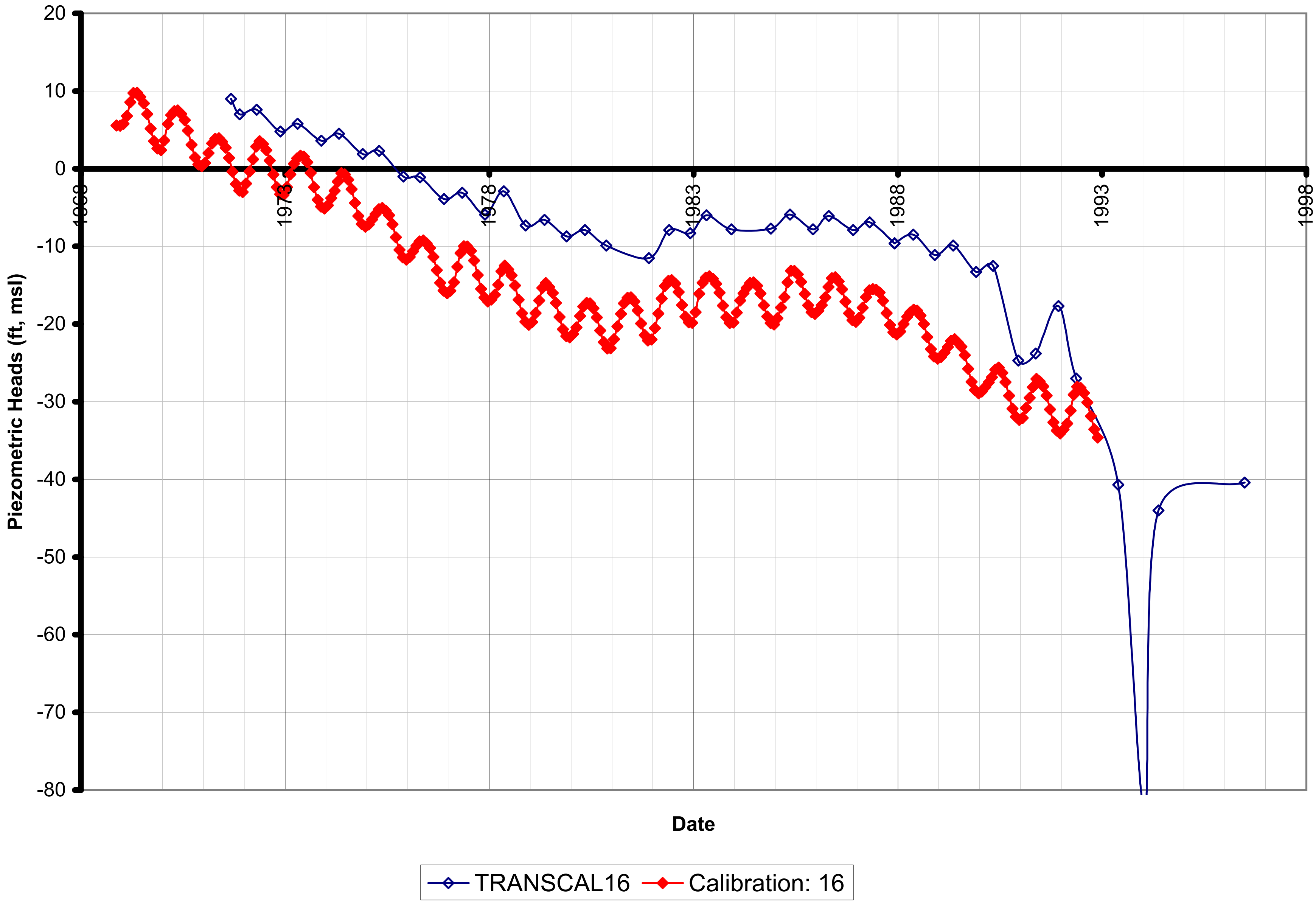


CDM Camp Dresser & McKee Inc.

TransCal-58.xls-32
9/14/2001

Figure 3-32
San Joaquin County Water Management Plan

Comparison of Observed Simulated Water Levels



CDM Camp Dresser & McKee Inc.

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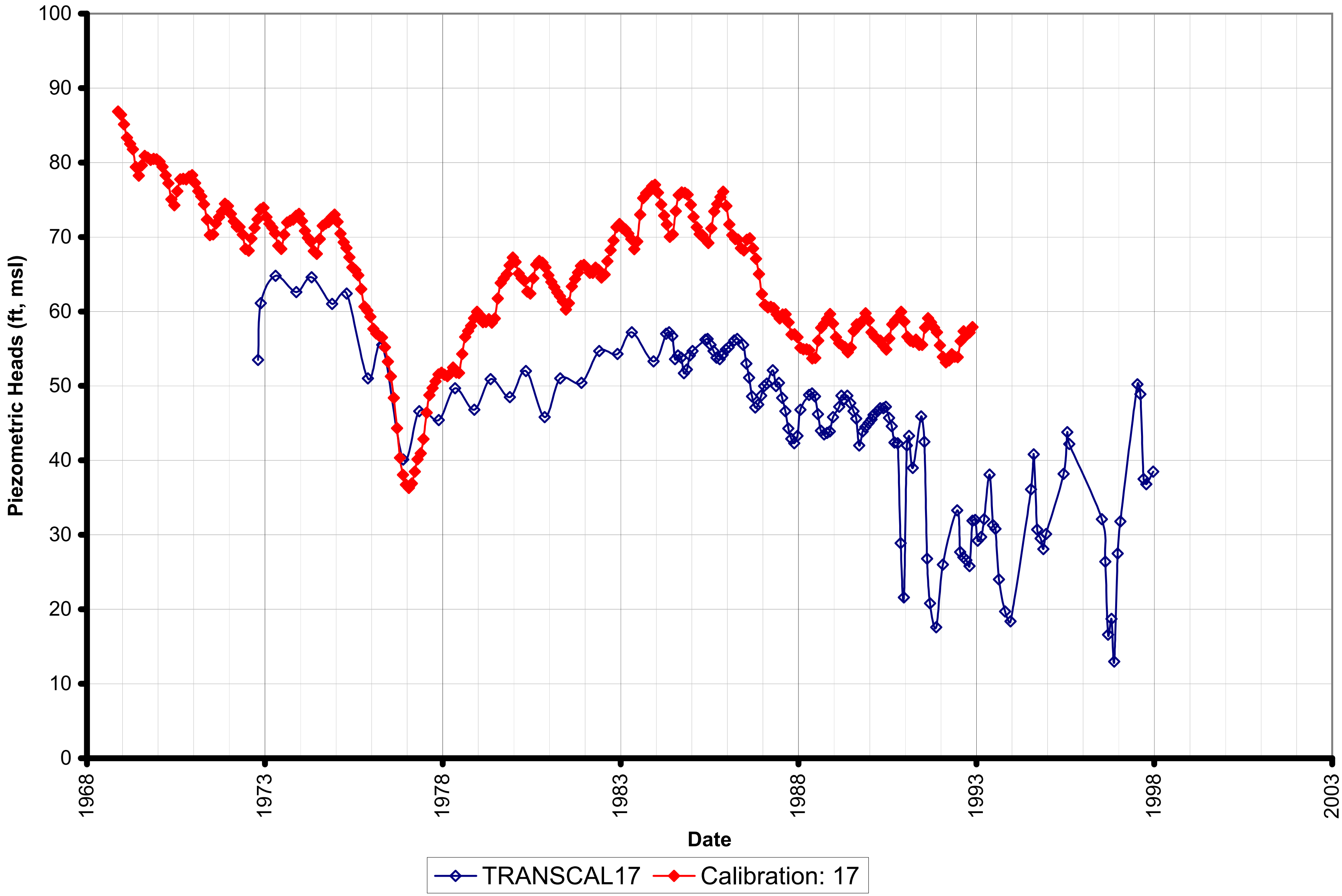
9/14/2001

Figure 3-33
San Joaquin County Water Management Plan

Comparison of Observed Simulated Water Levels



CDM Camp Dresser & McKee Inc.

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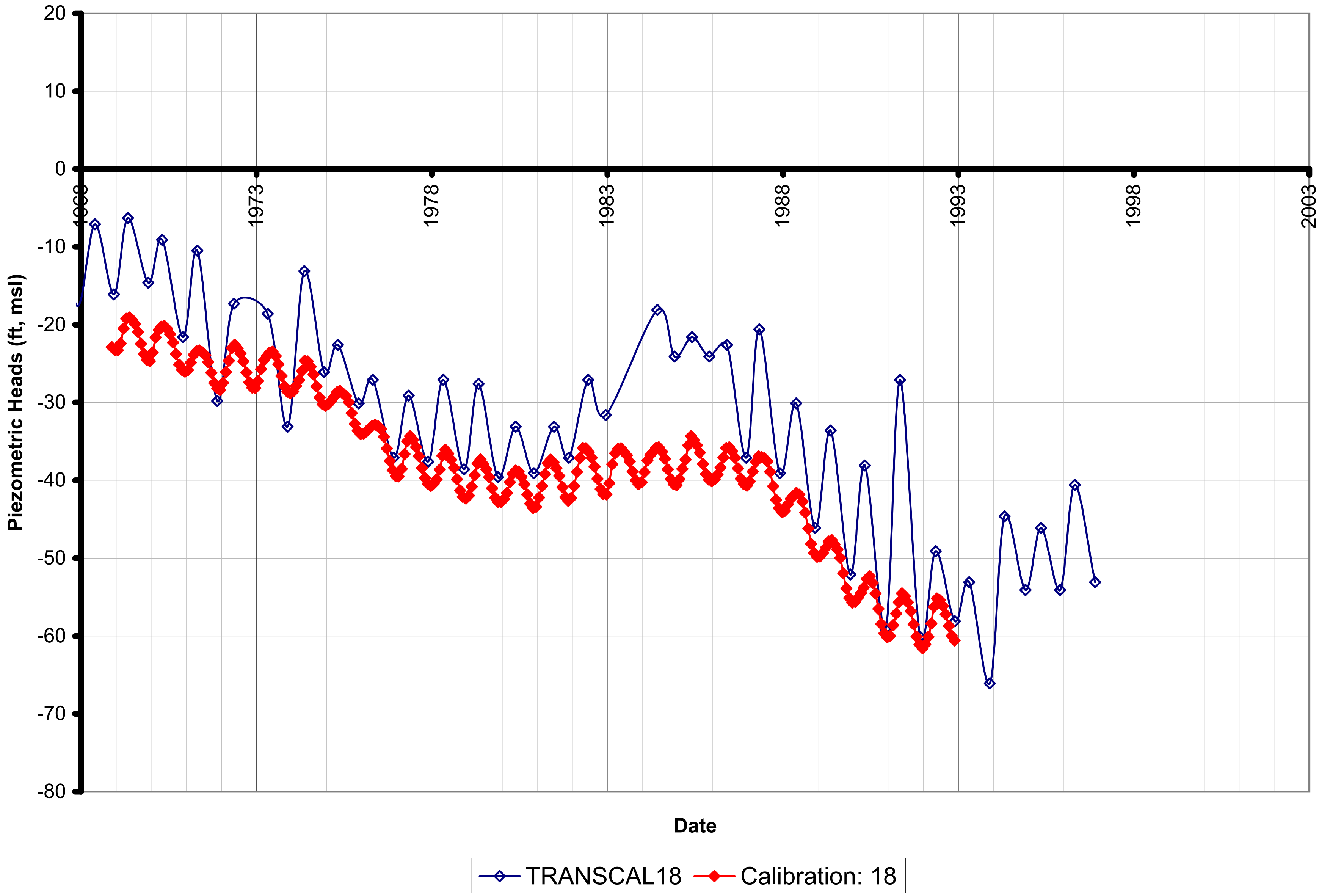
9/14/2001

Figure 3-34
San Joaquin County Water Management Plan

Comparison of Observed Simulated Water Levels



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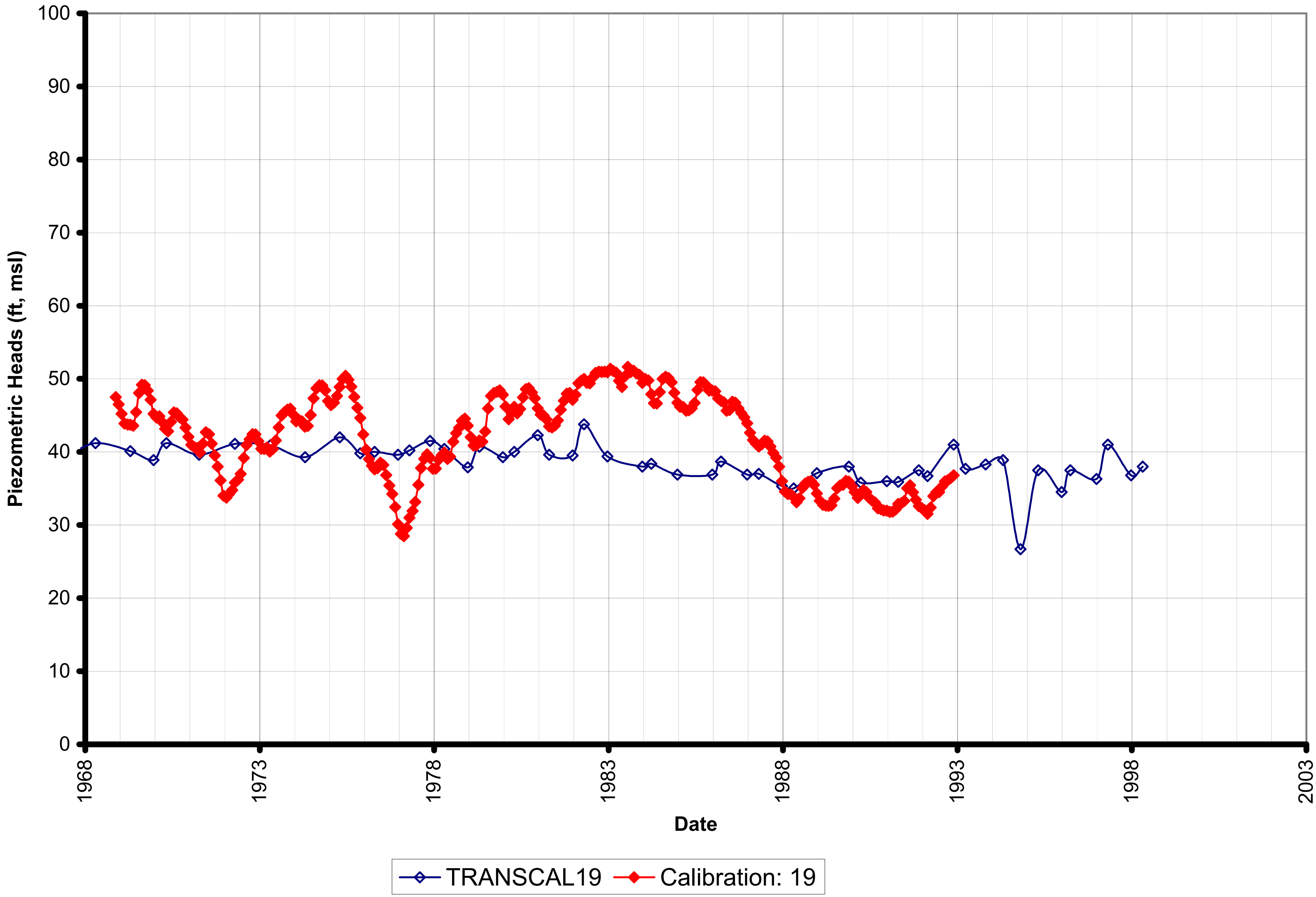
9/14/2001

Figure 3-35
San Joaquin County Water Management Plan

Comparison of Observed Simulated Water Levels

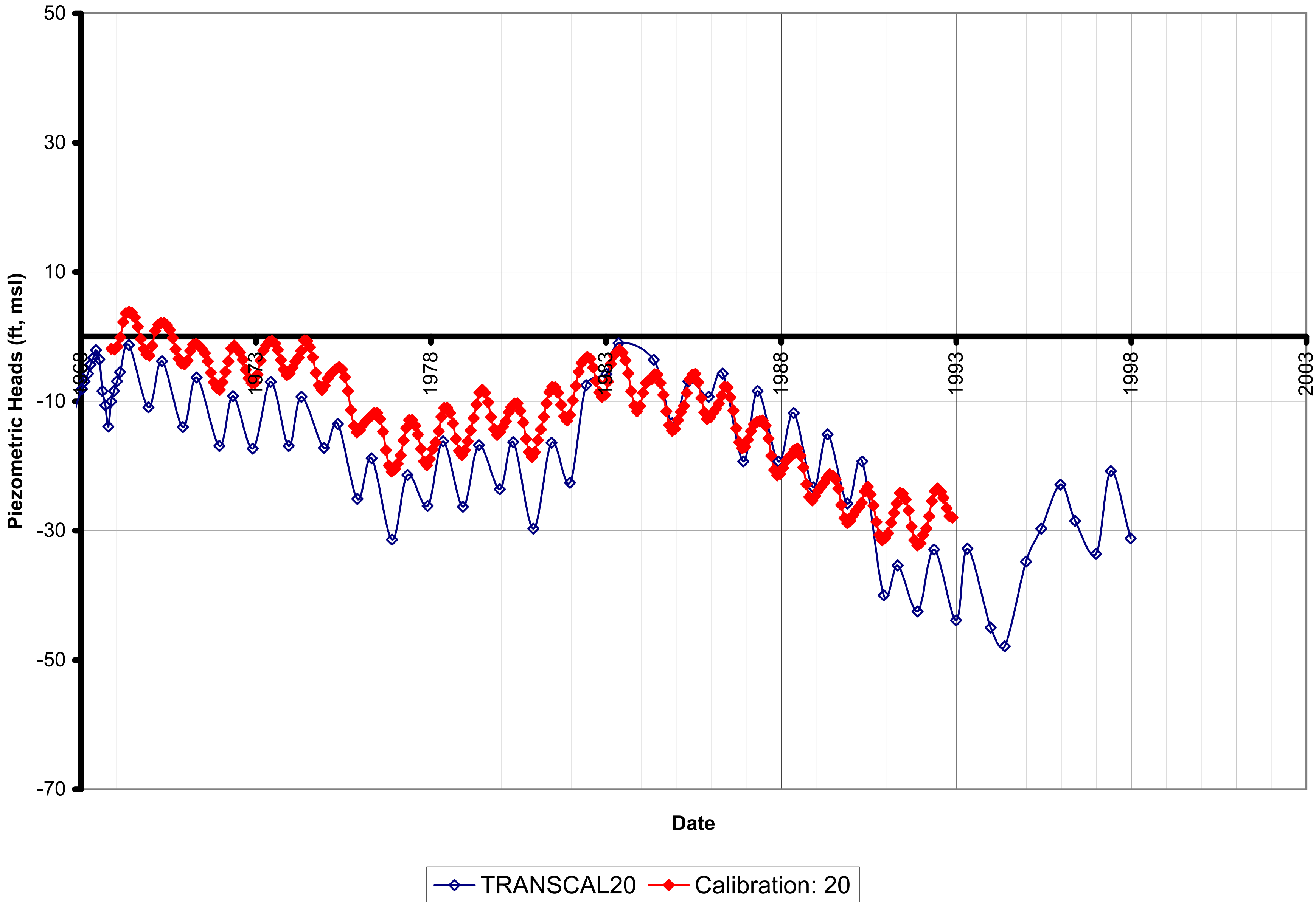


CDM Camp Dresser & McKee Inc.

TransCal-58.xls-36
9/14/2001

Figure 3-36
San Joaquin County Water Management Plan

Comparison of Observed Simulated Water Levels



CDM Camp Dresser & McKee Inc.

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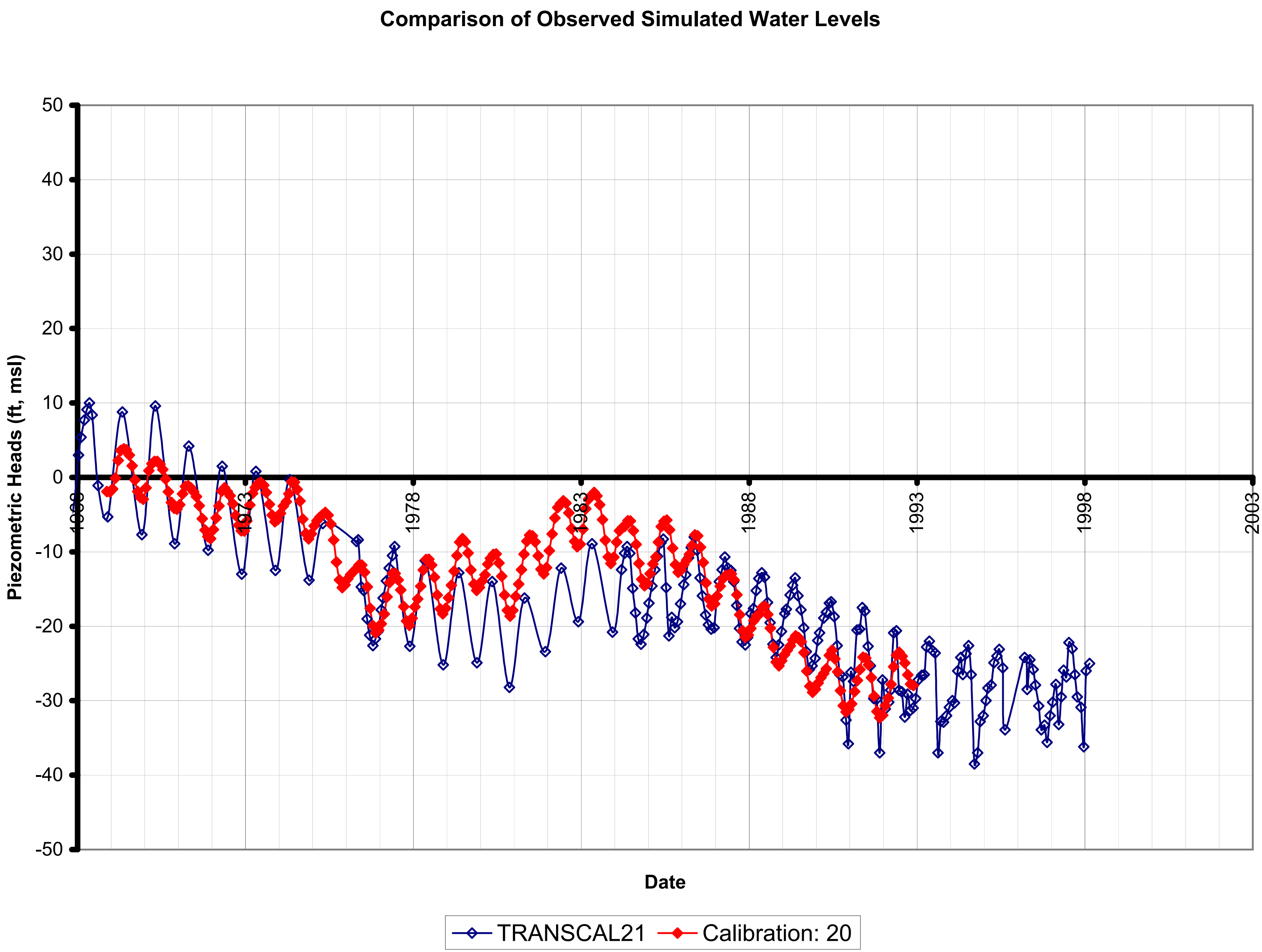
9/14/2001

Figure 3-37
San Joaquin County Water Management Plan



CDM Camp Dresser & McKee Inc.

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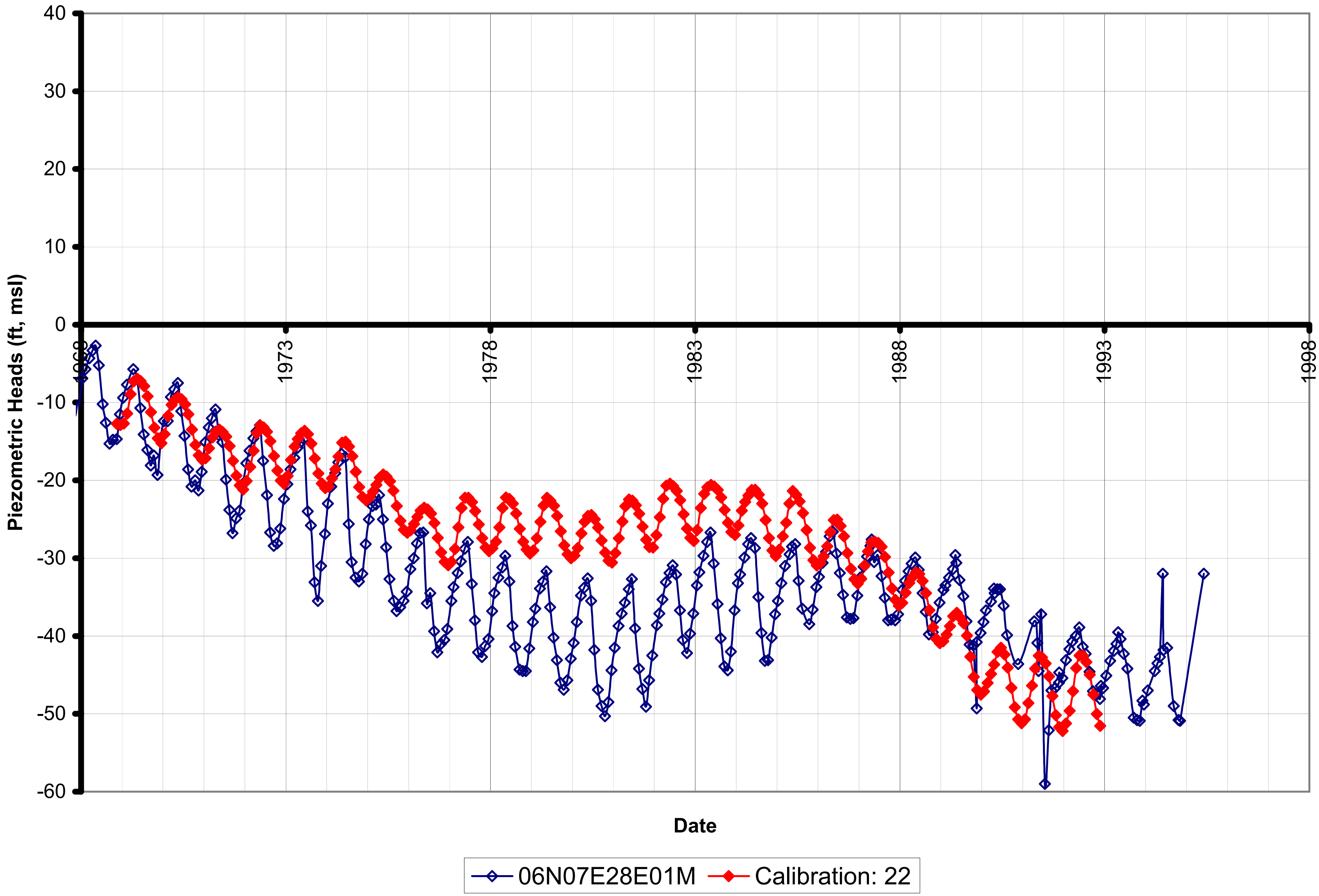
9/14/2001

Figure 3-38
San Joaquin County Water Management Plan

Comparison of Observed Simulated Water Levels



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9/14/2001

Figure 3-39
San Joaquin County Water Management Plan

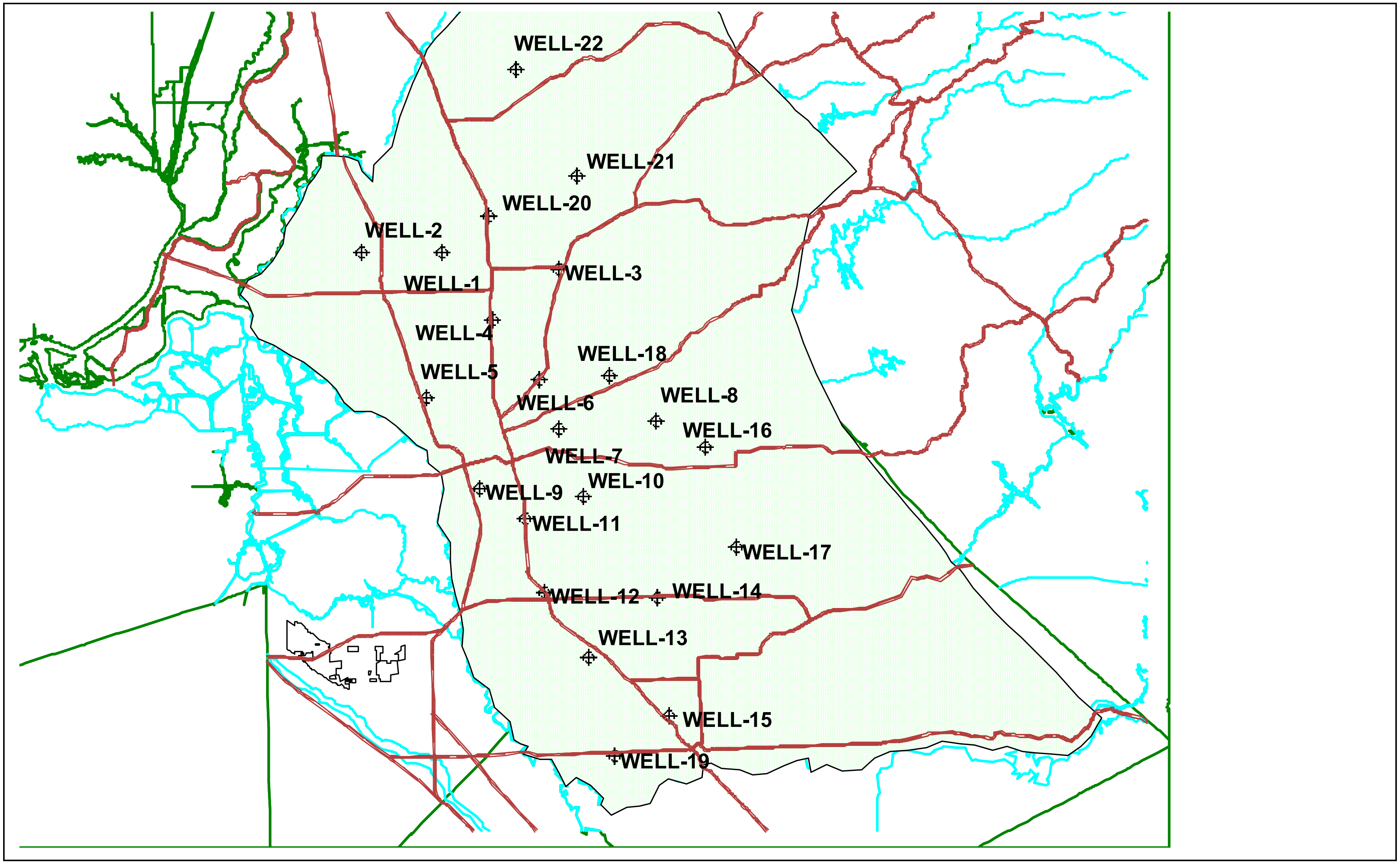


Figure 3-40
Well Hydrograph Location Map

Section 4
Model Application

4.1 Purpose

The purpose of the integrated groundwater and surface water model simulations was to provide a quantitative assessment of the relative benefit derived from each of the different core components of the water management plan. Additionally the overall impact of all the elements implemented under an integrated county water management plan was evaluated.

4.2 Methodology

The model was first calibrated to steady-State conditions for 1970 and 1993. A transient calibration was then developed spanning the period from 1970 to 1993. The model was then applied to simulate the baseline conditions over the planning horizon of the water management plan (from 2001 to 2030).

For the simulation of the period from 2001 to 2030, the historical hydrologic record from 1970 to 2000 was used. The 1970 to 2000 period is comparable to the 1922-2000 period in terms of an average water-year index. From 1970 to 2000, there were more wet years when compared to 1922-2000, but there were also more “critically dry” years. On average, the 1970 to 2000 period provides a good representation of hydrologic conditions under which the water management plan can be evaluated.

4.3 Modeling of Water Management Options

4.3.1 Baseline Condition

The baseline condition refers to the current and predicted condition of the Eastern San Joaquin County Groundwater Basin through the year 2030. Under baseline conditions, all water demands not met by surface water sources are met by groundwater pumping.

The average groundwater table contours for the study area for the year 2000 and 2030 are shown on Figures 4-1 and 4-2. By 2030, the two cones of depression, east of Stockton and north of the Mokelumne, have merged, and a large portion of the ESJCGB has groundwater levels lower than 60 feet below sea-level. Figure 4-3 shows the simulated loss in aquifer storage for entire model domain from the year 2000 through 2030 under no-action or baseline conditions.

4.3.2 Water Management Option Simulations

Selected individual water management options were simulated to evaluate their impact on the groundwater basin. The options simulated were:

- Water Management Option 1: New Hogan Reservoir Reoperation

- Water Management Option 2: South County Water Supply Project

- Water Management Option 3: Farmington Project
- Water Management Option 4: SEWD / CSJWCD Fully Exercise New Melones Rights
- Water Management Option 5: Freeport Groundwater Banking Project

The agreement for the transfer of 30,000 ac-ft between SSJID/OID and SEWD is incorporated into the baseline condition for the first 10 years, i.e. through 2010.

In addition to simulating each of these options individually, an integrated water management plan simulation was run. The integrated water management plan simulation included all the individual elements noted above, as well as an additional 125,000 ac-ft of recharge representing non-specific conjunctive use projects. These conjunctive use projects represent any number of water management options that may be implemented in the future, such as Middle Bar-Duck Creek option, WID Transfer, and NSJWCD Groundwater Recharge Project.

The main components of each simulation are described below.

New Hogan Reservoir Reoperation

Preliminary studies indicate that the reoperation of New Hogan Reservoir could result in an increase in yield of 20,000 to 25,000 ac-ft per year (SWRI, 2000). For the simulation of this option, it was assumed that approximately 30,000 to 45,000 ac-ft of additional yield was available from New Hogan during wet or above-normal years. During below-normal, dry or critical years, no additional water was available. This resulted in an average increase of approximately 23,000 ac-ft on a yearly basis from 2000 to 2030. Figure 4-4 illustrates the resulting groundwater levels in 2030 with the implementation of this option. Groundwater levels increase by approximately 30 percent in the Stockton area and by 19 percent in the SEWD area. In general, this option significantly reduces the extent of area with groundwater levels less than 80 feet below mean sea level (feet-msl).

South County Water Supply Project

For the simulation of this option, it was assumed that SSJID would deliver surface water to Escalon, Manteca and Lathrop as presented in the South County Surface Water Supply Project EIR, (ESA, 1999). The quantities to be delivered are summarized in Table 4-1. The actual quantities simulated as delivered in the model are linked to the growth in urban demand, and thus the net benefit to the groundwater basin is somewhat less than the planned capacity of this option. In the ESJCGB, the net reduction in groundwater pumping is approximately 30,000 ac-ft by the time all phases of the project are implemented. Note that since part of the Lathrop is outside, and Tracy is entirely outside the ESJCGB, not all of the surface water supplied to these cities contributes to overdraft reduction in the ESJCGB.

Table 4-1 *Water Quantities for South Counties Surface Water Supply Project*				
Phase/Period	**Lathrop**	**Escalon**	**Manteca**	**Tracy**
Phase 1: 2003-2011	3,200	0	11,000	10,000
Phase 2: 2012-2025	10,000	2,800	16,400	10,000

Figure 4-5 illustrates the resulting groundwater levels in 2030 with the implementation of this option. Groundwater levels increase by approximately 14 percent in the Stockton area and by 3 percent in the SEWD area.

Farmington Project

The Farmington Recharge Project was simulated as consisting of two principal recharge zones, with one in NSJWCD and one in western SEWD (see Table 4-2). In the northern recharge zone, approximately 10,000 ac-ft was recharged during all years except critically dry years. In SEWD, 10,000 ac-ft was recharged in average and below-normal years, and 40,000 ac-ft was recharged in wet and above normal years. Based on 1970 to 2000 hydrology, this results in approximately 25,000 ac-ft of recharge, which increases to 31,000 ac-ft of recharge using 1922 to 1992 hydrology.

Table 4-2 *Farmington Project Recharge Amounts and Location*			
Water Year Type	**Frequency of Occurrence (based on 1922 to 1992 hydrology)**	**NSJWCD (acre-feet)**	**SEWD (acre-feet)**
Wet	27%	10,000	40,000
Above Normal	21%	10,000	40,000
Below Normal	20%	10,000	10,000
Dry	17%	10,000	10,000
Critical	15%	0	0
Annual Average Basis		**8,000**	**23,000**

Figure 4-6 illustrates the resulting groundwater levels in 2030 with the implementation of this option. Groundwater levels increase by approximately 12 percent in the Stockton area and by 10 percent in the SEWD area.

