Appendix H:

2011 Groundwater Management Plan Update

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City of Vacaville Groundwater Management Plan Update

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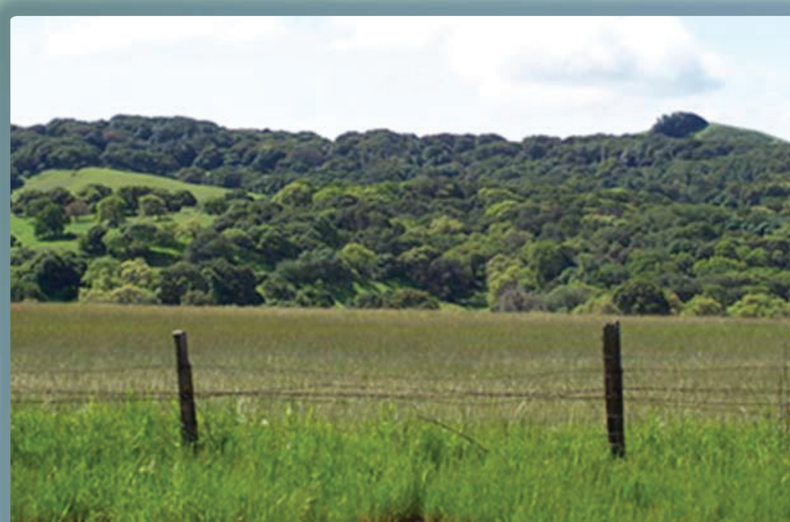

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1.0 INTRODUCTION

1.1 CITY DESCRIPTION AND OVERVIEW

1.1.1 City of Vacaville

The City of Vacaville, founded in 1850, is located at the base of the Vaca Mountains, approximately halfway between Sacramento and San Francisco on Interstate 80 (**Figure 1-1**). The City limits encompass over 21 square miles with a population in excess of 92,000, which makes Vacaville the third largest city in Solano County.

Water demand has increased as the City's population grew from about 43,400 in 1980 to 71,500 in 1990 and 92,000 in 2009. The rate of growth has been slower in recent years, and recently imposed growth measures are expected to ensure adequate water supply for the community (Nolte, 2005).

1.1.2 Authority for Groundwater Management

The City of Vacaville is a local public agency that provides water service to customers within the City limits. As a result of Assembly Bill (AB) 3030, the California Water Code (CWC), Section 10750 *et seq.*, provides local agencies with the authority to adopt and implement groundwater management plans. On March 9, 1993, the City Council of Vacaville voted to adopt a resolution of intent to draft a groundwater management plan, and following the requirements of the CWC at that time, the City passed a resolution on February 14, 1995 approving the *City of Vacaville AB 3030 Groundwater Management Plan* (West Yost, 1995). As described further below, the CWC was subsequently amended as a result of Senate Bill (SB) 1938 (Machado), effective January 2003. As a result, the City has prepared this updated Groundwater Management Plan to comply with the revised requirements.

1.1.3 Plan Purpose

The purpose of the Plan is to maintain a high quality, reliable, and sustainable water supply for the citizens of Vacaville. To accomplish this, the City will continue to manage groundwater conjunctively with its surface water resources and support groundwater basin management objectives directed toward the sustainability of groundwater supplies. Groundwater management involves the ongoing performance of coordinated actions related to groundwater withdrawal, replenishment, and protection to achieve long-term sustainability of the resource without detrimental effects on other resources. To accomplish the City's purposes and the regional basin management objectives, the Plan sets forth a framework and related actions necessary to meet those objectives.

1.2 OVERVIEW OF REGIONAL PLANNING EFFORTS

1.2.1 Agency Coordination

The City is one of the member agencies of the Solano County Water Agency (SCWA), which encompasses all of Solano County plus the University of California at Davis (UCD) and the Yolo County portion of Reclamation District No. 2068 (RD 2068). SCWA was established in 1951 as the Solano County Flood Control and Water Conservation District (SCFC&WCD) under the governance of the Solano County Board of Supervisors. The governing board was expanded in 1988 to include the Solano County Board of Supervisors; mayors of the cities of Vallejo, Benicia, Suisun City, Dixon, Rio Vista, Fairfield, and Vacaville; Solano Irrigation District (SID); Maine Prairie Water District (MPWD); and RD 2068. The SCFC&WCD changed its name to SCWA in 1989. SCWA is responsible for water supply and flood control within its service area. Its water supply role consists of providing untreated surface water to cities, water districts, and state agencies within its boundaries. Other stakeholders that are not SCWA members include Rural North Vacaville Water District (RNVWD), the Dixon-Solano Municipal Water Service (DSMWS), and California Water Service Company (CWSC).

SCWA's primary source of water is the Solano Project, which stores water in the Lake Berryessa Reservoir created by the construction of Monticello Dam on Putah Creek in 1957. Other Solano Project facilities include the Putah Diversion Dam and the Putah South Canal, which delivers Solano Project water to the City and other recipients.

The City is also a member of the Solano Water Authority (SWA), which is a joint powers authority formed in 1987 with the same membership as SCWA. The SWA conducts its work through project agreements; one of these projects, the Coordinated Groundwater Data Analysis Project or SWA-4, is responsible for groundwater data management in northern Solano County. SWA prepares periodic reports to summarize the compiled data and describe historical and current groundwater conditions. Participants in this project include the cities of Vacaville and Dixon, SID, MPWD, RD 2068, SCWA, and Solano County.

Four local agencies, including the City of Vacaville, SID, MPWD, and RD 2068, each adopted groundwater management plans prior to the 2003 CWC amendments. In 2004 and 2005, SCWA facilitated a coordinated effort among these agencies directed toward updates of these plans such that the plans would comply with the amended CWC and also to accomplish consistency among the plans to achieve basin management objectives (West Yost, 2006).

1.2.2 Integrated Regional Water Management Plan

An Integrated Regional Water Management Plan (IRWMP) was prepared in 2005 (Solano Agencies, 2005) for the Solano agencies, including SCWA and its member entities, that identifies and prioritizes all water related actions for these Solano County agencies. Among the highest priorities noted in the IRWMP are conjunctive water resources management and groundwater management. The City and other SWA-4 entities have actively participated in steps to implement the IRWMP.

1.3 CITY WATER SUPPLY

The City's water utility system was purchased from the Pacific Gas and Electric Company in 1959 by issuing voter-approved water revenue bonds (Nolte, 2005). Since that time, the City has systematically improved and upgraded the water utility system. Today, the City's system consists of transmission and distribution pipelines, storage reservoirs, wells, pumping facilities, and water treatment facilities. The system receives water from several sources, including Solano Project water from the Lake Berryessa Reservoir, State Water Project (SWP) water and Settlement Water from the North Bay Aqueduct (NBA), and groundwater from local City wells. The percentage of water used from each supply source varies due to the City's conjunctive management of its water resources. Prior to completion of the Solano Project, all water supplies provided for municipal purposes were developed from local groundwater. The City has received Solano Project water through an agreement with SCWA since 1959. In 1995, the City entered into a Water Master Agreement with SID that increases the City's allocation from this source until the year 2045. The City has also received surface water allocations from the SWP and from a purchase agreement with Kern County Water Agency. Settlement Water is not considered SWP water but consists of surface water from the Sacramento River and Sacramento-San Joaquin Delta estuary diverted under water rights held by the California Department of Water Resources (DWR). This water is made available by DWR in settlement of area-of-origin water right applications by the cities of Vacaville, Fairfield, and Benicia. The City would receive an increasing supply from SID through the year 2040 followed by a consistent supply of 10,050 AF until the year 2050 (City, in process). In aggregate, the estimated water resources available to the City in the year 2030 total 42,000 acre-feet (AF), including about 8,000 AF of groundwater (19% of the total supply).

1.4 LEGISLATION RELATED TO GROUNDWATER MANAGEMENT PLANS

The Legislature enacted legislation in 1992 (AB 3030) and 2002 (SB 1938), now incorporated in the CWC Section 10753, *et seq*. to encourage local public agencies to adopt plans to manage groundwater resources within their jurisdictions. The City is updating its Groundwater Management Plan to be compliant with revisions to the CWC that resulted from SB 1938.

SB 1938 provided that adoption of a groundwater management plan will be a prerequisite to obtaining funding assistance for groundwater projects from funds administered by DWR. To comply with SB 1938, a groundwater management plan must include components that address monitoring and management of water levels, groundwater quality degradation, inelastic land subsidence, and changes in surface flows and quality that either affect groundwater or are affected by groundwater pumping. SB 1938 specifies that groundwater management plans contain provisions to cooperatively work with other public (and presumably private) entities whose service areas or boundaries overlie the groundwater basin. Provisions must also be made to allow participation by interested parties in development of the plan. The plan must include mapping of the groundwater basin, as defined in DWR's Bulletin 118, along with the boundaries of the local agencies that overlie the basin. In this case, the Plan focuses on that portion of the Solano Subbasin that underlies the City. Finally, to comply with SB 1938, monitoring protocols must be designed to detect changes in groundwater levels, groundwater quality, inelastic land subsidence (for basins where subsidence has been identified as a potential problem), and flow and quality of surface water that either directly affect groundwater, or are directly affected by groundwater pumping.

The potential components of groundwater management plans are listed in CWC Section 10753:

- the control of saline water intrusion;
- identification and management of wellhead protection areas and recharge areas;
- regulation of the migration of contaminated groundwater;
- the administration of a well abandonment and well destruction program;
- mitigation of conditions of overdraft;
- replacement of groundwater extracted by water producers;
- monitoring of groundwater levels and storage;
- facilitating conjunctive use operations;
- identification of well construction policies;
- the construction and operation by the local agency of groundwater contamination cleanup, recharge, storage, conservation, water recycling, and extraction projects;
- the development of relationships with state and federal regulatory agencies; and
- the review of land use plans and coordination with land use planning agencies to assess activities that create a reasonable risk of groundwater contamination.

In 2002, SB 1938 amended and added to CWC Section 10750 *et seq.* regarding the implementation of local groundwater management plans. While the provisions of SB 1938 did not alter the potential components of a local groundwater management plan, as listed above, it added the following provisions:

- The local agency, in preparing a groundwater management plan, shall make available to the public a written statement describing how interested parties may participate in developing the plan. For that purpose, the local agency may appoint, and consult with, a technical advisory committee consisting of interested parties.

- In order to qualify for funding assistance for groundwater projects, for funds administered by DWR, a local agency must accomplish all the following relative to groundwater management (CWC 10753.7(a)):

    - Prepare and implement a groundwater management plan that includes basin management objectives for the groundwater basin that is subject to the plan.

    - Include groundwater management components that address monitoring and management of water levels, groundwater quality degradation, inelastic land subsidence, and changes in surface flows and quality that either affect groundwater or are affected by groundwater pumping.

    - Include provisions to cooperatively work with other public (and presumably private) entities whose service area or boundary overlies the groundwater basin.

    - Include mapping of the groundwater basin, as defined in DWR's Bulletin 118, and the boundaries of the local agency subject to the plan, plus the boundaries of other local agencies that overlie the basin.

- Adopt monitoring protocols designed to detect changes in groundwater levels, groundwater quality, inelastic land subsidence (for basins where subsidence has been identified as a potential problem), and flow and quality of surface water that either directly affect groundwater, or are directly affected by groundwater pumping.

Of the potential groundwater management activities listed in CWC Section 10753.8, those already being investigated and actively implemented as part of less formal groundwater management by the City include avoidance of overdraft, implementation of conjunctive use, monitoring of groundwater levels and quality, initiation of groundwater contamination control, analysis of basin yield for ongoing avoidance of overdraft, and regular analysis and reporting on groundwater conditions. The historic focus of informal groundwater management by the City has been on the quantity and quality of water supply, including avoidance of overdraft conditions, primarily by augmenting local groundwater supplies with supplemental, imported surface water resources. More recently, efforts have been added to include ongoing monitoring and the compilation of data into a database system. Recent efforts have also included use of an analytical groundwater model of the greater Vacaville area for analysis of aquifer system response to various groundwater extraction scenarios for a 20-year horizon. This work also provides an initial foundation for the future development of a numerical groundwater flow model that would be used to evaluate water supply, recharge, and conjunctive use alternatives that might be applicable to the basin. The City withdraws groundwater for municipal purposes from a deep aquifer, and most other extraction in the area occurs from overlying aquifers. Because there is much less risk of contamination of the deep aquifer as compared to shallow aquifers, the City’s groundwater management provisions have focused more on supply and less on groundwater contamination. However, this component of local groundwater management is important in terms of overall basin management objectives as described in more detail herein.

In summary, the City has had a formal AB 3030 Groundwater Management Plan since 1995. The City is updating its current plan to be compliant with the SB 1938 requirements as part of its interest in developing and sustaining reliable water supplies to meet its own and also basin needs. To ensure the reliability of groundwater supplies to meet existing and projected demands, the components of local groundwater management planning already implemented include a monitoring program, formulation and maintenance of a database to manage the monitoring data, analysis of and annual reporting on groundwater conditions in the basin, initiation of groundwater modeling, ongoing conjunctive use of local groundwater and imported surface water supplies, and coordination with other agencies on the control of localized groundwater contamination.

1.5 ORGANIZATION OF GROUNDWATER MANAGEMENT PLAN

The balance of this plan is organized to describe management objectives, or goals, for the basin; describe existing groundwater basin conditions, including areas of concern and identified problems; present historical and projected water demands by the City from the basin; and finally to present a set of groundwater management actions which, collectively, form the components of this Groundwater Management Plan.

2.0 SUMMARY OF CITY WATER SUPPLIES AND GROUNDWATER CONDITIONS

2.1 GROUNDWATER BASIN DESCRIPTIONS

As shown on **Figure 2-1**, the City of Vacaville overlies portions of two DWR-designated groundwater basins. The City primarily overlies the northwestern portion of the Solano Subbasin, which is one of 18 subbasins in the Sacramento Valley Basin of the Sacramento River Hydrologic Region. A small area in the southern portion of the City overlies the Suisun-Fairfield Valley Basin in the San Francisco Bay Hydrologic Region. The western portion of the City, west of the Solano Subbasin boundary, is located in the Sacramento River Hydrologic Study Area but does not overlie any area currently designated by DWR as a groundwater basin or subbasin (**Figure 2-1**).

All of the City's existing and proposed municipal wells are located in the Solano Subbasin. **Figure 2-2** also shows the other major purveyors in the northern portion of the subbasin. These include the City of Dixon, SID, RNVWD, MPWD, and RD 2068. Descriptions of the Solano Subbasin and the Suisun-Fairfield Valley Basin are provided below. These descriptions are partly based on the information contained in *California's Groundwater, Bulletin 118 Update 2003* (DWR, 2003). For the Solano Subbasin, a more detailed groundwater basin description is posted on the DWR web site (DWR, 2010).

2.1.1 Sacramento Valley Basin, Solano Subbasin (Basin Number: 5-21.66)

The Solano Subbasin includes the southernmost portion of the Sacramento Valley Basin and extends into the northern portion of the Sacramento-San Joaquin Delta. Overall, population density within the subbasin is sparse, with the major cities being Vacaville, Dixon, and Rio Vista. Subbasin boundaries are defined by Putah Creek on the north, the Sacramento River on the east (from Sacramento to Walnut Grove), the North Mokelumne River on the southeast (from Walnut Grove to the San Joaquin River), and the San Joaquin River on the south (from the North Mokelumne River to the Sacramento River). The western subbasin boundary, which extends through a portion of the City, is partly defined by the groundwater divide between the San Francisco Bay and Sacramento River Hydrologic Regions as described by DWR (2010). DWR reports that the location of the divide is roughly delineated by the English Hills (a section of the Coast Range south of Putah Creek and north of Vacaville) and the Montezuma Hills. There is an area west of the Solano Subbasin between the subbasin boundary and the Lagoon Valley/Vaca Valley fault in which some groundwater development has occurred, but which does not lie within a designated basin or subbasin area.

2.1.2 Suisun-Fairfield Valley Basin (Basin Number: 2-3)

The Suisun-Fairfield Valley Basin is composed of low alluvial plains, with surrounding foothills and mountains, located immediately north of Suisun Bay. The foothills of the Coast Ranges, lying west of Green Valley, bound the basin on the west. The southern extent of the Vaca Mountains forms the northern boundary of the basin. The eastern extent of the basin is marked by low ridges of consolidated rock that appear near the City and extend southeast to the Montezuma Hills (Thomasson et al, 1960).

2.2 SOURCES OF SUPPLY

As summarized in the City's General Plan Update (City, in process), the City's water supply includes both surface water and groundwater sources. The City's surface water sources are Lake Berryessa (Solano Project water) and the State Water Project (SWP) water delivered via the NBA. The balance of the City's water supply is groundwater. Current City water supplies are summarized in **Table 2-1** for normal, single-dry, and multiple-dry years. As indicated on the table, some of the Solano Project and SWP water supply is based on the City's entitlement and some is based on other agreements and settlements. The City's surface water entitlements for 2010 total 26,548 AF, but SWP deliveries are less than the entitlement in all but the wettest years. The availability of SWP water is approximately 64% of the entitlement in a normal year and is projected to decrease to 31% in a single-dry year and to 46% in a multiple-dry year. Therefore, approximately 16,991 AF of surface water would typically be available in a normal year. Total groundwater pumping by the City has decreased from 6,600 AF in 2007 to 5,068 AF in 2010. This represents a 5% reduction in the percentage of the City's total available water supplied by groundwater pumping in a normal year. Surface water use by the City of Vacaville from 2008 to October 2010 is outlined in **Table 2-2**.

Raw surface water deliveries to the City of Vacaville are regularly tested (at least quarterly) for microbiological constituents, regulated organic chemicals, inorganic chemicals, radioactivity, secondary aesthetic standards, and a series of unregulated constituents (pH, alkalinity, hardness, sodium, calcium, potassium, manganese, asbestos, bromide and total organic carbon). The surface water deliveries received by the City are typically high quality with the majority of constituents consistently falling below detection limits.

Projected water supply sources in future years are summarized in **Table 2-3**. Surface water supplies are expected to increase from 16,991 AF in 2010 to 21,754 AF in 2050. Total City groundwater pumpage in normal years is projected to increase to 8,000 AF in 2020 and 2025 as new City wells come on line.

2.2.1 City of Vacaville Pumpage

Prior to 1997, all City pumpage was from the Elmira Road well field, primarily from wells completed in the basal zone of the Tehama Formation but also including a small amount of pumpage from Well 1 completed in the Markley Formation. Concentrated pumpage in the Elmira Road area caused a localized cone of depression and declining groundwater levels in the basal zone. In order to alleviate this condition, the City began constructing new wells outside of the

Elmira Road area in the mid-1990s. Beginning with the construction of Well 14, which came on line in 1997, some pumpage has been redistributed from Elmira Road to the northeastern portion of the City. Two other northeast sector wells have since been constructed in the basal zone. Well 15 came on line in 2004, and Well 16 came on line in 2007. Construction of a new production well in the northeast sector, Well 17, is expected to begin in 2011. The northeast sector wells produced about 1,900 AF (41% of the total) in 2009 and 2010. The locations of existing City wells are shown on **Figure 2-3**.

The majority of the City's historical and current pumpage is from the basal zone of the Tehama Formation; Well 1 is the only non-basal zone well currently in operation. Total annual pumpage for the City from 1968 to October 2010 is shown on **Table 2-4** and **Figure 2-4**. Annual pumpage from the City's wells is divided into four categories on **Figure 2-4**:

1) Basal zone pumpage from the Elmira Road well field (Wells 2 through 13);
2) Non-basal zone pumpage from Well 1 at Elmira Road (currently less than 100 AF per year);
3) Basal zone pumpage from northeast sector wells (currently Wells 14, 15, and 16);
4) Non-basal zone pumpage from the DeMello well in the northeast sector (maximum of 160 AF per year in 2003, offline as of 2005).

The City's annual groundwater pumpage was relatively constant from 1968 to 1974, ranging from 2,862 to 3,316 AF per year. All pumpage during this period was from Elmira Road wells but was not differentiated by zone. Pumpage began to increase in 1975 and reached a peak of 8,024 AF in 1983. Pumpage decreased to 6,089 AF in 1984 and ranged from 5,421 to 6,236 AF, with an average of about 5,800 AF, during 1984 to 1992. Pumpage decreased to 4,395 AF in 1993 and continued to decrease to a low of 3,230 AF in 1996. Pumpage increased from1996 to 2002, reaching 6,638 AF in 2002. From 2002 to 2007 pumping remained relatively constant, averaging 6,635 AF per year. Since 2007, the City of Vacaville has gradually reduced the amount of groundwater it produces to 5,068 AF in 2010, which represents 31% of total use for that year. In 2007, 34% of water demand was supplied by groundwater.

Changes in the City's historical pumpage are correspondingly reflected in the water level data from the Elmira Road well field; specifically, water levels increased as pumpage decreased and vice versa. Notably, the relationship between pumpage and water level response and the development of the localized cone of depression was recognized in the 1980s (Mann, 1985). The City has since developed new groundwater supplies for municipal purposes north of Elmira Road and decreased its total pumping to reduce the local pumping depression in the Elmira Road area. Beginning with the construction of City Well 14, which came on line in 1997, roughly 40% of pumpage has been redistributed from Elmira Road to the northeast sector of the City.

Well 15, located northeast of Well 14, came on line in September 2004. Well 16, located northwest of Wells 14 and 15, was drilled in January 2005 and came on line in July 2007. The DeMello well (completed in the upper Tehama Formation) came on line in 2003, but the capacity of this well is much smaller than the basal zone wells and it has been used only for backup supply since 2004. It has been offline as of 2005. With the addition of the northeast sector wells, Elmira Road pumpage decreased from 5,549 AF in 2003 to 2,698 AF in 2009. Increased pumpage from the northeast sector wells in future years will further decrease reliance on the Elmira Road wells.

2.2.2 Other Pumpage in Northern Solano County

A brief summary of groundwater development in Solano County is contained in the IRWMP prepared in 2005. Prior to construction of the Solano Project, both municipal and agricultural users relied primarily on groundwater. Wells were perforated primarily in the Quaternary alluvium and the upper and middle zones of the Tehama Formation, and groundwater levels declined significantly in those zones. After completion of the Solano Project in 1958, most agricultural users switched to surface water, and groundwater levels recovered. Most growers in SID rely primarily on surface water, and growers in MPWD and RD 2068 use surface water exclusively (Solano Agencies, 2005).

After the City of Vacaville, SID, and the City of Dixon are the largest producers of groundwater in northern Solano County. SID operates wells to supplement surface water supplies and also to provide for drainage due to a high water table in certain areas. Although pumpage by privately owned wells in SID is unknown, annual metered pumpage is available for SID-owned wells since 1964. SID's pumpage ranged from a low of 2,311 AF during a wet year (1983) to a high of 13,965 AF during the 1976 drought year. SID's pumpage in 2005 (5,440 AF) was only slightly above the 40-year average of 5,363 AF.

The City of Dixon relies entirely on groundwater for its water supply. The City of Dixon is supplied with domestic water by California Water Service Company (Cal Water) and the Dixon-Solano Municipal Water Service (DSMWS). The City's water demand in 2005 was approximately 2,858 AF/year and is projected to be 3,899 AF/year in 2010 (Dixon, 2008).

The RNVWD also produces groundwater from the basal zone of the Tehama Formation. RNVWD pumpage was about 40 AF in 2003 (LSCE, 2003b). Pumpage by industrial and domestic wells in unincorporated portions of the Vacaville area is unmetered, but is assumed to be small. Groundwater development in the Vacaville area by others than the City has largely been from the upper part of the aquifer system rather than the basal zone of the Tehama Formation.

2.2.3 Conjunctive Water Use and Management

The City conjunctively manages its groundwater and surface water resources to most effectively use those resources during different water year types. This has been previously demonstrated to be an effective and flexible management approach. Continued conjunctive water management is expected to enable the City to meet its future water demands for a 20-year horizon and beyond. Groundwater-related objectives of the conjunctive water management plan are to:

1) Recognize and implement actions to prevent persistent water level declines, and
2) Continue to maintain water levels above historical lows when levels temporarily decline during dry years to minimize adverse consequences that would result from over pumping of the aquifer system.

As discussed below, groundwater monitoring data collected by the City indicate the response of the aquifer system to variations in the City's annual pumping amounts. Spring groundwater levels measured during 1992-1993 were initially used to establish "base year" groundwater levels, or the levels to which the aquifer had recovered in response to an estimated sustainable level of pumpage. The 1992-1993 base year groundwater levels have been augmented with more complete data collected during 2002-2010. This base year groundwater level concept serves to guide conjunctive management of the City's water resources. The base year concept is used to define the "normal condition" referenced in the Master Water Agreement between the City of Vacaville and SID signed on May 25, 1995. This plan was developed to ensure sustainable groundwater supplies in the City and SID service areas.

Base year water levels are not anticipated to be exceeded during "normal" water years (i.e., precipitation amount referred to as normal) in response to the pumpage associated with those years. The concept also recognizes that if pumpage is increased during single-dry or multiple-dry years, water levels would temporarily decline to below base year levels in response to increased pumpage. Following a short-term water level decline during a dry year with increased pumping, the base year groundwater levels provide a target to which to restore water levels.

2.3 GROUNDWATER CONDITIONS

2.3.1 Hydrogeology

Most City and non-City wells in the Vacaville area are completed in the Tehama Formation, which has been subdivided into upper, middle, and basal zones. The City's wells are largely completed in the basal zone of the Tehama Formation. City Well 1 is also partially completed in older pre-Tehama deposits. Shallow wells are typically completed in the upper zone of the Tehama Formation and the overlying Quaternary alluvium. A geologic map is provided as **Figure 2-5** to illustrate the regional geology. A detailed discussion of the regional geologic setting, including geologic cross sections, is provided in *Hydrostratigraphic Interpretation and Groundwater Conditions of the Northern Solano County Deep Aquifer System* (LSCE, 2010). A brief summary of geologic conditions is provided below.

The Pliocene and Pleistocene Tehama Formation is the primary aquifer for agricultural and municipal water supply in northern Solano County, including the Vacaville area. This formation consists of slightly to moderately consolidated fluvial, alluvial, and lacustrine deposits and includes interlayered clay, silt, sand, and gravel beds. A stiff blue lacustrine clay found near the upper boundary of the formation and other relatively continuous clay layers divide the formation into upper, middle, and basal zones.

In the Vacaville area, the continuous clay layers within the Tehama Formation appear to thin to the west-southwest, with some layers pinching out altogether. The Tehama Formation has a thickness of up to 2,200 feet in the vicinity of the City's eastern boundary and an outcrop area of over 35 square miles in the English Hills, north of the City, and continuing north toward the Solano County line (**Figure 2-5**). This outcrop serves as the primary recharge area for the Tehama Formation.