SEWD/CSJWCD Fully Exercise New Melones Rights

Under baseline conditions, it was assumed that SEWD / CSJWCD could on an average annual basis utilize approximately 41,000 ac-ft of water from New Melones. This estimate is based on the New Melones Interim Plan of Operations (NMIPO), and the conveyance capacity limitations in transferring the water from the Stanislaus to both SEWD and CSJWCD. SEWD and CSJWCD have combined rights to 155,000 ac-ft, which would only be available in wet years. To simulate this option it was assumed that 134,000 ac-ft could be diverted in wet years, 70,000 ac-ft in above-normal years, 30,000 ac-ft in below-normal years, 17,000 ac-ft available in dry years and no water was available during critical years. This resulted in an average availability of 59,000 ac-ft on an annual basis, or a net increase of 18,000 ac-ft over the baseline conditions (see Table 4-3).

Table 4-3
Estimated Current and Projected Deliveries from New Melones to SEWD and CSJWCD[1]

Water Year Type	Frequency of Occurrence (based on 1922 to 1992 hydrology)	Potential Current Delivery to SEWD and CSJWCD (acre-feet)	Potential Future Delivery to SEWD and CSJWCD (acre-feet)
Wet	27%	80,000	134,000
Above Normal	21%	48,000	70,000
Below Normal	20%	33,000	30,000
Dry	17%	19,000	17,000
Critical	15%	0	0
Annual Average Basis		**41,000**	**59,000**

Figure 4-7 illustrates the resulting groundwater levels in 2030 with the implementation of this option. Groundwater levels increase by approximately 12 percent in the Stockton area and by 18 percent in the SEWD area.

Freeport Project

The simulation of the Freeport Project involves the recharge of water diverted from the Sacramento River near the town of Freeport. The location and amount of recharge was based on the most recent project concept at the time the work was done. This involved recharging 31,000 ac-ft in NSJWCD and 62,000 ac-ft in SEWD, for a total recharge of 93,000 ac-ft. The final project concept will likely involve a combination of direct recharge and in-lieu. The recharge only occurs in years classified as “wet” and above normal years. In “below normal”, “dry” and “critical years” 18,600 ac-ft and 37,200 ac-ft of groundwater is pumped for export from NSJWCD and SEWD respectively. The total groundwater export is 55,800 ac-ft per year in appropriate years.

The gain to the ESJCGB is 26,000 ac-ft per year. This was based on 1970 to 2000 hydrology in which 55 percent of the years were classified as either wet or above-normal. Figure 4-8 illustrates the resulting groundwater levels in 2030 with the implementation of this option. Groundwater levels increase by approximately 5 feet (20 percent increase) in the Stockton area and by 19 feet (19 percent increase) in the SEWD area.

Integrated Water Management Plan

The options listed above on an annual average basis could account for approximately 132,000 ac-ft of water being recharged to the groundwater basin. It is estimated that another 60,000 to 70,000 ac-ft of net recharge would be require to reduce the overdraft

[1] The values in this table are average values based on the modeling done for New Melones Interim Plan of Operations, (USBR,1997). Actual simulated deliveries in the hydrologic model vary from year to year and are dependent on inflow to New Melones and other factors, not only on water year type.

by 2030. To simulate the impact of this additional 60,000 ac-ft of recharge, the integrated water management plan was simulated with approximately 125,000 ac-ft of wet year recharge, and 75,000 ac-ft of groundwater pumping in dry years (see Table 4-4). This represents any number of water management options that may be implemented in the future, such as Middle Bar-Duck Creek option, WID Transfer and NSJWCD Groundwater Recharge Project.

Table 4-4
Summary of Recharge and Groundwater Pumping for Simulated Water Management Options (Based on 1970-2000 Hydrology)

Option	Additional Quantity Recharged Through Direct Recharge or In-lieu for WMOs	Additional Quantity Extracted in Dry Years	Net Gain to Groundwater Basin
New Hogan Reoperation	23,000	0	23,000
South County Water Supply Project	34,000	0	34,000
Farmington Project	25,000	0	25,000
Exercise New Melones Rights	18,000	0	18,000
Freeport Project	93,000	55,800	32,000
Unspecified Conjunctive Use Projects	125,000	75,000	60,000

Figure 4-9 illustrates the resulting groundwater levels in 2030 with the implementation of the selected specific options, and the additional 60,000 ac-ft representing upspecified conjunctive use options. Groundwater levels increase by approximately 77 percent in the Stockton area and by approximately 80 percent in the SEWD area.

The time-varying results from the simulations are shown on figures 4-10 through 4-31. These figures illustrate the predicted groundwater levels under baseline conditions, and with the water management plan implemented at selected wells throughout the study area. The calibrated groundwater levels from 1970 to 2000 are also depicted. The locations of the selected wells are shown on in the previous section figure 3-40.

Figure 4-32 illustrates groundwater level profile along Highway 4 in Stockton and SEWD. The figure clearly illustrates the impact of the implementing the core water management options, with water levels increasing in some areas by 50 feet.

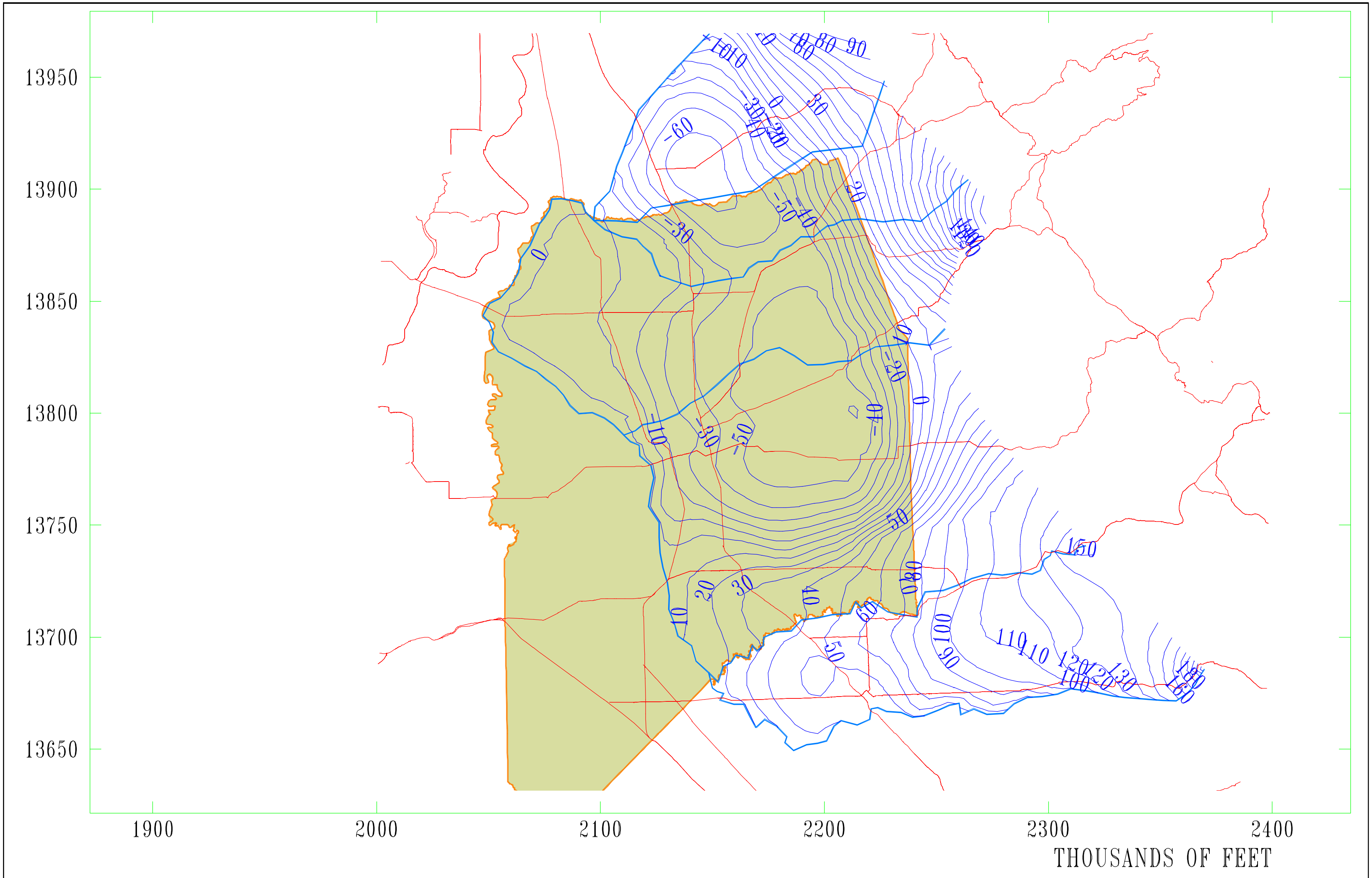
Results Summary

Table 4-5 and Table 4-6 provide a summary of the impact of the selected options individually, and these selected options as part of an overall integrated water management plan. In Table 4-5, the average increases in groundwater levels in two areas are summarized.

Table 4-5 *Impact of Selected Options – Groundwater Levels*		
Scenario/Option	**Average groundwater level in Stockton Area (feet, msl)**	**Average groundwater level in SEWD (feet, msl)**
No Action – Baseline (2030)	***-27***	***-81***
	Average Increase with Option/Plan (feet)	
Reoperation of New Hogan Reservoir	8	15
South County Water Supply Project	4	2
Farmington Recharge Project	3	8
Fully Exercise New Melones Rights	2	10
Freeport Project	5	19
Integrated Water Management Plan	13	40

In Table 4-6, the impact of the water management options in saline intrusion rates (rate of groundwater migration from west of Stockton towards the cone of the depression) is shown.

Table 4-6 *Impact of Selected Options – Saline Intrusion*	
Water Management Option	**Rate of Saline Water Intrusion (feet per year)**
No Action:Baseline Conditions (2030)	***334***
Reoperation of New Hogan Reservoir	196
South County Water Supply Project	184
Farmington Recharge Project	167
Fully Exercise New Melones Rights	168
Freeport Project	152
Integrated Water Management Plan	***99***



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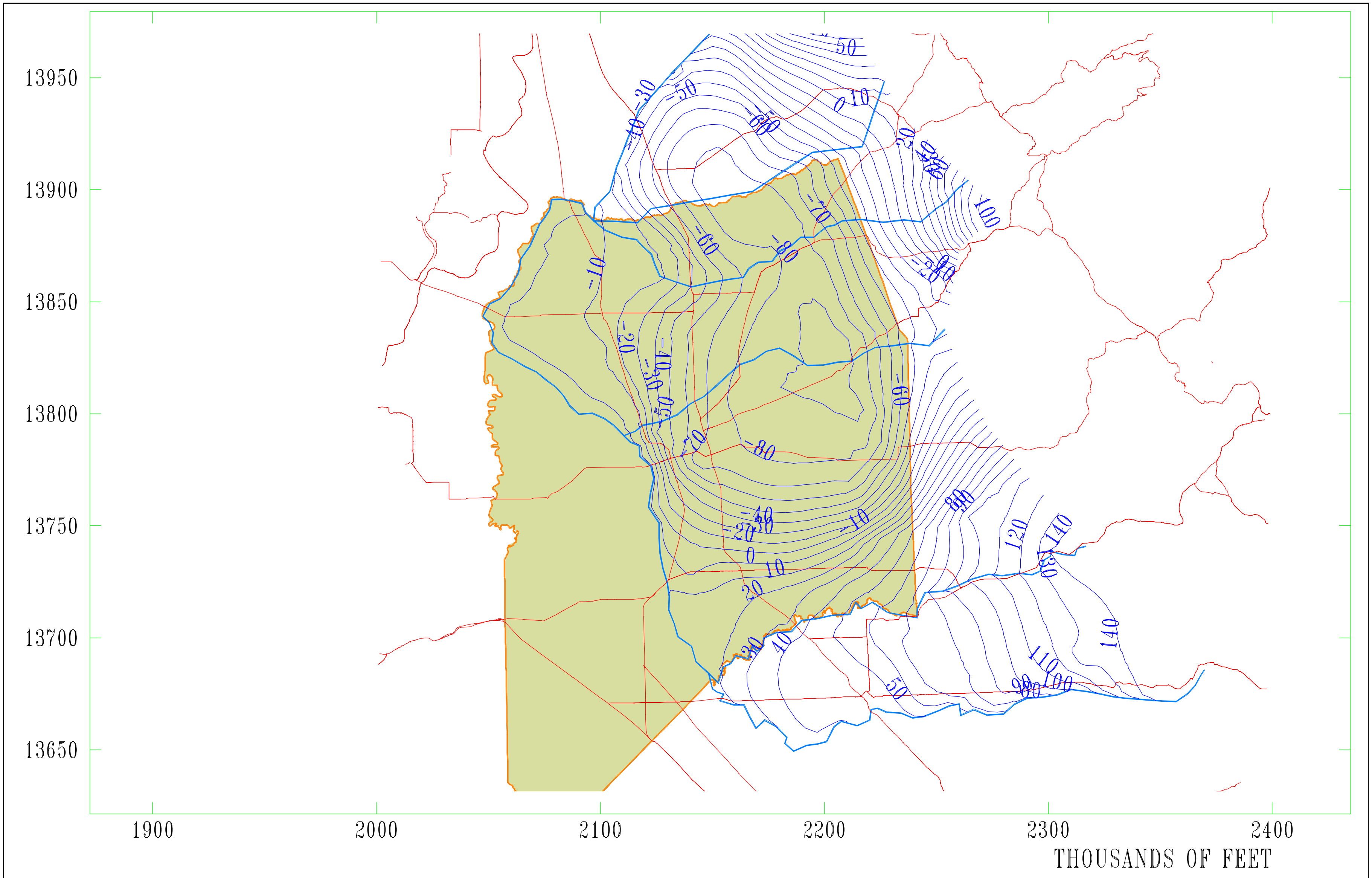
Simulated Groundwater Table Contours
Baseline Conditions: Year 2000

San Joaquin County Water Management Plan

FIGURE
4-1



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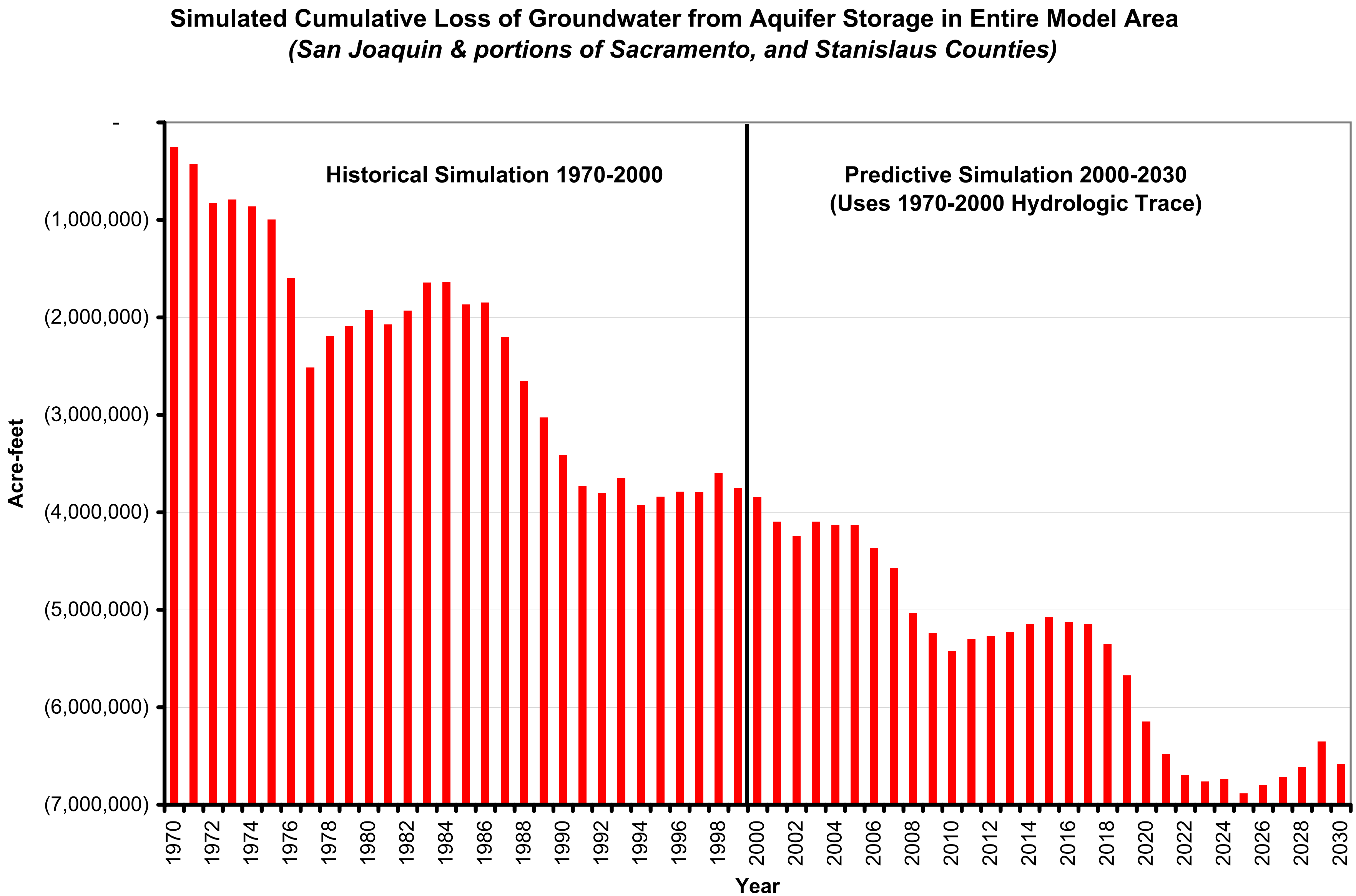
CDM

Simulated Groundwater Table Contours
Baseline Conditions: Year 2030

San Joaquin County Water Management Plan

FIGURE
4-2


Simulated Cumulative Loss of Groundwater from Aquifer Storage in Entire Model Area
(San Joaquin & portions of Sacramento, and Stanislaus Counties)
Historical Simulation 1970-2000
Predictive Simulation 2000-2030
(Uses 1970-2000 Hydrologic Trace)
Acre-feet
-
(1,000,000)
(2,000,000)
(3,000,000)
(4,000,000)
(5,000,000)
(6,000,000)
(7,000,000)
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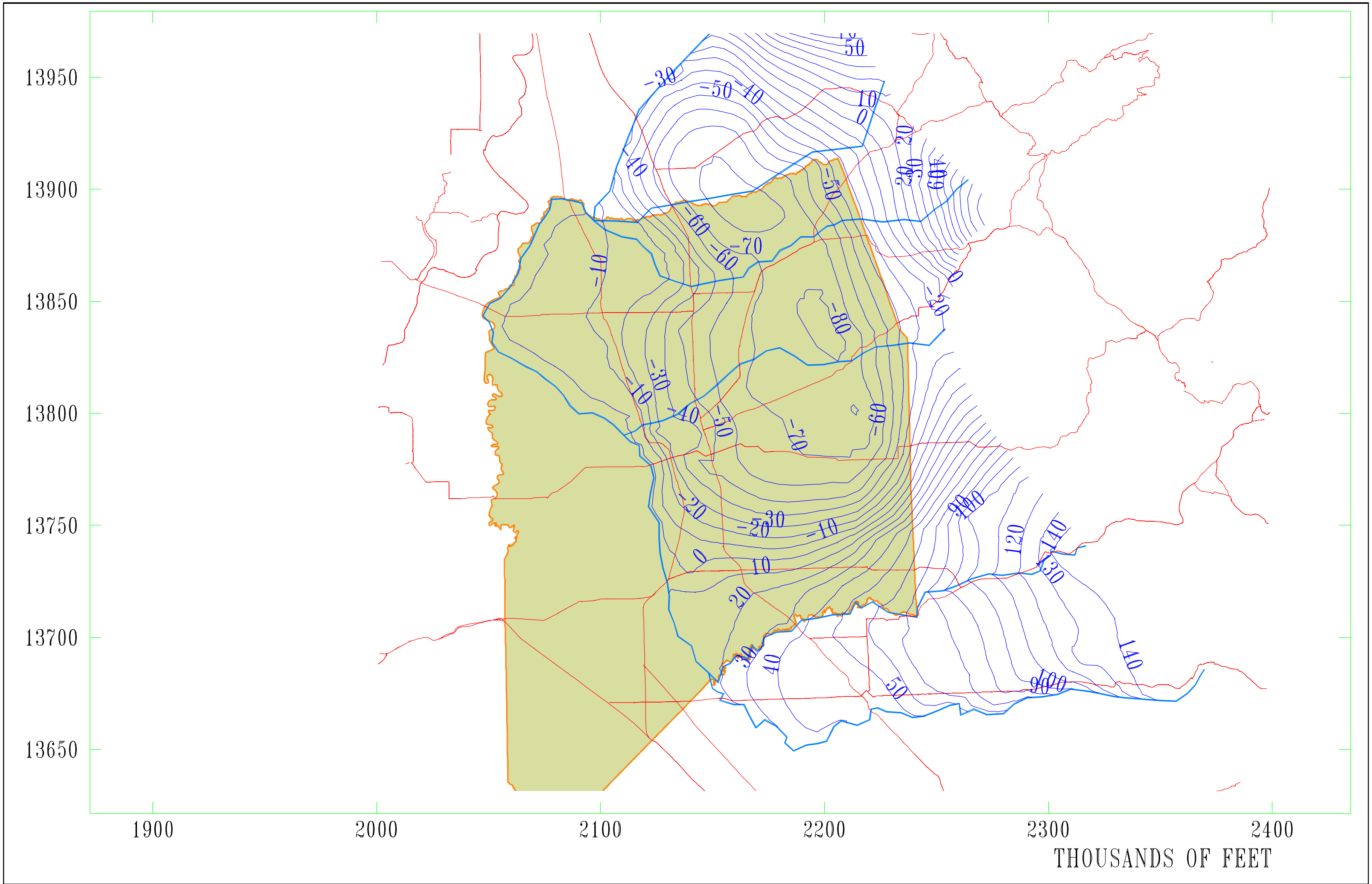
2030
Year



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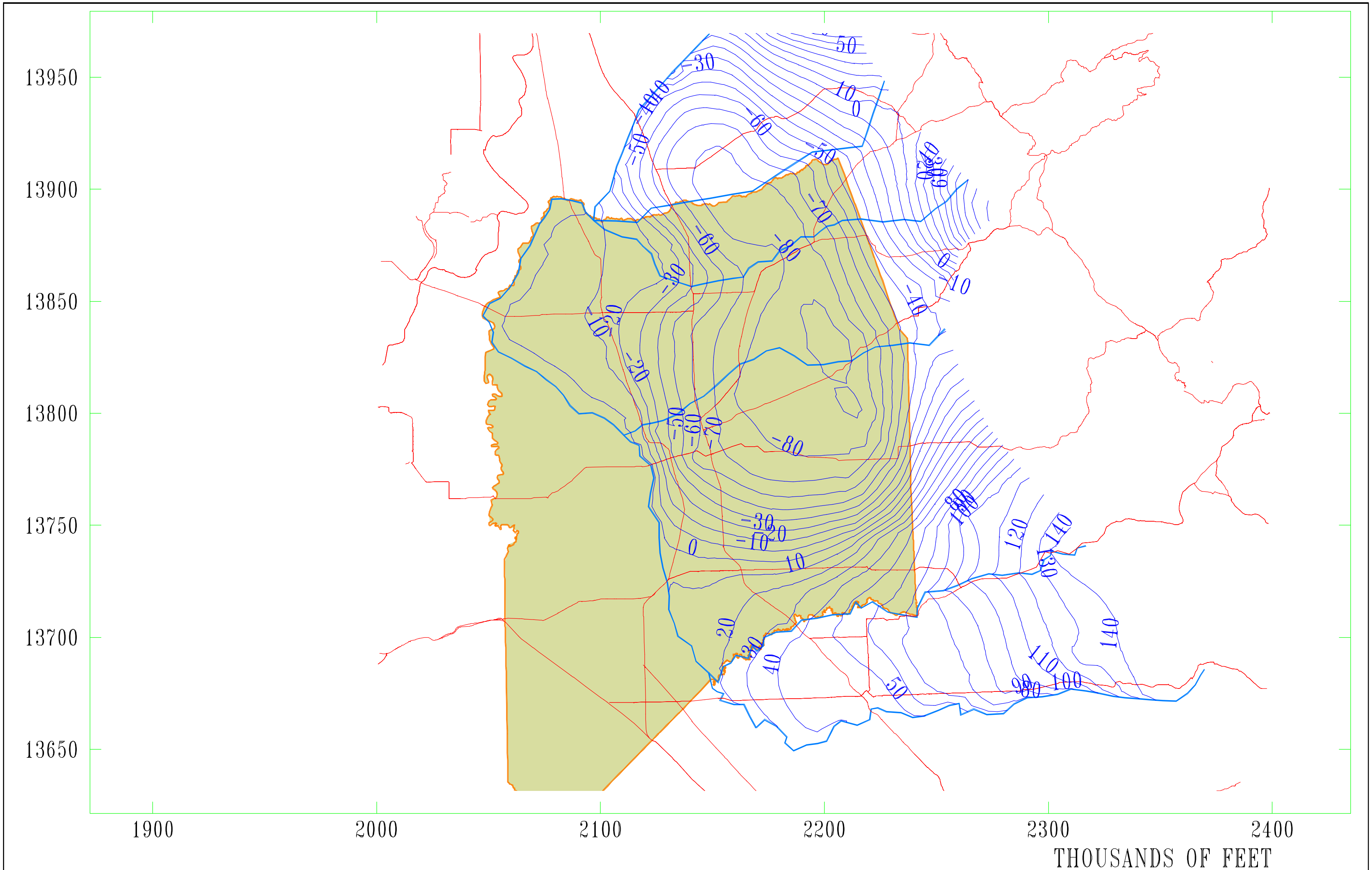
Simulated Groundwater Table Contours
New Hogan Reoperation – In-lieu SEWD

San Joaquin County Water Management Plan

FIGURE 4-4



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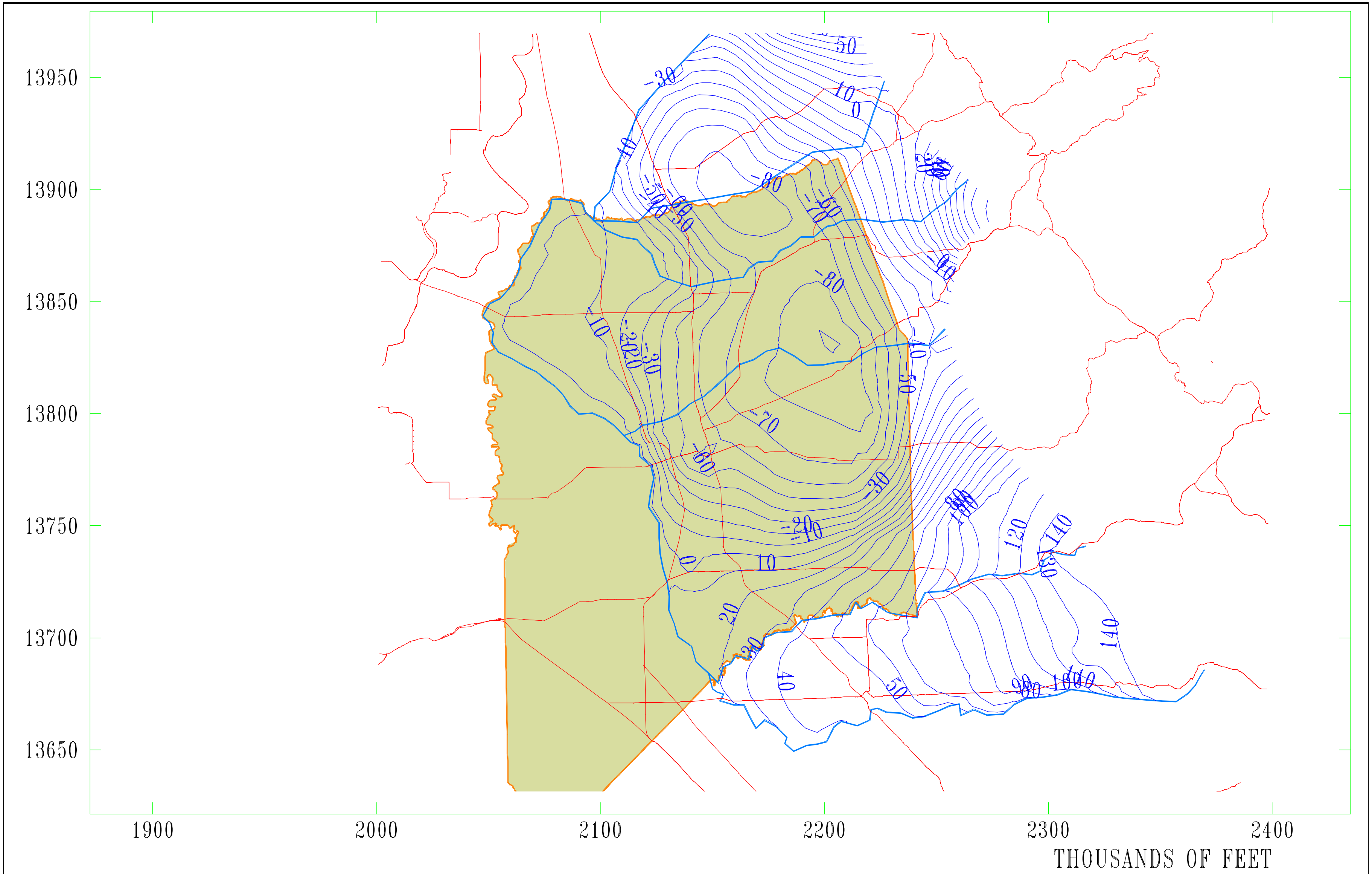
Simulated Groundwater Table Contours
South County Surface Water Supply Project
Year 2030
San Joaquin County Water Management Plan

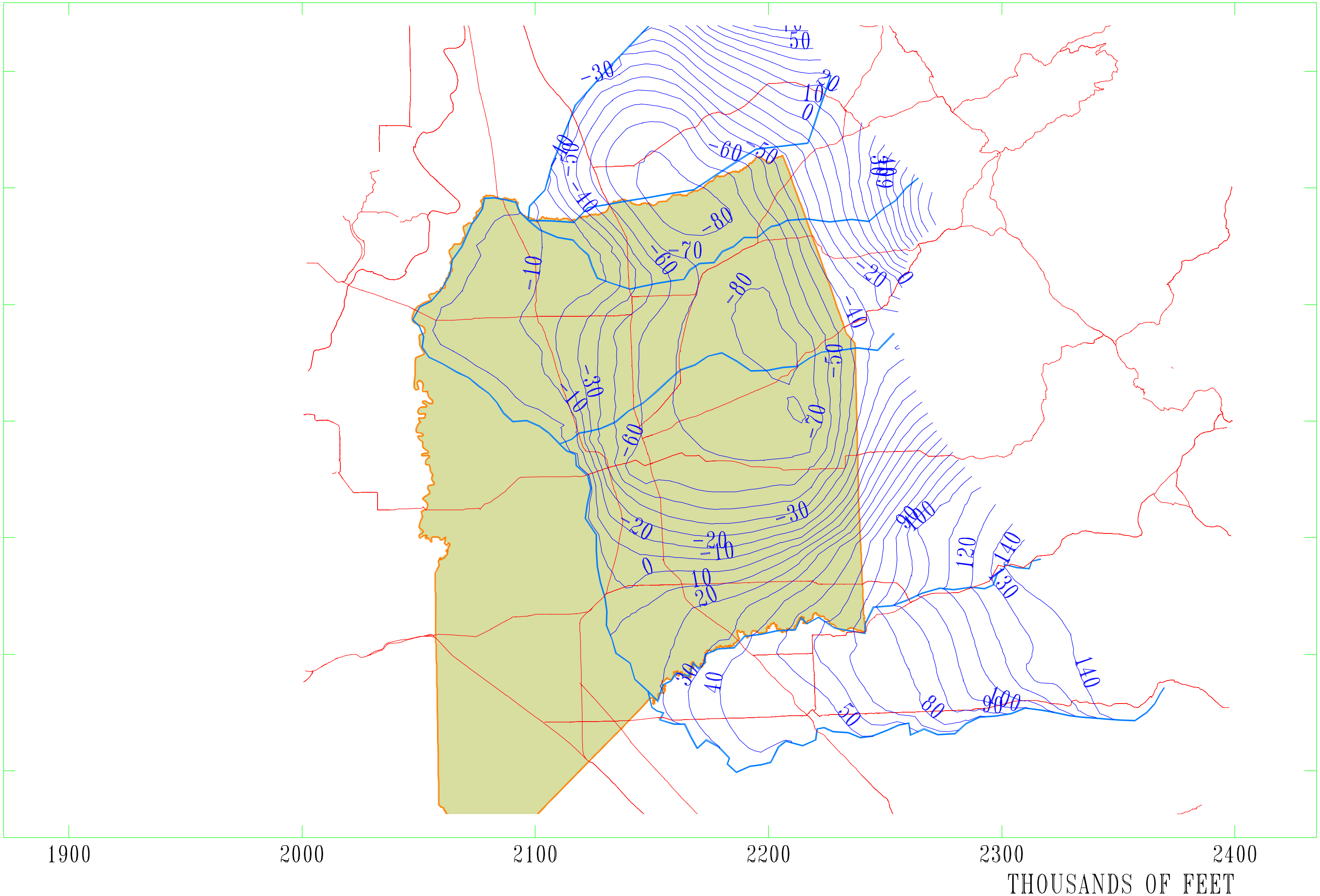
FIGURE
4-5



consulting engineering construction operations CDM

Simulated Groundwater Table Contours
Farmington Recharge Project
Year 2030
San Joaquin County Water Management Plan

FIGURE
4-6



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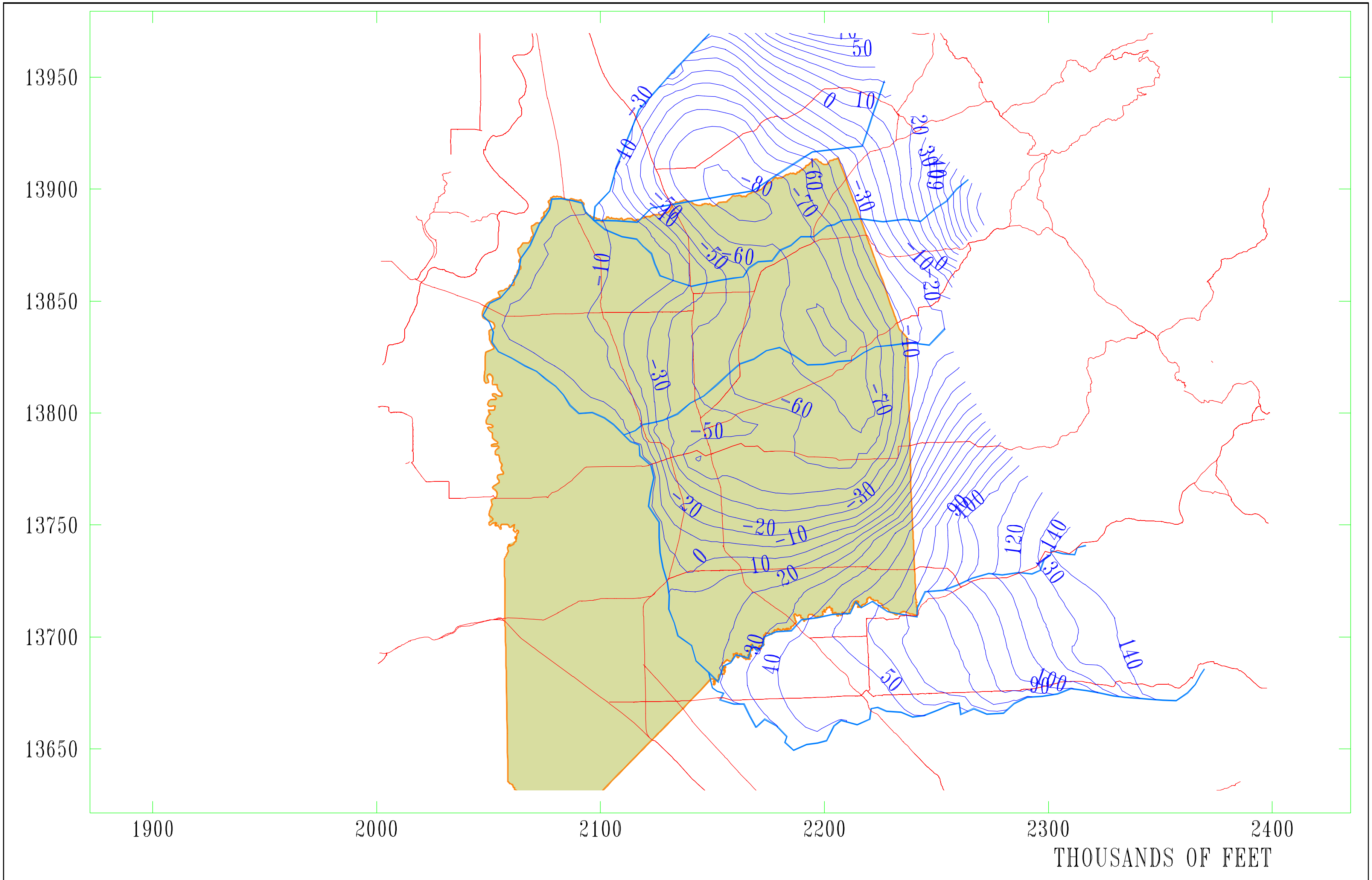
Simulated Groundwater Table Contours
Exercise New Melones Rights-In-lieu SEWD, CSJWCD
Year 2030
San Joaquin County Water Management Plan

FIGURE 4-7



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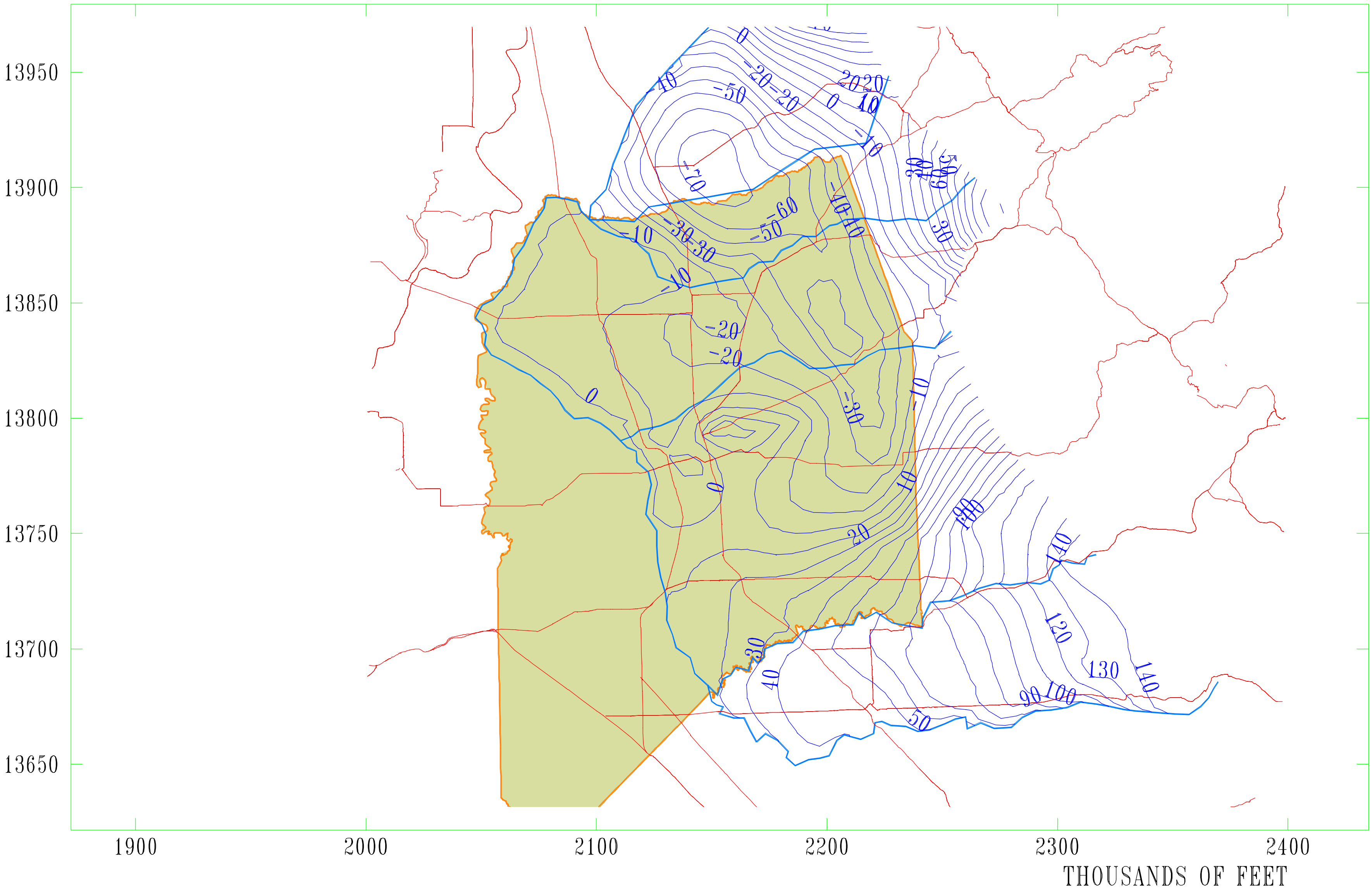
engineering
construction
operations

CDM

Simulated Groundwater Table Contours
Freeport Project-In-lieu & Recharge in SEWD, NSJWCD
Year 2003
San Joaquin County Water Management Plan

FIGURE
4-8



consulting
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operations

Simulated Groundwater Table Contours
Integrated Water Management Plan
Year 2030
San Joaquin County Water Management Plan

FIGURE
4-9

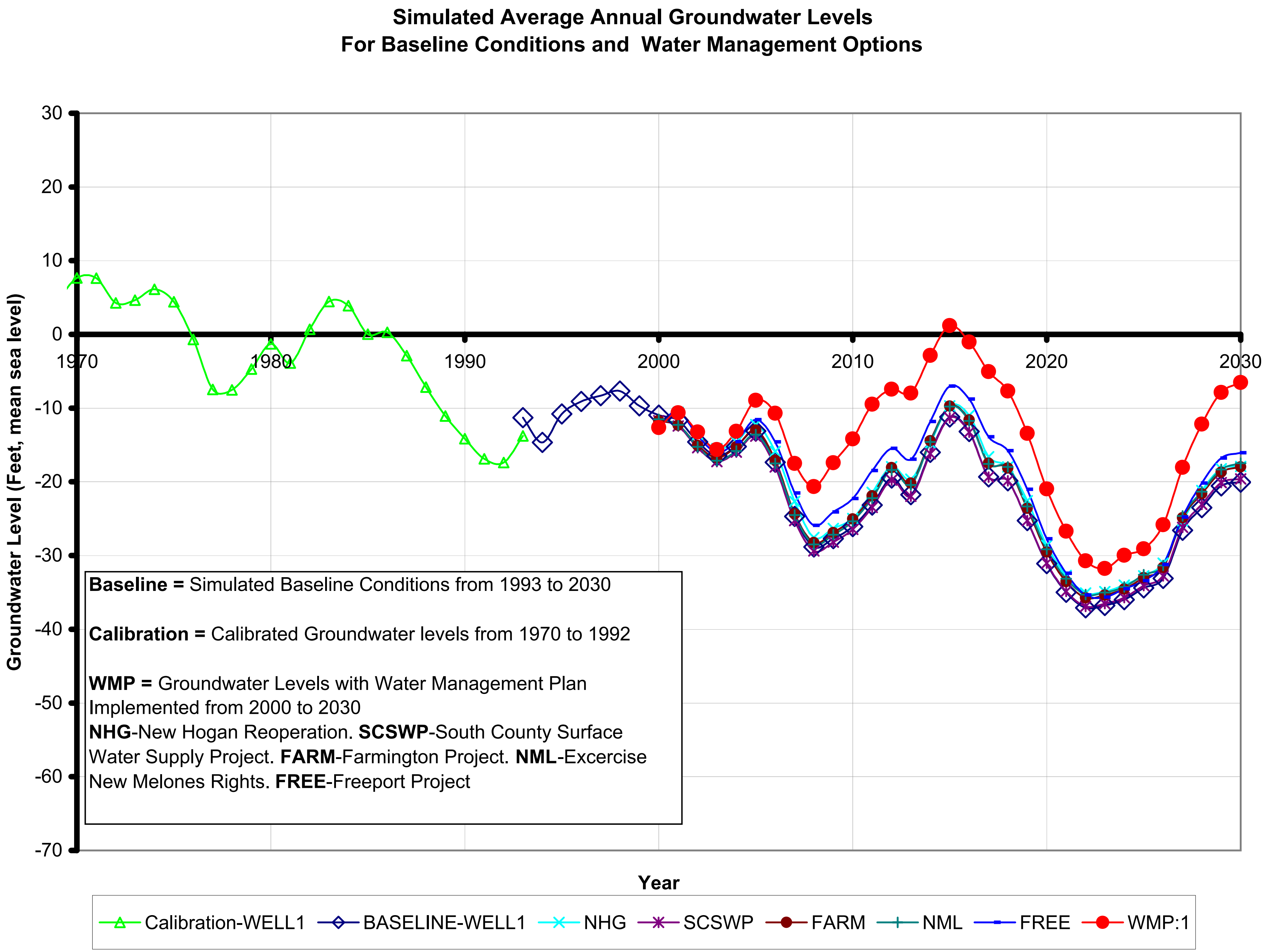

Figure 4-10
Simulated Groundwater Levels (1970-2030)
San Joaquin County Water Management Plan

CDM Camp Dresser & McKee Inc.
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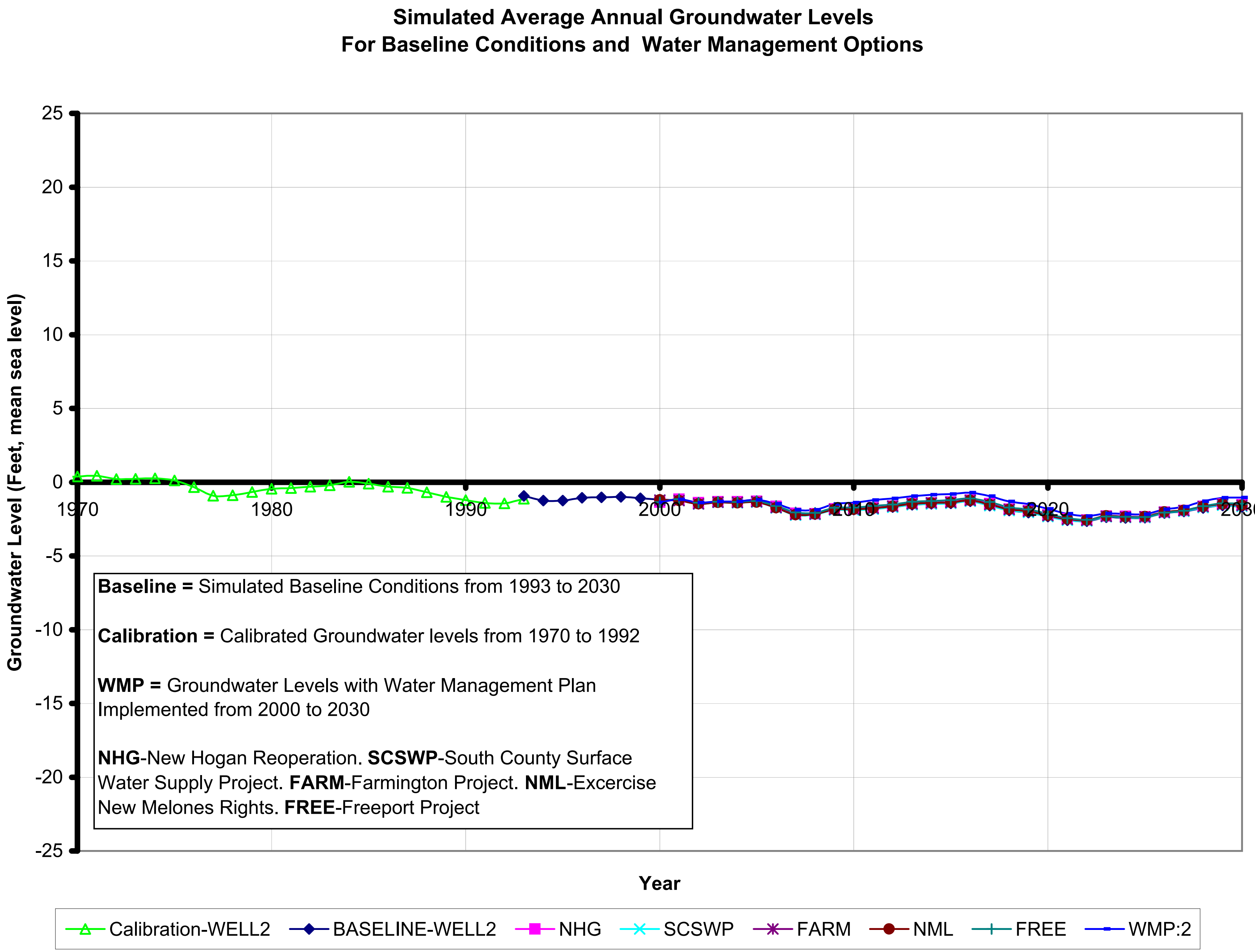

Figure 4-11
Simulated Groundwater Levels (1970-2030)
San Joaquin County Water Management Plan

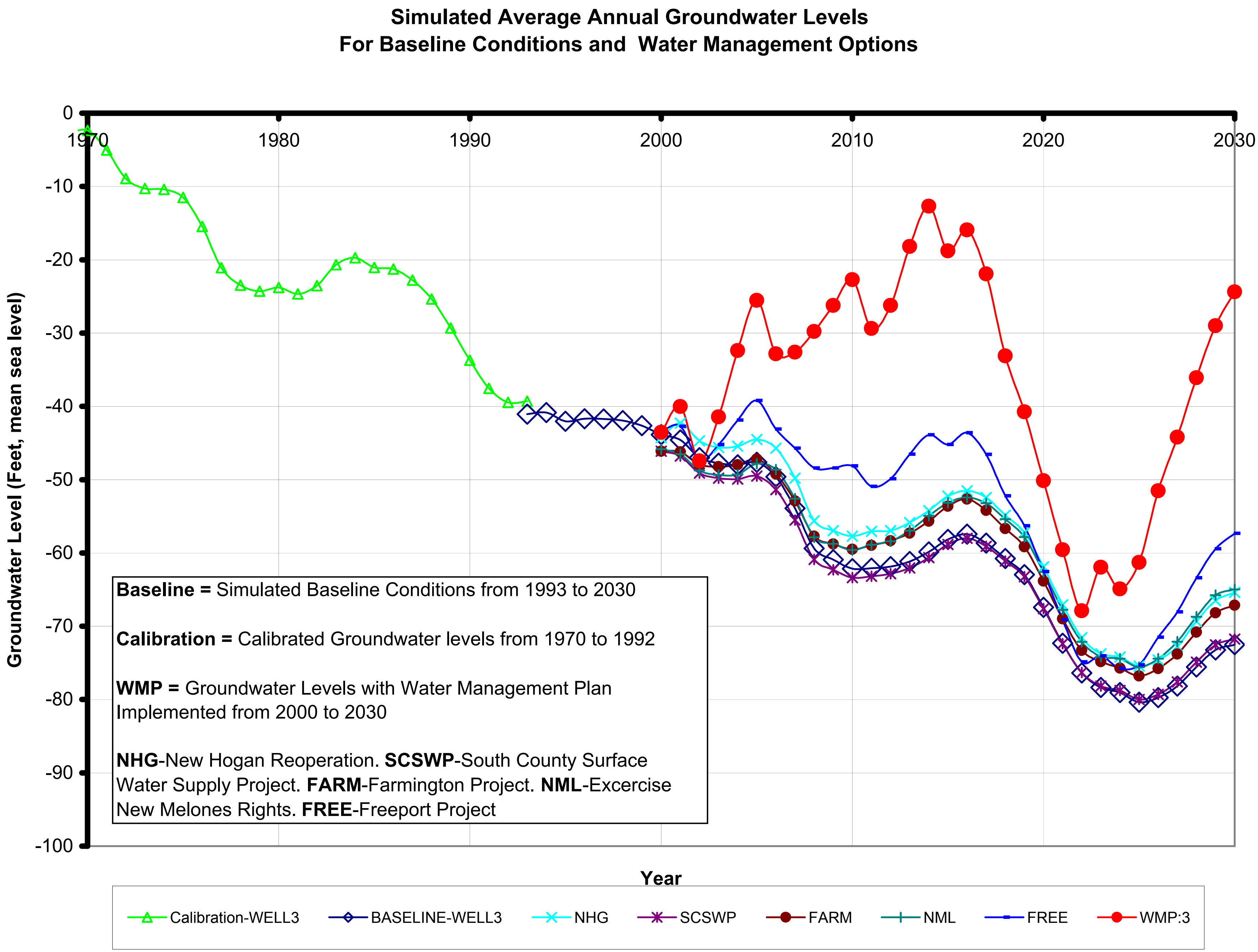

Figure 4-12
Simulated Groundwater Levels (1970-2030)
San Joaquin County Water Management Plan

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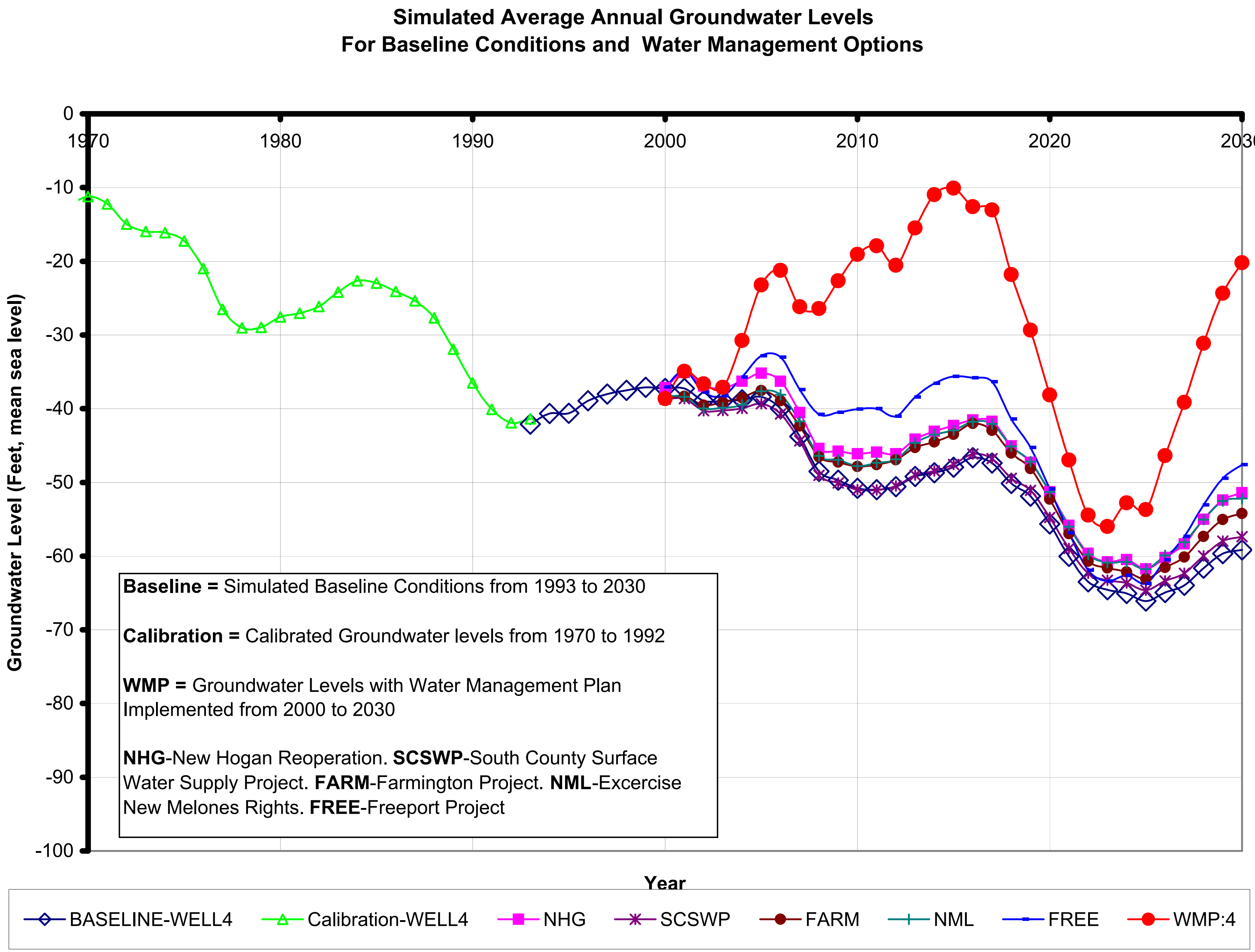

Figure 4-13
Simulated Groundwater Levels (1970-2030)
San Joaquin County Water Management Plan

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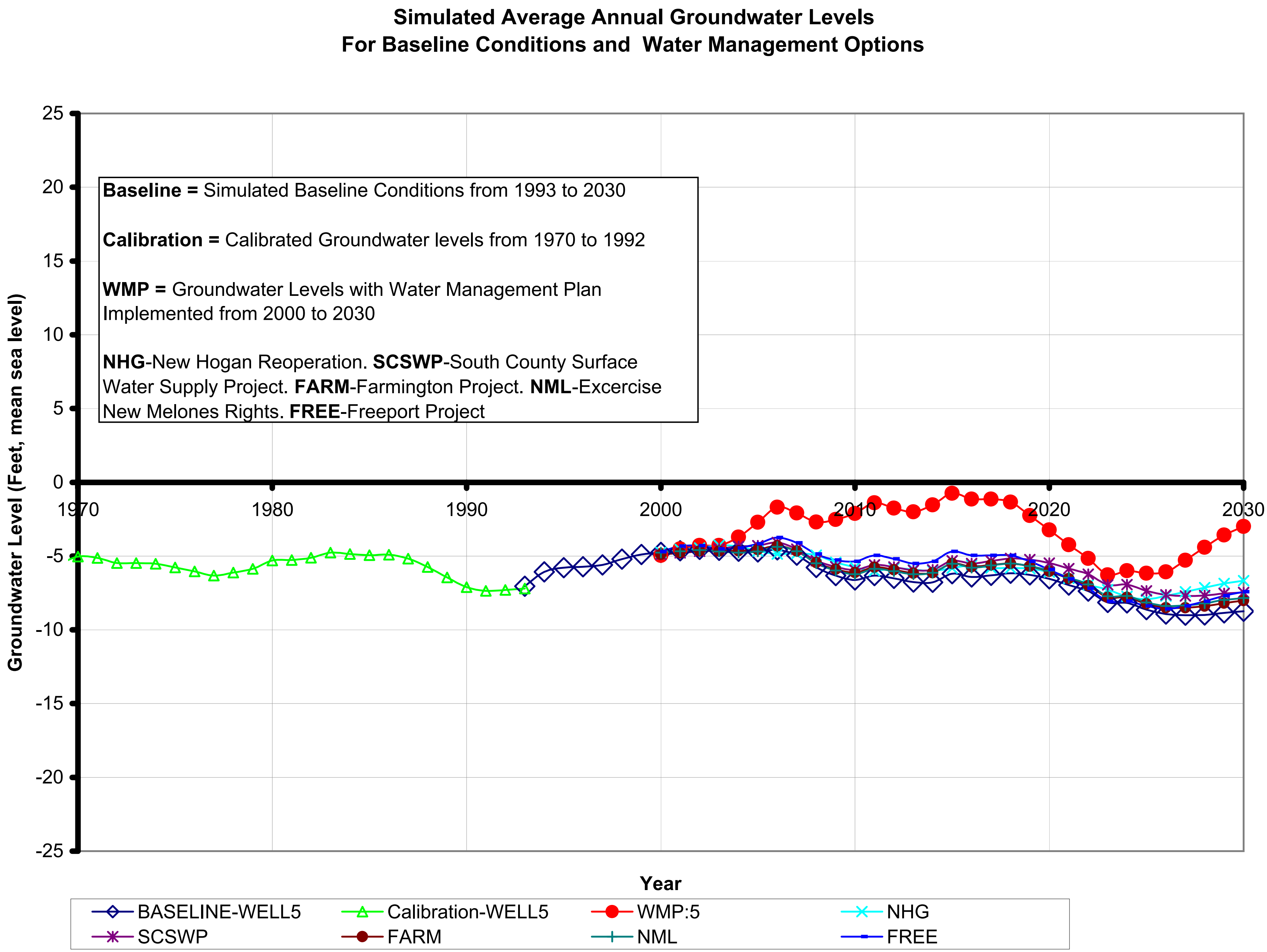

Figure 4-14
Simulated Groundwater Levels (1970-2030)
San Joaquin County Water Management Plan

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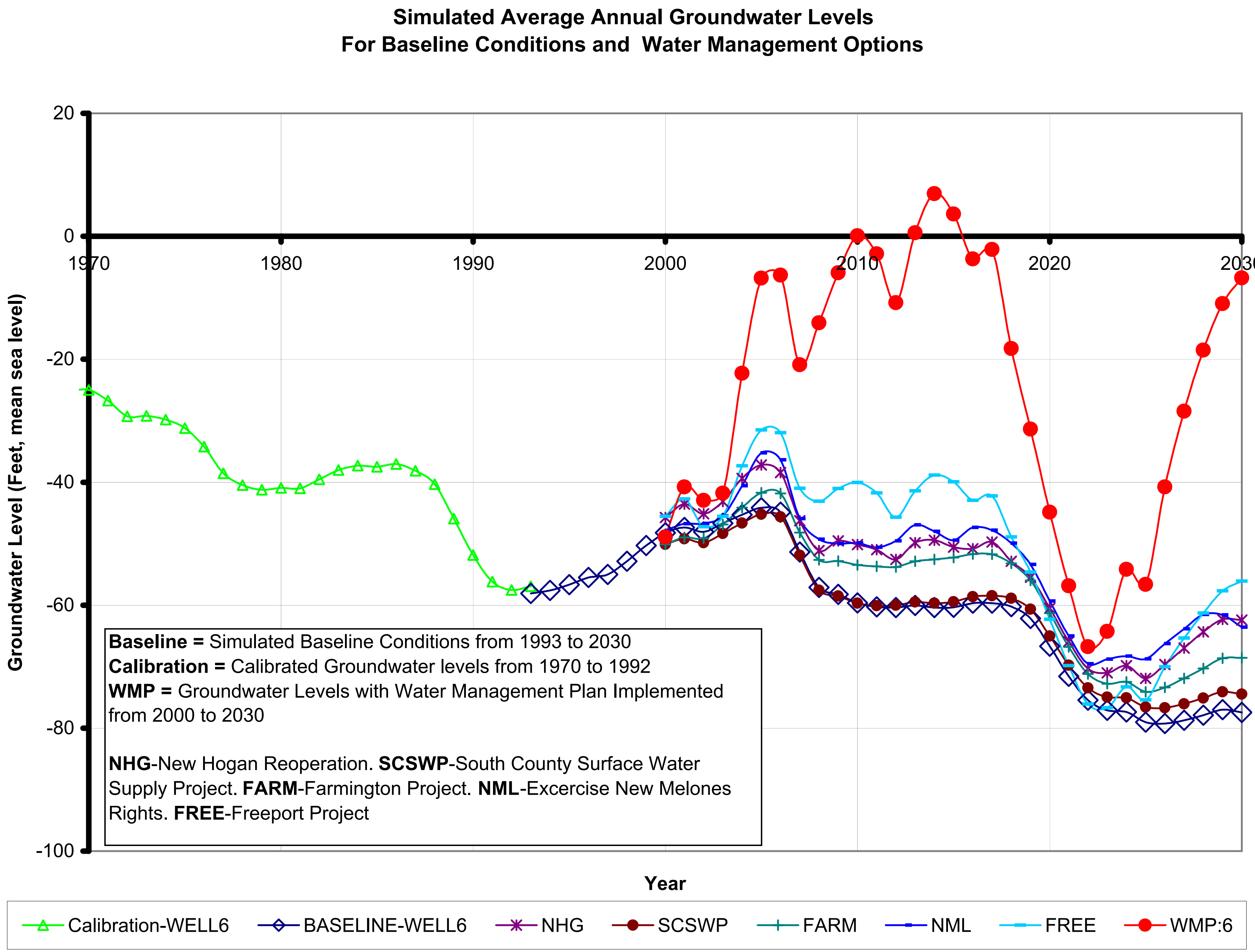

Figure 4-15
Simulated Groundwater Levels (1970-2030)
San Joaquin County Water Management Plan

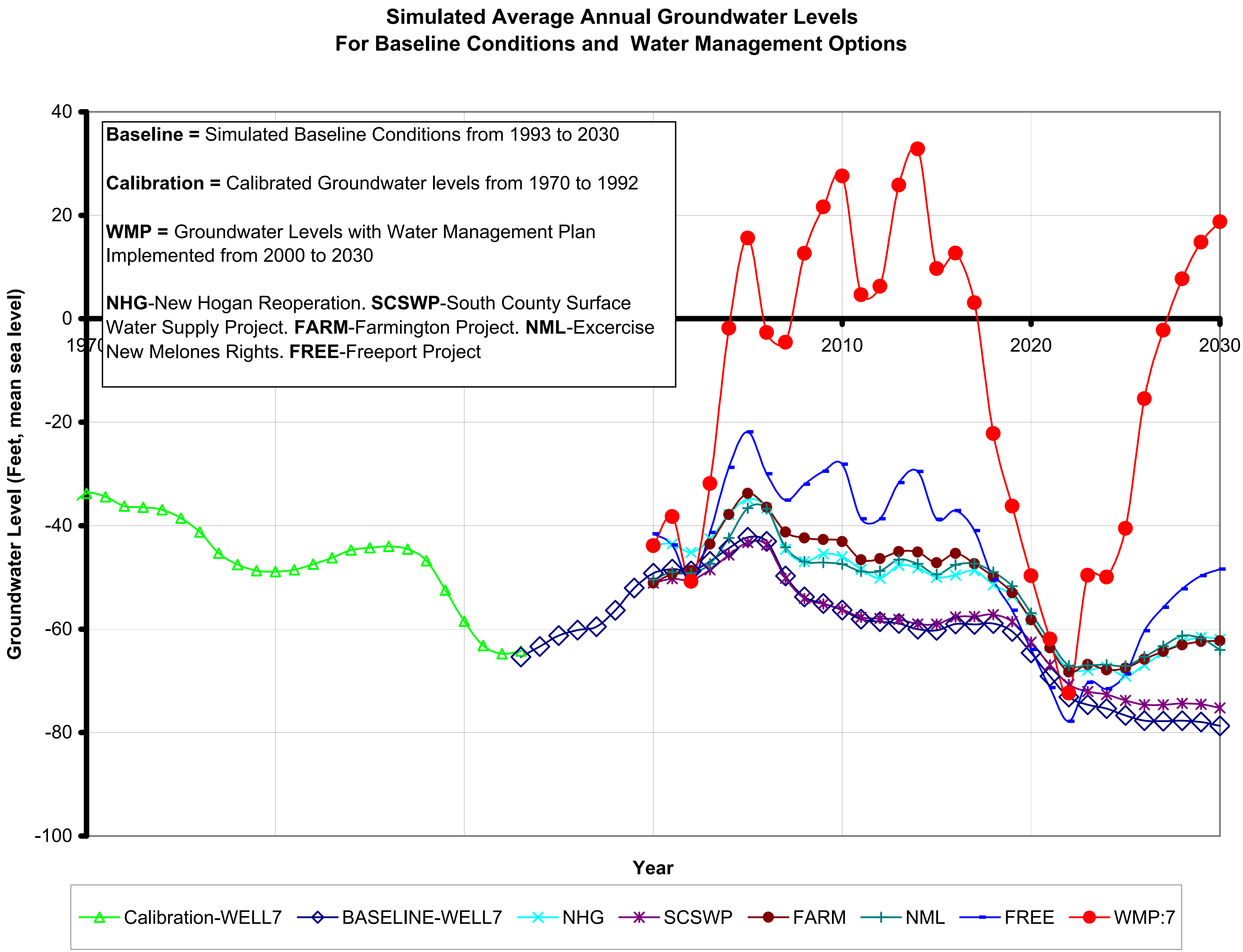

Figure 4-16
Simulated Groundwater Levels (1970-2030)
San Joaquin County Water Management Plan

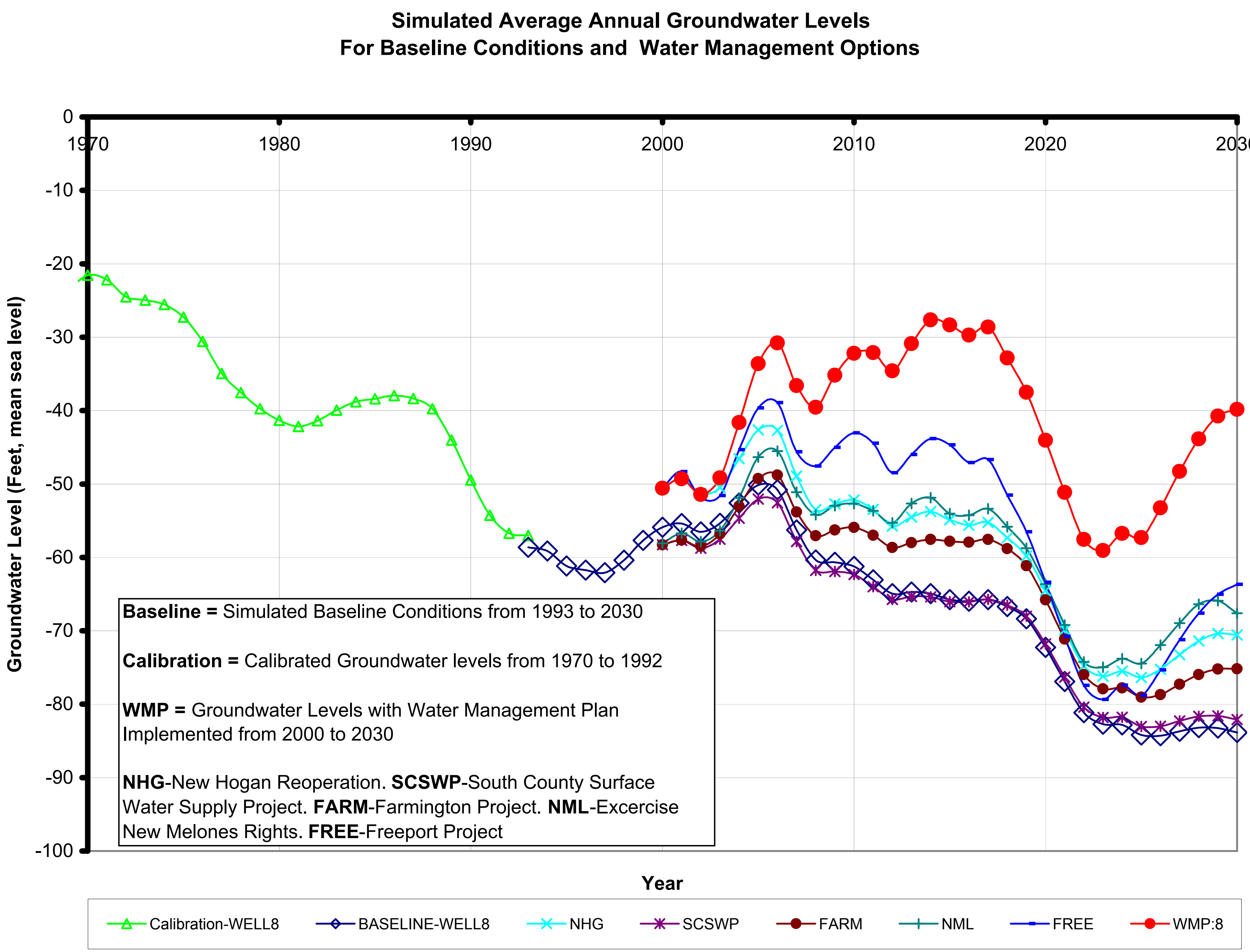

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Figure 4-17
Simulated Groundwater Levels (1970-2030)
San Joaquin County Water Management Plan

Simulated Average Annual Groundwater Levels
For Baseline Conditions and Water Management Options