The upper and middle zones of the Tehama Formation are used for domestic and agricultural water supply. Southwest of the Highway 80/Midway Road junction, these zones are characterized by predominately thick, fine-grained silt and clay with a few thin sand and gravel beds. Northeast of this area, the number of coarser-grained beds appears to increase. In most western areas, the fine-grained nature, discontinuity of the sands, and generally low yields make these zones unsuitable for high capacity municipal water wells. Typically, these zones are only capable of producing 100 to 300 gallons per minute (gpm) with specific capacities of less than 2 gallons per minute per foot (gpm/ft), although some wells can produce up to 1,000 gpm. Aquifer test data in the upper zone are limited, but a transmissivity of only 1,500 gallons per day per foot (gpd/ft) was estimated based on a test of the City's DeMello well. Reliable transmissivity estimates are not available for the middle zone.

The basal zone of the Tehama Formation includes gravel and cobble deposits and layers of volcanic tuff and conglomerate cemented with calcium carbonate. The more permeable portions of the basal zone are comprised primarily of gravelly sand with calcium carbonate cementation in some areas. The basal zone occurs near the surface on the western edge of the City's Elmira Road well field and gradually deepens to the east (**Figure 2-6**, basal zone outlined in blue). The basal zone ranges in thickness from less than 400 feet in the Elmira Road area, to greater than 700 feet between Vacaville and Dixon (**Figure 2-7**). Up to 350 feet of this zone yields significant quantities of groundwater. The bottom of the basal zone occurs at a depth of about 2,400 feet in the vicinity of the City's Easterly Wastewater Treatment Plant and near the Midway Road/Highway 80 junction area. East of these areas, the basal zone appears to contain fine-grained sand beds. Detailed correlations using numerous oil and gas test holes with geophysical logs indicate that the basal zone extends beneath the Dixon area at a depth of 2,000-2,500 feet. The top of the basal zone was encountered at 1,980 feet bgs during construction of a multiple completion monitoring well in the Dixon area for SCWA (LSCE, 2010). Regional correlations suggest a finer-grained sandy zone extending eastward to beneath the Davis area at depths below existing municipal wells. However, the yield and water quality of this zone are presently unknown.

Specific capacities of wells completed in the basal zone in the Vacaville area generally range from 4 to 24 gpm/ft, depending on the thickness of aquifer materials encountered by the well and included in the perforated interval. The City's municipal basal zone wells range in capacity from 500 to 1,800 gpm. The mean transmissivity of the basal zone is roughly 48,000 gpd/ft (LSCE, 2003a; LSCE, 2008). The transmissivity is significantly lower to the north in the RNVWD wells (mean of about 17,000 gpd/ft).

The Lagoon Valley/Vaca Valley fault flanks the eastern side of the Vaca Mountains and was recognized by Thomasson (1960) and others. The Lagoon Valley/Vaca Valley fault is an extension of the Vaca-Kirby Hills fault and is interpreted as a high-angle, northwest striking, east dipping, normal fault associated with Miocene to Pliocene age uplift and volcanism. Data to determine the hydraulic properties of this fault are limited, and it is unknown whether the fault affects groundwater flow.

2.3.2 Groundwater Levels

Groundwater level data for the City's wells are available from the City's monitoring program, which is discussed in Section 3.3. The monitoring program includes semi-annual manual water level measurements in 13 production wells and 11 monitoring wells. In addition to the manual measurements, nine production wells are also monitored electronically with transducers connected to the City's Supervisory Control and Data Acquisition (SCADA) system. Groundwater levels in other wells in and near the City are also monitored at least semi-annually by (or on behalf of) other entities, including SCWA, DWR, the U.S. Bureau of Reclamation (USBR), SID, and RNVWD (**Figure A-1**).

Representative water level hydrographs for the Vacaville area are provided in **Appendix A** (**Figures A-3 and A-4)**. The hydrographs included in **Appendix A** are organized according to the four primary formations in which the wells are completed: Quaternary alluvium and the upper, middle, and basal zones of the Tehama Formation (**Figure A-2**). Groundwater elevation contour maps prepared for the basal zone of the Tehama Formation are also included in **Appendix A** (**Figures A-7 to A-10**) to indicate the hydraulic gradient and direction of groundwater flow beneath the City.

Water levels in wells completed in Quaternary alluvium and the upper zone of the Tehama Formation (**Figure A-3**) show similar trends. Water levels in those zones generally show declining levels from the 1940s to the early 1960s as a result of increasing groundwater pumpage. Beginning in the 1960s, water levels rose following the delivery of surface water from the Solano Project and corresponding reductions in groundwater pumpage. Water levels have remained relatively high since the late 1960s, largely unaffected by wet or dry climatic periods, with depths to water typically less than 10 feet. Groundwater levels in the Quaternary alluvium and upper zone of the Tehama Formation show small seasonal effects with slightly higher groundwater levels in the spring. Water levels in these relatively shallow aquifers appear to be unaffected by basal zone pumpage.

Water level data are more limited for wells completed in the middle zone of the Tehama Formation. **Figure A-3** illustrates groundwater levels for two wells (6N/1W-23C1 and 7N/1W-34F1) monitored by DWR in the Vacaville area that had sufficient historical data to indicate water level trends in this zone. Groundwater level trends in these wells are generally similar to those observed in the upper zone of the Tehama Formation. Also shown in **Figure A-3** are two monitoring wells (Rural North Vacaville Water District (RNVWD) MW-446 screened between 426 and 436 feet and RNVWD MW-594 screened between depths of 564 to 584 feet) located near RNVWD production Well No. 1. Groundwater levels in the RNVWD monitoring wells show declining groundwater levels until about 2008. The trends in these wells are likely due to local pumping effects from the RNVWD water supply well and a higher level of hydraulic connectivity between the middle and deeper (basal) Tehama Formation deposits.

Water level data since 2000 for the basal zone of the Tehama Formation are shown in (**Figure A-4**). A response to reduced pumping since 2008 can be seen in all of the wells shown. A detailed hydrograph of City Well 8 at Elmira Road shows a typical water level response to pumpage for the City's basal zone wells since 1988 (**Figure 2-8**). In order to obtain generally static measurements, manual water level measurements in the City's wells since 1992 have been preceded by a three-day shutdown period that eliminated the most pronounced effects of recent pumping by one or more nearby wells to ensure consistent and generally static monitoring conditions. Beginning in 2002, selected transducer measurements from the City's SCADA system have been available to indicate the highest water levels in the spring and the lowest water levels during the summer.

As noted above, the City has considered 1992 to 1993 to represent a "base year" groundwater level condition. The maximum spring water levels in 2003 were approximately the same as 1992 for a similar level of Elmira Road pumpage (about 5,400 AF per year), and the spring 1993 and 2003 water levels are highlighted on **Figure 2-8**. Water level data from Well 8 reflect changes in the City's basal zone pumpage from the Elmira Road well field; specifically, water levels increase as pumpage decreases and vice versa. Elmira Road basal zone pumpage decreased from 1992 to 1996, was relatively constant from 1996 to 1999, and increased from 1999 to 2002. The City kept its total production at a constant level (between 6,600 and 6,700 AF) from 2002 through 2007, then pumpage decreased to about 5,800 AF in 2008 and to 4,600 AF in 2009. The changes in pumpage resulted in increasing water levels in Well 8 from 1992 to 1998, relatively constant water levels from 1998 to 2000, and water level declines of about 35 to 40 feet from spring 2000 to spring 2002 as pumpage increased. Spring water levels declined slightly from 2003 to 2005, recovered in 2006, and declined slightly in 2007. Hydrographs of other Elmira Road wells show water level declines from 2000 to 2005 and relatively stable water levels beginning in 2005. In spring 2009, groundwater levels in the basal Tehama Formation recovered by about 14 feet to an elevation of about -66 feet. In spring 2010, groundwater levels rose to an elevation of about -61 feet in response to further decreases in pumpage in 2009.

The City has reduced its Elmira Road basal zone pumpage by shifting more pumpage to new wells constructed in the northeast sector (Wells 14, 15, and 16). As of 2010, 42% of groundwater production occurred in the northeast sector wells, up from 30% in 2007 and 16% in 2000. Overall, this has resulted in water level declines in the northeast sector wells and reduced drawdown in the Elmira Road well field. A hydrograph of Well 14, which has the longest period of record of the northeast sector production wells, is included in **Appendix A** (**Figure A-4**). Water levels in Well 14 declined at a faster rate between 1998 and 2005 than in the Elmira Road wells (about 50 feet in seven years), stabilized between 2005 and 2007, and as discussed above, have risen since 2007.

Groundwater elevations in the basal zone are much lower than in the middle and upper zones in the Vacaville area, ranging from about 20 feet above sea level in RNVWD to 60 feet below sea level in the vicinity of the City's main well field on Elmira Road. A pumping depression in the basal zone exists in the Elmira Road area, and the gradient for groundwater flow is southerly toward this depression. North of the City, the gradient has a magnitude of approximately 45 feet per mile (measured between RNVWD MW-1389 and Vacaville MW-16 1430 2009 to 2010), which is much steeper than the gradient in the upper zone of the Tehama Formation. The gradient becomes less steep in the Elmira Road area, e.g., the gradient between Well 14 and the Elmira Road wells is only about 3 feet per mile. This is due to the northerly expansion of the cone of depression in the Elmira Road area as more pumpage has been shifted to Wells 14 and 15 in the northeast sector.

2.3.3 Comparison of Groundwater Level Responses in Different Aquifer Zones

Groundwater elevations in the deeper, more confined zones of the Tehama Formation have shown considerable variation over time in direct response to changes in the amount of groundwater used as a source of supply by the City. Groundwater levels in shallower, unconfined to semi-confined aquifers (e.g., the Quaternary alluvium and the upper zone of the Tehama), in which private water supply wells are typically constructed, appear to be largely unaffected by basal zone pumpage. Groundwater levels in the shallower compared to deeper portions of the aquifer system are shown in **Figures A-5 and A-6.** **Figure A-5** shows three monitoring wells near City Well No. 15. The shallowest well (MW-188, screened from a depth of 158 to 178 feet) shows stable groundwater elevations. Monitoring well MW-508, screened from a depth of 438 to 498 feet, also shows stable groundwater elevations. As seen in **Figure A-5**, water level trends in MW-188 and MW-508 are unaffected by the City's pumping. MW-1815, screened at multiple depths between 1,207 to 1,785 feet in the basal Tehama Formation, shows water level trends in response to the City's pumping. Similarly, **Figure A-6** shows three monitoring wells located near City Well No. 16. As seen in **Figure A-6**, groundwater levels in the shallowest monitoring well (MW- 117 screened from 97 to 107 feet) are unaffected by the City's pumping, whereas groundwater levels measured in the two deeper monitoring wells (MW-1176 and MW-1430, which are completed in zones that are also among the zones screened by Well No. 16), show a direct response to the City's pumping.

During 1968 to 2009, the City's total groundwater production ranged from 2,862 to 8,165 AF with significant variability in pumpage during that period. Even so, groundwater levels representing the shallower part of the Tehama Formation have shown little to no effect in relation to the City's basal zone pumpage. The basal Tehama Formation is highly confined meaning there are large sections of lower permeability materials, silts and clays, which occur between the zones from which the City's wells produce groundwater and the overlying units. This confinement has caused rapid, notable responses to groundwater levels in the pumped basal zone and at the same time precludes noticeable groundwater level responses in the overlying shallower part of the aquifer system.

As the City expands groundwater development of the basal Tehama Formation in the northern to northeastern areas, similar groundwater level observations are anticipated. Specifically, it is anticipated that additional drawdown will occur in the basal zone in response to such pumping, while little or no groundwater drawdown is anticipated in the shallower part of the aquifer system. Ongoing monitoring is recommended to further evaluate groundwater level trends in relation to the City's utilization of groundwater produced from the basal Tehama Formation.

2.3.4 Groundwater Quality

Historical groundwater quality data for the City's water supply wells are available from 1986 to the present, and the results are summarized in **Table 2-5**. Every three years, the City performs water quality monitoring as required for all public water supply systems. The City also collects samples annually for nitrate analysis. Water quality is generally good at all City wells, and most of the historical data do not show signs of water quality degradation. Concentrations have remained steady.

Total dissolved solids (TDS) concentrations in the basal zone wells ranged from 270 to 546 milligrams per liter (mg/L) in 2008. The TDS concentration in Well 1 was 546 mg/L in 2008, which slightly exceeds the recommended secondary Maximum Contaminant Level (MCL) of 500 mg/L but not the upper secondary limit of 1,000 mg/L. Nitrate concentrations exhibit more variability from well to well than TDS, but concentrations have been stable at most wells. Nitrate (as NO_3) ranged from non-detect (<2 mg/L) in Well 16 to 19.9 mg/L in Well 5 during 2007 to 2008. Nitrate concentrations in Wells 1, 2, 5, and 13 have historically been over 10 mg/L nitrate (as NO_3), but not near the MCL of 45 mg/L.

Concentrations of trace elements in the City wells have generally been low. Copper and selenium have been non-detect at all City wells; and iron, manganese, and zinc have been non-detect at most City wells. Arsenic, boron, chromium-VI, and total chromium are typically detected at relatively low concentrations (less than half the MCL), except in Well 16 where arsenic approaches, and on one occasion has exceeded, the MCL of 10 µg/L[1].

There have been localized instances of impacts to shallow groundwater quality due to hazardous chemical contamination, but existing or potential municipal supplies have not been affected. Analyses for volatile organic compounds (VOCs) and other manmade constituents in the City's water supply wells have all been non-detect.