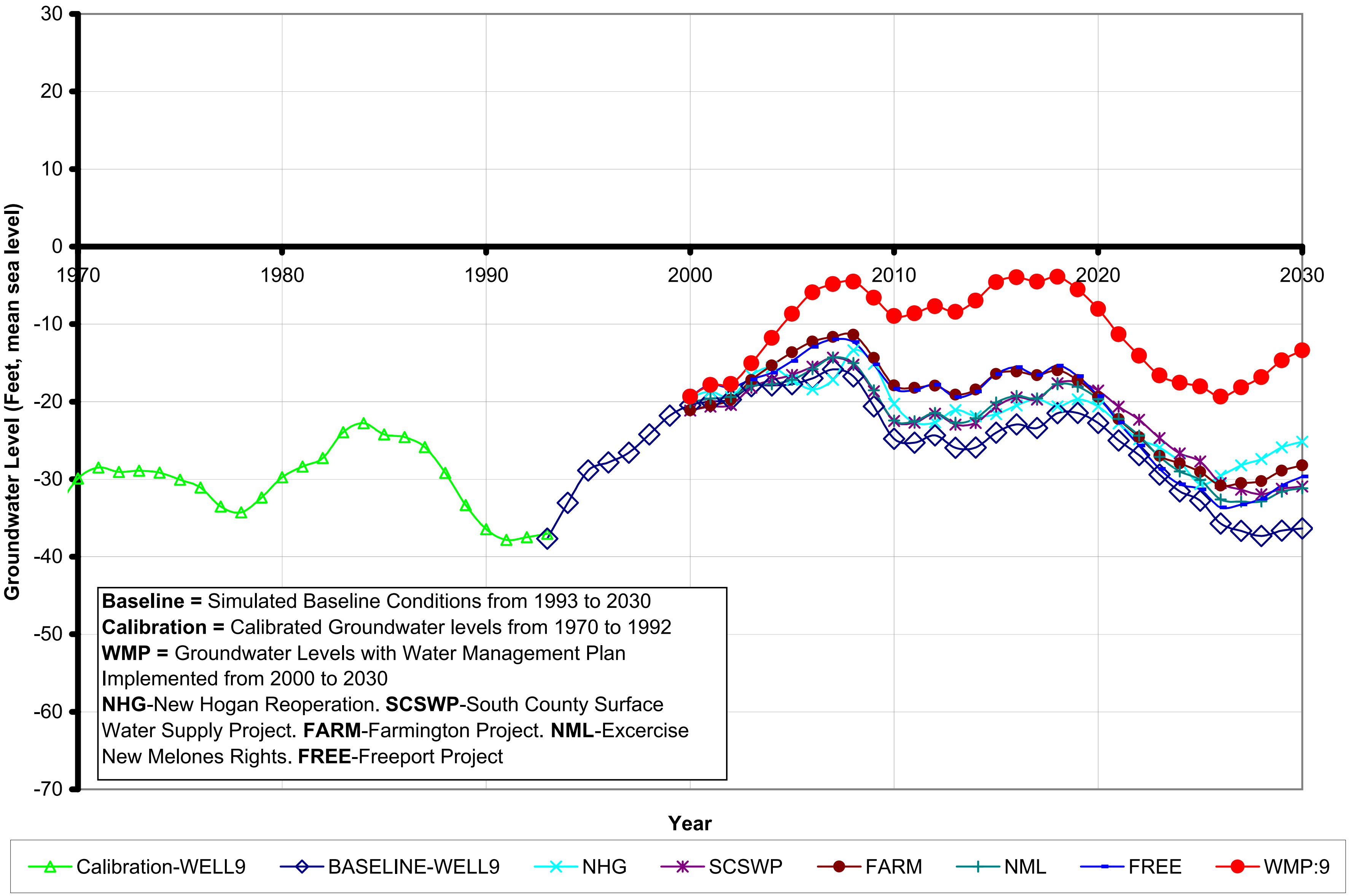

Figure 4-18
Simulated Groundwater Levels (1970-2030)
San Joaquin County Water Management Plan

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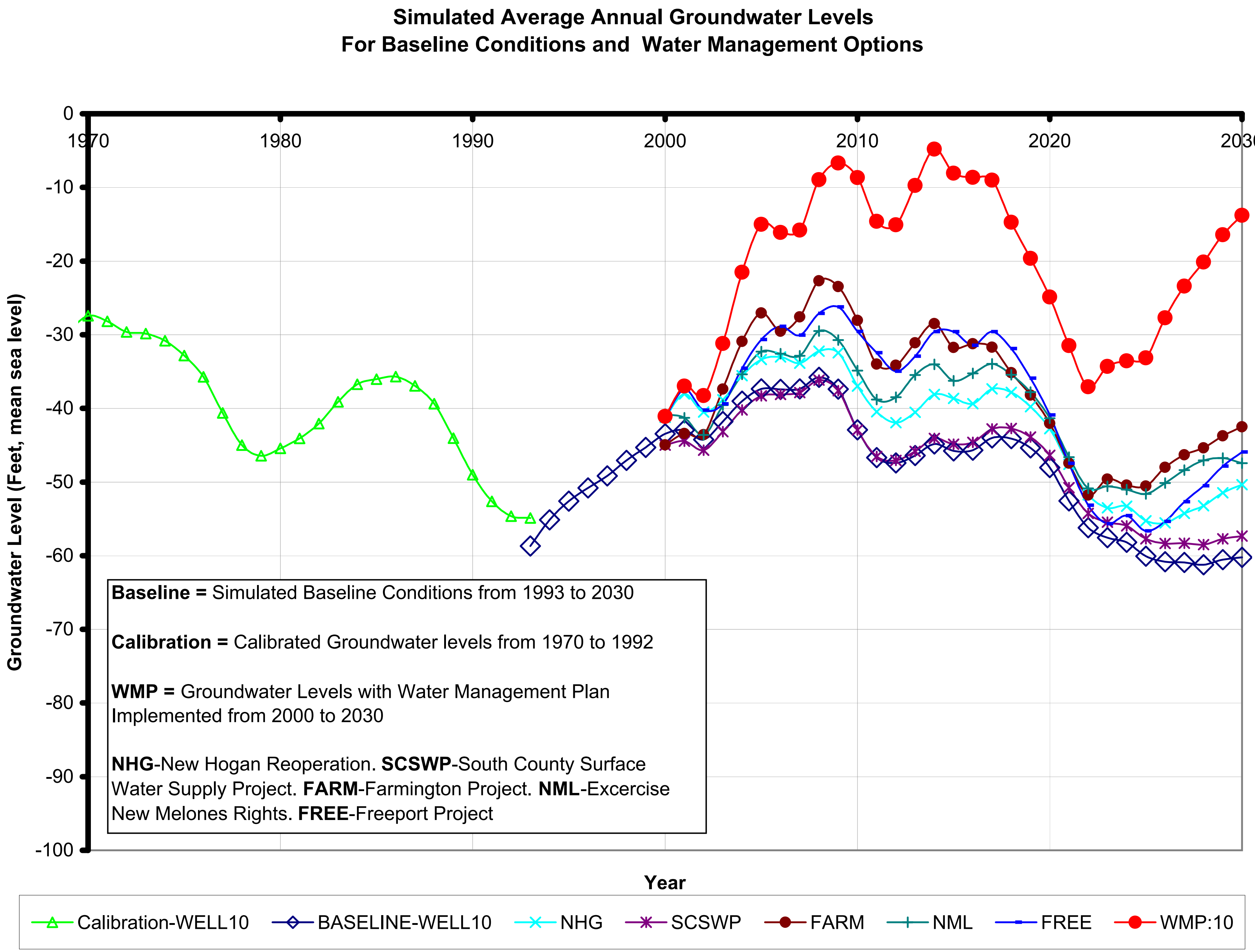

Figure 4-19
Simulated Groundwater Levels (1970-2030)
San Joaquin County Water Management Plan

CDM Camp Dresser & McKee Inc.
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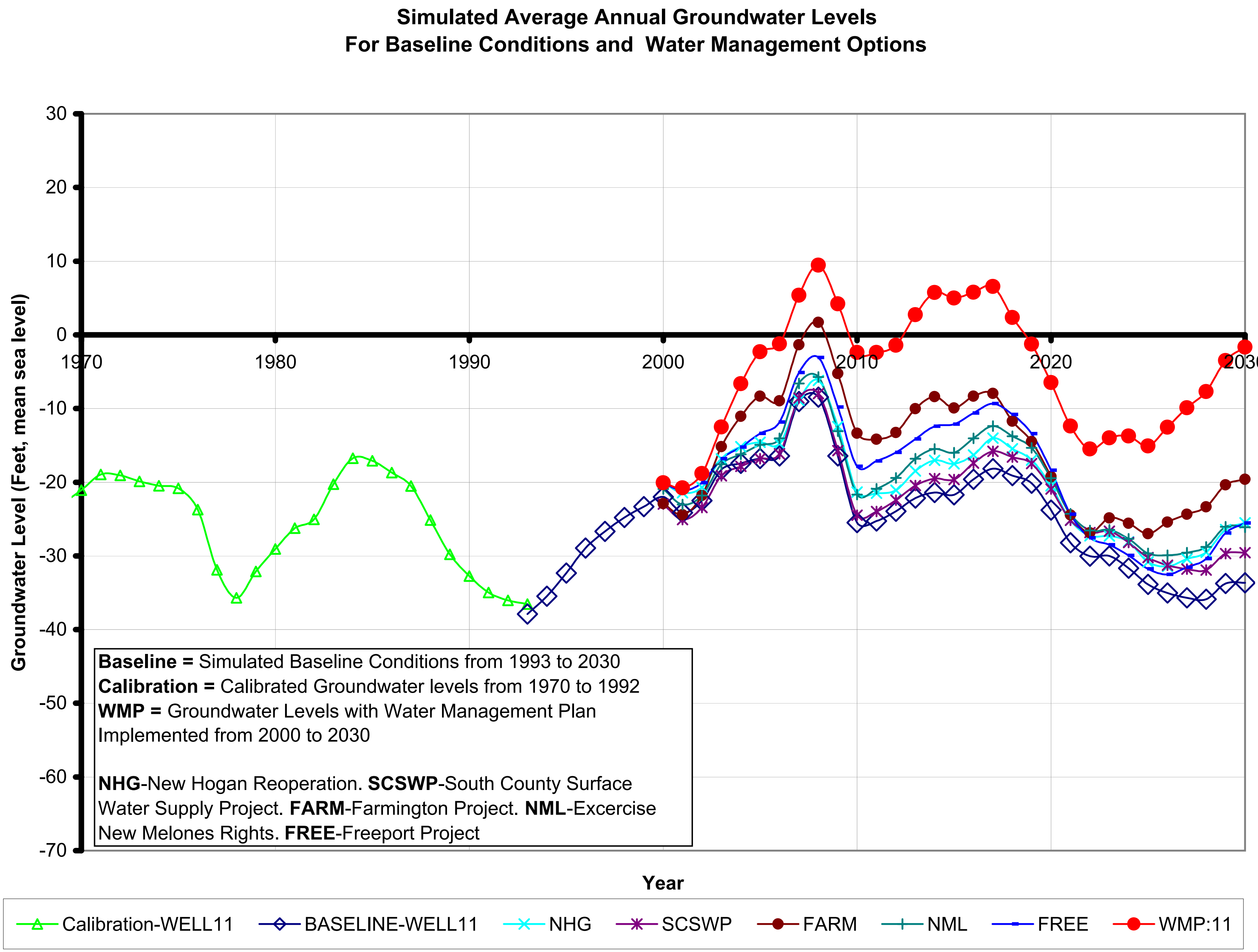

Figure 4-20
Simulated Groundwater Levels (1970-2030)
San Joaquin County Water Management Plan

Simulated Average Annual Groundwater Levels
For Baseline Conditions and Water Management Options

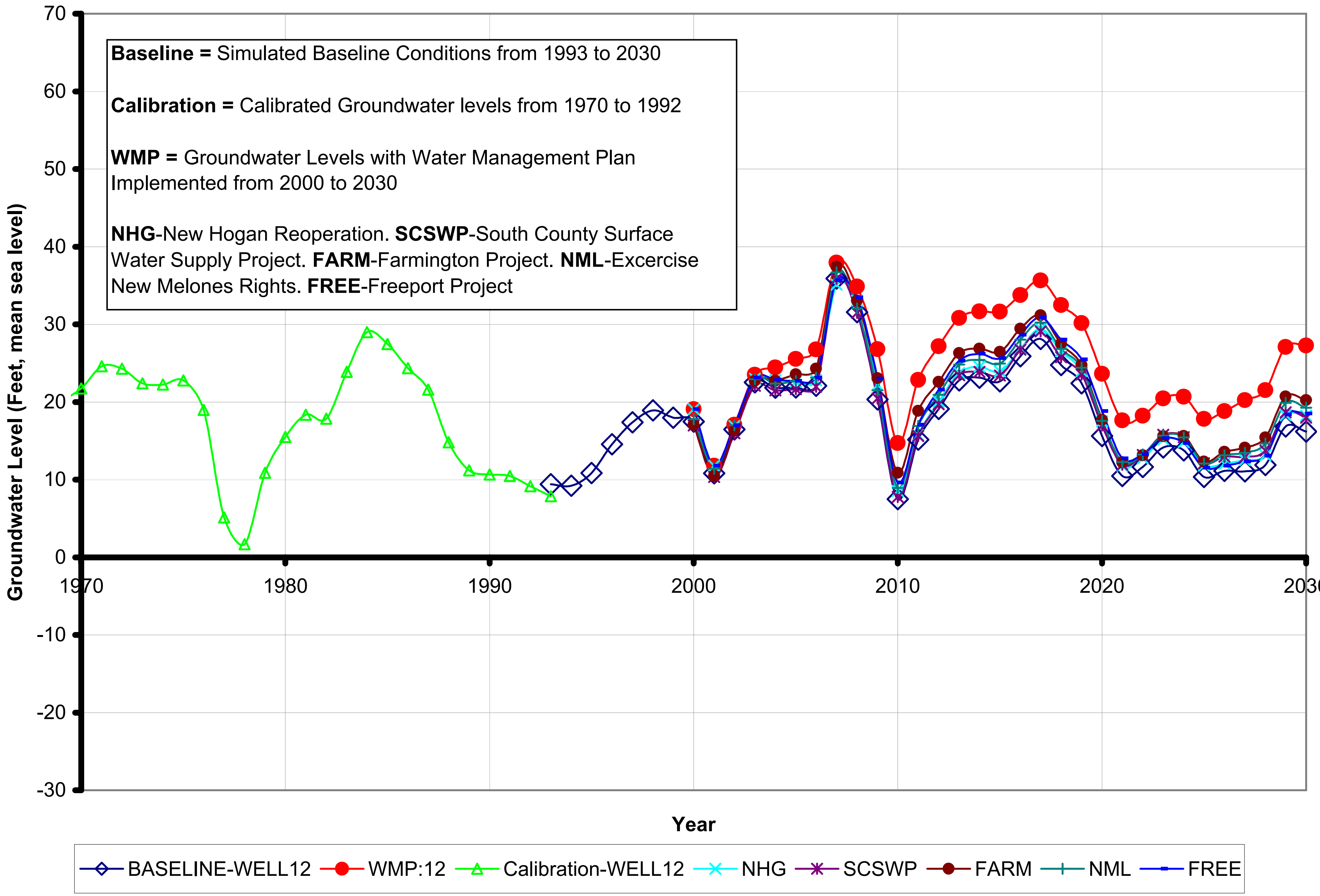

Figure 4-21
Simulated Groundwater Levels (1970-2030)
San Joaquin County Water Management Plan

CDM Camp Dresser & McKee Inc.
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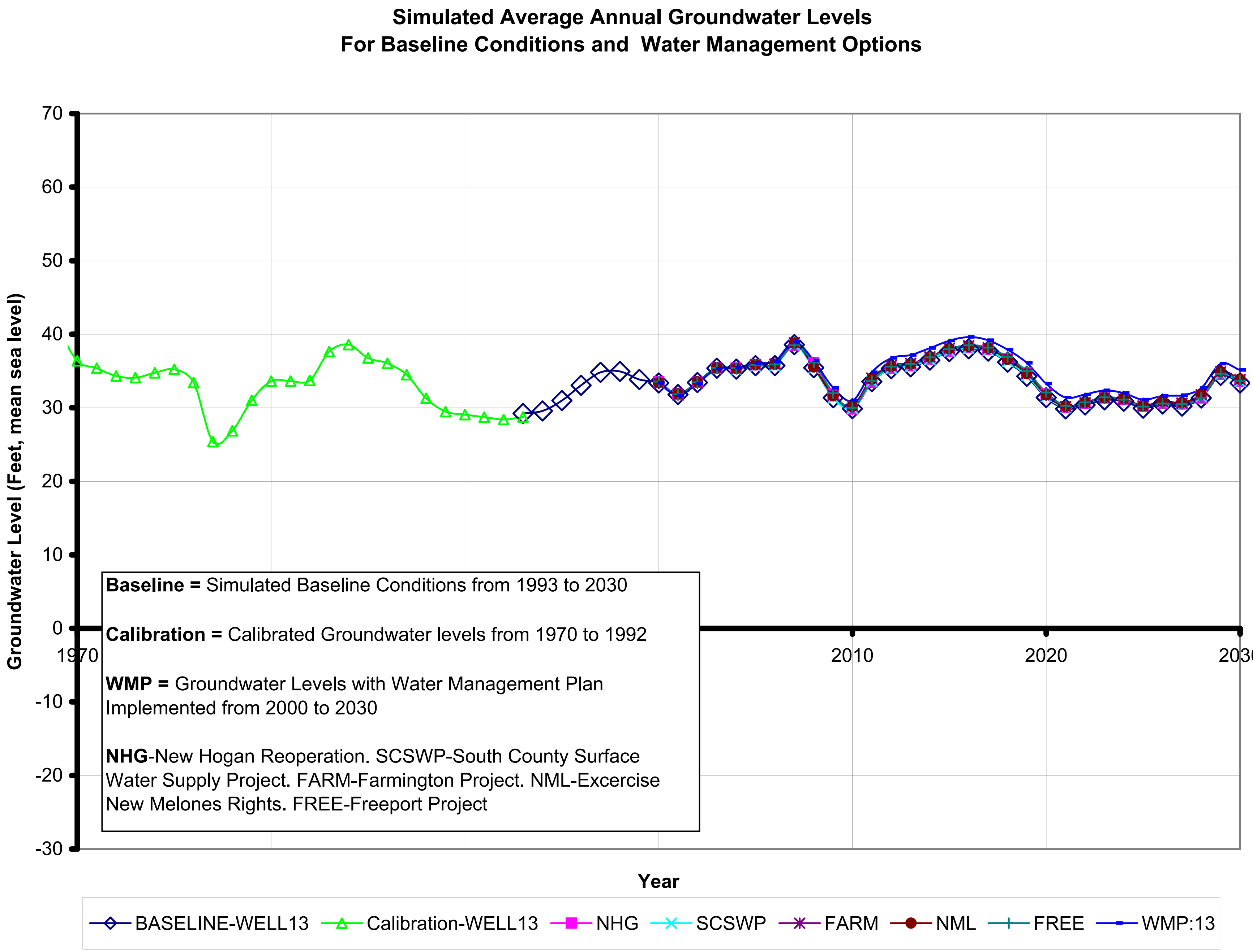

Figure 4-22
Simulated Groundwater Levels (1970-2030)
San Joaquin County Water Management Plan

Simulated Average Annual Groundwater Levels
For Baseline Conditions and Water Management Options

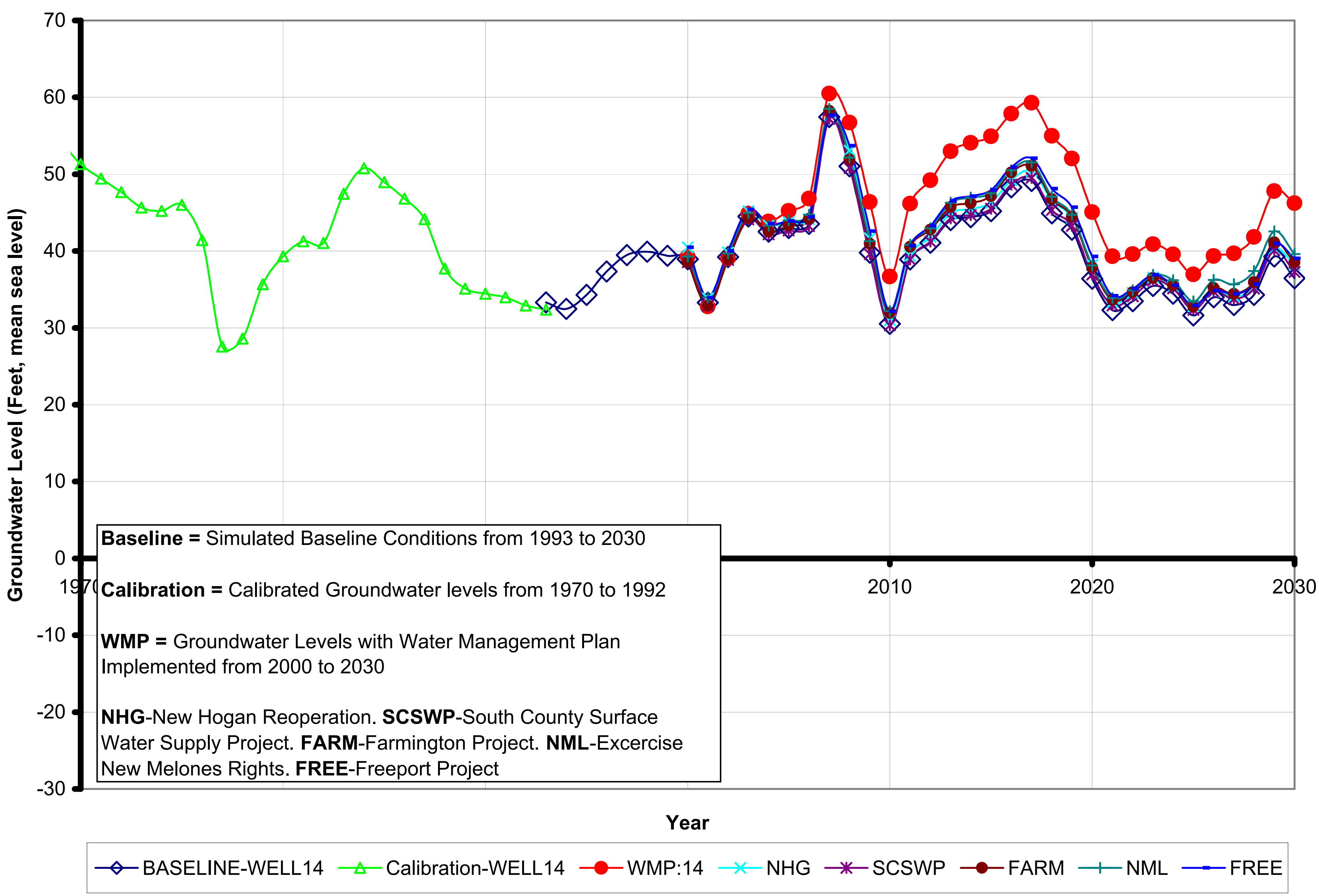

Figure 4-23
Simulated Groundwater Levels (1970-2030)
San Joaquin County Water Management Plan

CDM Camp Dresser & McKee Inc.
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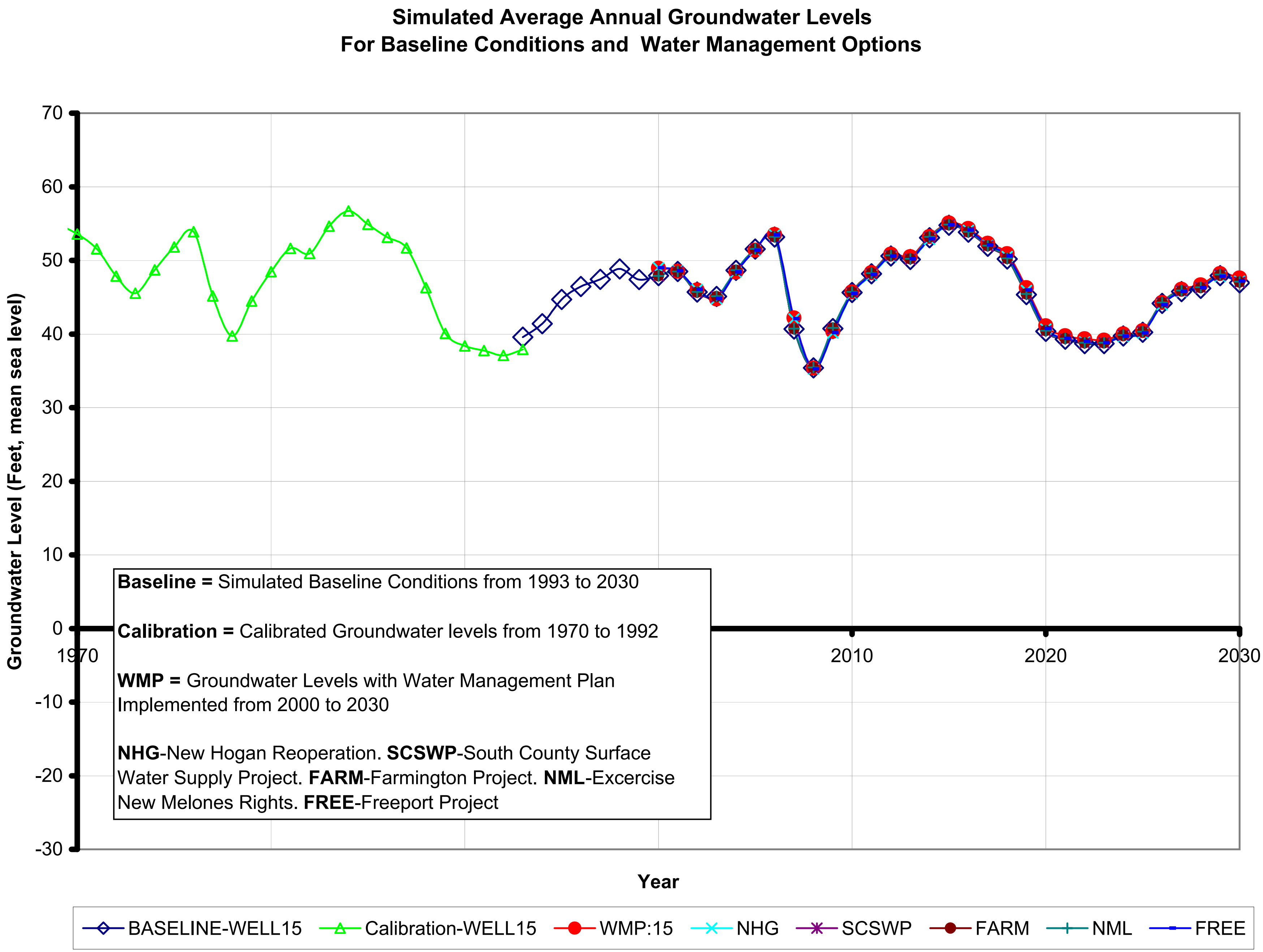

Figure 4-24
Simulated Groundwater Levels (1970-2030)
San Joaquin County Water Management Plan

Simulated Average Annual Groundwater Levels
For Baseline Conditions and Water Management Options

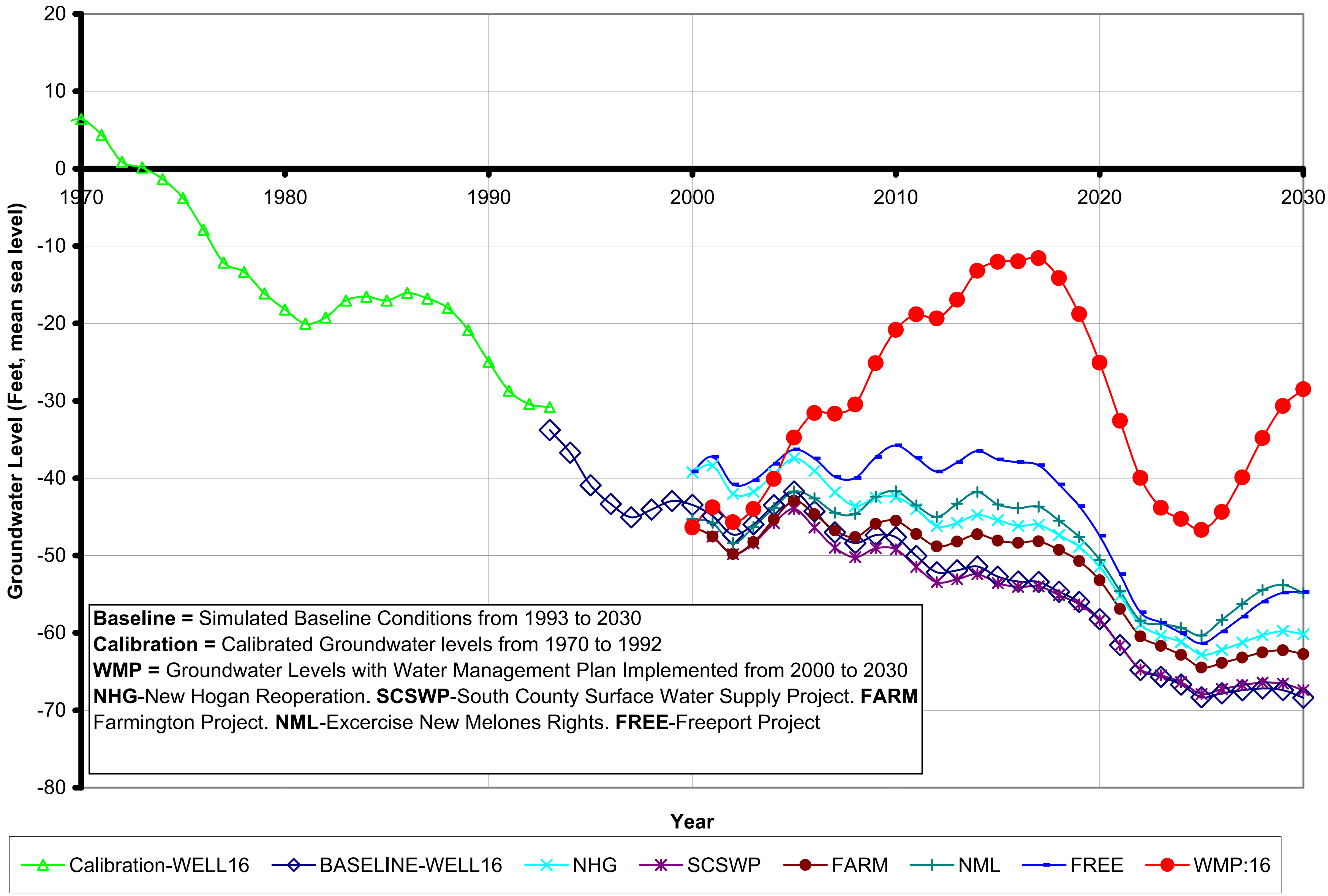

Figure 4-25
Simulated Groundwater Levels (1970-2030)
San Joaquin County Water Management Plan

Simulated Average Annual Groundwater Levels
For Baseline Conditions and Water Management Options

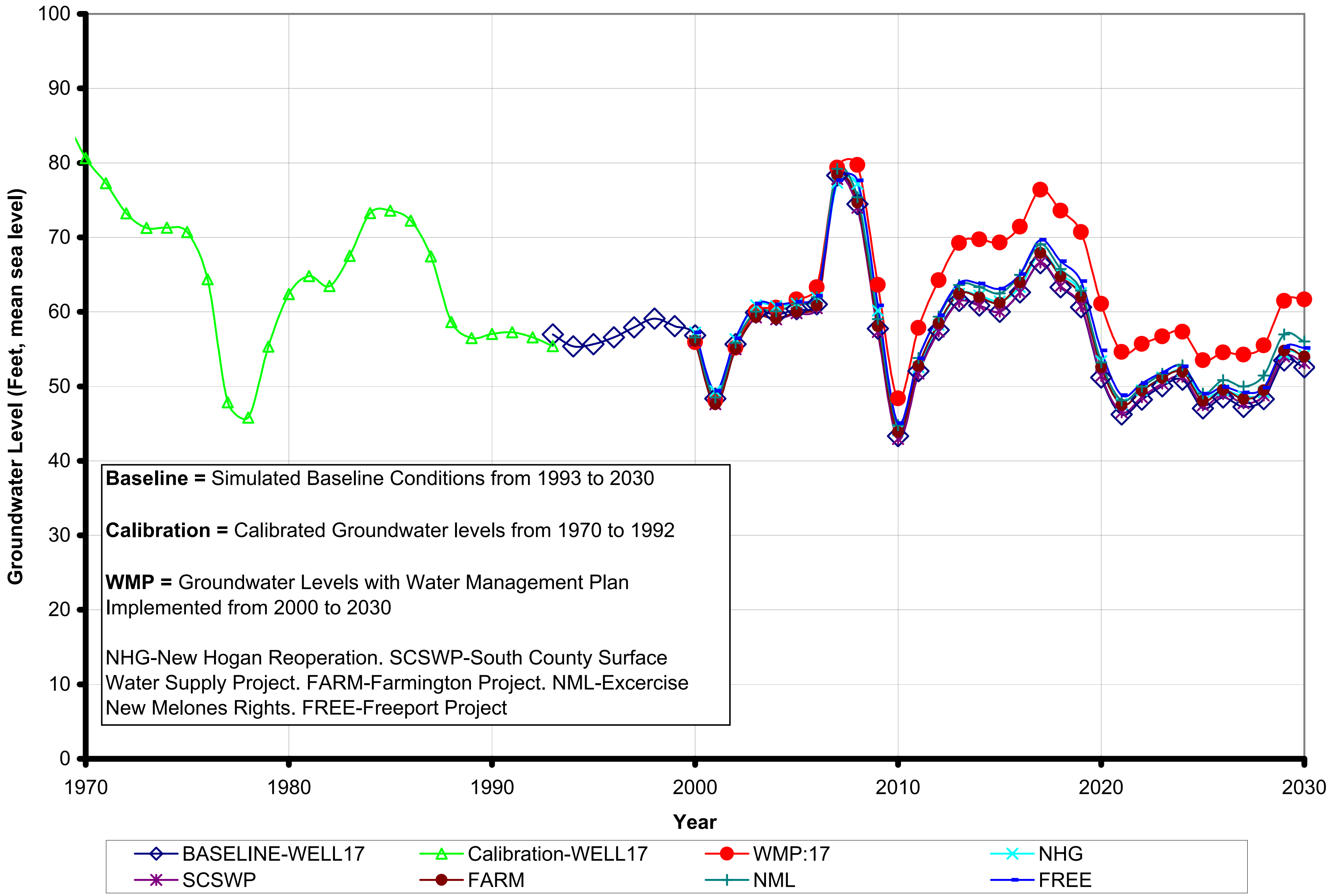

Figure 4-26
Simulated Groundwater Levels (1970-2030)
San Joaquin County Water Management Plan

CDM Camp Dresser & McKee Inc.
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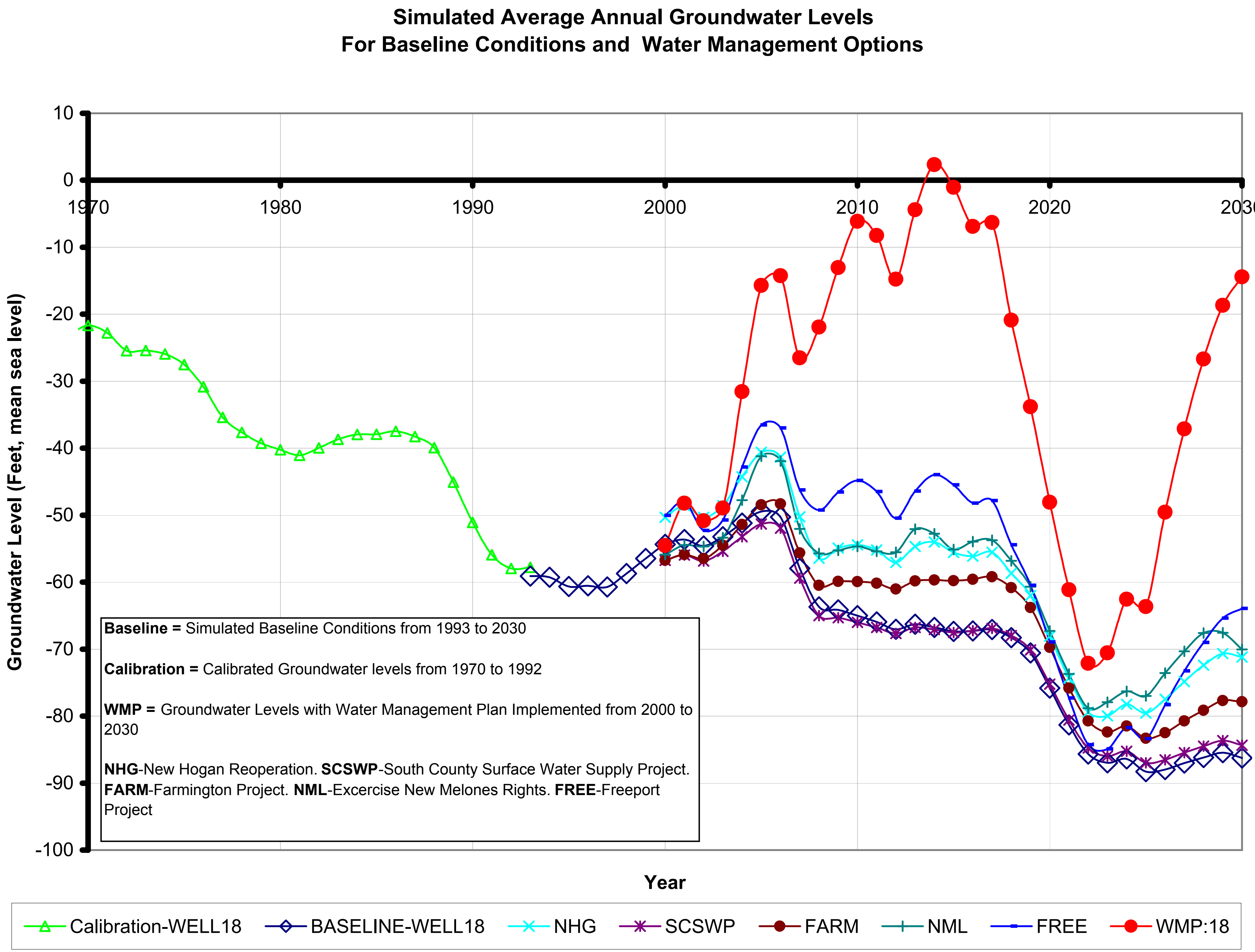