2.3.5 Land Subsidence

Limited monitoring of land subsidence has been conducted in Solano County using leveling surveys that relied on conventional spirit level surveying equipment prior to 1985. Since 1985, conventional survey methods have largely been replaced by Global Positioning System (GPS) techniques. The results of historical spirit level and more recent GPS surveys have been combined to estimate total subsidence and subsidence rates in the southern portion of the Sacramento Valley. The greatest subsidence in the Valley, more than 20 feet in some areas, has occurred in the Delta region as a result of draining of peat soils (Blodgett et al., 1990). Subsidence north of the Delta is caused primarily by groundwater pumping, but oil and gas extraction may be responsible for a significant fraction of the total subsidence in some areas.

The only available estimate of historical land subsidence near the City is based on Ikehara's 1994 report *Global positioning system surveying to monitor land subsidence in the Sacramento Valley, California, USA* that contains estimated subsidence rates for 18 benchmarks in the southern Sacramento Valley. One of these benchmarks (X128 R71) is located approximately halfway between the cities of Vacaville and Dixon. There was approximately 2.4 feet of total subsidence at this location between 1971 and 1989, which represents a subsidence rate of 0.131 feet/year. The location of this site, along with other subsidence monitoring stations in northern Solano County and adjoining portions of Yolo County, is shown on **Figure 2-9**.

Although greater subsidence rates have occurred to the north in Yolo County, the Vacaville area is considered to have a relatively high potential for future subsidence based on the historical data, geologic conditions, and lowered groundwater levels in the basal zone, particularly in areas

[1] An investigation of the elevated arsenic concentration on February 8, 2007 led to controlled operation of Well 16 to ensure the delivered water quality is within the drinking water standard for arsenic of 10 µg/L (LSCE, 2009).

where limited development of the basal zone has occurred historically. In January 2011 two permanent GPS subsidence stations will be added to the regional monitoring network. These stations, located at City Well 16 and SCWA's Dixon monitoring well (**Figure 2-3**) will help decision makers to identify and mitigate any subsidence that may be occurring.

2.4 AREAS OF CONCERN

Although groundwater conditions in the Vacaville area are generally good, there are several areas of concern that may require changes in future groundwater management. These include:

- Sustainable pumpage from the basal zone of the Tehama Formation,
- Preservation of groundwater quality, and
- Prevention of significant future land subsidence.

From 2002 to 2007 the City's total annual pumping rate was held relatively constant at 6,600 to 6,700 AF. Water level data and groundwater modeling results from that period, summarized above and in LSCE (2003a), indicate that future City pumpage from the basal zone ranging from 7,000 AF, based on existing City wells, to 8,000 AF, with additional northeast sector wells, could be sustained to meet normal-year demands. As discussed above, spring groundwater levels measured in City wells during 1992 to 1993 were used to establish "base year" groundwater levels, or the levels to which the aquifer has recovered in response to an estimated sustainable level of pumpage from the Elmira Road well field. The actual amount of sustainable basal zone City pumpage will depend on factors such as other pumping in the area, the locations and perforated intervals of future wells, and effects of climatic conditions and land use factors on groundwater recharge reaching the basal zone. More recently, it has been observed that reducing overall pumping to 4,600 to 4,700 AF has produced significant rebound in groundwater levels. It is assumed that the continued shifting of pumpage away from the Elmira Road area will enable the City to increase pumpage from the basal zone without causing future chronic water level declines. It is also expected that if the City continues to pump at the currently reduced rates, groundwater levels in and around the City of Vacaville will continue to rebound.

In general, the City's groundwater supply is of high quality and meets drinking water standards. Groundwater produced from the basal zone of the Tehama Formation contains slightly elevated arsenic concentrations at Well 16. Vertical flow within the well structure causes some water quality variability when the well is idle; as a result, the City operates this well in a manner to ensure that the produced water meets the MCL for arsenic of 10 ug/L. There have also been localized instances of impacts on shallow groundwater quality due to hazardous chemical contamination, but existing or potential municipal supplies have not been affected to date. This Plan includes recommendations for prevention, monitoring, and mitigation of future threats to groundwater quality.

Land subsidence monitoring data are very limited in the Vacaville area, but data from one USGS report discussed above show that about 2.4 feet of total subsidence occurred between Vacaville and Dixon between 1971 and 1989. There are no data to indicate how much subsidence occurred within the City limits, and especially in the vicinity of the Elmira Road well field, but historical water level declines and geologic conditions result in a potential for future subsidence. Ensuring that groundwater levels in the basal zone do not decline below 1992 levels at Elmira Road will reduce the risk of significant future subsidence in this area. Declining water levels in the northeast sector, which have resulted from the City's more distributed pumping scheme, may increase the risk of subsidence in that area. Two subsidence monitoring stations to be added to the regional monitoring network in January 2011 will help the City to analyze any trends and mitigate impacts as needed.

3.0 GROUNDWATER MANAGEMENT PLAN OBJECTIVES AND COMPONENTS

3.1 GROUNDWATER MANAGEMENT PLAN OBJECTIVES

The overall purpose of the Plan is to maintain a high quality, reliable, and sustainable water supply for the citizens of Vacaville. To accomplish this, the City will continue to manage groundwater conjunctively with its surface water resources and support basin management objectives (BMOs) directed toward the sustainability of groundwater supplies within the basin and subbasin. Groundwater management involves the ongoing performance of coordinated actions related to groundwater withdrawal, replenishment, and protection to achieve long-term sustainability of the resource without detrimental effects on other resources. To accomplish the City's purposes and the regional BMOs, the Plan sets forth a framework and related actions necessary to meet those objectives.

The City's utilization of surface water supplies from various sources along with local groundwater development represents a long history of water resource and water supply management actions that are consistent with what can be considered to be overall objectives for the Solano Subbasin. The BMOs addressed by this Plan can be expressed as follows:

1. **Assessment of Groundwater Basin Conditions.** Programs to monitor and report on groundwater levels, groundwater quality, and pumpage have been implemented to assess groundwater conditions in the Solano Subbasin. Plans to expand the existing programs and add monitoring of land subsidence are in progress. These monitoring programs are necessary to ensure that undesirable effects such as long-term groundwater level declines, groundwater quality degradation, and significant inelastic land subsidence are avoided. Regional coordination of groundwater monitoring is important, and monitoring programs should be reevaluated periodically to determine whether the location, depth, and frequency of monitoring is adequate. Data collected by the monitoring programs need to be evaluated on a regular basis to ensure that other BMOs are met.

2. **Avoidance of Progressive Groundwater Level Declines.** It is important that groundwater pumpage in the Solano Subbasin not exceed the sustainable yield of the subbasin in order to avoid chronic water level declines that could lead to overdraft conditions or cause significant inelastic land subsidence. This objective can be met through periodic evaluation of groundwater level and pumpage data collected by the monitoring program, along with refining the estimated sustainable yield of the subbasin.

3. **Preservation of Groundwater Quality.** This objective involves actions needed to sustain a supply of good quality groundwater for beneficial uses in the basin. It includes coordinated efforts that will be required to conduct a regional monitoring program that

identifies short and longer-term water quality trends. It also includes wellhead and recharge area protection and actions to avoid salt accumulation and/or mobility of naturally occurring constituents. Also included in this BMO will be the active characterization and solution of any groundwater contamination problems through cooperation with responsible parties or through independent action if timely response by responsible parties is not forthcoming and the preceding management objectives are thereby impacted or constrained.

4. **Increased Conjunctive Use of Surface Water and Groundwater Resources.** Several entities in the Solano Subbasin, including the City and SID, have used surface water and groundwater conjunctively for decades. There are opportunities to expand these programs in the future and to increase the use of recycled water to meet existing and projected demands. Included in this management objective is the non-degradation of surface water flows or quality as a result of groundwater management practices. In addition to being classified as a separate BMO, conjunctive use is one of the primary means of accomplishing BMOs 2 and 3 above.

Quantitatively, the preceding objectives translate into general preservation of groundwater levels and quality in the basin. Groundwater levels are allowed to fluctuate through seasonal demands and local hydrologic variations (wet and dry periods), but a progressive lowering of groundwater levels that could lead to overdraft would be prevented. As discussed in more detail in Chapter 2.0, the hydrogeologic setting in the Vacaville area and the City's extraction of groundwater from the deeper part of the aquifer system has resulted in large groundwater level fluctuations in the basal unit of the Tehama Formation. Fluctuations have been much smaller in the upper part of the aquifer where changes are primarily due to seasonal variations. Due to the integrated or conjunctive use of local groundwater and imported surface water, the City has managed its extraction, including locations and quantity, to prevent progressive lowering of groundwater levels in the deeper aquifer in the area beneath the City. A continuation of such local conjunctive use operations will help to accomplish the second BMO (avoidance of progressive groundwater level declines) while continuing to utilize local groundwater to meet a portion of the City's projected water requirements.

The City plans to intermittently use more groundwater from the basal zone of the Tehama Formation for dry-period and/or emergency water supply. Interpretation of historical pumping fluctuations and corresponding aquifer response suggests that such intermittent utilization of a slightly larger fraction of the Tehama Formation's large storage capacity during dry years can successfully contribute to meeting the City's water requirements while still accomplishing the management objectives listed above, primarily via corresponding reductions in pumping during normal and wet years.

3.2 PLAN CATEGORIES AND COMPONENTS

To accomplish the BMOs discussed above, this Plan incorporates a number of components that are divided into five categories: 1) monitoring program, 2) water resource sustainability, 3) groundwater resource protection, 4) agency coordination and public outreach, and 5) plan implementation and updates. Each of these categories and the Plan components within each category are described in this section.

The Plan components reflect the focus on local groundwater management in the Solano Subbasin by the City and continuing cooperation with the members of the SWA and other stakeholders in the Solano Subbasin. In summary, this Plan aids the City in the continued management of its own groundwater resources, and provides the foundation for the City and other entities in the basin to cooperatively manage and potentially expand use of groundwater on a regional basis for municipal and emergency water supply purposes.

<u>Category 1: Monitoring Program</u>

- 1A. Elements of Monitoring Program
- 1B. Evaluation and Reporting of Monitoring Data

<u>Category 2: Water Resource Sustainability</u>

- 2A. Maintaining Stable Groundwater Levels
- 2B. Determination of Sustainable Pumpage
- 2C. Continuation of Conjunctive Use Operations
- 2D. Integration of Recycled Water
- 2E. Water Conservation

<u>Category 3: Groundwater Resource Protection</u>

- 3A. Well Construction and Destruction Policies
- 3B. Identification and Management of Recharge Areas and Wellhead Protection Areas
- 3C. Management and Mitigation of Contaminated Groundwater
- 3D. Long-Term Salinity Management

<u>Category 4: Agency Coordination and Public Outreach</u>

- 4A. Continuation of Local, State, and Federal Agency Relationships
- 4B. Public Outreach
- 4C. Water Awareness Education

<u>Category 5: Plan Implementation and Updates</u>

- 5A. Plan Implementation and Reporting
- 5B. Provisions to Update the Groundwater Management Plan

3.3 COMPONENT CATEGORY 1: MONITORING PROGRAM

The City's groundwater monitoring program was initially described in its first *AB 3030 Groundwater Management Plan* (West Yost, 1995), and additions to the monitoring program were outlined in a report updating local groundwater conditions through 2003 (LSCE, 2004b). The City's current groundwater monitoring program includes monitoring of groundwater levels, quality, and production. As discussed below, the City is coordinating with SCWA on the addition of two land subsidence monitoring stations to the regional monitoring program in January 2011.

3.3.1 Component 1A: Elements of Monitoring Program

The City's groundwater monitoring program is summarized in **Table 3-1**, and the monitoring locations are shown on **Figure 3-1**. The monitoring program summarized on this table and figure does not include 14 shallow monitoring wells located at the City's two wastewater treatment plants (WWTPs). There are nine monitoring wells at the Gibson Creek WWTP and five monitoring wells at the Easterly WWTP. Although these wells are not included in the groundwater monitoring program summarized below, the monitoring results are evaluated as part of achieving the third BMO (preservation of groundwater quality).

Groundwater Levels

As shown in **Table 3-1**, manual water level measurements are currently made by the City on a semi-annual basis in 11 of its 13 production wells and all of its dedicated Tehama Formation monitoring wells. In addition to the manual measurements, nine production wells are equipped with transducers connected to the City's SCADA system. Additional transducers are scheduled to be deployed in wells MW-14, MW15-1815, MW16-1430, MW-98A, and MW-98C in January 2011.

In 1992, the City implemented a program to obtain spring and fall water level measurements from its production wells that best represent static conditions. Manual water level measurements are preceded by a three-day shutdown period for all wells in order to eliminate the most pronounced effects of recent pumping to ensure consistent and generally static monitoring conditions. However, the spring measurements often do not reflect the highest groundwater levels of the year, and the fall measurements provide little indication of the low groundwater levels that occur during the summer. Since 2002, transducer measurements from the City's SCADA system have also been available to indicate the highest water levels in the spring and the lowest water levels during the summer. The SCADA system allows the City to continuously monitor pumpage and water levels in most of its active production wells. The exceptions are Well 1, which has a SCADA connection that monitors pumpage but not water levels, and Wells 2, 3, and DeMello, which are not connected to the SCADA system. Water level readings are taken every 10 seconds in the other wells, and the data are automatically uploaded via radio or telephone line to a computer at the City's Water Treatment Plant on Allison Road.

In 2001, the City began manual water level measurements in monitoring wells completed in all three zones of the Tehama Formation. As summarized in **Table 3-1**, manual water level measurements are currently made semi-annually (spring and fall) in 11 monitoring wells.

Several other entities also monitor groundwater levels in the vicinity of the City, including SCWA, DWR, USBR, SID, and RNVWD. Data collected by DWR and USBR are available on DWR's website, and data collected by SID and RNVWD are available from those districts. SWA also acts as a repository for water level data collected by DWR, USBR, SID, and UCD under the SWA-4 agreement. The purpose of the SWA-4 agreement is to coordinate groundwater monitoring data among the SWA member agencies and also other agencies, including DWR and USBR. SCWA has responsibility for managing the data and preparing periodic reports on behalf of SWA to summarize the compiled data and describe historical and current groundwater conditions.

SWA has completed an initial report on groundwater conditions in northern Solano County (Summers Engineering, 1995) and three data summary reports, the most recent of which is entitled *2003-2005 Ground Water Report, Groundwater Conditions in Solano County* (SWA, in progress). This report lists the wells with groundwater data, shows the sampling frequency, and refers to a database that includes the well construction and water level data. The report includes data for 139 to 202 wells, depending of the year water levels were measured. The majority of these wells are monitored monthly or semi-annually; some wells are monitored annually. The majority of these wells are agricultural or domestic wells perforated in the upper aquifers (above 400 feet).

The regional groundwater monitoring program has been expanded. In October 2007, SCWA began installing multiple-completion monitoring wells at four locations in northern Solano County. Since then, monitoring wells have been installed at all four locations and are currently equipped with transducers. Transducer data are downloaded and analyzed at least semi-annually. Manual water level measurements are taken on the same frequency. A summary of construction information and monitoring activities for each SCWA monitoring well is provided in **Table 3-2**.

Groundwater Quality

Groundwater quality sampling of the City's production wells for general minerals, inorganics, and organics is conducted every three years as required for all public water supply systems. The City also collects samples annually for nitrate analysis. Samples were collected quarterly for radionuclide analysis from May 2005 to January 2006, and the City has received a 9-year waiver from the California Department of Public Health (DPH) for future radionuclide sampling because the gross alpha results were below the threshold of 3 pCi/L. The City's current groundwater quality monitoring program is summarized in **Table 3-1**.

SWA does not include groundwater quality data in its periodic monitoring reports; therefore, there is no central repository for water quality data in Solano County. In the vicinity of the City, RNVWD and SID conduct routine groundwater quality sampling. Although RNVWD has two production wells, only one is operated for public water supply. Due to elevated arsenic concentrations, exceeding the MCL of 10 ug/L, in the second production well, it is currently offline. Routine water quality sampling is conducted in both wells as required by DPH.

SID's *SB 1938 Groundwater Management Plan Upgrade* (Summers Engineering, 2006) states that groundwater quality is monitored on a rotating basis in agricultural wells in the SID service area. Although the number of wells sampled each year and the sample analyses conducted are not specified, SID produces a brief annual report each year that includes groundwater quality results. The 2009 annual report shows that four wells were sampled, and the samples were analyzed for general minerals including nitrate, boron, and sodium adsorption ratio (SAR). The 2009 annual report also indicates that nine SID wells have been sampled since 2001, and most of these were sampled every other year (Summers Engineering, 2009).

Groundwater Production

The City monitors pumpage in its water supply wells on a daily basis. As shown in **Table 3-1**, all but three water supply wells are connected to the SCADA system that allows the City to monitor pumpage electronically. By February of 2011, Wells 2 and 3 will be added to the SCADA system, leaving only the inactive DeMello Well to be monitored manually. The electronic pumpage data are typically recorded daily (at noon), but more frequent data can be collected if necessary. Other well information such as flow rate, pressure, pump speed, chemical tank level, etc. are also recorded daily.

There is no regional compilation of pumpage data in Solano County because SWA does not include pumpage in its database or reports. In the vicinity of the City, municipal pumpage is monitored by RNVWD. SID monitors agricultural pumpage from District wells but does not monitor non-District pumpage within its boundaries. As noted above, the DeMello well has been offline since 2005.

Land Subsidence

The City does not currently monitor land subsidence within its boundaries, and regional monitoring of land subsidence in Solano County has been limited. Regional land subsidence monitoring has included non-instrumented GPS monuments and continuous GPS monitoring stations; there are no extensometers in Solano County. In January 2011, two permanent GPS subsidence stations (located at the Vacaville Well 16 and SCWA Dixon monitoring well sites) will be added to the regional monitoring network.

The Sacramento-San Joaquin Delta non-instrumented GPS network consists of about 120 monuments, including about 30 monuments in Solano County. This network was initially surveyed in 1997 and resurveyed in 2002, but funding has not been available to process the data from the 2002 resurvey. Yolo County also has a non-instrumented GPS monitoring network consisting of 58 stations. The Yolo County network was surveyed in 1999, 2002, and 2005. The 2005 survey of the Yolo County network included several stations in northern Solano County. GPS monitoring locations in northern Solano County and adjoining portions of Yolo County are shown on **Figure 2-9**.

Instrumented GPS monitoring stations are generally referred to as Continuously Operating Reference Stations (CORS). Each CORS site includes a high-resolution GPS receiver and antenna with a solar collector and battery for power supply. The GPS receivers are attached to steel or concrete structures that are anchored deep into the soil. GPS positions are recorded at intervals of five to 30 seconds, and a daily average is calculated from all of the data to achieve maximum accuracy. CORS sites use some form of telemetry (typically a radio transceiver) to upload the data. After processing, the data are accessible on Internet sites operated by entities such as the National Geodetic Survey (NGS) or the California Spatial Reference Center (CSRC).

At present, there is one CORS site in northern Solano County. This site, labeled P267, is located south of Dixon and approximately six miles east of the City (**Figure 2-9**) and is operated by the Plate Boundary Observatory. Historical data are limited for this station, which began operation in

April 2005. The two new subsidence stations scheduled for January of 2011 will also be operated by the Plate Boundary Observatory.

Surface Water Flows and Quality

Monitoring of surface water flows and quality is generally not applicable to the City of Vacaville for three reasons: 1) there are no major streams in the vicinity of the City, 2) the City's production wells are completed in relatively deep and confined zones of the Tehama Formation (primarily the basal zone), and 3) there is no direct interaction between groundwater in this zone and surface water.

As required by DPH, the City monitors the quality of surface water delivered by the Solano Project and the SWP on a quarterly basis. Both raw and treated surface water are sampled at the City's water treatment plant and analyzed for nitrate on a quarterly basis (except for the first quarter) and for general mineral, general physical, inorganic, and organic constituents annually.

Actions

- Continue the City's existing groundwater monitoring program and complement with information gathered by other local and state agencies (e.g., DWR, SID, and USBR).

- Expand regional groundwater monitoring programs to ensure effective groundwater resource management and accomplishment of the BMOs.
    - Coordinate with SCWA regarding the adequacy of regional groundwater monitoring networks and programs.
    - Coordinate with SCWA on planned construction of additional monitoring facilities in northern Solano County.
    - Coordinate with SCWA on implementation of a land subsidence monitoring program.

3.3.2 Component 1B: Evaluation and Reporting of Monitoring Data

Groundwater level, quality, and production data collected as part of the City's monitoring program are periodically entered into a database, which allows the data to be summarized on tables and plots in an efficient manner. The data are routinely reviewed to check for any significant changes in groundwater conditions. On a less frequent basis, the data are comprehensively evaluated and a report is prepared to summarize the data.

The most recent evaluation of groundwater conditions in the Vacaville area is presented in the report entitled *Hydrostratigraphic Interpretation and Groundwater Conditions of the Northern Solano County Deep Aquifer System*, (LSCE, 2010). Previous reports have been prepared at least every other year beginning in 2000. Most of these reports have been comprehensive, detailed reports that contain much more analysis than is generally required in a routine annual summary of the data. Such routine annual reporting is recommended in the future, as described below.

Actions

- Prepare a brief annual summary of groundwater and land subsidence data collected through spring (i.e., March or April) in a groundwater management report to be completed each year by August 1st.

- Coordinate with SWA-4 on the maintenance and utilization of the regional monitoring database, including regular transfer of City data and coordination with others on the use of the data to assess basin conditions relative to the BMOs. Additionally, coordinate with SWA-4 on monitoring protocols (such as groundwater level objectives) being used to assess the effect of pumpage on levels and achieving BMOs.

- Coordinate with SWA-4 regarding the adequacy of regional evaluation and reporting of groundwater data. Potential improvements to the SWA database and reports include:
    - the addition of the City's wells and water level data;
    - the addition of groundwater quality, pumpage, and land subsidence data;
    - preparing reports on an annual basis to summarize data collected during the previous year; and
    - preparing a coordinated update of groundwater conditions in the subbasin at least every five years.

3.4 COMPONENT CATEGORY 2: WATER RESOURCE SUSTAINABILITY

3.4.1 Component 2A: Maintaining Stable Groundwater Levels

Accomplishment of the second BMO (avoidance of progressive groundwater level declines) requires that generally stable groundwater levels be maintained in the Tehama Formation, especially in the basal zone. On a subbasin scale, there have been increases in groundwater levels and storage since the Solano Project began delivering water in the late 1950s. As described above, however, groundwater levels in the basal zone of the Tehama Formation continue to exhibit a localized cone of depression in the vicinity of the City's Elmira Road well field, and groundwater levels in this area have fluctuated directly in response to the amount of pumpage. Following several years of maintaining total annual pumpage at 6,600 to 6,700 AF, basal zone groundwater levels in the Elmira Road wells appear to have stabilized as of spring 2006. Since 2007, reduced groundwater pumping by the City has caused groundwater levels in the basal aquifer to rebound significantly (upwards of 25 feet in some areas).

Water level fluctuations in the basal zone are typical of conditions in an area where groundwater and surface water are conjunctively managed. Historically, more groundwater was pumped from storage during dry years, and that storage was replenished when pumpage was reduced during subsequent wet years. Annual pumpage was held constant from 2002 to 2007 to observe water level responses in the basal zone. As discussed above, the City's conjunctive water management program allows it to adjust its groundwater production so that groundwater levels recover to spring 1992-1993 "base year" levels during normal years. The base year water levels are used to define the "normal condition" referenced in the Master Water Agreement (SID and City, 1995). Groundwater levels may decline below base year levels during dry years with increased pumpage, but levels should remain above historical lows. Conjunctive water management is again used to restore groundwater levels to base year conditions following a dry year when increased pumpage has occurred.

In recent years, the City has also managed the location of its groundwater extraction in an effort to shift pumpage away from the Elmira Road well field to the northeast sector of the City. Prior to the construction of City wells 14, 15, and 16 in the northeast sector, there was no significant groundwater development of the basal zone of the Tehama Formation for municipal water supply in this area, although a small amount of groundwater is known to be produced from this zone for commercial purposes. Somewhat further north, there is a small amount of groundwater development from this zone by RNVWD. The City plans to develop some additional groundwater to supplement its currently available groundwater and surface water resources and add that yield to the existing water supply. One area identified for potential future groundwater development is in the northeast sector.

Actions

- Continue to manage groundwater and surface water conjunctively to ensure that groundwater levels in the Elmira Road wells recover to spring 1992-1993 "base year" levels during normal years based on the following criteria:
    - During dry years with increased pumpage, recognize that groundwater levels may decline below base year levels but maintain groundwater levels above historical lows.
    - Use conjunctive water management to restore groundwater levels to base year conditions following a dry year when increased pumpage has occurred.
    - Use 1992-1993 base year groundwater levels, in conjunction with the more complete data from 2002-2003, to measure aquifer system response to pumping and assess the sustainable pumpage.

- Manage pumping away from Elmira Road to prevent progressive groundwater level declines in other areas.

- Continue groundwater development programs that help to achieve the BMOs by optimizing the pumping distribution in the City's urban planning area.

3.4.2 Component 2B: Determination of Sustainable Pumpage

In order to accomplish BMOs that pertain to groundwater in the Vacaville area, it will be important to determine what yield can be developed on both a regular and an intermittent (dry period or emergency) basis. A determination of sustainable pumpage, particularly for the basal zone of the Tehama Formation, will be required to accomplish the main objectives of operating within the yield of the groundwater basin and avoiding overdraft.

The intent of this Plan component is to develop further understanding and quantification of sustainable pumpage from the Tehama Formation (especially the basal zone), accounting for variations in hydrologic conditions and the location and amount of pumpage, so that groundwater development and use can be managed in such a way to meet an appropriate fraction of total water demand while avoiding over pumping that could result in overdraft conditions.

In the future, in coordination with other SWA members and state and federal agencies, implementation of this Plan component will be important in accomplishing the first and second management objectives for the basin. The observation of historical groundwater conditions, in combination with knowledge of pumpage from the basal zone of the Tehama Formation, has led to the City's current operational practices as well as general expectations regarding the approximate yield of this aquifer in the vicinity of the City. Historical operating experience, complemented by observed groundwater conditions, is an appropriate basis to initially determine available groundwater supplies. However, it is possible and appropriate to more precisely analyze the basin to determine values or ranges of yield under varying hydrologic conditions, and to assess the impacts of various management actions that might be implemented in the basin. Previous reports, including LSCE (2010), include recommendations for the future development of a numerical groundwater flow model that could be utilized for determination of the yield of the subbasin under existing land use and groundwater and surface water development conditions. Such a model could also be used for implementation of this Plan component to assess the yield of the subbasin under future land use conditions as well as future ranges of surface water importation, groundwater development, and recycled water use through varying hydrologic conditions, i.e., wet and dry periods that affect the availability of imported surface water.