Figure 4-27
Simulated Groundwater Levels (1970-2030)
San Joaquin County Water Management Plan

CDM Camp Dresser & McKee Inc.
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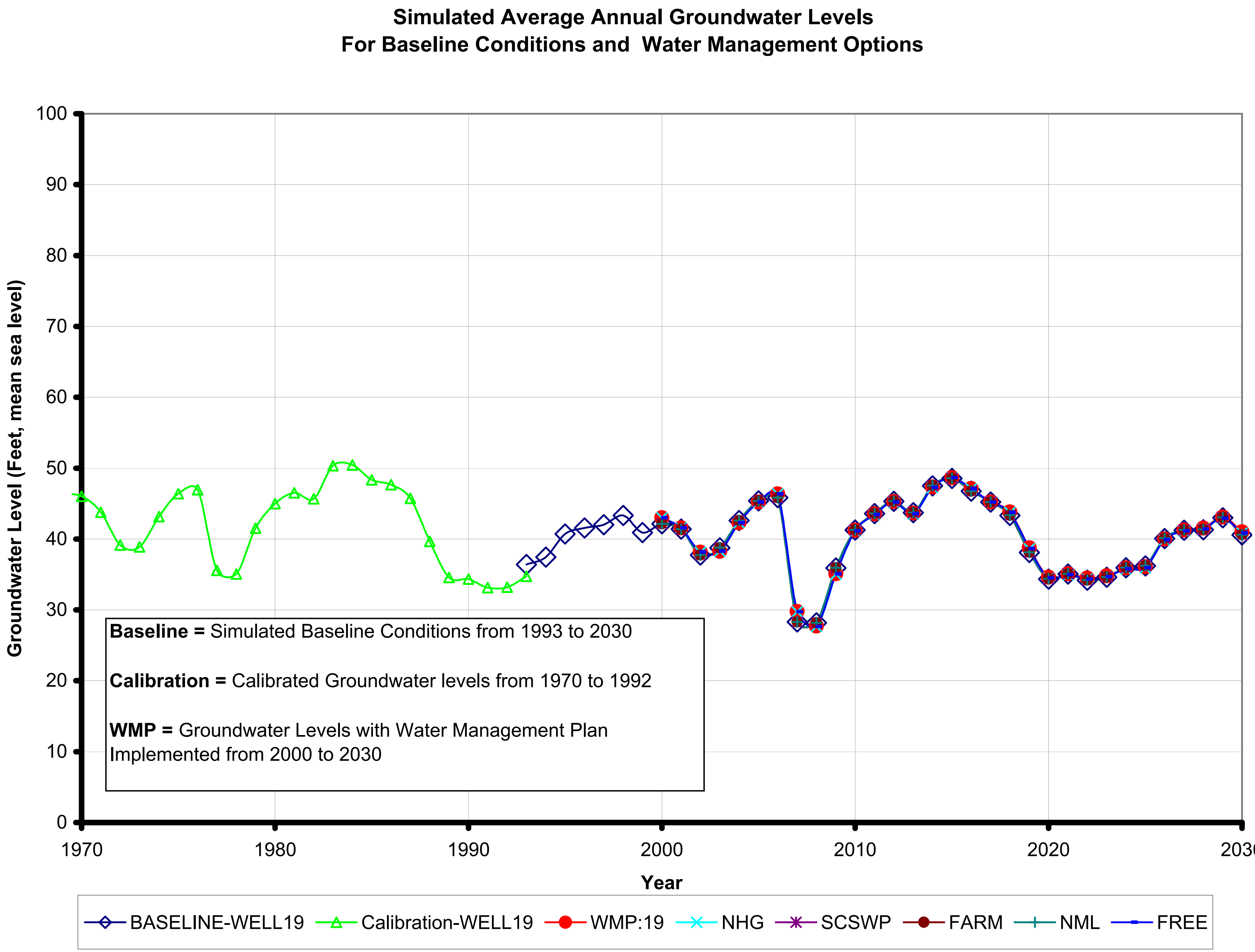

Figure 4-28
Simulated Groundwater Levels (1970-2030)
San Joaquin County Water Management Plan

CDM Camp Dresser & McKee Inc.
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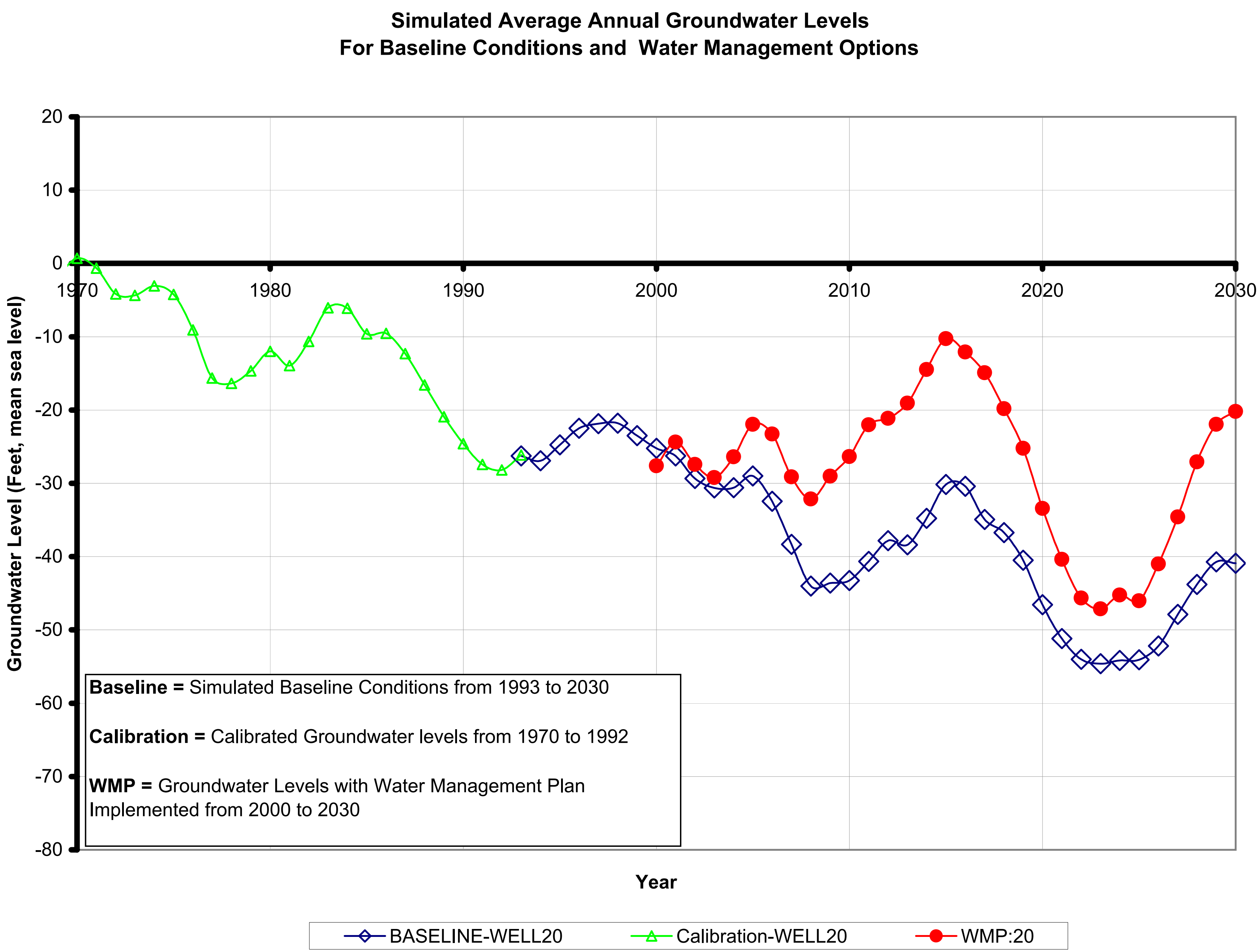

Figure 4-29
Simulated Groundwater Levels (1970-2030)
San Joaquin County Water Management Plan

Simulated Average Annual Groundwater Levels
For Baseline Conditions and Water Management Options

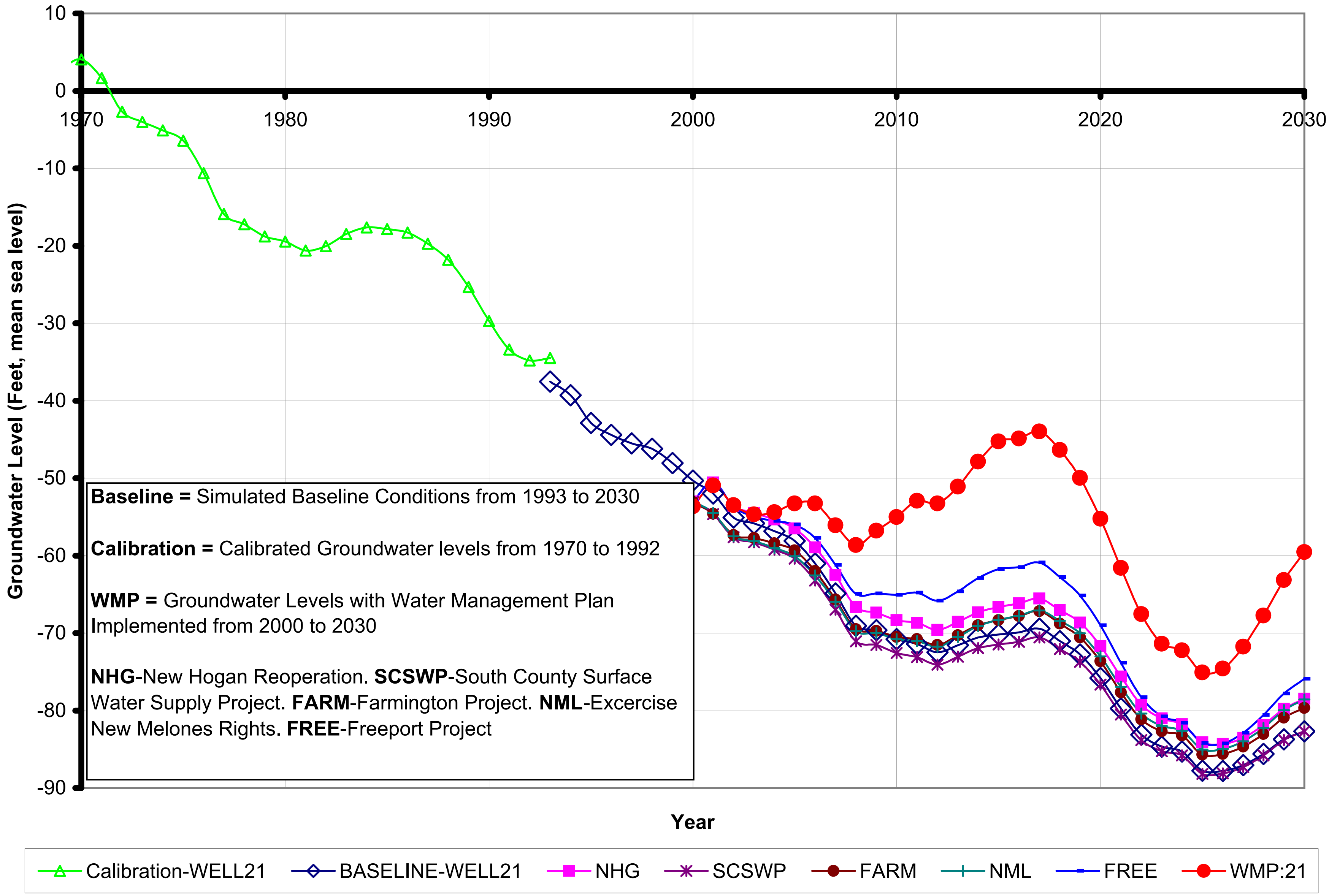

Figure 4-30
Simulated Groundwater Levels (1970-2030)
San Joaquin County Water Management Plan

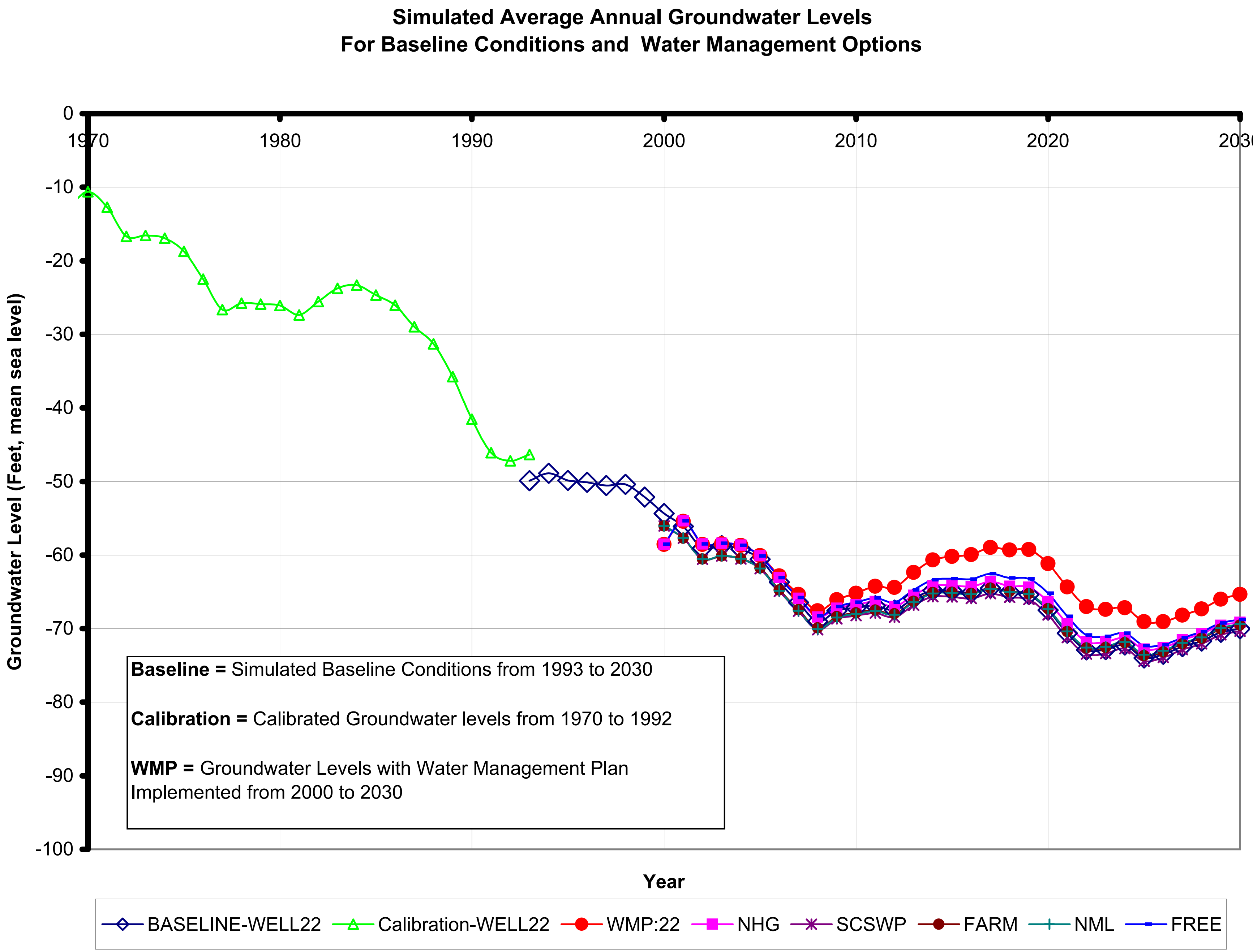

Figure 4-31
Simulated Groundwater Levels (1970-2030)
San Joaquin County Water Management Plan

Section 5
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Workshop Summary

San Joaquin County Water Management Plan
Workshop # 1, May 2000

Introduction

Workshop No. 1 was conducted to introduce the Steering Committee to the development process of the San Joaquin County Water Management Plan. Key personnel were introduced, including John Pulver (San Joaquin County Flood Control and Water Conservation District) and Ken Payne (Camp Dresser & McKee).

The San Joaquin County Water Management Plan must be developed by the County entities to ensure that it meets the needs of all groups within the County. Over the next year, the County and CDM will conduct Steering Committee Meetings approximately once every two months to discuss technical findings and receive direction on the process.

The next meeting will be on June 22, 2000, and will discuss the basics of groundwater and surface water as background for the Steering Committee. The remainder of the technical team will also be introduced.

Workshop Summary

San Joaquin County Water Management Plan
Workshop # 2, June 22, 2000

Introduction

Workshop # 2 is summarized below–see attached printouts of slides for additional information on the presentation. Ken Payne of Camp Dresser & McKee Inc. (CDM) provided an overview of the purpose and agenda of the workshop. The workshop included the following topics:

- Introduction to Groundwater/Surface Water
- Workshop Series Topics
- Principles of Participation
- Decision Making on the Final Plan

Introduction to Groundwater/Surface Water

Mr. Payne presented a short overview of groundwater and surface water basics. This information was intended to provide all stakeholders with a base of knowledge to facilitate discussions on hydraulic, hydrologic and hydrogeologic issues. A summary of hydrologic and hydraulic terms will be provided.

Groundwater travels much more slowly than surface water. Groundwater wells in San Joaquin County typically pump 1000-1200 gallons per minute, but groundwater can only move about 2 feet per day. Looking at these numbers and recharge rates, it is clear why San Joaquin County is experiencing overdraft conditions.

Mr. Payne showed an example of a groundwater model from the San Gabriel Basin. The model, which has two injection wells to recharge water, indicates that injecting groundwater primarily impacts flows around the injection well. The choice of recharge methods and locations within a basin will have varying degrees of success depending on local conditions.

Workshop Series Topics

CDM provided a handout showing topics for future workshops, along with the analysis activities to be conducted by the technical team. The flowchart on the handout maps out the progress for the series of eight meetings, including the topics to be discussed during the meetings as well as the work that the technical team will complete between meetings. The table on this handout helps to explain the role of the committee members in terms of what the technical team will provide, and what kind of participation is expected from committee members. As the chart shows, development of the San Joaquin County Water Management plan is a *stakeholder*-driven decision-making process.

The group also decided that it would be helpful for the entire group to receive comments or discussion email between stakeholders and the technical team that might be of interest to the group as a whole. The technical team agreed to set up an email account to distribute the correspondence.

Principles of Participation

The "Principles of Participation" handout is designed to inform the stakeholders of their role in the decision-making process. It describes the project scope, some initial goals, and the discussion process. The group decided that it is a good idea to have a facilitator, and discussed suggestions from the technical team. Short biographies of each potential facilitator will be sent out for review. The stakeholders will rank the facilitators, and the technical team will then choose a facilitator in time for him or her to be present at the next workshop.

Reasons for the decline in stakeholder participation were also discussed. The group agreed that one role of the facilitator can be to increase participation through outreach and possibly by changing the meeting time. However, the group also thought that it was likely that stakeholders will start to attend meetings when the group begins to make decisions. Another suggestion was to have alternates for each stakeholder, and the group agreed to this idea.

Decision Making on the Final Plan

To provide information to the stakeholders, the technical team will collect data, develop the alternatives, evaluate those alternatives, document the plan and present it to the Board. The stakeholder decision-making process, as detailed in the slide presentation, will parallel this effort. The following points were made during discussion:

- It was suggested that it would be helpful for the stakeholders to have the technical team present the final plan to their boards. During discussion, the group decided that the stakeholders would play an active role during the process in communicating information to their Boards and constituents, as indicated in the Principles of Participation. The group agreed that it would be helpful for the technical team to prepare outreach materials to ensure consistency between stakeholders, and potentially have formal presentations towards the end of the process. The technical team will prepare a communications plan to further define public outreach efforts.

- The group was interested in how the steering committee was selected. The County indicated that it invited the major water interests, but was trying to limit the invitations so that the group could accomplish the goals. The steering committee list went before the Board, so the public had a chance to comment. The group suggested sending out email information or making presentations to other groups throughout the County, but it was agreed that this could wait until there is more information to share. This aspect of public outreach will also be included in the communications plan.

- There will most likely be projects suggested to meet various objectives that will be broadly supported on the county level, but there will also be projects that are smaller and have support on a local level. These projects will be prioritized in the implementation plan.

- The decision-making process, including defining goals and objectives, identifying performance measures, weighting objectives, and evaluating the options, may not necessarily identify one "correct answer." The purpose of the process is to identify stakeholder concerns and preferences to provide a starting point for discussion on those preferences, so that the committee may develop consensus where possible and work toward a plan that all parties can live with.

- To begin discussion on what the County-wide plan is trying to achieve, the technical team drafted a chart of goals and objectives based on County literature, previous discussions, and the County Strategic Plan. The flow stems from the County's Mission Statement, branching out into more specific descriptions of goals in the form of a set of objectives. The following suggestions were made:

  - "Minimize land use rights" should become "Minimize land use impacts."

  - The salinity problem should be specifically addressed under the water quality goal. In addition to improving the salinity problem, part of the objective should be to characterize the existing problem.

  - Some objectives seem to be relatively unimportant, such as "Minimize traffic impacts." However, even if an objective is minor, it should be included if it might impact the decision. Relative importance can be indicated during the objective-weighting exercise.

  - Add "Maintain or improve quality of life" as an objective.

  - A concept of "Equity" should be added, both in terms of equity between local areas within San Joaquin County, and equity between San Joaquin County and surrounding areas.

  - Under the goal "Support beneficial water conservation programs," add an objective "Incorporate water re-use."

- Goals and objectives can be regional, and they do not all need to be county-wide. However, the group must remain balanced, and should not allow the plan to become skewed. While a problem or concern may only impact one stakeholder, it must be understood by all of the stakeholders in order for them to make decisions that will benefit the group.

Workshop Summary

San Joaquin County Water Management Plan
Workshop # 3, July 27, 2000

Introduction

Workshop # 3 is summarized below–see handouts and printouts of slides for additional information on the presentation. Jack Sieglock, San Joaquin County Board of Supervisors, opened the meeting. Ken Payne of Camp Dresser & McKee Inc. (CDM) welcomed the participants and provided an overview of the purpose and agenda of the workshop. The workshop included the following topics:

- Status of Water Management Plan
- Surface Water Supply Options
- Evaluation of Land Use and Water Use

The selection of Performance Measures, which was an agenda item for this workshop, was postponed to a later workshop.

Status of Water Management Plan

Coral Damkroger of CDM reviewed the overall approach for development of a county-wide plan, updated the committee on progress to date and overviewed the decision making process. She discussed the objectives hierarchy, which is to be considered a work in progress and a means for stimulating discussion regarding what the Plan can achieve. Participants suggested that the objective *Maintain Quality of Life* could mean many things, is difficult to measure and is not completely described by landscaping impacts. The group agreed to move this objective to the conservation-oriented branch of the objectives hierarchy.

Surface Water Supply Options

Dave Schuster of the Surface Water Resources Institute noted that a great deal of work has been done in pursuit of surface water management in the county. He explained that the goal of this section of the workshop is to determine whether the technical team has correctly defined the problem to be solved, delineated the issues of concern relative to surface water, and included the complete list of relevant projects. See copies of Mr. Schuster's handouts for additional information. The Steering Committee members are encouraged to continue to comment on these points.

Mr. Schuster presented three primary issues of concern, for which water supply will be part of relevant approaches:

- Groundwater Overdraft: This problem includes groundwater quality concerns as well as groundwater levels. A broad description of the solution to this problem is represented by the concept of *conjunctive use*, which requires surface water supply. The main question that this type of a solution would raise is "Where do we get the water to use as part of the solution, and what facilities are needed?"

- South Delta problems include water level and quality problems. Saline intrusion is a major concern as well. Solving these problems may not be within the scope of this county's plan, but this committee can work at developing a countywide plan that does not have a harmful effect on South Delta, and will seek to provide a beneficial effect.

    - New Melones is a potential source of water for the dilution of the salts and may be a potential source of water for fish flows. The assumption we make regarding South Delta's problem is important. If we assume that someone else is going to solve South Delta's quality problem, we will have a different amount of New Melones water available to us than if we assume that this problem is going to be solved with water from New Melones. We need to consider contingencies when developing alternatives.

    - Discussions by the Steering Committee recognized that the solution to South Delta problems should not affect the eastern county and vice versa.

- The Southwest part of the county, including Tracy and the four DMC contractors, may require additional water supplies. The DMC is not expected to address its water augmentation issues in this area using groundwater. While this project will not solve their problems, these groups are hoping for county support to receive their contract supplies from the CVP.

- Tracy requires additional water supplies. A proposed supply is the South San Joaquin Irrigation District water transfer from the Stanislaus system using New Melones water. It may be that delivery to Tracy and Lathrop cannot be initiated under this agreement. Some work is needed to determine whether this transfer will have impacts on the State Water Project or others.

Water Supply Options – Approach

Mr. Schuster explained that the technical team has a two-part approach for identifying water supply options. First, they will look at how to maximize the use of what SWRI terms "local" sources, and then they will look for possibilities to develop one or more imported water supplies. "Local" supplies in this context means those supplies that we have access to, that are not currently being used.

Mr. Schuster presented several charts depicting flood waters that could be available for supply use. Steering Committee members had several suggestions and comments regarding these and other potential surface water supplies. The points below summarize these discussions. The Steering Committee members are encouraged to continue to offer suggestions for water supply options. .

- Water district entitlements should be evaluated to compare entitlements to actual use and demands.

- Additional surface and groundwater storage may provide water supply benefits.

- The Plan should distinguish water rights that are associated with applied water for agricultural use from other kinds of water rights. Water that is obtained with agricultural water rights should not be included in the Plan for other uses.

- There may be some available water in the main stem of the San Joaquin River, downstream of Vernalis and upstream of the Stanislaus. Fishery issues associated with use of this water and the infrastructure requirements should be examined.

- There could be a great deal of water available in some years. Mr. Schuster presented exceedance curves illustrating the probability of excess flows for each month. The amount of spill flow available increases as the probability of occurrence decreases. That is, in a given year there is a small probability that a large spill flow will occur, and a larger probability that a smaller amount of flow will be available.

- SWRI's calculations of surplus flow indicate East Bay MUD's estimate of the surplus, after downstream obligations are met. These calculations do not take into account any water that might be used by Woodbridge in excess of the 60,000 AF to which it is entitled.

- The Mokelumne River flood flows, in particular, may represent a promising source of spill water, as it is likely to produce surplus flows in most months of the year.

- Reliability issues associated with potential flood flow sources are that they are only available during some years, on a non-predictable basis, and only for a short period. This water would usually be available during periods when it is more difficult to get into the groundwater system. In addition, flow retention and recharge facilities would be required to make use of the flows to address the groundwater overdraft problem. Regulating reservoirs, for example, might be required to retain the water until it is possible to use it for recharge.

- New Melones may have the potential to provide supply. Much water from New Melones has been dedicated to fishery programs such as the Anadromous Fish Recovery Program . The more water that is dedicated to fishery flows, the less is available for other uses. It may be that, by changing the point of diversion, some of the New Melones water could be used. By diverting the water downstream of tranditional diversion points, it would be used *after* it has served fishery and water quality purposes. This would have the added advantage of political appeal.

- It may be of use to reexamine what is actually required for fish flows. Studies have found that the pulse flow in the spring may not provide the desired benefits to migrating salmon. The current quantity of water may be too high, and the timing and variance of the release are more important than the quantity.

- City of Stockton 1485 water may provide an additional local source.

- Pulling reservoirs down below the normal flood rule curve and continually storing water in wet years may provide another source, reducing spills (NHI work).

- A 216 study was mentioned as a means for examining the potential benefits associated with reoperation of reservoirs. Stockton East Water District asked the Corps to do a 216 study on New Hogan Reservoir, on the Calaveras River. Reoperation may change the availability of water from New Hogan.

- Lodi is embarking on a large scale GW cleanup for which consultants speculate that more water will be pumped than they can use, and there may be difficulties with putting it back into the ground.

Land Use and Water Use

Fran Borcalli of Borcalli and Associates, Inc. provided the group with information regarding current land and water use in the county. Agricultural areas in the eastern part of the county rely predominantly on groundwater. Some landowners, he explained, do not use their own contract surface water. Many agricultural users use groundwater. If some users were switched over to surface water, there is the potential to help recover the groundwater basin.

The group's discussion focused on the prospect of a ground-to-surface water switchover program. Farmers on drip irrigation generally prefer using ground water with their systems because it is cleaner, reliable and under their control. While there is the potential to switch some agricultural use to surface water, doing this is likely to require an incentive or incentive package. Appropriate incentives were suggested, including rate advantages, subsidized infrastructure and equipment. Participants noted that irrigators would look for reliability of deliveries, and would likely want low pressure water that had been filtered for use in their systems.

- Accessing this water requires cooperation of the farmers and a plan is required for accomplishing wide-scale switchover.

- There are some efforts at local districts to test the success of equalizing the costs of surface and ground water.

- Modesto has a ground-to-surface water switchover program involving limited acreage, which seeks to provide low pressure, coarsely filtered water. They found that it is difficult to get water user groups to act together.

- The natural east-west waterways in the county represent good conveyance facilities.

Participants noted the need for a comprehensive approach, one that incorporates estimates of the amounts of water available from some of these options and that uses a coordinated approach for achieving the county's goals.

Workshop Summary

San Joaquin County Water Management Plan

Workshop # 4, September 28, 2000

Introduction

The content of Steering Committee Workshop # 4 is summarized below. Paper copies and CDs of the presentation materials will be sent if requested. Tom Gau, from the San Joaquin County Public Works Department, opened the meeting. Dave Auslam of Camp Dresser & McKee Inc. (CDM) welcomed the participants and provided an overview of the purpose and agenda of the workshop. The workshop included the following topics:

- Project Overview
- Land and Water Use
- Groundwater Modeling

Project Overview

Dave Auslam explained the personnel changes that have occurred since the last meeting. Ken Payne has decided to move to the Bay Area, so Dave Auslam has replaced him as project manager. Mr. Auslam has been a member of the project team since the beginning of the project. In addition, John Pulver has been added to the CDM Team as the Project Coordinator to provide information and insights into San Joaquin County water issues and help communicate with stakeholders.

Mr. Auslam stated that the original "Workshop Series Topics" chart will need to be revised because the last meeting was cancelled. In addition, the last three meetings will be combined into two meetings to help the project stay on schedule. Meetings were scheduled in advance for the fourth Thursday of each month, but in November and December, this Thursday falls during a holiday period. Therefore, these last meetings will be rescheduled, and the dates will be indicated on the revised topics chart. This chart will be sent to stakeholders before the next meeting.

The technical team has identified a Problem Statement that defines the problem that needs to be addressed by the Water Management Plan alternatives:

Potential loss of water supply as a result of water quality degradation.

This statement was discussed, and stakeholders made the following comments:

- In addition to water quality, water supply is a major part of the problem.

- A broader context is needed for the problem statement.
- This statement does not address the problems for the Southwest County.

Mr. Auslam stated that the technical team would revise the statement and distribute the new problem statement to the stakeholders.

Land and Water Use

Fran Borcalli presented information on County land and water use. The latest available Department of Water Resources (DWR) land use survey is from 1996, and many changes have occurred since then. There are substantially more acres planted with wine grapes, and there are areas where non-irrigated land has become irrigated. DWR cannot update the survey in the project time frame, so the CDM Team will update significant changes with local information and assistance from the Extension Service and District Farm Bureau.

Mr. Borcalli presented the land use map and a map illustrating the sources of water. The water source map does not include urban areas because that information is not included in the DWR database, but it will be added in the future. Water sources also need to be updated from local information sources.

Mr. Borcalli also presented a map showing current city limits within the County, and spheres of influence as outlined by the County. These spheres of influence are significant land use changes where primarily agricultural land will shift to urban use. Currently, about 400,000 to 500,000 people live within the urban areas of San Joaquin County. If all of the area within the spheres of influence is developed at a similar density to the current urban areas, then the urban areas would accommodate approximately 1,000,000 people.

Mr. Borcalli displayed a map illustrating water districts on the east side of the County to indicate areas that will be included in the AB3030 Plan (Groundwater Management Plan). He asked if the map is accurate because it shows some overlapping water districts. Stakeholders verified that Woodbridge Irrigation District and Stockton East Water District overlap substantially, as shown on the map. The AB3030 plan will give the unincorporated areas on the east side of the County the right to manage their groundwater.

For this plan, the terms "water use" and "water demand" are not synonymous. Water use is the amount of water used to maintain economic activity. Water demand is the amount of water needed to meet water use requirements without letting the water quality degrade.

Mr. Borcalli presented figures for evapotranspiration, applied water, and excess applied water by water district. He then presented a similar table that will show applied water and wastewater once the data collection is complete. Some people claim that both agricultural and urban uses have similar water use/acre, but Mr. Borcalli's figures illustrated that this is not necessarily true. Some cities were similar to agricultural water districts, but some cities had substantially higher water use figures.

During discussion on land and water use figures, stakeholders expressed the following concerns:

- Consumptive use figures should be used in determining demands instead of applied water figures. Mr. Borcalli agreed, and said that consumptive use is used to determine applied water. In urban areas, wastewater is more or less equivalent to excess applied water from a planning standpoint.
- The agricultural water use figures only included east side water districts. Mr. Borcalli stated that the CDM Team would also examine the west side.
- The applied water figures are different than those reported by the individual districts, so concern was expressed about the information source. Mr. Borcalli said that the information came from DWR by each crop type, and he combined the individual crop uses for each water district.
- The applied water was figured for 1996, but applied water changes by year, depending on the precipitation that year. Applied water should be averaged over several year types. In addition, different soils throughout the County retain different amounts of water, so they require different amounts of applied water.
- Evapotranspiration for a plant needs to take into account both applied water and rainwater. However, this project has defined evapotranspiration as the amount of applied water that is utilized by plants, and excludes precipitation. Mr. Borcalli indicated that precipitation is taken into account to arrive at the applied water figures. The applied water will be the basis for sizing facilities.
- The range of values for urban water use seems too large to be accurate. However, differences between urban areas, such as water meters, open space, and system reliability can cause this range.
- An alternative including wastewater reuse needs to consider that the wastewater is often reused within the County by residents downstream of the discharge point.

Groundwater Modeling

Brendan Harley from CDM introduced the groundwater and surface water model that is being used to study the County. The slides from this presentation are available to interested stakeholders. Mr. Harley discussed the current state of the model, and the necessary next steps.

The model is run on a monthly time step, but that might need to be reconsidered if stakeholders feel that the system changes on a more rapid rate. The CDM model was originally an IGSM model created by the County, DWR, and the Bureau of Reclamation. CDM has converted the original model to DYNFLOW, which is a different modeling program that interacts with GIS software to make it possible to graphically examine inputs and outputs.

The goal of this modeling effort is to display the inputs and outputs, update model inputs and assumptions as necessary, and provide the model to the County when the project is completed.

There are several features in the IGSM model that Mr. Harley does not understand. The stratigraphy in the model does not agree with an IGSM model of Sacramento County, which overlaps with the San Joaquin model. The Sacramento model includes regional aquitards that are not included in the San Joaquin model, and the geologic features vary between models.