Actions

- Assess levels of pumpage relative to the sustainable yield of the principal aquifer system.
    - Update sustainable pumpage estimates with expanded monitoring data (e.g., monitoring conducted with the new SCWA monitoring wells installed at the periphery of the urban planning area).

- Refine assessment of hydrogeologic conditions and the conceptual model in preparation for the future development of a regional numerical groundwater flow model.
    - Improve groundwater extraction (non-City pumpage) and recharge estimates.
    - Refine conceptual model of subbasin (e.g., conceptual model for enlarged study area).
    - Investigate stream-aquifer interactions.

- Discuss joint development of a regional numerical groundwater flow model to simulate and evaluate future water resources management scenarios with SWA and other entities that overlie the subbasin.

3.4.3 Component 2C: Continuation of Conjunctive Use Operations

The City conjunctively manages its groundwater and surface water resources to most effectively use those resources during different water year types. This has been previously demonstrated to be an effective and flexible management approach. Conjunctive water management goals have been established particularly to accomplish the second BMO, i.e., avoidance of progressive groundwater level declines. Continuation of conjunctive water management is expected to enable the City to meet its future water demands to a 20-year horizon and beyond. Groundwater-related objectives of the conjunctive water management program are to:

- Recognize and implement actions to prevent persistent groundwater level declines.
- Continue to maintain groundwater levels above historical lows when levels temporarily decline during dry years in order to minimize subsidence and other adverse consequences caused by over pumping of the aquifer system.

Planning for additional groundwater development has preliminarily involved the use of an analytical groundwater flow model (LSCE, 2003 and 2007). Monitoring data have been and will continue to be utilized to assess actual response to pumping (particularly within the basal zone) so that operations can be adjusted as necessary to achieve this BMO, i.e. avoidance of progressive groundwater level declines.

As part of the conjunctive management of surface water and groundwater to meet the City's requirements, it is recognized that there will be variations in the amount of available surface water supplies from year to year, particularly since a large fraction of the supply is imported from outside the subbasin. Similarly, there are expected to be variations in groundwater conditions as a function of the local hydrogeology that affect, among other things, the natural recharge to the groundwater basin from year to year. Local hydrology, which affects local groundwater conditions in the basal zone, may be considerably different from the hydrology in a distant (Central Sierra Nevada) location that directly affects the availability of imported surface water in any given year.

Recharge to the basal zone is expected to occur primarily east of the English Hills and north of the Vacaville area where the Tehama Formation outcrops. A significant portion of the recharge is probably the result of leakage from the overlying Quaternary alluvium and the upper zone of the Tehama Formation in the outcrop areas (**Figure 2-5**). Thus, conjunctive water management by the City necessitates particular attention to groundwater level recovery from year to year to ensure that water levels in the basal zone are maintained to meet a regular component of the City's water supply in normal and wet years and a larger component of the water supply during "dry periods" that affect supplemental surface water availability. In light of all the preceding, continuation of this Plan component is essential to accomplishing all the BMOs.

Actions

- Continue the City's conjunctive management of its available water resources;
- Coordinate with other SWA members to explore other conjunctive use opportunities directed toward the BMOs.

3.4.4 Component 2D: Water Conservation

The City of Vacaville is committed to implementing water conservation programs. The 2005 UWMP contains descriptions of the conservation measures that the City has implemented, plans to implement, or intends to study (Nolte, 2005). This section highlights those measures that are the same as the best management practices (BMPs) outlined by the California Urban Water

Conservation Council. For more than 18 years, the City has participated in a Water Conservation Council that includes other cities in Solano County and SCWA, the City's wholesale supplier of imported surface water. Through regional partnering efforts, the cities have shared resources and benefited from each other's programs and studies.

Water conservation and related public education measures have generally been developed in California to achieve the following goals:

- meet legal mandates,
- reduce average annual potable water demands,
- reduce sewer flows,
- reduce water demands during peak seasons, and
- meet drought restrictions.

The City has implemented the following BMPs to increase water conservation:

- distribution system water audits and leak detection and repair;
- public information;
- school education;
- conservation pricing;
- conservation coordinator;
- residential plumbing retrofits;
- metering with commodity rates for all new connections and retrofit of existing connections;
- large landscape conservation programs and incentives;
- conservation programs for commercial, industrial, and institutional accounts; and
- water waste prohibition.

The City's water conservation and public education program will expand to include the following BMPs found to be locally cost-effective, as detailed in the 2005 UWMP. These BMPs are intended to reduce California's long-term urban water demands and have been incorporated into the water demand management measures section of the Urban Water Management Planning Act.

- Water survey programs for single-family residential and multi-family residential programs (surveys of customers having the greatest potential to reduce water use started in 2006);
- High-efficiency washing machine rebate programs (the City supports the rebate program offered by Pacific Gas & Electric Company); and
- Residential ultra-low-flow toilet replacement program (the City exempted itself from this water demand management measure in its 1999 Water Management Plan; however, it is continuing to research an effective and efficient method to implement in the future).

The City uses a variety of communication tools to encourage water conservation. These tools include: press announcements and newspaper advertisements; public workshops; City web site posting with a dedicated water conservation section to promote water conservation practices and water rate information; billing software that shows each customer's water use over the last 12 months; cooperative exhibits, demonstration sites, library displays, and a water model used for public meetings and school education; public information through regional projects; speakers for community groups and the media; and coordination with other government agencies, industry groups, public interest groups, and the media.

This Plan component will be incorporated with educational and outreach material to complement other Plan components. This update of the City's Plan includes continuation of public water awareness programs directed toward achievement of the BMOs.

Actions

- Continue to implement and promote water conservation programs within the City's service area.

3.5 COMPONENT CATEGORY 3: GROUNDWATER RESOURCE PROTECTION

3.5.1 Component 3A: Well Construction and Destruction Policies

Most of the City's groundwater supply is developed from the basal zone of the Tehama Formation. The City's wells are commonly completed to depths of over 600 feet, including many wells over 1,000 feet deep and one well over 1,800 feet deep. Proper well design and construction is required to prevent the movement of poorer quality water between aquifers through the well structure. In coordination with SWA, the City has implemented well construction guidelines to minimize the potential for groundwater quality degradation in deeper aquifers. These guidelines, which especially include the installation of deep seals, are followed for construction of all new City wells. The City also continues to follow the Solano County Code (see below) and guidance provided in DWR Bulletins 74-81 and 74-90 on well construction (DWR, 1981 and 1990).

The Solano County Environmental Health Services Division of the Department of Resource Management is responsible for well construction permitting in Solano County. The County Code, Chapter 13.10, effectively implements the State Well Standards for water supply wells, monitoring wells, and cathodic protection wells. Permitting of municipal supply wells is also within the purview of DPH. The third BMO, preservation of groundwater quality, requires that all wells be properly constructed and maintained during their operational lives and properly destroyed after their useful lives, so that they do not adversely affect groundwater quality by, for example, serving as conduits for movement of contaminants from the ground surface and/or from an aquifer with poor groundwater quality to one with good quality. Toward that end, this component is included in the overall plan to support well construction and destruction policies, and to participate in their implementation in the subbasin, particularly with regard to surface and inter-aquifer well sealing and proper well destruction, which are critical in the management of a multiple aquifer system.

Actions

- Continue current well construction and destruction policies.

- Coordinate with other SWA members as appropriate on well construction and future resource utilization.

3.5.2 Component 3B: Identification and Management of Recharge Areas and Wellhead Protection Areas

The 1986 Amendments to the federal Safe Drinking Water Act (SDWA) established requirements for new Wellhead Protection Programs (WPPs) to protect groundwater that supplies drinking water wells for public water systems. Each state was required to prepare a WPP and submit it to the USEPA by June 19, 1989. However, California did not develop an active statewide WPP at that time. Subsequently, in 1996, reauthorization of the SDWA established a related program called the Source Water Assessment Program. In 1999, the DPH Division of Drinking Water and Environmental Management developed its Drinking Water Source Assessment Program (DWSAP), which was approved by USEPA. The overall objective of the DWSAP is to ensure that the quality of drinking water sources is protected. The wellhead protection aspect of this groundwater management plan component is now essentially required as a result of the 1996 SDWA reauthorization.

In California, the DWSAP satisfies the mandates of both the 1986 and 1996 SDWA amendments. The California DWSAP includes delineation of Groundwater Protection Zones surrounding an existing or proposed drinking water source where contaminants have the potential to migrate and reach that source. The program includes preparation of an inventory of activities that may lead to the release of contaminants within these zones. The activities, referred to in the DWSAP as Potentially Contaminating Activities, include such land uses as gas stations and dry cleaners, as well as many other land uses. Known contaminant plumes regulated by local, state, and federal agencies are also included. The Groundwater Protection Zones, which are determined based on local hydrogeological conditions and also well operation and construction parameters, represent the approximate area from which groundwater would be withdrawn during 2, 5, and 10-year time periods. These zones also represent the area in which contaminants released to groundwater could migrate and potentially affect the groundwater extracted by wells located within the designated zones. The DWSAP evaluation also includes a risk or vulnerability ranking based on a combined numerical score that results from points assigned to various evaluations conducted as part of the DWSAP process. This ranking provides a relative indication of the potential susceptibility of drinking water sources to contamination.

DPH is responsible for conducting DWSAP assessments for systems existing prior to the adoption of the California program but has encouraged purveyors to perform their own assessments. Assessments for existing systems were due to be completed by May 2003.

Permitting of a new water supply well requires that the applicant complete a DWSAP analysis as part of the permit process. Fifteen DWSAP assessments have been completed on behalf of the City. The results of the DWSAP assessments can be used as a planning tool to guide land use development in the vicinity of water sources. The DWSAP analyses prepared for water sources in the basin should, in some fashion, be reviewed at least every five years and updated as appropriate. The collective DWSAP information can also be integrated with other management activities, including siting of new wells, land use policies, and the County's Code concerning well construction.

This Plan component is included to incorporate the DWSAP efforts into the City's Groundwater Management Plan. Compliance with these DPH requirements is a key part of accomplishing the BMOs.

Actions

- Employ wellhead protection measures to ensure long-term sustainability of good quality water.
    - Use DWSAP information, including delineation of source area and protection zones.
    - Require deep sanitary seal construction standards for municipal supply wells.
    - Employ well destruction policy to prevent groundwater contamination.

- Coordinate with other SWA members (as applicable) regarding DWSAP analyses (and also other environmental assessments) conducted to help guide management decisions in the subbasin.

- Promote recharge area protection to mitigate impacts of urban infrastructure and sources of groundwater contamination that could reduce recharge potential.

3.5.3 Component 3C: Management and Mitigation of Contaminated Groundwater

In general, groundwater is of high quality and meets drinking water standards in the Vacaville area.

In the more publicized arena of hazardous chemical contamination that falls under the purview of the Regional Water Quality Control Board and sometimes other state or federal agencies, there have been localized instances of impacts on groundwater quality; however, these do not constrain existing or potential municipal supplies. This Plan includes active monitoring of groundwater quality and active participation with local health and other agencies as appropriate to identify spills, leaks or other threats to groundwater quality, and to participate in their control and cleanup such that groundwater quality is not impacted and does not limit water supply. Mitigation measures will be employed (well construction, placement, treatment, etc.) as an element of developing groundwater supplies in order to reduce nitrate concentrations and other constituent concentrations if they exceed drinking water standards, as necessary.

When groundwater remediation activities involve groundwater extraction, remediated groundwater may be discharged to Publicly Owned Treatment Works (POTW) with permitting authority through the POTW program and the appropriate regulatory agency approvals, including the Regional Water Quality Control Board and the State Water Resources Control Board. Remediated groundwater may also be discharged to surface water, applied to land, recycled, or otherwise beneficially used or discharged, with all required agency approvals and permits.

The Solano County Environmental Health Services Division has local oversight for groundwater protection through the Underground Storage Tank (UST) and Hazardous Materials programs. The UST regulations provide groundwater protection through annual integrity testing and stringent tank requirements.

Prevention is the most important factor in minimizing groundwater contamination. The City promotes public awareness of the importance of preventing water pollution through its web site and other outreach tools.

Actions

- Identify short and longer-term water quality trends and actions needed to sustain a supply of good quality groundwater.

- Employ BMPs to limit potential sources of contamination in the environment.

- Coordinate with the County Environmental Health Services Division and other land use/regulatory agencies to develop a method for identifying contamination concerns and mitigating public water supply contamination.
    - Identify locations of point sources of contamination.
    - Identify major nonpoint sources of contamination.
    - Mitigate potential impacts on groundwater quality resulting from point or nonpoint sources of contamination.
    - Identify short and longer-term water quality trends and actions needed to sustain a supply of good quality groundwater.

- Coordinate with other SWA members and the County Environmental Health Services Division to assess the quality of groundwater used by private well owners in the subbasin.

3.5.4 Component 3D: Long-Term Salinity Management Programs

In general, groundwater quality in the Solano Subbasin is such that groundwater supplies meet standards for beneficial uses in the basin, which include primarily Municipal and Domestic Supply and Agricultural Supply. There also have been no notable historical trends of groundwater quality degradation in the Solano Subbasin over time. However, several factors suggest that observations and interpretation of groundwater quality warrant attention to ensure long-term preservation of groundwater quality. Notable among these factors are: 1) historical and current agricultural irrigation practices, 2) other historical and current land uses that have contributed or can contribute higher salt concentrations than other sources of water supply in the basin (including, but not limited to, water softeners), 3) the presence of high water tables which cause increased soil salinity due to evaporation in some areas, and 4) tidal influences in the Sacramento-San Joaquin Delta. The combination of these factors suggests that, on a long-term basis, there could be an accumulation of dissolved minerals in the aquifer system if salinity is not managed in a way to avoid undesirable groundwater quality degradation. Consequently, this component is included in the overall Groundwater Management Plan to include the interpretation of groundwater quality data and to incorporate groundwater quality as an important consideration in the implementation of the other Plan components, most notably continuation of conjunctive use operations, integration of recycled water, and management and mitigation of contaminated groundwater. The long-term salinity management component is essential to accomplishing the third management objective of preserving groundwater quality in the basin.