The conductivities (more or less permeable units) are widely varied within a small patch of the San Joaquin IGSM model in the general area of the groundwater depression. Mr. Harley is unsure why these conductivities were used, but his assumption is that they were changed during IGSM model calibration.

Ideally, the original model developers would have documented these decisions during the modeling effort, but the model was created by a number of different sources and the documentation does not exist. DWR has provided assistance from WRIME, a company with several employees who are IGSM experts and can hopefully shed some light on these decisions. As the reasons for these decisions are explained, the inputs and assumptions will be changed if necessary to reflect more recent information.

These problems could impact the results of the model, but Mr. Harley pointed out that this is a regional model designed to make regional planning decisions. The questions from the IGSM model reflect local differences, and they do not impact large, regional decisions about groundwater overdraft.

The model inputs include 1988 urban and agricultural land use. The DYNFLOW model will allow more recent land use information to be used. DYNFLOW also uses the actual crops, soil types, and rainfall in each cell instead of estimating information based on aggregate data for a larger area. The major land use problem is to determine future crop patterns, which will require local input.

The steady state model has been refined and calibrated, and appears to reasonably agree with heads from monitoring wells. CDM presented a graph which illustrates a large groundwater depression from heavy pumping southeast of Stockton. Historical trends of the County show that 2.5 million acre-feet of water has been depleted from the groundwater aquifer.

The steady-state model also shows the direction of groundwater flow throughout the County. This information impacts recharge locations because the County does not want to recharge water in areas where the water will travel outside of the County. For example, the model shows that groundwater north of the Mokelumne River is moving north towards the groundwater depression in Sacramento County near Galt. For this reason, the County probably does not want to initiate a groundwater recharge program north of the Mokelumne.

Mr. Harley displayed a map of the salt water front that started to the west of Stockton and is traveling east. He showed that if there is no change to the groundwater depression, the salt front would move east of Highway 99 within the next 60 years. One possibility to reduce the salt migration is to disperse the pumping around Stockton, which will help raise the depression and slow the salt migration into the County.

The next steps in model development will include:

- Develop a transient model (a model that will change over time);
- Integrate local soil and crop data;
- Update land use and water demands; and
- Refine and recalibrate the final model.

Stakeholders during the meeting raised the following comments and concerns:

- Only major surface water bodies are modeled, so the model does not take into account smaller creeks and streams like Little John's Creek. Mr. Harley said that local input is required to tell the modelers if this creek is large enough that it should be included in the model. He also said that there are some areas in the model that include fluxes entering the groundwater, but are not explicitly modeled as surface water bodies.
- The eastern edge of the aquifer is not as deep as the western side, so there is some concern that if the groundwater overdraft continues, the eastern wells will run dry.
- If there is recharge pumping on the west side of the County to try to stop the saltwater intrusion, the model needs to show how it impacts the remainder of the County. Mr. Harley stated that the model would show these impacts.
- Tweaking the land and water use or stratigraphy to calibrate the model could produce incorrect modeling results. Mr. Harley said that the transient model would illustrate any problems with the calibration assumptions.

- Instead of saying that the County lost 2.5 MAF of storage, the County can say that it now has a 2.5 MAF reservoir. This storage is very significant if the County wants to start a conjunctive use program.

Future Meetings

The next meeting was set for Thursday, November 16, 2000 at 1:30 p.m.

Workshop Summary

San Joaquin County Water Management Plan
Workshop # 5, November 16, 2000

Introduction

The content of Steering Committee Workshop # 5 is summarized below. Jack Sieglock, from the San Joaquin County Board of Supervisors, opened the meeting. Dave Auslam of Camp Dresser & McKee Inc. (CDM) welcomed the participants and provided an overview of the purpose and agenda of the workshop.

Mr. Auslam briefly discussed the future schedule, and set a date for the next meeting of January 11, 2001. During the next several meetings, the Technical Team will be relying on the stakeholders to actively provide input and start to make difficult decisions. Mr. Auslam re-distributed the "Principles of Participation" from earlier meetings to emphasize team expectations. The "Principles of Participation" are attached to the meeting summary for further information. The workshop included the following items:

- Status of Groundwater Model
- No-Action Alternative
- List of Options
- Surface Water Options
- Preliminary modeling of Groundwater Options

Status of Groundwater Model

Since the last Steering Committee Meeting, progress has been made on the model in the following areas:

- *Transient Model.* The transient model is running, and has been calibrated using historical data and cropping patterns. Calibration indicates that the model might not be a perfect representation of the County's groundwater, but it is close enough to use for planning purposes. Also, the seasonal patterns seem to be well represented, which is a significant factor in planning for future high demand seasons.

- *GIS Information.* CDM is moving towards a model that will accept GIS information so that current and future cropping patterns can be changed easily during alternative runs.

A stakeholder asked if there is an analytical measure to indicate if a model is "close enough," and Brendan Harley (CDM) answered that much of that decision is based on judgement. It is important to make sure that the level of accuracy is reasonable for the entire basin, and right now the model is probably within 10-20% of the head levels throughout the County.

No-Action Alternative

If no changes are made to water use within the County, the groundwater depression east of Stockton well is expected to get worse. At this point, there is a front of water with 300+ mg/l chloride concentrations moving east under Stockton. In 60 years, the groundwater model has simulated that the front will be just east of Highway 99.

The groundwater model has estimated that the saline water will move eastward at a speed of 200 feet per year. A stakeholder expressed concern that 200 feet per year is too fast for the groundwater to move, but there is 50 feet of head difference between the west side of Stockton and the groundwater depression.

The groundwater model shows interaction with the groundwater depression in southern Sacramento County, near Galt. At times, that depression meets the San Joaquin groundwater depression. This interaction means that if groundwater recharge occurs in this area, the water will probably be delivered to Sacramento County.

List of Options

Fran Borcalli presented a list of surface water, groundwater, and other options. These lists are attached to the meeting summary. These lists represent general options suggested by stakeholders, described in other reports, or discovered during technical analysis. The technical team is looking for any additional suggestions to these lists.

Surface Water Options

Dave Schuster presented information regarding surface water supply options, which is detailed in the attached memorandum. Mr. Schuster started his presentation by discussing the problems within the County by region.

Southwest County

Historically, the southwest portion of the County had a very reliable water supply from the Central Valley project. However, passage of the CVPIA in 1992 has resulted in a very unreliable supply. CVP forecasts indicate that agricultural users will only receive 45% of deliveries if 2001 is a normal year, where they would have received 100% prior to passage of the CVPIA. They need County support to influence the Bureau to implement the CVPIA in a more balanced way between water supply and environmental needs.

South Delta Water Agency

The SDWA has seasonally reduced water levels, primarily due to CVP and SWP pumping. Upstream uses on the San Joaquin River have decreased flows and water quality, which impacts the SDWA. Also, poor quality runoff enters the south Delta from farmlands to the west.

In 1986, the USBR and DWR agreed to build three barriers in the south Delta that would eliminate the negative impacts of project pumping. However, the U.S. Fish and Wildlife has not allowed the barriers to be built due to concerns about the effect of the barriers on Delta smelt. U.S. Fish and Wildlife has told SDWA that they do not need any barriers, and they are adamantly opposed to the Grant Line Barrier. The SDWA needs political support from the County to get the barriers that they need.

Central Delta Water Agency

CDWA does not currently have a problem, but they could have a major problem if the cross channel closes for a long period of time. It is a possibility that in the future, the gates will be completely closed from February to June, which would negatively impact CDWA's water quality. The potential water quality impacts were illustrated last December, when the cross channel gates were closed to protect fish. Water quality was seriously impacted.

If CALFED builds an isolated facility from Hood on the Sacramento River to the project pumps in the south Delta, there are also potential water quality impacts. CDWA representatives indicated that they also have a water level problem near SDWA, and it will not be addressed with the barriers.

East Side of the County

The east side of San Joaquin County has a groundwater overdraft problem. During the last Steering Committee Meeting, the overdraft was estimated to be 100-125 TAF/year. This figure is based on current demands, but the Technical Team has calculated that future demands will change less than 2% on a County-wide level.

To reverse the groundwater overdraft and start to recover the basin, Mr. Schuster estimated that 200 TAF/year of surface water is needed. This figure agrees with work done by the Corps and Montgomery Watson on the Farmington project, which estimated that 183 TAF/year of surface water would be needed to reverse the groundwater overdraft. The 200 TAF includes 75 TAF that will start to recover the basin and bring the groundwater back up to historic levels. The basin will need to be filled approximately 1 MAF to significantly slow the saltwater intrusion.

Mr. Schuster has assembled "viable options" for the project, which include any actions that develop additional water that could be funded by the County and external sources. The external funding could be state or federal money, or it could be from other users who want to store their water in the San Joaquin County basin for a fee. Mr. Schuster found on-stream reservoirs, such as Auburn Dam, not to be viable because the current political climate will not allow them to be funded by state and federal agencies, and the County cannot afford to fund the projects independently.

Mr. Schuster compiled a list of surface water options to determine if the water was available to solve the groundwater overdraft problem. Many of the described surface water options will require the construction of off-stream regulating reservoirs. The flows in the rivers come very quickly during the flood season; such as on the Calaveras River, where the flow is often during only one month. Because the flow comes quickly, we cannot build recharge facilities capable of fully utilizing the water, so regulating reservoirs are necessary to store the water until it can be used.

Surface Water Options

The surface water options are detailed in Mr. Schuster's memo, but the following section briefly summarizes each option.

Calaveras River	
Flood flows collected in a 120 TAF reservoir	30 TAF
New Hogan reoperation	23 TAF
Stanislaus River	
Flood flows collected in a 100 TAF reservoir	21 TAF
Utilization of CSJWCD and SEWD full contract entitlement during available years	16 TAF
Diversion of contract water from the Delta	70 TAF
Water transfers	51 TAF
Mokelumne River	
Flood flows	
Injection wells (quantity depends on number installed)	?
WID and WWUCD use of flood flows	10 TAF
Duck Creek Reservoir	50 TAF
North San Joaquin Irrigation District	10 TAF
Little Johns Creek	
Flood flows	28 TAF
San Joaquin River	
Obtaining unappropriated water from the San Joaquin River	?
Diverting wastewater released to the Delta and delivering Treated wastewater to farmers	45 TAF
American River	
Flood flows	?
EBMUD storage of American River water	?

Conservation	?
Total	**354 TAF**

Groundwater Options

Brendan Harley discussed three preliminary groundwater options, and the results of modeling each example. The three options considered included:

- Change Lodi's water supply source from 16 TAF of groundwater to entirely surface water;
- Use 50 TAF of surface water to supply farmers in SEWD for in-lieu recharge; and
- Use 90 TAF of surface water to supply farmers in SEWD and CSJWCD for in-lieu recharge.

A stakeholder expressed concern about in-lieu recharge, using the City of Lodi as an example. In Lodi, it is much cheaper to use groundwater than surface water. It seems to make more sense to leave Lodi on groundwater, and use the excess surface water for direct recharge into the basin.

The technical team stated that all recharge methods will probably be used in the final plan, but that it is very difficult to get water into the basin through direct recharge or injection.

Another stakeholder pointed out that if the County uses surface water as a wet year supply, then they know that the groundwater basin is safe and can be used during droughts. Additionally, a stakeholder stated that groundwater may not be the cheaper alternative indefinitely because it is very likely that groundwater will need to be treated in the future.

A distribution system will be expensive to install, and percolation basins will most likely be cheaper. However, the technical team would like to compare the costs of projects to the value of the groundwater resource instead of comparing costs to the costs currently incurred. The costs of each alternative will be determined to allow stakeholders to compare alternatives, but the cost of doing nothing is much more expensive than simply the cost of providing water.

The groundwater options were evaluated using the groundwater, and the preliminary measures of success were to examine impacts on the groundwater depression and the saltwater intrusion.

Lodi. Cities are an easier target to switch to surface water because most of the infrastructure to deliver the water is already in place. However, modeling the Lodi alternative showed very little impact on the saltwater intrusion. Part of this finding results from the relatively small amount of water (16 TAF) that the option includes.

SEWD. The SEWD option raises the groundwater level approximately 20 feet in the center of the groundwater depression, and slows the saltwater migration slightly. The modeling indicates that the groundwater takes 10-15 years to recover 80% of the groundwater elevations. A stakeholder suggested that Stockton's abandoned wells be used to inject water to stop the saltwater migration, and the technical team said that altering the wells is only effective a small percentage of the time.

SEWD and CSJWCD. This option provides 100 TAF to farmers in SEWD and CSJWCD, which creates in-lieu recharge in the basin. This option produced the most dramatic results because the recharge made the saltwater stop migrating eastward.

A stakeholder asked if saltwater is a concern north of the Calaveras River. Representatives from Lodi, Woodbridge Irrigation District, and Stockton stated that they had no evidence to believe that there was a problem.

Workshop Summary

San Joaquin County Water Management Plan

Workshop # 6, January 25, 2001

Introduction

The content of Steering Committee Workshop # 6 is summarized below. Jack Sieglock, from the San Joaquin County Board of Supervisors, opened the meeting. Dave Auslam of Camp Dresser & McKee Inc. (CDM) welcomed the participants and provided an overview of the purpose and agenda of the workshop. The workshop included the following items:

- County-wide Baseline Water Conditions
- East County Groundwater Baseline Conditions
- Water Management Option Screening
- Proposition 13 Funding
- Schedule for Completion

The next Steering Committee Meeting will be held on February 8, 2001, at Stockton East Water District, to discuss alternatives.

County-wide Baseline Water Conditions

Fran Borcalli presented the Technical Team's calculations for baseline water demands in the years 2000 and 2030. The projections indicate that demands will not change appreciably, but some agricultural water will shift to urban uses. The demands utilize applied water as a basis for the calculations because that is the information necessary for the groundwater/surface water model. To calculate future demands, the Technical Team assumed that all land within urban spheres of influence would convert to urban uses.

The current and future water use was calculated using land use data from DWR's 1996 land use survey of San Joaquin County. This data was used because it contains very detailed information about land use and water source for each parcel of land in the County. During previous meetings, stakeholders were concerned that 1996 land use was very different than current land use because many lands transitioned to vineyards. Mr. Borcalli examined information from the San Joaquin County Agricultural Commissioner's office that indicated the acres of land within the County that are under each type of agricultural production. This data indicates that current land use is not significantly different than 1996 land use, so the 1996 data is appropriate for planning-level estimates of demand.

Stakeholders had the following concerns about the demand projections:

- The future demand projections are not high enough. The increasing population will increase the need for agricultural products, and intensify agricultural production through double-cropping or similarly production-intensive farming.

- CALFED plans to convert Delta agricultural areas to wetlands, which have greater water needs.

- Urban use can be higher per acre than agricultural water use.

- Agricultural water use varies by year, and 1996 might not be the best year to use. Mr. Borcalli responded by referring to the Agricultural Commissioner's data to show that the main change is the transition to vineyards, which would often result in less water use because drip irrigation is very efficient.

- The transition to vineyards is not only on lands that were previously farmed for different types of crops, but also lands that were previously non-irrigated pasture. Therefore, the overall water use would increase. Mr. Borcalli responded by referring to the Agricultural Commissioner data to show that from 1996 to present, approximately 2000 acres of previously non-irrigated land went into irrigated agricultural production. This small amount of land transferred to irrigated production has little impact on the future demand estimates.

- If agricultural land irrigated by surface water transitions to urban land supplied by groundwater, the water source transition should be incorporated in the model. Mr. Borcalli responded that this transition is included in the model for each parcel.

East County Groundwater Baseline Conditions

Paul Hossain from CDM presented the groundwater baseline conditions that have been determined through the use of a groundwater/surface water model. Mr. Hossain's slides are attached for additional reference.

Previous estimates indicate an overdraft of approximately 120 TAF, but the current model shows that the overdraft may increase to 160 TAF. This number may decrease with additional efforts to refine the model.

Mr. Hossain divided the groundwater problem into two main pieces. In the short term, it is most important to address the salinity problem near Stockton. The model shows that by recharging 100 TAF in strategic areas, the salinity front would stop migrating eastward. After the salinity problem is addressed, the next step would be to stop groundwater overdraft and start using the basin for aquifer storage and recovery. The longer term actions would address the remaining 60 TAF of overdraft, but would allow the aquifer to be recharged more during wet years, and then the water could be used during dry years.

The stakeholders had the following comments:

- Calaveras County's potential to utilize their full water rights needs to be accounted for in projections for how much water is needed. Mr. Hossain indicated that the additional upstream water uses would be in addition to the 160 TAF of overdraft, and would be included when modeling the alternatives.

- Recharging only 100 TAF of water would not be enough to reverse the flow to stop the salinity migration. Mr. Hossain stated that the 100 TAF would need to be recharged near the groundwater depression to have an impact, and it would not address the basin-wide overdraft problems. The basin would not be in balance after recharging 100 TAF, but the groundwater levels near Stockton would increase enough to stop the migration.

- Repairing groundwater overdraft cannot be separated from salinity intrusion because the overdraft is the cause of the intrusion. If the overdraft is stopped, then the intrusion should also stop. Mr. Hossain agreed that stopping the overdraft would stop the intrusion. There are two major problems associated with the groundwater overdraft: increased pumping lifts and salinity intrusion. The salinity intrusion has the potential to significantly damage the groundwater basin, so it is important to address the problem as soon as possible. The salinity migration can be addressed with less water than the entire overdraft, so the most damaging element of the overdraft should be addressed first.

- Stakeholders would like to see overdraft conditions in the Lathrop / Manteca area in 2001. The Technical Team indicated that these conditions will be modeled as a part of the alternatives analysis because some alternatives could include shifting Lathrop or Manteca to surface water.

- The County should consider when they are recharging too much water into the basin. As the recharge increases, water will start to outflow to the Delta and will be lost to further use. Recharge should be limited so that it stays below the point of diminishing returns.

- One Stakeholder commented that it would be helpful of the data were presented in terms of acre-feet of overdraft per acre of overlying land.

- In the future, there could be reduced recharge due to better irrigation practices.

Water Management Option Screening

Carrie Metzger from CDM discussed the screening procedure for water management options. The options were first divided into three groups: surface water options (new surface water supplies), groundwater options (ways to recharge the groundwater), and other options (projects, plans, or policies that address regional issues).

The Technical Team then screened the options to determine which options should be further analyzed. The screening criteria include cost, political feasibility, environmental impacts, financial feasibility, benefits, water quality, and legal feasibility. These criteria are described in greater detail in Technical Memorandum 3 (TM 3). If an option had a fatal flaw in any of these areas, it was screened out and will not be pursued in following meetings. Table 4-1 from TM 3 was presented, and the complete option list was reviewed.

Ms. Metzger asked for comments regarding options that should be on the list, or options that were screened out that should still be included. Stakeholders had the following comments:

- In-lieu recharge in the cities of Lathrop and Escalon are screened out because they are receiving surface water as part of the South County Surface Water Supply Project, but Manteca is not screened out. Ms. Metzger responded that Lathrop and Escalon are projected to receive enough surface water to meet all of their demands, but Manteca will only receive surface water supply to meet half of their demand. The in-lieu recharge option for the City of Manteca refers to the remaining half of their demand.

- In-lieu recharge for the City of Tracy should be included.

- "Groundwater Recharge North of the Mokelumne River" was screened out due to lack of benefits. If the water does not benefit San Joaquin County, then it would benefit Sacramento County. The management plan should look at both counties' problems.

- The new Lathrop Master Plan calls for all wastewater to be recycled, so this option should be included. Ms. Metzger responded that there is an urban recycling option included in the "other" options, but Lathrop should be called out specifically because they already have a plan underway. Other stakeholders expressed concern about using recycled water for agricultural uses because the salts could accumulate in valuable agricultural land.

- The Farmington Report compares different types of recharge options. They found that direct recharge is not that land intensive. They also found that injection wells may be costly, but then the water is available when necessary. Dual irrigation systems are the key to in-lieu recharge.

- Surface water options for South Gulch and Duck Creek should be included.

- The option for a "New CVP Diversion Facility on the Lower San Joaquin River" does not include a diversion point. Dave Schuster (from the Technical Team) responded that the exact location had not yet been determined, and it would need further modeling. The intent is to locate the diversion point downstream of Vernalis so that the water could be used to meet Vernalis flow objectives before it is diverted for use. The diversion would have to be modeled to locate a diversion point where the South Delta would not be harmed. The stakeholder replied that the reason that water quality objectives are at Vernalis is so that water meets objectives when flowing into the Delta, and not for withdrawal downstream.

- Little John's Creek is not included in the options.

- Urban wastewater reclamation could be used as a salinity barrier, but the salinity of the reclaimed water would need to be low enough that it would be substantially better than the water migrating eastward.

Proposition 13 Funding

John Woodling from the Department of Water Resources (DWR) presented information on the process to receive money from Proposition 13. Additional information was distributed from the DWR website: http://www.water.ca.gov/grants-loans.

The focus of the program is on groundwater storage, and is designed to fund projects that will implement conjunctive use in a basin. In San Joaquin County, the first 100 TAF per year that would be used to halt salinity migration would not be water that could be withdrawn during dry years. San Joaquin County will need to craft the alternatives very carefully to receive funding for the entire project. The project might not be as attractive to receive funding as other areas that do not need to fix their basin before it can be used.

Projects will be evaluated based on seven ranking criteria, as described in the handout. One of the criteria is "Basin-wide Planning," so participating in the SJCWMP process should help to receive funding.

Applications for this year's funding are due February 20, 2001. If the project is not already defined, receiving funds this year will be difficult. Applications for next year will be due in July, and there will be more money available.

Schedule for Completion

Ben Swann from CDM distributed a schedule for project completion that extends the project until June, 2001. The next meeting will on February 8 at Stockton East Water District.

Workshop Summary

San Joaquin County Water Management Plan

Workshop # 7, February 8, 2001

Introduction

This Steering Committee Meeting was conducted as a workshop to develop alternatives for technical analysis. As a workshop, a meeting summary was not developed. The resulting alternatives are attached to illustrate the results of the meeting.

Table 2-1
Alternative 1

Water Source						How to get the water into the ground					
Option	Surface Water/Water Source	Quantity (TAF)	Tier	Cost ($/AF)	Total Annualized Cost ($ 000s)	Option	Groundwater/Delivery	Quantity (TAF)	Tier	Cost ($/AF)	Total Annualized Cost ($000s)
SW12	SSJID/OID to SEWD Transfers	30	1	40	1200	GW11	In-lieu Recharge in SEWD	30	1	40	1200
SW11	Farmington - Little John's Flood Flows	25	1	200	5000	GW4	Farmington Groundwater Recharge and Wetlands Feasibility Study	25	1	100	2500
SW5	New Hogan Reservoir Reoperation	25	1	10	250	GW11	In-lieu Recharge in SEWD	25	1	40	1000
SW10	SEWD, CSJWCD Fully Exercise New Melones Rights	45	1	10	450	GW11	In-lieu Recharge in SEWD	10	1	40	400
						GW15	In-lieu Recharge in the City of Stockton	25	1		
						GW9	In-lieu Recharge in CSJWCD	10	1	40	400
SW8	Water Transfers within San Joaquin County	44	1	-	-	GW13	In-lieu Recharge in the City of Manteca	16	1	150	2355
						GW19	In-lieu Recharge in the City of Escalon	3	1	150	480
						GW20	In-lieu Recharge in the City of Lathrop	11	1	150	1695
						O7	In-lieu Recharge in the City of Tracy	14	1	150	2100
SW9	WID and WWUCD use of additional Mokelumne River Flood Flows	10	2	10	100	GW11	In-lieu Recharge in SEWD	5	1	40	200
						GW8	In-lieu Recharge in the City of Stockton	5	1		
NEW	Utilize Stockton water right to divert water from the Delta					GW8	In-lieu Recharge in the City of Stockton				
	Totals for Water Sources	**179**			**7,000**		**Totals for Groundwater Options**	**179**			**12,330**
	Total Alternative Cost				**19,330**						

Other Options

Option	Other Option Name	Tier	Cost
O1	Delta Area San Joaquin County Water Supply Activities	1	-
O3	Southwest San Joaquin County Water Supply Activities	1	-

Table 2-2
Alternative 2

Water Source						How to get the water into the ground					
Option	Surface Water/Water Source	Quantity (TAF)	Tier	Cost ($/AF)	Total Annualized Cost ($ 000s)	Option	Groundwater/Delivery	Quantity (TAF)	Tier	Cost ($/AF)	Total Annualized Cost ($000s)
SW12	SSJID/OID to SEWD Transfers	30	1	40	1,200	GW11	In-lieu Recharge in SEWD	30	1	40	1,200
SW11	Farmington - Little John's Flood Flows	25	1	200	5,000	GW4	Farmington Groundwater Recharge and Wetlands Feasibility Study	25	1	100	2,500
SW5	New Hogan Reservoir Reoperation	25	1	10	250	GW11	In-lieu Recharge in SEWD	25	1	40	1,000
SW10	SEWD, CSJWCD Fully Exercise New Melones Rights	45	1	10	450	GW11	In-lieu Recharge in SEWD	10	1	40	400
						GW15	In-lieu Recharge in the City of Stockton	25	1		0
						GW9	In-lieu Recharge in CSJWCD	10	1	40	400
SW8	Water Transfers within San Joaquin County	44	1	-	-	GW13	In-lieu Recharge in the City of Manteca	16	1	150	2,400
						GW19	In-lieu Recharge in the City of Escalon	3	1	150	450
						GW20	In-lieu Recharge in the City of Lathrop	11	1	150	1,650
						O7	In-lieu Recharge in the City of Tracy	14	1	150	2,100
SW2	EBMUD/Sacramento County/San Joaquin County Sacramento River Diversion	25	2	?	?	GW2	Direct Recharge in SEWD	10	2	100	1,000
						GW17	NSJWCD Groundwater Recharge Project	5	2	100	500
						GW12	In-lieu Recharge in the City of Lodi	10	2	150	1,500
O6	Water Conservation Improvements	?	2	?	?						
O5	Urban Wastewater Reclamation	60	2	200	12,000	GW8	Injection Wells in the City of Stockton	60	2	300	18,000
	Totals for Water Sources	**254**			**18,900**		**Totals for Groundwater Options**	**254**			**33,100**
	Total Alternative Cost				**52,000**						

Other Options

Option	Other Option Name	Tier	Cost
O1	Delta Area San Joaquin County Water Supply Activities	1	-
O3	Southwest San Joaquin County Water Supply Activities	1	-

Table 2-3
Alternative 3

Water Source / **How to get the water into the ground**

Option	Surface Water/Water Source	Quantity (TAF)	Tier	Cost ($/AF)	Total Annualized Cost ($ 000s)	Option	Groundwater/Delivery	Quantity (TAF)	Tier	Cost ($/AF)	Total Annualized Cost ($000s)
SW12	SSJID/OID to SEWD Transfers	30	1	50	1,500	GW11	In-lieu Recharge in SEWD	30	1	40	1,200
SW11	Farmington - Little John's Flood Flows	25	1	200	5,000	GW4	Farmington Groundwater Recharge and Wetlands Feasibility Study	25	1	100	2,500
SW5	New Hogan Reservoir Reoperation	25	1	10	250	GW11	In-lieu Recharge in SEWD	25	1	40	1,000
SW10	SEWD, CSJWCD Fully Exercise New Melones Rights	45	1	10	450	GW11	In-lieu Recharge in SEWD	10	1	40	400
						GW15	In-lieu Recharge in the City of Stockton	25	1		0
						GW9	In-lieu Recharge in CSJWCD	10	1	40	400
SW8	Water Transfers within San Joaquin County	44	1	-	-	GW13	In-lieu Recharge in the City of Manteca	16	1	150	2,400
						GW19	In-lieu Recharge in the City of Escalon	3	1	150	450
						GW20	In-lieu Recharge in the City of Lathrop	11	1	150	1,650
						O7	In-lieu Recharge in the City of Tracy	14	1	150	2,100
SW6	NSJWCD-Mokelumne River water right	20	2	50	1,000	GW17	NSJWCD Groundwater Recharge Project	20	2	100	2,000
SW1	Calaveras River Flood Flows	30	3	450	13,500	GW9	In-lieu Recharge in CSJWCD	20	1	40	800
SW7	Stanislaus River Flood Flows	20	3	450	9,000	GW11	In-lieu Recharge in SEWD	30	1	40	1,200
SW3	Mokelumne River Flood Flows	50	3	450	22,500	GW11	In-lieu Recharge in SEWD	30	1	40	1,200
						GW 10	In-lieu Recharge in NSJWCD	20	1	40	800
	Totals for Water Sources	**289**			**53,200**		**Totals for Groundwater Options**	**289**			**18,100**
	Total Alternative Cost				**71,300**						

Other Options

Option	Other Option Name	Tier	Cost
O1	Delta Area San Joaquin County Water Supply Activities	1	-
O3	Southwest San Joaquin County Water Supply Activities	1	-

Workshop Summary

San Joaquin County Water Management Plan
Workshop # 8, April 19, 2001

Introduction

The content of Steering Committee Workshop # 8 is summarized below. Tom Gau, from the San Joaquin County Department of Public Works, opened the meeting. Dave Auslam of Camp Dresser & McKee Inc. (CDM) welcomed the participants and provided an overview of the purpose and agenda of the workshop. The workshop included the following items:

- Development of a "Master Alternative;"
- Groundwater modeling results on the Core Water Management Options (WMOs);
- Prioritization of WMOs; and
- Discussion of prioritization results, and reprioritization of WMOs as necessary.

Mr. Auslam also introduced Carolyn Ratto, from the California Center for Public Dispute Resolution, who facilitated the discussion on reprioritizing WMOs. Ms. Ratto also described the ISI Stakeholder Evaluation, which is a concurrent effort to interview stakeholders and further understand their opinions and objectives. The information gathered as a part of this evaluation will be used in the next phase of the plan development.

The "Master Alternative"

During the Steering Committee Meeting on February 8, 2001, three alternatives were discussed for further evaluation. The alternatives were composed of combinations of groundwater and surface water options (known as Water Management Options, or WMOs) as well as other options. The alternatives were very similar, with several option groups reoccurring in each alternative.

Each WMO represents a valid idea that has passed through an initial screening process, and the stakeholders decided that they were worth studying in more detail during the February 8 meeting. Since the options contained in all alternatives have merit, they were all combined into a "Master Alternative" that will include all alternatives, but prioritize them to provide a road map for the next phase of the plan.

The WMOs that were common to all three alternatives were termed the "Core Elements," with the remaining options left to be prioritized in the plan.

Groundwater Modeling Results

The "Core Elements" were modeled to see what their impacts would be on the groundwater depression in eastern San Joaquin County, both individually and when they are all combined. The core elements included the following WMOs:

- Exercise New Melones Rights;
- New Hogan Reoperation;
- Farmington Flood Flow Recharge;
- South County Water Supply Project; and
- SSJID / OID transfer (part of baseline through 2010).

A detailed summary of the groundwater modeling results was distributed prior to the meeting, with additional copies available at the meeting. The primary conclusions include:

- Core Elements are effective in greatly reducing saline water intrusion;
- Overdraft still exists, primarily north & north-;
- Other options / projects can address the overdraft; and
- Good opportunities exist for conjunctive use.

Prioritization of Water Management Options

The WMOs were prioritized according to the goals and objectives established during early meetings of the Steering Committee. The prioritization process was described in more detail in the "Evaluation Methodology" section distributed prior to the meeting, with extra copies available at the meeting.

Each option was rated according to the goals, and the WMOs were then separated into three tiers. The tiers were not designed to screen out any options, but to prioritize them for further study. The results of the WMO prioritization are attached.

Discussion of Prioritization Results

Carolyn Ratto led a discussion about the results presented and the prioritization of the options. Stakeholders expressed the following concerns:

Distribution System

- The quantities expressed for available surface water supplies may not be correct. "Average annual supplies" do not fully express the amounts that could be available every year, or the necessary capacity of facilities that would be needed to utilize this water.

- To provide enough water, some stakeholders recommended a distribution system to connect the Mokelumne, Calaveras, and Stanislaus River systems. The options address smaller projects that would be part of the plan, but bigger projects that link the smaller projects are more important. Connecting the three systems would allow more flexibility to utilize wet-year flows from any river system.

- Before decisions can be made on the existing options, more information is needed about the necessary conveyance associated with each WMO. The conveyance from the source to the point of use is critical information, as well as the facilities that are necessary at the point of use. WMO costs need to be determined based on the capacity, which will relate to the type of water that the option includes. (Utilizing wet-year water requires facilities larger than the "average annual" amount of supply.)

- The overall plan should start with distribution and determine where the water should be used. The distribution system needs to be designed to have the capacity to use wet-year flows. The analysis of the distribution system needs to account for impacts to downstream users.

- Interconnection of the river systems needs to be performed in the context of a project, or no one will pay for it.

Delta Impacts

- More information is needed to prioritize the options. Some critical pieces of information include how other areas of the County are impacted, whether Vernalis standards will be violated, and whether the water is "new" water or just reallocated within the County.

- DWR clarified that they see the plan as a roadmap for more detailed technical and environmental analysis. The next phase is not to build the projects, but to perform detailed technical feasibility studies and environmental reports.

- The technical team pointed out that if an option has negative impacts to parties in the County, there are two choices: either the option is not implemented, or the negative impacts must be mitigated.

- To some stakeholders, knowing that an EIR will be performed to address any impacts is not sufficient. They would prefer that no negative impacts occur in the first place. Another stakeholder pointed out that project proponents could incur negative impacts if projects are not carried out. Stakeholders need to consider the negative impacts from both implementation as well as maintaining the current situation.

- Wet-year water would be "new" water because it is water that would otherwise leave the County.

Option Prioritization

- Agricultural conservation is not a viable option because farmers are already 90% efficient, and they need to use whatever source is cheapest. All irrigation types utilize the same amount of water.

- There is no option within the Core Elements that would use water from the Mokelumne, and several stakeholders requested that an option be moved up.

- Agricultural stakeholders are very hesitant to be involved in another Countywide project because they do not feel that past projects have had positive impacts.

Workshop Summary

San Joaquin County Water Management Plan
Workshop # 9, June 14, 2001

Introduction

The content of Steering Committee Workshop # 9 is summarized below. Tom Gau, from the San Joaquin County Department of Public Works, opened the meeting. Dave Auslam of Camp Dresser & McKee Inc. (CDM) welcomed the participants and provided an overview of the purpose and agenda of the workshop. The workshop included the following items:

- Feasibility of connecting the three river systems in the County;
- Existing and needed conveyance facilities;
- New vs. re-allocated water; and
- Discussion of WMO prioritization changes since the last meeting.

During Workshop # 8, on April 19, various steering committee members raised the issue of water conveyance and distributions systems. Two issues with regard to water conveyance and distributions were discussed. The first was concept of connecting all the main rivers (Mokelumne, Calaveras, and Stanislaus) within San Joaquin County to provide flexibility to utilize wet-year flows from any river. The second issue was the necessary conveyance and distribution associated with each Water Management Option (WMO). In response to these issues CDM conducted additional evaluation of required water conveyance and distribution systems. This evaluation involved reviewing wet-year flow availability, existing distribution systems, and meetings with individual stakeholders to clarify and discuss their specific ideas and concerns. The result of this evaluation was the basis of the material presented during Workshop # 9.

Connecting the Three Rivers

Paul Hossain of CDM discussed the concept and feasibility of connecting the three river systems within the County. The objective of a county-wide transmission system would be to:

- Move water to where it is needed the most
- Make full use of excess storage capacity
- Potentially provide recharge benefits

As has been discussed throughout the project, the Mokelumne, Calaveras and Stanislaus are essentially fully-allocated – i.e. there is little or no firm water available to be diverted from them. Generally, the only water available is the unallocated wet-year flows. Wet-year flows can be significant but occur relatively infrequently. The highest quantity of wet-year flows are available on the Mokelumne River. Wet-year flows are also available on the Calaveras, Little Johns Creek and Stanislaus, but they are generally smaller.

If the wet-years flows were available at different times then connecting the rivers, with some storage system, would result in a higher overall yield. Data presented illustrated that the wet-year flows were typically available at the same on an annual basis. However, the monthly distribution of wet-year flows was shown to be somewhat different. The majority of the wet-year flow on the Calaveras River and Little Johns Creek is typically available December through April. In addition to December through April flows, some wet-year flow is available during May through November on the Mokelumne and Stanislaus Rivers.