Actions

- Implement measures to avoid salt accumulation and other adverse changes in groundwater chemistry in the subbasin.

3.6 COMPONENT CATEGORY 4: AGENCY COORDINATION AND PUBLIC OUTREACH

3.6.1 Component 4A: Continuation of Local, State, and Federal Agency Relationships

The City has long-established working relationships with local and state agencies that will continue on an ongoing basis. The City will continue to interact with state agencies, particularly DWR, on the operation of the SWP and the agreement with DWR for Settlement water. The availability of surface water resources is key to continued conjunctive use operations in the future. The City has a historical and ongoing working relationship with local agencies, as well as with other local groundwater pumpers, to manage supplies to effectively meet water demands within the available yields of imported surface water and local groundwater.

The joint powers authority process that led to the formation of the SWA is a classic illustration of local agency partnering that has produced the beginnings of integrated regional water resources management. As a result of the willingness of the SWA members to seek opportunities to work together and develop programs that mutually benefit the region as well as their individual communities, these agencies prepared and executed the SWA-4 Project that initiated a collaborative and integrated approach to several of the aspects of groundwater resource management that are now included in this Plan. As a result of the SWA-4 Project, the member agencies have the capability to integrate their database management efforts, develop a regional monitoring network, and prepare reports on groundwater conditions in the subbasin.

In 2004 and 2005, SCWA coordinated meetings and other exchanges between local agencies (including the City, SID, MPWD, and RD 2068) with adopted groundwater management plans. The purpose was to identify common elements that could be used by each agency to update its individual plan to be consistent with the amended Water Code. Periodic review and update of the plans is planned to be coordinated with the SCWA member agencies.

The SWA-4 members are especially engaged in collaborative activities that are directed toward an integrated regional approach to groundwater resources management. The SWA-4 members also have the opportunity to inform citizens in their service areas of groundwater management activities, including plan updates and opportunities for the public to attend meetings and/or provide comments on any issues of concern regarding groundwater in the northern Solano County area.

In 2005, SCWA adopted an IRWMP, which identifies and prioritizes water related actions for the Solano County agencies, including the City. One of the highest priorities of the IRWMP is continuation of conjunctive use and associated groundwater management. This Plan component is included to formalize the historical local and state agency working relationships as part of comprehensively managing local groundwater, in concert with imported surface water and local recycled water, to accomplish all the management objectives for the basin.

Actions

- Continue to develop working relationships with local, state, and federal agencies (regulatory and other) to achieve broader local and regional benefits.

- Continue to pursue grant opportunities in cooperation with SCWA to fund basin management activities and regional water projects including the planned IRWMP for the Westside Subregion that encompasses Solano County and other counties.

3.6.2 Component 4B: Public Outreach

The purpose of the Plan is to maintain a high quality, reliable, and sustainable water supply for the citizens of Vacaville. To accomplish this, the Plan components describe how the City intends to manage its water resources in support of four principle BMOs directed toward the sustainability of groundwater supplies. As the City is managing its water resources as a service to the local citizenry, the City is committed to engaging the public in awareness of the Plan's purpose and objectives.

The City plans to promote public awareness of the Plan through printed media, including bill inserts and periodic news releases.

Actions

- Continue public involvement process through the use of City Council meetings that periodically include updates on water resources management activities by the City.

- Continue public outreach through the use of the City's web site, bill inserts, radio spots, and printed media. These notices will include contact information so that interested parties can request additional information, ask questions, or provide comments on water resources management activities.

3.6.3 Component 4C: Water Awareness Education

The City of Vacaville is committed to implementing water awareness and conservation programs. The UWMP contains descriptions of the measures that the City has implemented, plans to implement, or intends to study (Nolte, 2005).

The City uses a variety of communication tools to provide for public information and involvement. These tools include: press announcements and newspaper advertisements; radio spots; public workshops; City web site posting with a dedicated water conservation section to promote water conservation practices and water rate information; billing software that shows each customer's water use over the last 12 months; cooperative exhibits, demonstration sites, library displays, and a water model used for public meetings and school education; public information through regional projects; speakers for community groups and the media; and coordination with other government agencies, industry groups, public interest groups, and the media.

This Plan component will be incorporated with educational and outreach materials to complement other Plan components, including the Water Conservation component. This update of the City's Plan will continue to include public education and water awareness programs directed toward achievement of the four BMOs.

Actions

- Continue water awareness education programs.

3.7 COMPONENT CATEGORY 5: PLAN IMPLEMENTATION AND UPDATES

3.7.1 Component 5A: Plan Implementation and Reporting

Action Plan

Table 3-3 summarizes the action items discussed under each Plan component and the implementation schedule for each item. Action items planned to be completed within two years are labeled "short-term" actions, and items expected to require more than two years to complete are labeled "long-term" actions. Action items that represent on-going groundwater management activities conducted by the City are labeled "continuing" actions.

Provisions to Cooperate with Other Agencies

The IRWMP adopted by SCWA in 2005 identifies and prioritizes regional water-related actions for the Solano County agencies, including the City. Highest priority actions identified in the IRWMP include quantifying countywide water demand and supply, increasing opportunities for conjunctive use, increasing the use of groundwater as part of conjunctive use operations, and implementation of water use efficiency programs (CDM, 2005). The City supports implementation of the current IRWMP and also efforts to develop a new IRWMP for the Westside Subregion.

As a member of the SWA-4 Project, the City will update other members on its groundwater monitoring and management activities. Updates to SWA-4 members include information and data transfer via reports and data exchanges as further described below.

Groundwater Management Reports

As described in the Introduction to this Plan, local groundwater management planning already includes, among several other activities, analysis of groundwater conditions and preparation of periodic reports on groundwater and all other aspects of water resources and water supplies within the Solano Subbasin in the vicinity of the City of Vacaville. In addition, the City updated its UWMP (Nolte, 2005) in 2005 and finalized a comprehensive report on groundwater conditions, including recommendations for additional groundwater and subsidence monitoring (LSCE, 2010).

Beginning in the 1980s, the City has prepared several reports to describe its groundwater utilization and summarize groundwater level and quality trends. The City plans to produce future reports on an annual basis to describe the status of management actions performed and/or recommended, including monitoring–related and other cooperative activities with other Solano County entities or state or federal agencies. These annual reports will include summaries of monitoring data collected during the previous year, including groundwater conditions (groundwater levels, quality, and production) and land subsidence data. The reports will include data collected through spring (March 31st) so that water level recovery during the winter months can be evaluated. The reports will also summarize current water requirements, use of local groundwater and imported surface water from the Solano Project and the SWP to meet those requirements, and other appropriate details about water requirements and supplies such as, for example, the status of introducing recycled water as a component of non-potable water supply. As appropriate, other more detailed technical reports on various aspects of Plan implementation and reports prepared in coordination with others, such as SCWA and/or SWA, would complement the City's annual management reports.

Actions

- Cooperate with other agencies.
  - Provide copies of adopted Plan, and related reports, to SCWA/SWA members.
  - Support the IRWMP, including implementation of priority objectives of the IRWMP.

- Prepare groundwater management reports.
  - Prepare annual groundwater management reports to be completed by August 1st. Reports will summarize activities conducted by the City to implement the components of the Plan and will include a summary of monitoring data collected through spring (March 31st).
  - Coordinate with SWA to prepare an update of groundwater conditions in the subbasin every five years.

3.7.2 Component 5B: Provisions to Update the Groundwater Management Plan

The components of this Plan reflect the current understanding of the occurrence of groundwater in the Solano Subbasin in the vicinity of Vacaville and specific problems or areas of concern about that resource. The Plan components are designed to achieve specified objectives to utilize local groundwater for regular water supply while both protecting and preserving groundwater quantity and quality. While the Plan provides a framework for present and future actions, new data will be developed as a result of Plan implementation. That new data could identify conditions which will require modifications to currently definable management actions. As a result, this Plan is intended to be a flexible document that can be updated to modify existing components and/or incorporate new components as appropriate in order to recognize and respond to future groundwater conditions. Review and update of this Plan would initially occur in about five years, or sooner if necessary. Subsequent future updates would be similarly scheduled. SWA members would be apprised of future updates to the City's Plan to ensure that the City's Plan is consistent with BMOs and management actions being implemented by others utilizing water resources within the same basin/subbasin. The City will also conduct outreach to encourage public participation in future Plan updates.

Actions

- Review and update Plan every five years or more often as needed.

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TABLES

Table 2-1

City of Vacaville Water Supply[1]

Source	Surface-Water Entitlement (ac-ft)	Normal Year		Single-Dry Year		Multiple-Dry Year	
		Percent Available	(ac-ft)	Percent Available	(ac-ft)	Percent Available	(ac-ft)
Solano Project							
Vacaville Entitlement	5,750	99	5,693	98	5,635	89	5,118
SID Agreement[2]	2,500	99	2,475	98	2,450	89	2,225
State Water Project							
Vacaville Entitlement	6,100	64	3,904	63	3,843	33	2,013
KCWA Agreement	2,878	64	1,842	63	1,813	33	950
Settlement Water	9,320	100	9,320	100	9,320	100	9,320
Groundwater[3]		100	7,000	120	8,400	110	7,700
Total	26,548		30,233		31,461		27,325

1. Source: Memorandum from David B. Okita (General Manager) to City/District Urban Agencies Subject - UWMP Reliability Data. August 10, 2010.
2. From: City of Vacaville General Plan Update - Water Supply and Service in Vacaville (In Process), http://www.vacavillegeneralplan.org.
3. Based on: Luhdroff & Scalmanini Consulting Engineers. Sept. 2003, *City of Vacaville, SB 610 Water Supply Assessment Groundwater Source Sufficiency.*

Table 2-2
City of Vacaville Water Supply Summary (Acre-Feet/Year)

		2008		2009		2010	
Source Agency	**Description**	**Allocated**	**Used**	**Allocated**	**Used**	**Allocated**	**Used**
Solano Project	Vacaville Entitlement	5750	0	5750	0	5750	0
Solano Project	Carryover	5230	4553	7428	2433	9793	2
Solano Project	SID Exchange	0	0	3000	3000	2500	2500
Solano Project	SID Exchange (M&I carryover)	0	0	678	678	527	527
State Water Project	Table A	3142	3142	3591	2276	4489	3513
State Water Project	Carryover	1960	1960	0	0	1520	1520
State Water Project	Benecia Exchange	1343	1343	0	0	0	0
State Water Project	Article 21	0	0	771	771	1040	1040
State Water Project	Settlement Water (E)	682	682	0	0	0	0
State Water Project	Settlement Water (B)	8638	1097	9320	3362	9320	1481
City of Vacaville	Groundwater Pumping		5784		4647		5068
	Total	26745	18561	30538	17167	34652	15651

Table 2-3
City of Vacaville Water Supply Sources in Normal Year
(acre-feet) [3]

Source	2010	2015	2020	2025	2050
Solano Project					
Vacaville Entitlement	5,693	5,693	5,693	5,693	5,693
SID Agreement[1]	2,475	3,094	4,084	5,569	9,850
State Water Project					
Vacaville Entitlement (Table A)	3,904	3,904	3,904	3,904	3,904
KCWA Agreement	1,842	1,842	1,842	1,842	1,842
Settlement Water	9,320	9,320	9,320	9,320	9,320
Groundwater[2]	8,000	8,000	8,000	8,000	8,000
Total	31,234	31,853	32,843	34,328	38,609

1. From: City of Vacaville General Plan Update - Water Supply and Service in Vacaville (In Process), http://www.vacavillegeneralplan.org.
2. Based on: Luhdroff & Scalmanini Consulting Engineers. Sept. 2003, *City of Vacaville, SB 610 Water Supply Assessment Groundwater Source Sufficiency.*
3. Source: *2010 Draft Urban Water Management Plan*. Vander Meadows Draft, W.S.A.R.