Several conclusions were presented based on the review of the availability of wet-year flows and current use of available firm and interim surface water. Currently, available firm and interim surface water is not fully utilized with the different watersheds and service areas. Additionally, flood flows are not fully utilized within each watershed. For example, Central San Joaquin Water Conservation District cannot use its firm supply of 49 TAF from New Melones. Additionally, SEWD does not have the capacity to use Calaveras River flood waters or water from New Melones. Distribution and conveyance systems within districts should be expanded to make full use of flood flows available within each watershed. The infrastructure to convey Stanislaus / New Melones water to CSJWCD & SEWD exists, however, it would need to be expanded. Given the availability of wet year flows on Mokelumne, a system to regulate and move this water south should be considered. A system that allows both transmission of water from south to north and north to south is not necessary. Such a system would probably be costly, and provide little additional benefit over a less extensive and complex system.

Several members of the steering committee raised the issue of whether or not some wet-year flows could be utilized without a regulating storage facility. It was agreed that a second Mokelumne River option would be included in the Draft Management Plan – this option would be for direct diversion of some wet-year flows for use within San Joaquin County.

Existing and needed conveyance facilities

Carrie Metzger of CDM discussed the second issue relating to water conveyance and distribution. The required conveyance and distribution for each WMO was summarized as either being the existing system, expansion / rehabilitation of existing or construction of entirely new distribution system components. Additionally, GIS maps of the distribution system and possible in-lieu and direct recharge areas in the east-side County were presented for three subareas: North San Joaquin Water Conservation

District, Stockton East Water District and Central San Joaquin Water Conservation District.

Additionally, the concept of average annual versus peak flows was clarified. The concern was that when looking at annual average flows (in many options) the water is available only during wet years, and during those years the flows (peak flows) are significantly larger than the average values. Consequently, transmission and distribution system capacity need to be adequate to meet the peak flows and not the annual average.

The conclusions presented with regard to existing and needed conveyance facilities was:

- Interconnection between areas was needed to increase flexibility.
- Improved conveyance systems would be adequate for the WMOs
- District-wide or multi-district master planning is require to plan the phasing of improvements and new infrastructure.

New vs. re-allocated water

Several stakeholders have emphasized the importance of understanding the difference between new water and water that is re-allocated from an existing use. In response to these concerns, Ben Swann of CDM presented the definitions of new and re-allocated water, and divided the WMOs into the category of water they represent.

New water was defined as water that without a project would not be utilized in the County, and would either not be available to the County, flow out of the County and/or would be used by some entity outside of San Joaquin County. New water increases the total water supply available to San Joaquin County. The implication of new water is that there is higher probability that consensus can be reached between SJCWMP Stakeholders to pursue such projects.

Use of existing water or re-allocation was defined as water that is already used, or available to be used by some entity within San Joaquin County. Water in this category would either continued to be used in the existing manner, or would be unused without the implementation of a project. Existing water does not necessarily increase the net water supply available to the County - it changes the pattern and location of use.

Discussion on new vs. re-allocated water

- Some steering committee members stated that under the provided definitions of new and re-allocated water, new water may indeed be new water to the county, but may not be so to the overall system or State.
- Even if water was considered unused or new – it is probably actually being used by aquatic life.

- Re-allocation of water will have environmental and recreational impacts that will have to be mitigated.

- The issue of over-allocation or over commitment of the New Melones system was discussed. It was noted that New Melones (B)(2) water releases need to be addressed. Delta area stakeholders require County support to address this issue.

- The yield from options that rely on re-allocated water will probably lower than currently estimated to mitigate probable impacts.

- If options that are based on re-allocation of water move forward, their associated impacts need to be understood and mitigated. For example, if additional water from the New Melones system is used, then the WMP needs to ensure that Vernalis standards are met.

WMO prioritization

Ben Swann of CDM updated the Steering Committee on the prioritization and grouping of the Water Management Options.

In general the grouping of the WMOs had not changed since the last meeting. The main changes that were made were:

- Grouping of the WMOs into 3 tiers only, removing the concept of the core element group.

- Revised yield estimates for some of the WMOs.

- Inclusion of a Mokelumne River option in Tier 2, and inclusion of the American River Water Rights option in Tier 3.

CDM also presented an overview of the how the Water Management Plan would move forward in response to Steering Committee member's concerns over "implementation". It was explained that the next phase of the plan would be a feasibility stage, followed by design, and finally implementation. It was noted that projects that make it through to design may not necessarily be implemented.

Discussion of WMO prioritization

- The concept of re-operation of reservoirs is generally misunderstood. The underlying concept of re-operation is that the location of water storage is changed to increase the overall yield of the system. When possible, water is stored in groundwater basins to provide more capacity in reservoirs to regulate more flow. Water stored in aquifers is then available for use when required including mitigating possible impacts to downstream users. It was also noted that there are potential environmental and recreational impacts associated with reservoir re-operation.

- Woodbridge Irrigation District is currently using its full pre-1914 Mokelumne water right. Through increased efficiency of on-farm irrigation systems water could be made available for recharge.

- Agricultural conservation was also discussed. It was noted that the estimated reduction in water usage due to agricultural conservation was too high, and that agricultural was already more than 90% efficient. Farmers will change cropping patterns based on the market and cost of production. It was concluded that implementing agricultural conservation may be difficult, but it was none the less important to keep it in the plan, since it may be a required component to obtain external funding.

- The current estimate of 28 TAF for the Freeport project is low. Based on more recent work, the benefit from the Freeport project could in the range of 30 to 50 TAF.

- The analysis and evaluation conducted for the SJCWMP cannot address all the issues raised by steering committee. The next phase of work, detailed feasibility studies will address issues, in more detail. The objective of this phase is to develop a plan comprised of various options designed to meet the committee's overall objectives and that has broad consensus among the stakeholders to move forward.

- The SJCWMP Steering Committee agreed with the need to move ahead with the next phase of the SJCWMP with list of project under the Master Alternative. The next phase will include detailed feasibility studies that will clearly identify benefits, costs and impacts associated with the projects.

Workshop Summary

San Joaquin County Water Management Plan
Workshop # 10, June 28, 2001

Introduction

The content of Steering Committee Workshop # 10 is summarized below. Jack Sieglock, from the San Joaquin County Board of Supervisors, opened the meeting. Ben Swann of Camp Dresser & McKee Inc. (CDM) welcomed the participants and provided an overview of the purpose and agenda of the workshop. The workshop included the following items:

- Organizational structure and management framework options;
- Funding opportunities and mechanisms; and
- Discussion on organizational options and funding.

Organizational Structure and Management Framework

Bob Vince of CDM discussed options for organizational structures and management frameworks. An organizational structure was defined as a formal agreement between plan participants that defines how they conduct business, and the management framework was the hierarchy of relationships between plan participants. To determine the best organizational structure and management framework, it is important to understand the activities that stakeholders expect the organization to fulfill. Possible activities include representing local interests on regional, state, and federal levels, pursuing funding, constructing projects, and facilitating public outreach.

Mr. Vince introduced four potential organizational structures, with examples of each structure:

- Joint Powers Authority (Northeastern San Joaquin County Groundwater Banking Authority);
- Memorandum of Understanding (Butte Basin Water Users Association);
- Special Districts (San Joaquin County Flood Control and Water Conservation District); and
- Nonprofit Mutual Benefit Corporation (San Joaquin Resource Management Coalition).

These organizational structures can be incorporated into a management framework, which illustrates how different entities within the County interact to carry out the plan. The range of frameworks goes from individual interest-based, where entities retain individual powers to govern and develop water resources, to mutual interest-based, where groups unify individual powers to govern and develop water resources. Mr. Vince presented examples of each end of the spectrum, as well as a more central example that featured a mutual interest-based framework that incorporated local control.

Funding Opportunities and Mechanisms

Ginger Strong of CDM presented mechanisms to secure federal, state, and local funding. When determining which source to pursue, entities must consider the amount required, when the funding is needed and how the timing fits into the budget or grant cycle, and existing funding for similar projects.

There are three approaches to secure federal funding:

- Federal agency requests funds during their internal budgeting process;
- Secure funds through the federal legislative process; and
- Apply for funds under an existing grant, loan or assistance program administered by a federal agency.

State funding is somewhat similar, and can be secured through the state legislative process or by applying for funds under an existing grant, loan, or assistance program administered by a state agency. Local funding can be critical as the basis of a cost-share agreement with state or federal agencies, and can be approached through an assessment program or money from general funds.

Ms. Strong presented a case study about the Kaweah River Delta Corridor Enhancement Plan. The project addressed multiple project goals, including flood protection and stormwater management, groundwater recharge, and riparian habitat restoration and enhancement. Three diverse project partners signed an MOU to undertake the plan and acquire funding. They received $100,000 from the State of California Wildlife Conservation Board for the initial study, and $1,000,000 from the Federal Government (U.S. Bureau of Reclamation) to complete the work. Local staff time and project maintenance costs were counted as in-kind contributions for cost share purposes.

Ms. Strong ended with several recommendations to consider when pursuing funding:

- Leverage your resources;
- Do not underestimate the competition for funding;
- Securing large amounts of project funding can take several years (stay committed); and

- Know that money often comes with a price tag, such as environmental benefits and urban BMPs.

Discussion

The discussion started with three topics regarding the information that was presented:

- What do you want the organization to do for you?

- What are your concerns/issues regarding organizational structures?

- Generate a list of current funding pursuits for water management options.

Discussion first focused on the second question, including stakeholder concerns and issues regarding potential organizational structures. The first item was discussed briefly before the end of the meeting, and the meeting ended before the final item could be discussed. CDM asked that stakeholders submit any funding pursuits via email. The following comments were made regarding organizational structures:

Recommendations

- The County and the consultants need to provide recommendations about organizational requirements. Ben Swann recommended that the Steering Committee should choose a framework that includes the entire county.

- The County sees several different focuses of the plan: once the plan is adopted, an entity needs to ensure that the plan is implemented and address changes, and the entity needs to act as an advocacy group with legislature and funding. The Steering Committee must speak with a common voice and benefit the entire county.

- The County suggested having a facilitated process after the plan development is complete to identify the best management structure. The County and DWR-ISI can finance this project jointly to discuss which parties need to be involved, DWR's stakeholder assessment, potential structures, and funding options. They can then reconvene this process to move forward. The County thinks that they need to continue the process with the same stakeholders to address everyone's concerns.

- CDM asked DWR if the group must agree on the course of action to ensure that projects will move forward. DWR responded that if the plan is funded through the ISI program, there must be group agreement. However, the group will also need project champions.

General Concerns

- Impacts on all regions of the County need to be taken into account.

- The County Board of Supervisors might not be the right group to oversee the management framework of the plan because party politics could hamper efforts to move forward. The County has historically struggled to implement projects, partially because of the politics within the County. A government authorization and an elected board of directors could be a more effective management structure. This model is very similar to the Metropolitan Water District of Southern California.

- The Water Management Plan will change, and a management structure needs to be a permanent structure capable of implementing that change. The entity chosen must have representatives that focus on the good of the County, and not simply on the good of the area that they represent.

- It is premature to determine an organizational structure before the group has determined which projects to pursue. This Steering Committee has developed the start of a plan, but additional work must be performed to choose which projects will be implemented. When the projects are identified, the group can then decide the organizational structure that best fits the needs of the projects.

Work for the Next Phase

- The next phase involves several different levels of work. There will be some general planning, and one aspect of that general planning could be to determine what kind of institution should be utilized to enter the next phases of work. The institution needs to benefit projects, or the project proponents will not participate.

- There are five or six projects on the base list, and the Steering Committee needs to determine how to move those forward. Some projects are already moving forward, but they all need to be moved forward. Eventually, all projects will have JPAs for the project beneficiaries.

- The Steering Committee has not examined all projects in depth and decided that they should move forward. Some projects are already moving forward, but the Steering Committee should still examine these projects to determine how they impact their neighbors. If individual entities disregard the County as a whole, there could be negative implications, such as lawsuits.

- The Steering Committee needs to determine what work needs to be done next to allow members to agree that projects should move forward. One stakeholder suggested that the "feasibility phase" needs to study engineering and economics as well as third party impacts. A full EIR is not needed, but the Steering Committee needs to assess conceptually if a project will shift benefit from one area to another.

Funding for the Next Phase

- This study has been funded through the County, but DWR needs to explain what they need in order to give the County funding to move forward. DWR needs to recognize that the process is under control to give money. They need to know what work needs to be done, other funding sources, and how much it will cost.

- Several stakeholders discussed the possibility that the County's Zone 2 assessment could provide funds for the next steps of work involved in the plan. The County, however, stated that the Zone 2 fund does not have sufficient funds to pay for additional work. The assessment provides $800,000 per year, but $500,000 goes to staff salaries. Zone 2 spending is currently more money than is coming in from the assessment.

- Zone 2 cannot fund the remaining work; so several stakeholders agreed that individual entities could contribute funds towards future work.

Stakeholders made the following comments regarding activities that the organization should or should not undertake:

- The Water Management Plan will be a dynamic plan, and elements will drop out or be added in the future. The structure needs to be capable of shepherding projects through this process.

- An organization should take the general plan and develop a strategic plan for each management area.

- The entity formed should not have the ability to "kill" a project. Currently, the Board of Supervisors can say that the project is not in conformance with the plan, but they cannot kill the project. It was suggested that this power should not be added to a new entity.

Workshop Summary

San Joaquin County Water Management Plan

Workshop # 11, August 2, 2001

Introduction

The content of Steering Committee Workshop # 11 is summarized below. Jack Sieglock, from the San Joaquin County Board of Supervisors, opened the meeting. Dave Auslam of Camp Dresser & McKee Inc. (CDM) welcomed the participants and provided an overview of the purpose and agenda of the workshop. The workshop included the following items:

- Presentation on the recommended strategy;
- Discussion on the recommended strategy; and
- Discussion on draft plan comments.

Recommended Strategy

Ben Swann presented the recommended strategy outlined in the Executive Summary, which was distributed during the meeting. The recommended strategy is based on the following rationale:

- *Continued joint decision-making*. The parties within the County need to continue to work together to reduce redirected impacts, wield greater political influence, and increase their likelihood to obtain state and federal funding.

- *Use technical tools for modeling*. The groundwater model developed during this plan is a valuable tool available for future stages of evaluation. Additionally, this project has helped develop a decision-making framework of stakeholder goals and objectives that could help to make important planning decisions, especially if stakeholders move to quantify the objectives with measurable indicators.

- *Moving projects toward implementation*. The stakeholders need to reach consensus on the studies or next steps for each projects, and start to move the projects forward.

- *Funding projects*. By working together, County groups have a much greater chance to receive state or federal funding. To be successful in obtaining state or federal funding, projects should include: environmental benefits to fulfill state or federal agency mandates; regional benefits to expand the zone of benefit to cover more of the area included by state or federal agencies; and project partners to bring political, strategic, technical and financial support.

There are several steps that the new County-wide planning group can take to help fulfill the strategic rationale:

- Develop and sign an MOU that establishes a County-wide planning group;

- Revisit the MOU signed by DWR and the SJCFC&WC;

- Continue using the groundwater model to provide quantitative, predictive data for project evaluation;

- Develop a comprehensive decision-making tool;

- Define the appropriate "next steps" for each of the projects in the Master Alternative;

- Develop specific federal, state or local funding strategies for each of the projects in the Master Alternative; and

- Move forward as a County-wide planning group on projects.

Discussion

- The County had several suggestions for moving forward, including:
  - Utilize a facilitated process to determine the best management framework and organizational structure;
  - Complete a stakeholder evaluation; and
  - Understand and clarify the expectations of the stakeholders.

  The County believes they have a verbal commitment from DWR to finance this interim work.

- DWR's suggestions included:
  - Determine how to move forward;
  - Develop Basin Management Objectives; and
  - Identify the group, what people can come together on, who should take the lead, and utilize information from the stakeholder evaluations.

  DWR will fund the assessment, facilitation, and the development of a technical scope of work. The Steering Committee will have to then determine if they can assemble the necessary funding to move into the next phase.

Comments on the Draft Plan

- In the agricultural conservation section, there are no references to the effect of flood and drip irrigation on deep percolation.

- The introduction lacks reference to the effects of overdraft and saline intrusion.

- No distinction is made between applied and consumed water.

- The agricultural conservation section is not completely accurate. More water is used with drip and sprinkler irrigation because drip systems run every night and sprinklers introduce more evaporation. Neither method contributes to groundwater recharge as much as flood irrigation.

- There should be a suggestion to conserve groundwater and flood with surface water to benefit the groundwater level.

- Agricultural conservation information is abundant and should be researched to help reflect information that is more accurate.

- If the benefits of agricultural conservation are misstated, that can cause public relations problems later and give people unrealistic expectations.

- There is reference to conserving agricultural water by changing crop patterns to less water-intensive crops. County farmers do not have control over cropping patterns because the market will drive the type of crops planted.

- There is no reference to development covering land and changing absorption rates. Another stakeholder responded that the groundwater model takes a lot of these factors into account and should receive greater emphasis in the document.

- It should be understood that the primary reason for adding a conservation component to every option is for funding eligibility.

- There is no mention of capturing floodwater to help recharge the Tracy area. Other stakeholders responded that Tracy is implementing their own groundwater recharge program.

- In Table 2-2, water that is included in the "Loss to Streams" is not lost to the overall system.

- The amount of water needed to solve the saline intrusion will not resolve the Eastern County recharge problem.

- It would be useful to know how the conservation analysis was developed. A careful water balance has to be done. For example, if there is less applied agricultural water, there is less for recharge. A 50% conservation figure is not realistic. There are redirected impacts that have to be brought to light on a project-by-project basis.

- In Table 2-4, Oakdale ID demand changes significantly from 1996 to 2030. The table needs further explanation (including assumptions), and the quantities seem too low.

- In the Options table in Section 4, the options are fairly specific. The document needs to refer to comparable alternatives so that substitutions can be made without have to go through a plan amendment process. This could be in the description rather than the table.

- Is Woodbridge OK with the reference to transfers? Where did the transfer cost come from, as it seems too low?
- Care must be used if broadening the project descriptions, as the analysis may no longer fit the description.
- The reference list lacks the EIR on South County Surface Project and the cities' and County's General Plans. Check the use of some specific phrases as they are being used inaccurately, such as, "transfer rights" instead of "transfer water".
- In Table 2-4, are the figures applied or consumed? CDM states they are applied, but stakeholders are concerned that the demand figures are too low.
- Why is EBMUD's banking project not on the option list? CDM stated that they will add groundwater banking as a general option in Section 3, and the Freeport option is already included in Section 5. The Steering Committee did not specifically mention EBMUD because they are not yet ready to narrow the prospective partners for banking projects.

Concerns About the Need for a New MOU

Stakeholders asked why an MOU is needed to continue the process. CDM stated that it would provide for a number of things:

- It will greatly improve the chances for outside funding.
- It represents "buy in" for the process, and "buy in" that the County has an action plan.

DRAFT

MEMORANDUM

To: San Joaquin County Steering Committee

From: Dave Schuster

Date: November 16, 2000

Subject: Potential solutions to San Joaquin County's water supply problem.

Purpose

The purpose of this memorandum is to share with the members of the San Joaquin County Steering Committee the Camp Dresser Mckee consulting team's thoughts on alternative means of solving the county's water supply problem(s) and obtain comments on this work from the committee. The final steps will be to 1) incorporate the Steering Committee comments, 2) further flush out ideas by developing a rough reconnaissance level study on facilities that will be needed to implement the identified alternatives for solving the water supply problem(s), and 3) develop a surface water supply augmentation implementation plan.

Introduction

The San Joaquin County water supply problem has been defined in this memorandum as four separate but interrelated problems which are:

- Southwestern county Delta Mendota Canal service area water contractors. This area's primary problems are an unreliable Central Valley Project (CVP) contract water supply, lack of alternative supplies, and significant population growth in the City of Tracy.

- South Delta Water Agency area. This area's primary problems are reduced water levels during the irrigation season due primarily to CVP and State Water Project (SWP) pumping from the south Delta and poor quality water due to reduced San Joaquin River flows caused by upstream development and increased salt load from the west side of the San Joaquin Valley.

- Central Delta Water Agency area. This area has no serious problems today but is threatened with potential problems due to 1) closures of the CVP Delta Cross Channel gates to protect emigrating salmon smolts and 2) construction of an isolated canal from Hood on the Sacramento River to the project pumps which could lead to permanent closure of the Cross Channel gates.

- East County area. Potential loss of groundwater resources as a result of water quality degradation because there are insufficient surface water supplies to meet demand.

Each of the above problems and potential solutions are discussed in this memorandum. The majority of the work has been done identifying potential surface water supplies that could be used to solve the groundwater basin salinity intrusion problem.

Southwestern San Joaquin County

There are four agriculture and one urban water districts in the southwestern portion of the county who do not obtain their respective water supply by diverting water from the Delta using a riparian water right. Each district is discussed below.

Banta Carbona Irrigation District:

The district has historically used 40 to 60 TAF per year to meet its farmers water supply needs. The district's primary water source is from the San Joaquin River and the second or supplemental supply is from the Delta Mendota Canal (DMC) under a CVP water service contract for 25 TAF.

These two sources of water were sufficient to meet the district's water supply needs in all but 1977 for 40 years. The passage of the Cental Valley Project Improvement Act (CVPIA) in 1992 and CVP operational constraints due to ESA requirements have reduced the reliability of the district's CVP supply dramatically. For example, the 2001 CVP forecast is that the CVP agriculture water users will receive a 45% supply if 2001 is a normal year. The users would have received a 100% supply prior to the CVPIA.

The reduction of CVP contract water has forced the district to maximize diversions from the San Joaquin River when water is available. The district does not have groundwater resources that can be used by the district because the groundwater has high TDS and it contains Boron and inadequate blending capability exists within the district.

Some of the districts over this groundwater basin do pump groundwater and put it into the Delta Mendota Canal in exchange for replacement water deliveries from the DMC. The DMC has sufficient water to blend the high TDS and Boron to levels that are safe for agricultural use downstream of the point the groundwater is discharged to the canal. These districts need the county to exempt this pump back program from any ordinance the county may enact that prohibits export of groundwater from the county. The pump back program has no negative impact on the San Joaquin County groundwater overdraft problem.

Banta Carbona I. D. needs San Joaquin County (preferably the Board of Supervisors) to support their efforts to increase the reliability of the CVP supply. That can be done by the Department of Interior using the discretion the federal courts have provided in the implementation of Section

3406 b(2) of the CVPIA. Currently Interior is using that discretion to maximize the negative impact of the CVPIA on the water users. This can only be changed through political pressure on the next president's administration.

Plain View Water District:

The district has historically used 6 to 20.6 TAF per year to meet its farmers water supply needs. The district's sole water source is from the Delta Mendota Canal under a CVP water service contract for 20.6 TAF. The district does not have groundwater resources that can be used by the district because the groundwater has high TDS and it contains Boron and inadequate blending capability exists within the district. Some of the districts, including Plainview, over this groundwater basin do pump groundwater and put it into the Delta Mendota Canal in exchange for replacement water deliveries from the DMC. The DMC has sufficient water to blend the high TDS and Boron to levels that are safe for agricultural use downstream of the point the groundwater is discharged to the canal. The pump back program has no negative impact on the San Joaquin County groundwater overdraft problem and should not be prohibited by a county ordinance designed to protect the east county groundwater basin from additional overdraft.

Plain View Water District's water supply problem is the same as Banta Carbona Irrigation District, their CVP water supply has become very unreliable since enactment of the CVPIA. The district's problem is more severe since, unlike Banta Carbona Irrigation District, they do not have any other source of water except the CVP contract supply and groundwater.

Like Banta Cabona Irrigation District, Plainview needs the county to politically support their efforts to influence Interior to adjust the utilization of Section 3406 b(2) water in a way to increase the reliability of the CVP contract supply.

West Side Water District:

The district has historically used 27 to 41.5 TAF per year to meet its farmers water supply needs. The district's primary water source is diversions from Old River and the second or supplemental supply is from the Delta Mendota Canal under a CVP water service contract for 7.5 TAF.

The West Side Water District situation is exactly the same as the Banta Carbona Irrigation District and the Plainview Water District.

Del Puerto Water District:

Del Puerto Water District has a CVP contract for 140.21 TAF and the district's water supply problem is the unreliability of this supply since enactment of the CVPIA. This district needs assistance from the county like the other CVP contractors in the county.

City of Tracy:

The City of Tracy has a 10 TAF CVP contract and uses about 5.7 TAF of groundwater from the city's confined aquifer. The city's CVP contract water is, obviously, urban water which is given a higher priority than agriculture users by the U.S. Bureau of Reclamation.. For example, the agriculture contractors will get a 45 % supply in 2001 if normal rainfall occurs and the urban contractors will get an 80% supply.

This supply had been sufficient to meet the needs of the city historically but the dramatic growth that has occurred in recent years and is projected to continue will soon require more water than the city's available supply. The city's demand for water is about 13.2 TAF in 2000 and is projected to increase to 40 TAF per year by 2015. The city is aggressively pursuing water supply augmentations measures to meet the projected future water supply need. For example:

- As the city annexes land into the city from surrounding water districts, assignments of CVP contract water from those water districts to the city are negotiated. A total of 20.5 TAF is currently being pursued for assignment. This assigned water will have a CVP agriculture priority and will have limited value during drought conditions under the current USBR CVP operation policies.

- The city is investigating a groundwater conjunctive use program using wet year water including the above CVP contract water assignments. The city recently received a CALFED grant to pursue this investigation.

- The city has agreed to a transfer of 10 TAF from the South San Joaquin Irrigation District (SSJID) to the city.

The City of Tracy needs the County of Sacramento's assistance in 1) increasing the reliability of CVP contract water, 2) obtaining the assignment of CVP contract water from the agriculture water districts to the city, and 3) supporting the SSJID transfer if USBR and/or the Department of Water Resources (DWR) challenge the proposed transfer and if the transfer does not harm the South Delta Water Agency (SDWA) or the harm is mitigated.

South Delta Water Agency

Currently the SDWA frequently has a problem with low water levels during the irrigation season caused primarily by the CVP and State Water Project (SWP) pumping from the south Delta. USBR and DWR agreed with the SDWA in 1986 to build three barriers in the south Delta that would tidal pump water into the south Delta which would eliminate the negative impacts of project pumping. These three barriers would also improve water quality in the south Delta.

The three agencies have been trying to build these barriers ever since and have been blocked by U.S. Fish & Wildlife Services' (F&WS) concerns about the effect of the barriers on delta smelt.

F&WS concerns, in my opinion, are unfounded but the Endangered Species Act (ESA) has provided F&WS with the power to block construction of the barriers under the current federal administration. In addition, the F&WS and others want to construct a barrier at the head of Old River near Vernalis to increase the survival of out migrating San Joaquin River chinook salmon smolts. This barrier would significantly reduce the south Delta water quality and water levels if the Old River barrier is constructed and the other three barriers are not. The SDWA needs the San Joaquin County's assistance in influencing the next president's administration to get the three barriers constructed.

The SDWA also has a problem with increased salt load in the San Joaquin River due to irrigation on the west side of the San Joaquin Valley with Delta water. The solution to this problem is not currently clear. The SDWA could use the county's assistance in identifying and seeking a solution to the San Joaquin River quality problems.

Finally, the county must be alert to the potential impacts of surface water solutions to the county's groundwater problem on the SDWA. Those impacts either should not occur or appropriate mitigation must be provided.

Central Delta Water Agency

The Central Delta Water Agency (CDWA) currently diverts good quality water and has no water supply problems during the irrigation season. The CDWA problem is a threat to the agency's current water quality due to closures of the of the Delta Cross Channel gates to protect out migrating chinook salmon smolts during the February through June period. These closures have been required since 1995 but each year since then have been wet and no problems have occurred to date. That will not be the case during very dry years. In those years water quality in the central Delta will degrade early in the irrigation season. The CDWA needs San Joaquin County to join the CDWA, DWR, Contra Costa Water District and USBR and assist in arguing for opening the gates periodically during dry years to improve water quality. The argument will be that the needs of fish must be balanced with the needs of Delta agriculture water users and urban water users south of and adjacent to the Delta.

A long term threat to the CDWA water quality is an isolated canal that connects the SWP and CVP pumps to the Sacramento River at Hood. The canal would allow permanent closure of the Delta Cross Channel gates which would have a significant negative impact on the central Delta water quality. CDWA would like the county to assist CDWA insure that if the canal is constructed, then the cross channel gates remain open or some other mitigation for CDWA water quality degradation be required and legally assured.

Groundwater Overdraft in the East County

Definition of the Problem

The first step in addressing the continued reduction in the San Joaquin County groundwater basin and resultant salinity intrusion was to define the problem to be solved. CDM groundwater experts have estimated that an average annual surface supply of 100 to 125 TAF is needed to stop any further reduction in groundwater storage. In addition, the basin must be refilled by about 1 MAF to stop any further salinity degradation of the basin. Therefore, a goal of increasing the available surface water supplies of 200 TAF per year has been established for this initial assessment. That water would be used to reduce pumping from the basin via in-lieu deliveries and by putting the water directly into the basin through recharge projects.

If the 200 TAF is obtained, it will take ten to fifteen years to bring the basin storage to a point where no further salinity intrusion occurs. It will take two to ten years to implement some of the identified actions. Therefore, the final solution is twenty to twenty five years away. That is a long time and will occur only if the actions eventually selected by the county and the Steering Committee are pursued aggressively. Even then, more of the basin will become unusable because of salinity intrusion. The point is a sense of urgency must be felt by everyone involved in implementation of the solution and all parties must work together to solve a serious groundwater overdraft problem that will eventually effect all users of the groundwater basin.

The Task

Our task, in my opinion, is to use all of the information that has been developed by various entities over the past 25 years (no significant new work) and determine whether or not there are sufficient viable actions that, if implemented, would develop an average annual water supply equal to 200 TAF. Initially, I thought we would develop multiple alternatives, screen those alternatives and select a preferred alternative. It became clear soon after this effort started that there were not that many alternatives. The task instead became to determine whether or not there were enough viable actions available to develop the targeted 200 TAF. That was done by identifying all possible viable actions and determining the potential benefits of each action. If more water than required is potentially available, then the next task would be to select the actions to be pursued first.

What does viable action mean? My definition is:

> Any action that develops additional surface water supplies that could potentially be funded using 1) local funds, 2) Proposition 13 funds, 3) other State and Federal funds likely available through CALFED, and 4) funds from other water users who want to store water in the basin for their own use for a fee to be paid to the county. That fee would be paid in water.

Using the above definition, the only actions I have initially screened out are large onstream reservoirs such as Auburn Dam and Reservoir. Onstream projects were screened out because they are beyond the county parties ability to pay for alone and no Federal or State funds would be available for onstream reservoirs.

The remainder of this memorandum is a list of all viable actions that if combined and implemented could produce at least 200 TAF. Where required, I have developed a rough estimate of the potential benefits of each action.

Water Supply Actions

The following actions are organized by watersheds where appropriate. A table summarizing all actions and potential benefits is attached.

A. Calaveras River

1. There are significant flood control releases made from New Hogan Dam in many years that are not used in the county. These flows could be used to recharge the basin if recharge, conveyance, and regulating storage facilities were available. This water is available in relatively large quantities during short periods of time. In my opinion, it will not be possible to fully utilize this water with recharge facilities only. Therefore, I have assumed regulating storage must be constructed in the following potential benefits analysis.

The data source used was from the "U.S. Department of Interior - Bureau of Reclamation Draft Programatic Environmental Impact Statement (PEIS)." These flows were compared to historical U.S. Corps of Engineers New Hogan Reservoir daily release records and found to be a reasonable estimate of year 2020 level of development New Hogan Reservoir operations.

This data (Table 1) shows there was water available for diversion to a recharge facility or regulating reservoir in 34 years of the 70 year study period. Almost all of the water is available occurs during the December through March period. The percent chance of having the amount of water shown or more and the percentage split of that total by month is shown below.

Table 1

Chance of Occurrence (%)	Total (TAF)	December (%)	January (%)	February (%)	March (%)
40	54	78	22	0	0
30	100	43	54	0	3
20	125	0	22	55	23
10	209	15	22	16	47

The above data indicates that there is 100 TAF or more available in 30% of the 70 year period studied. However, one half or more of that water occurs in one month. For that reason, I have assumed a regulating reservoir will be required to maximize the average yield of this potential supply.

To make a very rough estimate of the amount of average annual supply these flows could produce I assumed the capability to divert 500 cfs of these flood flows to a 120 TAF offstream regulating reservoir was available. The offstream reservoir would be located so water could be diverted from New Hogan Reservoir by gravity to the regulating reservoir. The resultant average annual supply developed by this system during the 70 year period studied was 30 TAF. The size of the regulating reservoir could be reduced or the average annual yield increased by the amount of direct recharge that could be done during the December through March period. This estimate, although rough, does provide a good idea of the amount of average annual yield and the infrastructure necessary to develop that yield.

It will require the county or the Stockton East Water District to apply for and obtain a permit from the State Water Resources Control Board to divert flood flows during the November through April period to surface storage and groundwater storage before this water could be put to use. These flood flows occur when there is surplus water in the system and all Central Valley area of origin water users needs are being fully met. The Central Valley Project (CVP) and State Water Project (SWP) would be using some of this excess water and that supply could be reduced although that is unlikely. Since the county has senior rights to the projects through the area of origin laws, the chances of obtaining a permit from the SWRCB would not be jeopardized or reduced by negative impacts to the projects.

The only probable issue before the Board would be how much water must be left in the river to protect adult steelhead in the river. This likely constraint could reduce the amount of water available to the groundwater recharge project.

2. The Stockton East Water District and Calaveras County Water District currently receive water from New Hogan Reservoir under contracts with USBR. Calaveras has a contractual right to 43% of New Hogan Reservoir's estimated firm yield of 100 TAF and Stockton East 57%. Currently Calaveras County uses about 3 TAF per year and Stockton East uses Calaveras County's unused water on an interim basis.

In many years, contract water is delivered and the result is the reservoir is drawn down to the maximum required flood control reservation in the fall. The remaining 150 TAF is saved to protect against potential dry years. If the reservoir is drawn down below the maximum required flood control reservation, more water could be delivered to Stockton East and in many years this storage reduction is refilled the following year with water that would otherwise have been released for flood control purposes. The reduction in carryover storage would reduce the project's firm yield and result in less water being available in drought years. Stockton East would have to make up that dry year shortage with increased groundwater pumping.

Joe Countryman with Murray, Burns and Kienlan did a rough analysis of this type of operation and calculated that the average annual deliveries to Stockton East could be increased by about 23 TAF.

Implementation of this proposal would require an amendment to the Stockton East Water District's contract with USBR. The amendment would allow the district to take greater amounts of water than currently allowed under the contract and allow USBR to deliver less water in dry years if necessary. In essence, the contract would be converted from a firm yield contract to an average annual yield contract. The Calaveras County Water District's current contractual rights would have to be protected.

This proposed action would reduce the amount of flood flows available for diversion to recharge or storage facilities by a small amount.

Stanislaus River

1. There are significant flood control releases made from New Melones Dam in many years that are not used to meet New Melones Project purposes. These flows could be used to recharge the basin if recharge, conveyance, and regulating storage facilities were available. This water is available in relatively large quantities during short periods of time. In my opinion, it will not be possible to fully utilize this water with recharge facilities only. Therefore, I have assumed regulating storage must be constructed in the following potential benefits analysis.

This data represents New Melones Reservoir spills plus Tullock reservoir spills due to inflow between New Melones Dam and Tullock Dam. The data source is the "U.S. Department of Interior - New Melones Interim Plan of Operations (NMIPO) - 1997." The NMIPO is a long-term strategy for operation of New Melones Reservoir and is currently being used by USBR to operate the project.

This data (Table 2) shows there was water available for diversion to a recharge facility or regulating reservoir in 31 of the 70 years studied. Except in very wet years, most of the water is available in the December through April period. The percent chance of having the amount of water shown or more and the percentage split of that total by month is shown below

Table 2

Chance of Occurrence (%)	Total (TAF)	December (%)	January (%)	February (%)	March (%)	April (%)
40	0					
30	9	0	0	100	0	0
20	35	15	44	41	0	0
10	377	0	24	28	48	0

There is very little flood control water available from the Stanislaus River except in very wet years. In addition, there will be a lot of water available from the other sources within the county in the years that flood water is available from the Stanislaus River. Whether Stanislaus flood flows are used or not will depend on a more detailed analysis of the regulating reservoir size and cost to decide if Calaveras River water will be sufficient to fill the reservoir or can Stanislaus River water also be diverted to storage.

To make a very rough estimate of the amount of average annual supply these flows could produce I assumed that the capability to divert 1,000 cfs of these flood flows to a 100 TAF offstream regulating reservoir was available. The resultant average annual supply this system could develop during the 70 year period studied was 21 TAF. A 200 TAF regulating reservoir with a 1,000 cfs diversion rate would increase the average annual yield to 32 TAF.

It will require the county or some other entity within the county apply for and obtain a permit from the State Water Resources Control Board for diversion of Stanislaus River flood flows during the November through April period to surface and/or groundwater storage before this water could be put to use. These flood flows occur when there are water in the system and all Central Valley area of origin water users needs are being fully. The CVP and SWP would be using some of this excess water and that supply could be reduced although that is unlikely. Since the county has senior rights to the projects through the area of origin laws, the chance of obtaining a permit from the SWRCB would not be jeopardized by negative impacts to the projects.

2. The Central San Joaquin Water Conservation District (CSJWCD) and the Stockton East Water District (SEWD) together have a contractual right to 155 TAF per year for New Melones Project yield when available. Currently these districts can utilize 90 TAF per year. Increasing the two districts ability to fully utilize their respective contract water would decrease groundwater pumping by 65 TAF in some years. To utilize this water the districts would have to expand their existing distribution systems. Financial assistance would be required to for distribution system expansions and to make the price of surface water for the farmers competitive with the cost of using groundwater. The farmers would need to maintain the ability to irrigate with groundwater during dry years. The districts could instead transfer the unused New Melones contract water to others that can put that water to use. Such transfers would require USBR approval.

The CSJWCD and SEWD contract water was to be firm water with shortages only in lengthy droughts when the contracts were executed. Since then the New Melones Project's ability to deliver the contract water has been reduced dramatically because significant quantities of water has been reallocated to fishery enhancement purposes by the Clinton Administration. The New Melones Project can now deliver the 90 TAF to the districts only 34% of the time. USBR calculates that the average delivery to the districts would be 40 TAF with the current New Melones Project operation plan. That would mean the additional 65 TAF would be available less than 34% of the time. For this analysis, I'm going to assume the additional 65 TAF would be available only 25% of the time. This is a conservative assumption.

The districts, South Delta Water Agency, and others have argued that too much water is being dedicated to the fishery and those arguments have included scientific information. So far the arguments have been to no avail. That is likely to continue unless there is a significant change in the political appointees that U.S. Fish and Wildlife Service and the National Marine Fisheries Service report to.

3. A portion of the contract entitlement that is not available at Godwin could be diverted from the San Joaquin River downstream of Vernalsis. This would require USBR to agree to add another point of diversion to the existing contracts. The New Melones Project authorization legislation directed USBR to deliver project water within the basin. Much of the project water today is used for fishery protection via increased instream minimum flow requirements. That water goes to the Delta where much of it is pumped by the CVP and SWP to users south of the Delta. So approving the additional point of diversion would allow USBR to more closely comply with the Congressional directive. A contract amendment that allowed New Melones contract water to be diverted from the Delta would reduce current CVP and SWP water supplies. Water users in the San Luis and Delta Mendota canals service area and possibly the SWP contractors would object to this contract change.

The deliveries to SEWD and CSJWCD from the San Joaquin River would likely occur only during the July through September period because of fishery concerns and because only water withdrawn from storage would be delivered. Even with these constraints, the average annual deliveries from the New Melones Project to SEWD and CSJWCD from the Delta would range from 40 TAF to 110 TAF. The average annual supply increase would be 70 TAF. This

The average quality of the water diverted from the San Joaquin River would be 520 ppm TDS.

4. The Oakdale Irrigation District and South San Joaquin Irrigation District (SSJID) have right to use 600 TAF of water released from the New Melones Project under a August 30, 1988 agreement with USBR. Due to conservation measures implemented by both districts, the districts do not fully utilize the full 600 TAF water right. The two districts are currently transferring 30 TAF to SEWD and SSJID has proposed to transfer an additional 31 TAF to four cities within the county. The 31 TAF will increase to 44 TAF as the cities' demand increases over time. The City of Tracy would receive 10 TAF of the SSJWD transfer proposal.

Each of these proposals have been questioned by USBR and others. USBR has stated that the districts can not transfer their water rights water outside of the districts' service area. USBR and others also wonder how additional deliveries from New Melones Reservoir can be made without reducing flows available for instream flows and for South Delta Water Agency water quality improvement. It seems impossible to USBR that there is no impact although that impact may be insignificant.

These proposed transfers have already added 30 TAF to the county's surface water supplies and that total could increase to 44 TAF if USBR does not try to block both transfers. There may be additional water available for transfer. I don't know how much more water, if any, is available. It is important to find a way to make these transfers work without harming other San Joaquin County interests. It is in the county's interest to keep the water in the county and not have it released downstream for other purposes and, therefore, the county should support these transfers if they are challenged by the USBR and others. The county should also require that the transfers not impact the SDWA if the impact is deemed to be significant.

Mokelumne River

1. There are significant flood control releases made from the East Bay Municipal Utility District's Mokelumne River Project in many years. These flows could be used to recharge the basin if recharge, conveyance, and regulating storage facilities were available. This water is available in relatively large quantities during short periods of time. In my opinion, it will not be possible to fully utilize this water with recharge facilities only. Therefore, I have assumed regulating storage must be constructed in the following potential benefits analysis.

The data source is the "East Bay Municipal Utility District's Aquifer Recharge and Storage Project - Task Report A (EBMUD/ESJP Joint Water Supply Program) March 8, 1996." These flows (Table 3) represent releases from Camanche Reservoir that are not required to meet downstream minimum fishery flow requirements or downstream water users with water rights to Mokelumne River water that are senior to EBMUD's water rights. The releases are made for flood control purposes either during the flood season or during the remainder of the year to reduce the reservoir storage in preparation for the following flood season. EBMUD's study that produced these flow estimates assume 2020 level of development in the basin and within the district's service area plus the recent EBMUD settlement agreement with the Federal Energy Regulatory Commission which defines the minimum flow that must be provided from Camanche Reservoir for the Mokelumne River fishery.

There are significant quantities of water available from the Mokelumne River and equally important is that water is often available during the summer months. The percent chance of having the amount of water shown or more and the percentage split of that total by month is shown below

Table 3

Chance of Occurrence (%)	Total (TAF)	December (%)	January (%)	February (%)	March (%)	All Other Months (%)
40	132	4	14	11	0	61
30	212	0	0	0	0	100
20	434	9	17	1	11	62
10	551	0	0	43	24	33

There are a number of ways this water could be used to help the San Joaquin County overdraft problem. One would be to inject water from the Mokelumne Aqueduct directly into the basin. The benefits would be shared with EBMUD. This action is being pursued by more than one agency within the county. The amount of water supply benefit cannot be calculated today.

Another option would be to utilize Woodbridge Irrigation District (WID) and Woodbridge Water Users Conservation Districts' (WWUCD) rights to the above flood flows. The two agencies transferred their senior water to EBMUD in exchange for a firm commitment from EBMUD to deliver 60 TAF to the agencies in all years except extremely dry years in 1965. These agencies retained the right to use any flood control releases. Prior to the 1970's WID and WWUCD consistently used 50 TAF more water than 60 TAF entitlement when available. Their ability to utilize these flows has diminished significantly the past ten years with the maximum take over the 60 TAF entitlement of 25 TAF in 1993 and 10 TAF or less in all other years when flood releases were available. This reduction is due primarily to urbanization within the service areas and a shift from rice to crops that use less water.

WIR and WWUCD ability to utilize Mokelumne River flood flows could be increased if they had the water rights to deliver water to the urban areas in their respective districts and/or move the Mokelumne River water through the districts for delivery to the City of Stockton or to groundwater recharge facilities.

The agencies would have to apply to the State Water Resources Control Board to add these two uses to their existing permits which are for irrigation uses only and to expand their area of use for the water. This permit change would be protested by a number of water interests. Increasing the diversion of Mokelumne River flood control releases would reduce CVP and SWP water supplies and some of the projects' water contractors would likely protest the application. DWR and USBR would very likely not protest these changes to the districts' permit. The contractors' protests would likely be dismissed because WID and WWUCD have a right to take this water and reduce the projects' water supply under California's area of origin laws.

DWR and USBR would, however, ask the State Board to add the Term 91 condition to this use. That permit condition would require WID and WWUCD diversions to cease when CVP and SWP storage was being used to meet Delta flow requirements. This requirement, which would likely be implemented by the State Board, would not allow the agencies to divert Mokelumne River flood flows in July and August and some May and Junes. EBMUD may also protest this application to protect their ability to enlarge Pardee Reservoir sometime in the future. It may require an agreement between EBMUD and the agencies to resolve this issue. It is also possible state and federal fishery agencies could be concerned about the increased diversions impact on salmon during the salmon smolt emigration period (May and June). WID is currently constructing a new screened diversion structure and, hopefully, this new screen will allay the fishery agencies concerns.

If the agencies obtained the water rights permit, they may be able to increase their ability to utilize the Mokelumne River flood flows by 30 to 40 TAF. That increase would equate to an annual average yield of about 10 to 15 TAF (very rough preliminary estimate).

A third way to utilize the Mokelumne River flood control releases would be to construct a dam on Duck Creek and divert water from Pardee Reservoir. A new water rights permit from the State Board would be required and the county has applied for that permit. This application would result in the same protest discussed above except there should be fewer fishery concerns.

R.W. Beck and Associates conducted a study on the potential benefits of the Duck Creek Project in 1992. They assumed the water rights to the Mokelumne River flood control releases would be shared 50/50 between a 200 TAF EBMUD enlargement of Pardee Reservoir and the Duck Creek Project. The fishery issues related to the Mokelumne River minimum flow requirements were not resolved at the time of the study so they used three alternative fishery flow requirements. The fishery requirements are known today so the use of the Beck study results requires some interpolation of the data. In addition, the Term 91 condition would likely be imposed on these new diversions to storage which would reduce R.W. Becks and Associates conclusions by a small quantity. The only alternative that can be used with confidence from the Beck study assumes a 200 TAF Duck Creek Reservoir and a 1,000 cfs conveyance capacity from Pardee Reservoir to the Duck Creek Project. This alternative would produce an average annual yield of about 50 TAF.

James Hanson did a reconnaissance level cost estimate on the above project in 1983. The total cost for a 200 TAF Duck Creek project with a 1,000 cfs diversion capacity from Pardee Reservoir was $280 million (1982 dollars).

The Duck Creek Project was strongly opposed by the landowner in 1985. In addition, the land the project would use has a Conservation Easement with the State of California. Therefore, this project may be opposed by the California Department of Fish and Game and the California Wildlife Conservation Board.

2. North San Joaquin Irrigation District has a water right for up to 20 TAF per year for water from the Mokelumne River that is surplus to EBMUD's needs. This right will expire this year. The district also has a contract with EBMUD for storage in Pardee and/or Camanche reservoirs for use any time direct diversion water is not available. The district currently uses no more than 3 TAF per year leaving up to 17 TAF available for recharge into the basin. The Corps estimated in their Farmington report that an average annual quantity of 10 TAF would be available to the basin after irrigation needs in the district have been met.

The district recently received a CALFED grant for a pilot groundwater recharge project. This project would utilize the above water for recharge. This project would store up to 1.0 TAF per year. The district stated in the CALFED grant application that a large scale recharge project of 40 to 50 TAF per year was possible. If that is true, then the district could provide a significant opportunity for storing Mokelumne River flood flows in the future. The district also stated in the

CALFED grant application that they were going to renew their water right but only for 5 TAF per year.

The North San Joaquin Irrigation District should, in my opinion, try to renew their current water right for the full 20 TAF and maintain their contract for storage with EBMUD if possible. I am going to use the Corps estimate that an average annual supply of 10 TAF per would be available to the basin after the district's irrigation needs have been met and that this water could be put to use by direct recharge in the district's service area, construction of facilities that would make the surface water usable in drip irrigation systems, or transferring the unused water to others in the county that would put the water to use.

Little Johns Creek

1. There are significant flood control releases made from the Farmington Dam in many years. These flows could be used to recharge the basin if recharge facilities were available. This water is available in relatively large quantities during short periods of time. In my opinion, it will necessary to utilize this water by diverting the flood flows into recharge facilities. Offstream regulation storage is not an option for this effort because the water would have to be pumped into the regulating reservoir. The cost would be prohibitive. Therefore, I have assumed recharge facilities storage must be constructed in the following potential benefits analysis.

The data source is the "U.S. Department of Interior - Bureau of Reclamation Draft Programatic Environmental Impact Statement (PEIS)." These flows were compared to historical U.S. Corps of Engineers Farmington Reservoir daily release records and found to be a reasonable estimate of year 2020 level of development Farmington Reservoir operations.

This data (Table 4) shows there was water available for diversion to a recharge facility in all but one of the years of the 70 year study period. Almost all of the water is available in the December through April period. The percent chance of having the amount of water shown or more and the percentage split of that total by month is shown below.

Table 4

Chance of Occurrence (%)	Total (TAF)	December (%)	January (%)	February (%)	March (%)	April (%)
40	54	1	4	23	51	16
30	66	9	50	14	23	4
20	83	2	26	20	24	23
10	106	1	5	19	15	46

Therefore, there is about 65 TAF or more available in 30% of the 70 year period studied.

The amount of average annual yield produced by Little Johns Creek would depend on the recharge capability of basins yet to be developed but are being evaluated by the Corps of Engineers. However, if the capability to recharge 10 TAF per month were available, the average annual yield would be about 28 TAF. This estimate, although rough, does provide an idea of the amount of average annual yield that could be developed and the infrastructure necessary to develop that yield.

The Corps has developed recharge rates for various methods of recharge and rates of recharge for method. These recharge rates are based on study results from short-term recharge plot projects that do a good job of calculating the initial rate of recharge but were not in operation long enough to determine the long-term recharge rate. The Corps is leaning towards field flooding because their project has a secondary objective of developing seasonal wetlands. They are using rates that range from 0.25 to 0.5 ft/day for field flooding (preferred alternative) in the feasibility study which has just begun. So it would require about 1,000 acres of agriculture land to provide the 10 TAF per month recharge amount used in my potential benefit estimate.

Another idea developed by the Corps and SEWD is to construct recharge/storage pits near the SEWD treatment plant. Water could be put into these pits for recharge and be treated and delivered to the City of Stockton. Less than 90 acres would be required. The Corps would have to approve SEWD diversions of thee flood flows during the flood season. The district and the Corps are discussing this possibility today. If required, a new diversion facility could be constructed.

It will require the county or SEWD to apply for and obtain a permit from the State Water Resources Control Board for diversion of Farmington Project flood flows during the November through April period before this water could be put to use. These flood flows occur when there are water in the system and all Central Valley area of origin water users needs are being fully. The Central Valley CVP and SWP would be using some of this excess water and that supply could be reduced although that is unlikely. Since the county has senior rights to the projects through the area of origin laws, the chances of obtaining a permit from the SWRCB would not be jeopardized by negative impacts on the projects.

San Joaquin River

1. There is unappropriated water available from the San Joaquin River during the September through May period in almost all years. The county or other entity in the county could apply to the State Board for this water. The application would be opposed by F&WS and DF&G diversions during the March through June period to protect delta smelt and splittail eggs and larvae, NMFS and DF&G will oppose any reduction in San Joaquin River flows during the October through November period to protect migrating adult salmon, and NMFS and DF&G will oppose any reduction in San Joaquin River flows during the April through June period to protect

emigrating salmon smolts. This opposition will make it difficult, but not impossible, to appropriate any significant amounts of new water from the San Joaquin River because the State Board will require the applicant to obtain a biological opinion from each of the above fishery agencies before deciding on the application for unappropriated water from the San Joaquin River. This option should, however, be retained and pursued if insufficient water is obtained through implementation of other actions.

2. The City of Stockton has the right to divert water from the Delta a quantity of water equal to the amount of wastewater released to the Delta by the city. F&WS, NMFS, and DF&G will oppose this diversion for the same reasons the diversion of unappropriated water would be opposed. It may still be possible to divert the full amount from the Delta during the summer months but that would require agreement by DWR and USBR. These unknowns make it impossible to estimate potential benefits. This option should, in my opinion, be pursued through discussions with the fishery agencies and the CVP/SWP operators to determine the quantity of water that could be diverted from the Delta.

Any treated waste water that is released to the Delta could be used to irrigate agriculture crops which would result in reduced groundwater pumping. Many farmers oppose the use of reclaimed water because they fear it could harm their ability to market their crop. Therefore, there are only a few crops that farmers will agree to use reclaimed water. Even with this constraint, this option should be pursued. It is possible that by diverting wastewater released to the Delta and delivering reclaimed water to farmers, the current use of the basin could be reduced by as much as 45 TAF per year.

American River

1. EBMUD and Interior are currently in a process that is supposed to lead to an Interior decision on where EBMUD will be allowed to divert their CVP contract water and what constraints will be placed, if any, on that diversion. In my opinion, the EBMUD diversion will likely be constrained by Sacramento County's interpretation of the Judge Hodge's decision. If so, EBMUD will need somewhere to store wet year water and San Joaquin County will have a high priority. Potential benefits can not be calculated today.

Once Interior makes a decision EBMUD may be able to move forward on their original proposal which was to divert American River water to San Joaquin County where the water would be stored in the basin. EBMUD would retain the right to 50% of that water and must have the ability to get that water in very dry years. EBMUD's water will be stored in the basin and used very infrequently. Therefore, an agreement with EBMUD would be very beneficial to the county. Once EBMUD has water and the county is sure of that, the county or other entities in the county should aggressively pursue an agreement with EBMUD.

2. There are significant quantities of flood flows available from the American River. These

flows would be diverted at Nimbus Dam into Folsom South Canal and then the canal would have to be extended into San Joaquin County. To utilize these flood flows will likely require regulation storage. I have not estimated the potential benefits because the cost of that water would be very high. This option should be retained and pursued if other options do not provide enough water to solve the groundwater problem.

Conservation

The City of Stockton and other cities in the county treat their wastewater and release it to the Delta. Increased water conservation would reduce groundwater pumping and the amount of water released to the Delta. An aggressive water conservation program would help solve the groundwater problem. I do not have sufficient information to estimate the potential benefits. Aggressive urban and agriculture water conservation programs would also make it easier to obtain the State and Federal funds needed to implement many of the actions that have been discussed.

Conclusion

The bottom line is there are enough actions available to the county and the others in the county to meet the 200 TAF average annual yield goal. Obtaining that quantity of water will require implementation of at least seven actions that will be difficult to implement. The cost of solving the groundwater problem will be high and the most difficult task will be to find funding for the effort. Almost none of the proposed actions will occur unless all of the San Joaquin County interests combine forces plus agree to jointly fund most of the actions.

The next steps in the process are:

- All parties review this memorandum and provide comments. Comments should address questions such as have I identified all potential viable actions, are my benefits estimates in the ballpark, are my facts correct, etc.

- The comments will be incorporated into the memorandum and finalized through a technical memorandum from CDM to the county after another review by the Steering Committee and the county.

- Select a set of actions for initial implementation.

- Develop a detailed surface water supply augmentation implementation plan that includes the identification of teams that should pursue each action and a means of coordinating the overall effort.

11-16-00

Total Potential Water Supply that Could be Developed to Solve the San Joaquin County Groundwater Overdraft

Project	Average Annual Supply (TAF)
Calaveras River	
Flood flows	30
New Hogan flood control re-operation	23
Stanislaus River	
Flood flows	21
Utilization of full contract entitlement (diversion at Goodwin)	16
Diversion of contract entitlement water from the Delta	70
Water transfers	51
Mokelumne River	
Flood flows	
Injection wells	?
WID and WWUCD use of the flood flows	10
Duck Creek Reservoir	50
North San Joaquin Irrigation District	10
Little Johns Creek	
Flood flows	28
San Joaquin River	
Obtaining unappropriated water from the San Joaquin River	?
Diverting wastewater released to the Delta and delivering treated waste water to farmers	45
American River	
Flood flows	?
EBMUD storage of American River water	?
Conservation	?
Total potential increase in water supply	354

MEMORANDUM

To: San Joaquin County Steering Committee

From: Dave Schuster

Date: February 2, 2001

Subject: Update of November 16, 2000 memorandum

I provided the Steering Committee a draft memorandum dated November 16, 2000 at the November Steering Committee meeting. That memorandum defined San Joaquin County's four pronged water supply problem and identified actions that could be implemented by the county and/or water agencies in the county to provide water for the east county groundwater basin. I asked for comments from the Steering Committee members on this memorandum and have received comments from San Joaquin County staff, DWR Integrated Storage Investigation Program staff, Stockton East Water District (SEWD), South San Joaquin County Irrigation District (SSJID), and Woodbridge Irrigation District. In addition, Camp, Dresser and Mckee groundwater experts, Paul Hossain and Harley Breden, have provided information that allows a more definitive description of the east county ground water basin problem. Finally, the U.S. Department of Interior (Interior), East Bay Municipal Utility District (EBMUD) and the city and county of Sacramento have reached agreement on the location of and conditions for EBMUD diversions of the district's CVP contract water. This agreement provides more light on the issue of future storage of EBMUD contract water in the San Joaquin County groundwater basin.

The purpose of this memorandum is to update the November memorandum based on the above information.

Groundwater Overdraft in the East County

Definition of the Problem

In the November memorandum I established a target of developing 200 TAF of surface water that would be used to reduce the groundwater pumping from the basin by that amount. That was based on an estimated annual average overdraft that ranges from 120 to 160 TAF and the need to add additional storage to protect against drought conditions and resultant basin storage reductions.

The overdraft condition has resulted in a deep cone of depression in the southwestern portion of the Eastern San Joaquin County Groundwater Basin and salinity intrusion into the basin (see Appendix A of TM 3). The salinity intrusion results in the permanent loss of part of this basin for future use.

CDM did a model run that assumed the groundwater pumping near the cone of depression was reduced by 100 TAF per year. The model results showed that the salinity intrusion would gradually decrease over 10-20 years. If groundwater gradients are reversed (i.e. by filling the cone of depression in the Stockton area), salinity intrusion could be stopped and possibly reversed. The timing of these changes depend on 1) type of projects implemented and their location and 2) hydrologic conditions.

This new information leads to a problem statement that has two parts. The first part or phase must be to reduce the groundwater pumping near the cone of depression by about 100 TAF as soon as possible. That would entail finding surface water supplies that can be used by Stockton East Water District, Central San Joaquin Water Conservation District, and the City of Stockton in-lieu of using groundwater. Solving part one of the groundwater problem must be done with a sense of urgency since every year that passes with no action an additional portion of the basin becomes unavailable.

After part one of the problem is solved the basin will still have an overdraft of 20 to 60 TAF per year. That overdraft will result in continued reductions in the basin storage and higher cost for groundwater users because of greater pumping lifts. That overdraft will not, however, likely result in any problems such as subsidence or additional salinity intrusion in the near term. However, as upstream counties water needs increase the water supplies from the Calaveras and Stanislaus rivers will decrease. That decrease could increase the overdraft by 50 TAF or more.

Water supply augmentation options that have been identified that increase surface water supplies in area of the cone of depression quickly and are financially feasible should be pursued immediately. More expensive projects that are more difficult to implement should also be pursued now knowing that they will take time and will be needed to eliminate the overdraft. If feasible, projects that would increase the amount of water in basin storage, in addition to simply eliminating the overdraft, should also be pursued possibly in partnership with out of county entities.

Potential Solutions to Part 1

As stated above, the model run that assumed a 100 TAF reduction in groundwater pumping over and near the cone of depression showed that salinity intrusion would stop in ten to fifteen years. To reduce pumping by 100 TAF, without fallowing, an additional 100 TAF of surface water supplies over the amount of surface water assumed available in the model. The model uses historical surface supplies through about 1992. New supplies have become available to the area near or over the cone of depression since 1992. SEWD and CSJWCD can now take some of their New Melones Reservoir CVP contract supplies and could not before 1992. The City of Stockton started receiving 30 TAF of Stanislaus River water via a water transfer between the city, SEWD, SSJID and Oakdale Irrigation District (OID) two years ago. These two new sources of water equate to an average annual supply of about 45 TAF. Therefore, the recent actions taken by these districts have resulted in almost one half of the 100 TAF being available already but not used. We need to find 55 TAF more.

SEWD and CSJWCD have a collective contractual right to 155 TAF of CVP water from New Melones Reservoir. USBR does not make that amount available in all years under that agency's current interim plan of operations for the New Melones Project. Generally, the full 155 TAF is available in wetter years and no water is available in dry years. SWRI staff calculated that an average annual quantity of 55 TAF would have been available during the 1922-91 period. If, under the interim plan, the two water districts and the City of Stockton could use this water, the total amount of new water available to the cone of depression area would go up to 85 TAF when coupled with the 30 TAF transfer from SSJID and OID.

As discussed in the November memorandum, New Hogan Reservoir could be re-operated with the objective of increasing the average annual deliveries from that reservoir. Initial analysis of this option show that simply re-operating the Hew Hogan Project could attain an increase of 20 TAF per year on the average. That 20 TAF brings the total amount of new water to 105 TAF. There is one significant unknown at this time, however. That unknown is due to the discovery of steelhead in the Calaveras River last year. If the National Marine Fisheries Service decides to do anything to protect the Calaveras River steelhead population they allege exists, the question becomes will those protections reduce the total available supply from the New Hogan Project? I have insufficient information today to be able to even guess on the answer to that question.

The water needed to stop the salinity intrusion is available today with no new facilities required to develop that water. If the water is available, then why isn't it being used today? SEWD and CSJWCD deliver about 35 TAF per year over above the delivery of the New Hogan Reservoir water and the OID/SSJID transfer water with the two districts present distribution systems. The districts' limited ability to utilize the New Melones Project contract water is due to the size of their respective distribution systems and the farmers' understandable unwillingness to develop the ability, which is expensive, to use surface water that is available less than 50% of the time.

The New Melones water and New Hogan re-operation water is available only in wetter years and would require an increase in the districts surface water delivery capability. Utilizing this water would require a significant expansion of the current distribution systems. In addition, farmers would have to maintain the ability to utilize groundwater and surface water because the surface water is not available in many years. Farmer's cost would also increase because of the cost for the New Melones water.

Therefore, the water is not being used today because the SEWD and CSJWCD farmers do not want to incur the cost of a significant expansion of the districts' distribution systems and, in most cases, the cost of developing dual on farm distribution systems.

In summary, the groundwater model results show that the salinity intrusion can be stopped in ten to twenty years if the current groundwater pumping over and near the cone of depression is reduced by an additional 55 TAF over the 30 TAF OID and SSJWD transfer and the New Melones Project water that is currently being put to use. Fifty-Five Thousand acre-feet is available today but cannot be utilized until the SEWD and CSJWCD distribution systems is enlarged and other landowner concerns are addressed. That enlargement will likely not occur unless funds are found to assist the districts pay for the distribution system and farmers increased cost.

Finally, the water that is currently available to SEWD and CSJWCD that could be used to solve the salinity intrusion problem will decrease overtime as upstream water users on the Calaveras and Stanislaus rivers need for water increases. The decrease could be as much as 50 TAF in the next 20 to 30 years. That water will have to be replaced with water from new projects such as utilization of Sacramento River flood flows and Little Johns Creek flood flows and the San Joaquin River diversion of New Melones CVP contract supplies. In addition, the amount of water available today could be increased today through adjustments to USBR's interim New Melones Project operation plan. If the water currently dedicated on an interim basis to instream flow requirements were reduced, there would be more water available for maintaining South Delta water quality and for SEWD and CSJWCD.

EBMUD Diversions of CVP Contract Water

Background

EBMUD currently has a contract with USBR for 150 TAF per year. The point of diversion in the contract is on the Folsom South Canal. The canal has not been constructed to the EBMUD diversion point so EBMUD cannot take delivery of CVP water until their contract is amended to allow a different point of diversion. EBMUD wanted to amend their USBR contract to allow them to take their CVP water from the terminus of the existing Folsom South Canal.

The Sacramento County, EDF and others lawsuit, designed to block any EBMUD diversion from the American River, was decided at the Superior Court level in 1989. In that decision, EBMUD won the right to take CVP water from the American River at Nimbus Dam but only when the flows were greater than the minimum flow requirements established by the Judge (the so called Hodge flow requirements). The result was that EBMUD would get water only in relatively wet years. EBMUD doesn't need water in wet years so they pursued increasing storage in the district by building the Buckhorn Dam and reservoir. That project was killed by a local vote. Subsequently, EBMUD went back to USBR in an effort to amend the contract so they could take water at Nimbus Dam using a favorable interpretation of the Hodge decision. They hoped to store water in the San Joaquin County groundwater basin and possibly in an enlarged Los Vaqueros Reservoir.

USBR agreed to EBMUD's desires and a draft contract amendment was released by USBR in 1999. Every interest in Sacramento County was opposed and that opposition was fierce. The process eventually led to Interior, at Senator Feinstein's urging, telling EBMUD to reach an agreement with the Sacramento interests, represented by the City and County of Sacramento, on a diversion point acceptable to all parties and the conditions for that diversion. One condition of Sacramento interests was no EBMUD diversions at Nimbus Dam into the Folsom South Canal and both Interior and the Senator supported Sacramento's position.

Current Status

These discussions between the county, EBMUD and USBR eventually boiled down to two diversion alternatives with specific conditions, which are:

Lower American River two miles upstream of the I-5 Bridge

Contract conditions:

- Allowed to divert water only when storage space is available in the existing EBMUD system. CVP water could also be diverted to "new" storage if EBMUD develops a water storage strategy that is acceptable to USBR.
- Diversions allowed only when there is more flow in the American River than the Hodge requirements.
- Maximum diversion rate is 155 cfs (maximum possible annual diversion 112 TAF)

The above conditions for EBMUD diversions (assuming no new storage is available) results in diversions in 42 of the 70 years studied (1922-91 period). The average annual diversion is 14 TAF and the maximum annual diversion was 47 TAF. The average annual diversion during the 1929-34 drought is 14 TAF, the 1987-91 drought is 9 TAF and the 1976-77 drought is 10 TAF.

Sacramento River near Freeport (near the City of Sacramento owned property approximately one mile north of the Town of Freeport)

Contract conditions:

- Allowed to divert water to storage in the EBMUD Mokelumne River project when the total storage in Comanche and Pardee reservoirs is projected to be less than 500 TAF on October 1st of that year.
- Total diversions limited to 165 TAF in any consecutive three years.

- Maximum diversion rate is 155 cfs (maximum possible annual diversion 112 TAF)

The above conditions for EBMUD diversions results in diversions in 29 of the 70 years studied (1922-91 period). The average annual diversion is 21 TAF and the maximum annual diversion was 99 TAF. The average annual diversion during the 1929-34 drought is 49 TAF, the 1987-91 drought is 59 TAF and the 1976-77 drought is 77 TAF.

EBMUD and Sacramento executed a Memorandum of Agreement last week. USBR is also a signatory as a "cooperator." That agreement establishes a six-month deadline on developing a joint project diverting water at Freeport on the Sacramento River. The diverted water would be pumped into a pipeline that would take the water to the Folsom South Canal. Many of the actions required to implement a Freeport Project such as obtaining a water right to divert water from the Sacramento River and the required ESA consultations cannot be completed in the six-month period. My impression is that the parties hope to be able to size the project and develop firm funding mechanisms by that time.

Sacramento hopes to obtain a right to pump water from the Sacramento River by having Sacramento Municipal Utility District water rights transferred to the city and county. A Sacramento diversion will reduce the water supply available to the CVP and SWP water users south of the Delta. Therefore, Sacramento's effort to obtain Sacramento River water will be very contentious and difficult unless they agree to take water only when their diversion does not reduce CVP and SWP supplies. USBR's role and ability to impose conditions on this project are unclear. Sacramento would use the water to reduce groundwater overdraft creating cone of depressions near Galt and Laguna. Sacramento would likely have to use injection wells to get the water into the ground.

I'm not sure what EBMUD's plans to do. They still need to negotiate a contract amendment with USBR. A draft contract was released by USBR January 19, 2001. USBR position today is that EBMUD will only be allowed to take CVP water at Freeport for the purpose of reducing water shortages. Hence, the condition that EBMUD can take water at Freeport if EBMUD total storage is projected to go below 500 TAF. If USBR sticks to their current position, EBMUD will have no right to divert Sacramento River water to storage. So, EBMUD would have to obtain a right to divert Sacramento River water like Sacramento. Since EBMUD is an exporter and not an area of origin water users under California's water rights law, EBMUD can only obtain a right to divert water that is surplus to the needs of the area of origin water users and CVP and SWP water users needs. Therefore, they would only get wet year water that will be available during the December through March period. Whether this will be acceptable to EBMUD or not is unclear. It is also unclear whether or not USBR will stick with their position that EBMUD cannot use CVP contract water diverted at Freeport for groundwater or surface storage.

EBMUD may simply take the dry year water being offered by USBR through renegotiation of their CVP contract at Freeport and use surplus Mokelumne River water for increased groundwater and/or surface storage. The district could do that by enlarging Pardee Dam and/or storing water in the San Joaquin County groundwater basin.

San Joaquin County interests have worked to get included in the Freeport diversion project. The county will be allowed to participate in the project but they must bring a plan for using Sacramento River water and bring a credible funding mechanism to the table. Both EBMUD and Sacramento are skeptical that San Joaquin County will be able to do that. Sacramento is not opposed to San Joaquin County's participation, however, if they can bring a project to the table that is acceptable to all the parties.

There is a theme in both Sacramento's and USBR's participation in this effort and that is the total project diversion capacity must remain small. The definition of small is unclear plus the ability of Sacramento and/or USBR to make this requirement stick is unclear.

San Joaquin County, like Sacramento County, would have to obtain a water right to divert Sacramento River water. Like Sacramento County, that effort will be contentious and lead to CVP and SWP south of the Delta water users opposing the project unless the county agrees to only divert water when it does not harm those water users. If the county gets a water right, it will be to divert water primarily during the wetter periods, which are September through April under an area of origin water right allocation and December through March if the diversion is only done when it does not harm any existing water user. The county could put the water to use through injection wells, deep percolation basins and in-lieu deliveries to the cities.

The facilities to get the water to the county and to get the water into the ground directly or through in-lieu deliveries will be very expensive. The county will have to share proportionally in the cost of a pumping plant at Freeport, a sophisticated fish screen at Freeport, conveyance from the river to San Joaquin County and facilities to get the water into the ground. One important positive aspect of the Freeport project is that it could give San Joaquin County entities access to Sacramento River water. That could be very important in future years.

Many of the other potential projects identified in the November 2000 memorandum will also be expensive but will not have the high conveyance cost. Therefore, the Freeport project should, in my opinion, be considered as a good alternative that must be compared to other alternatives.

The following facts should be kept in mind when doing that comparison:

- The salinity intrusion problem can be solved with water already available to the county water entities. Additional water will be needed in the future as upstream demand increase.
- There is surplus wet year water available today from the Mokelumne, Calaveras, and Stanislaus rivers that will require the same cost for getting the water into the ground but conveyance cost will be less expensive.
- There will be very little opposition from entities outside of county to the county's use of surplus flows from rivers in the county other than the county will probably have to come to agreement with EBMUD on the joint use of Mokelumne River surplus flows

Miscellaneous Corrections

The following changes to the November 16, 2000 memorandum are necessary because of obvious mistakes and comments received from others:

<u>Page 5:</u>
First line – Insert "from the Delta" after "quality."

<u>Page 5:</u>
Seventh line – Replace Sacramento County with San Joaquin County.

<u>Page 8</u>
I state that the yield of the New Hogan Project is 100 TAF. The yield of the project is being reevaluated and the 1987-92 drought will result in a lower project yield. That fact is not important, however, since the key question is what is the average annual yield of the project?

<u>Page 9</u>
I state that the re-operation of new Hogan will require a contract amendment with USBR. That is not true. There are no impediments to operating the project to maximize average annual yield versus on a yield basis.

<u>Page 10</u>
I state on this page that the New Melones Project can now only deliver the 90 TAF 34% of the time. What was not clear is that fact is not due to a physical constraint but due to the fact that the US Fish and Wildlife Service has decided to use significant amounts of New Melones Project water for instream flow requirements using the authority provided by the Central Valley Project Improvement Act.

Page 9

<u>Page 11</u>

I state that the average water quality of CVP contract water diverted from the San Joaquin River would be 520 TDS. This number was derived from the USBR New Melones operations model which SWRI used for this analysis. The maximum quality was 745 ppm TDS and the minimum was 221 ppm TDS.

<u>Page 12</u>

I stated that WID and WWUCD had transferred their senior rights to EBMUD in exchange for a firm commitment from EBMUD to deliver 60 TAF to the agencies in all years except extremely dry years when some shortages would occur. That statement is wrong and poorly worded. The districts retain their senior water rights and have not transferred those rights to EBMUD. The districts have agreed with EBMUD that if EBMUD the districts deliver 60 TAF with reductions to 39 TAF in critically years on a firm basis through an agreement . The districts can still divert can still divert flows that are surplus to EBMUD's obligation to meet downstream flow commitments for fish and other water rights obligations. If EBMUD does not comply with that the provisions of that agreement, WID and WWUCD would continue to divert Mokelumne River water under the districts' water rights.

<u>Page 15</u>

First line – Strike "control."