Table 2-4
City of Vacaville Annual Well Production (acre-feet)

Year	Elmira Road			Northeast Sector			All Wells		
	Basal Zone (Wells 2-13)	Non-Basal Zone (Well 1)	Total	Basal Zone (Wells 14-16)	Non-Basal Zone (DeMello)	Total	Basal Zone (Wells 2-16)	Non-Basal Zone (Well 1 & DeMello)	Total
1968									2862
1969									3046
1970									2871
1971									3198
1972									3255
1973									3125
1974	2,870	446	3,316				2,870	446	3,316
1975	3,492	478	3,970				3,492	478	3,970
1976	4,525	440	4,965				4,525	440	4,965
1977	4,725	368	5,093				4,725	368	5,093
1978	4,667	353	5,020				4,667	353	5,020
1979	5,858	327	6,185				5,858	327	6,185
1980	6,595	395	6,990				6,595	395	6,990
1981	7,540	200	7,740				7,540	200	7,740
1982	7,429	254	7,683				7,429	254	7,683
1983	7,751	273	8,024				7,751	273	8,024
1984	6,067	22	6,089				6,067	22	6,089
1985	5,709	144	5,853				5,709	144	5,853
1986	5,595	229	5,824				5,595	229	5,824
1987	6,085	151	6,236				6,085	151	6,236
1988	5,292	129	5,421				5,292	129	5,421
1989	5,897	148	6,045				5,897	148	6,045
1990	5,519	106	5,625				5,519	106	5,625
1991	5,298	149	5,447				5,298	149	5,447
1992	5,405	126	5,531				5,405	126	5,531
1993	4,395	0	4,395				4,395	0	4,395
1994	3,889	4	3,893				3,889	4	3,893
1995	3,856	30	3,886				3,856	30	3,886
1996	3,128	102	3,230				3,128	102	3,230
1997	3,240	14	3,254	132		132	3,372	14	3,386
1998	3,369	34	3,403	502		502	3,871	34	3,905
1999	3,288	33	3,321	775		775	4,063	33	4,096
2000	4,278	52	4,330	811		811	5,089	52	5,141
2001	5,162	113	5,275	939		939	6,101	113	6,214
2002	5,564	101	5,665	973		973	6,537	101	6,638
2003	5,456	93	5,549	919	160	1,079	6,375	253	6,628
2004	5,130	107	5,237	1,325	60	1,385	6,455	167	6,622
2005	4,862	96	4,959	1,722	0	1,722	6,584	96	6,680
2006	4,840	95	4,934	1,701	0	1,701	6,541	1,701	6,635
2007	4,590	101	4,691	1,920	0	1,920	6,511	101	6,612
2008	3,575	92	3,667	2,116	0	2,116	5,692	92	5,784
2009	2,644	54	2,698	1,946	0	1,946	4,593	54	4,647
2010	2,902	69	2,971	2,097	0	2,097	4,999	69	5,068

Table 2-5
Groundwater Quality Northern Solano County

Well Name	Date	EC (µmho/cm) 900 b	TDS (mg/L) 500 b	pH 6.5/8.5 b	Total Alkalinity [1] (mg/L)	Cations: Ca (mg/L)	Mg (mg/L)	Na (mg/L)	K (mg/L)	Anions: SO_4 (mg/L) 250 b	Cl (mg/L) 250 b	HCO_3 [1] (mg/L)	NO_3 [1] (mg/L) 45a	F (mg/L) 2 a	Trace Elements: Al (µg/L) 1000 a	As (µg/L) 10a	B (mg/L) 1 c	Ba (mg/L) 1 a	Cr (µg/L) 50 a	Cr (VI) (µg/L)	Cu (mg/L) 1.3a	Fe (mg/L) 0.30b	Fe (f) (mg/L) 0.30 b	Mn (µg/L) 50 b	Mn (f) (µg/L) 50 b	Se (µg/L) 50a	Zn (mg/L) 5a
Well 01	2/18/1987	780	**530**	7.3	320	67	28	56	2.9	82	3	320	12	-	-	<4	-	0.11	<20	-	<0.02	<0.03	-	<10	-	<2	<0.01
Well 01	6/19/1990	790	**540**	7.6	310	72	25	55	2.5	69	35	310	13	-	<100	<10	-	<0.1	<10	-	<0.05	<0.1	-	<30	-	<5	<0.05
Well 01	1/1/1994	-	**520**	-	-	-	-	-	-	-	20	-	11	-	-	3	-	-	ND	-	-	-	-	-	-	ND	-
Well 01	1/1/1997	-	-	-	-	-	-	-	-	-	21	-	14.2	-	-	4	-	-	ND	-	-	-	-	-	-	15	-
Well 01	1/1/1999	-	-	-	-	-	-	-	-	-	-	-	12.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 01	4/29/1999	815	**500**	7.3	326	85.1	26.6	54.1	2.6	62	23	398	12.8	-	ND	2.6	-	ND	23	-	ND	ND	-	2.2	-	ND	ND
Well 01	10/31/2000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	ND	-	-	-	-	-	-	-	-
Well 01	11/1/2000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.5	-	-	-	-	-	-	-
Well 01	1/1/2001	-	-	-	-	-	-	-	-	-	-	-	12.8	-	-	-	-	-	2.3	-	-	-	-	-	-	-	-
Well 01	5/17/2001	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	ND	1.5	-	-	-	-	-	-	-
Well 01	1/1/2002	-	-	-	-	-	-	-	-	-	-	-	12.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 01	3/7/2002	789	**530**	7.4	331	87	27	59	2.8	63	23	404	12.76	-	ND	2.1	0.2	ND	ND	1.7	ND	ND	-	ND	-	ND	ND
Well 01	5/27/2003	-	-	-	-	-	-	-	-	-	-	-	12.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 01	3/16/2005	656	**530**	7.4	322	87	28	57	2.9	65	24	-	12	-	-	<2	-	-	<10	-	<0.05	<0.1	-	<20	-	<5	<0.05
Well 01	1/25/2006	-	-	-	-	-	-	-	-	-	-	-	13.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 01	3/14/2007	-	-	-	-	-	-	-	-	-	-	-	12.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 01	1/31/2008	846	**546**	7.7	305	51	23	47	2.7	63	23	-	12.4	-	ND	1.4	0.16	0.094	3.8	-	ND	ND	-	ND	-	ND	ND
Well 02	2/18/1987	520	390	7.3	220	39	21	44	3.6	47	16	220	11	-	-	<4	-	<0.1	<20	-	<0.02	<0.03	-	<10	-	<2	<0.01
Well 02	6/17/1991	540	310	7.8	204	39	20	48	2.3	36	15	204	7.8	-	<100	<10	-	<0.1	<10	-	<0.05	<0.1	-	<30	-	<5	<0.05
Well 02	1/1/1993	-	-	-	-	-	-	-	-	-	-	-	9.3	-	-	ND	-	-	ND	-	-	-	-	-	-	5	-
Well 02	3/29/1993	-	-	-	-	-	-	-	-	-	-	-	8.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 02	6/21/1993	-	-	-	-	-	-	-	-	42	-	-	9.3	-	-	-	-	-	-	-	-	-	-	-	-	5	-
Well 02	1/1/1994	-	-	-	-	-	-	-	-	-	-	-	5.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 02	5/2/1994	570	380	7.3	220	53	22	51	3.5	46	16	130	9.5	-	<50	<5	-	0.1	<10	-	<0.05	<0.1	-	<30	-	<5	<0.05
Well 02	1/1/1996	-	370	-	-	-	-	-	-	-	19	-	27	-	-	ND	-	-	ND	-	-	-	-	-	-	ND	-
Well 02	1/1/1997	-	380	-	-	-	-	-	-	-	16	-	9.7	-	-	ND	-	-	ND	-	-	-	-	-	-	9	-
Well 02	1/1/1998	-	-	-	-	-	-	-	-	-	-	-	10.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 02	1/1/1999	-	-	-	-	-	-	-	-	-	-	-	15.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 02	6/3/1999	550	320	7.8	243	49.7	21.2	51.5	2	35.3	20.4	296	15.1	-	ND	1.9	-	ND	11	-	ND	ND	-	ND	-	ND	ND
Well 02	10/31/2000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-	-
Well 02	11/1/2000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4.7	-	-	-	-	-	-	-
Well 02	1/1/2001	-	370	-	-	-	-	-	-	-	-	-	11.1	-	-	ND	-	-	ND	5	-	-	-	-	-	-	-
Well 02	5/17/2001	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4.2	4.3	-	-	-	-	-	-	-
Well 02	1/1/2002	-	-	-	-	-	-	-	-	-	-	-	11.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 02	3/7/2002	558	370	7.4	216	51	21	44	3.3	42	16	263	11	-	ND	3	0.13	ND	6.2	4.7	ND	ND	-	ND	-	ND	ND
Well 02	5/27/2003	-	-	-	-	-	-	-	-	-	-	-	11.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 02	3/16/2005	486	380	7.6	223	53	22	46	3.3	43	17	-	11	-	-	2	-	-	<10	-	<0.05	<0.1	-	<20	-	<5	<0.05
Well 02	3/15/2006	-	-	-	-	-	-	-	-	-	-	-	13.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 02	5/10/2007	-	-	-	-	-	-	-	-	-	-	-	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 02	1/31/2008	616	380	8	161	85	28	59	2.9	40	19	-	13.3	-	ND	1.6	0.24	0.067	1.7	-	0.0035	0.035	-	ND	-	ND	ND
Well 03	3/30/1987	410	340	7.9	210	36	20	39	3.3	34	8	208	4	-	-	<4	-	0.12	20	-	<0.02	0.03	-	<10	-	<3	<0.01
Well 03	1/1/1992	-	-	-	-	-	-	-	-	-	-	-	ND	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 03	3/3/1992	520	320	7.9	200	33	24	47	3	45	12	200	<0.4	-	<100	<10	-	0.14	12	-	<0.05	<0.1	-	<30	-	<5	<0.05

Table 2-5 (continued)
Groundwater Quality Northern Solano County

Well Name	Date	EC (µmho/cm) 900 b	TDS (mg/L) 500 b	pH 6.5/8.5 b	Total Alkalinity [1] (mg/L)	Cations: Ca (mg/L)	Cations: Mg (mg/L)	Cations: Na (mg/L)	Cations: K (mg/L)	Anions: SO_4 (mg/L) 250 b	Anions: Cl (mg/L) 250 b	Anions: HCO_3 [1] (mg/L)	Anions: NO_3 [1] (mg/L) 45 a	Anions: F (mg/L) 2 a	Trace Elements: Al (µg/L) 1000 a	Trace Elements: As (µg/L) 10 a	Trace Elements: B (mg/L) 1 c	Trace Elements: Ba (mg/L) 1 a	Trace Elements: Cr (µg/L) 50 a	Trace Elements: Cr (VI) (µg/L)	Trace Elements: Cu (mg/L) 1.3 a	Trace Elements: Fe (mg/L) 0.30 b	Trace Elements: Fe (f) (mg/L) 0.30 b	Trace Elements: Mn (µg/L) 50 b	Trace Elements: Mn (f) (µg/L) 50 b	Trace Elements: Se (µg/L) 50 a	Trace Elements: Zn (mg/L) 5 a
Well 03	3/29/1993	-	-	-	-	-	-	-	-	-	-	-	5.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 03	6/21/1993	-	-	-	-	-	-	-	-	37	-	-	6.2	-	-	ND	-	-	16	-	-	-	-	-	-	6	-
Well 03	1/1/1994	-	-	-	-	-	-	-	-	-	-	-	3.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 03	1/26/1995	480	320	7.6	200	42	21	41	4	38	11	120	6.6	-	<50	2	-	0.12	14	-	<0.05	<0.1	-	<30	-	<5	<0.05
Well 03	1/1/1996	-	340	-	-	-	-	-	-	-	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 03	3/20/1996	-	-	-	-	-	-	-	-	-	-	-	4.9	-	-	ND	-	-	ND	-	-	ND	-	ND	-	-	-
Well 03	1/1/1997	-	-	-	-	-	-	-	-	-	-	-	5.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 03	1/1/1998	-	-	-	-	-	-	-	-	-	-	-	5.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 03	4/29/1999	510	300	7.7	218	43.1	19.7	40.7	4.1	38	10	266	ND	-	ND	3.1	-	ND	26	-	ND	ND	-	ND	-	ND	ND
Well 03	8/24/2000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14	17	-	-	-	-	-	-	-
Well 03	10/31/2000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12	-	-	-	-	-	-	-	-
Well 03	11/1/2000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	15	-	-	-	-	-	-	-
Well 03	1/1/2001	-	330	-	-	-	-	-	-	-	9.9	-	6.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 03	2/15/2001	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	11	-	-	-	-	-	-	-	-
Well 03	5/17/2001	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14	14.4	-	-	-	-	-	-	-
Well 03	3/7/2002	506	330	7.7	218	46	20	40	4.3	37	9.9	266	6.6	-	ND	3	ND	ND	15	15.9	ND	ND	-	ND	-	ND	ND
Well 03	5/27/2003	-	-	-	-	-	-	-	-	-	-	-	6.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 03	3/16/2005	461	340	7.8	210	45	20	41	4.2	37	9.9	-	6.8	-	-	2.6	-	-	17	-	<0.05	<0.1	-	<20	-	<5	<0.05
Well 03	3/15/2006	-	-	-	-	-	-	-	-	-	-	-	4.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 03	3/14/2007	-	-	-	-	-	-	-	-	-	-	-	13.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 05	2/25/1986	570	380	7.3	240	54	22.6	56.8	-	56	24	240	2.7	-	-	<4	-	<0.05	<20	-	<0.02	<0.03	-	<10	-	<5	<0.01
Well 05	2/22/1989	654	400	7.5	230	54	22	58	2.1	62	26	230	12	-	-	<4	-	<0.06	20	-	<0.02	<0.03	-	<10	-	<2	<0.02
Well 05	3/3/1992	700	430	7.6	238	64	26	47	3	57	37	238	<0.4	-	<100	<10	-	<0.1	<10	-	<0.05	<0.1	-	<30	-	<5	<0.05
Well 05	1/1/1993	-	-	-	-	-	-	-	-	-	-	-	15.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 05	3/29/1993	-	-	-	-	-	-	-	-	-	-	-	14.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 05	6/21/1993	-	-	-	-	-	-	-	-	56	-	-	15.1	-	-	-	-	-	-	-	-	-	-	-	-	6	-
Well 05	1/1/1994	-	-	-	-	-	-	-	-	-	-	-	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 05	1/26/1995	610	410	7.5	240	61	25	54	3	52	28	140	13	-	<50	2	-	<0.1	<10	-	<0.05	<0.1	-	<30	-	<5	<0.05
Well 05	1/1/1996	-	460	-	-	-	-	-	-	-	30	-	13.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 05	1/1/1997	-	-	-	-	-	-	-	-	-	-	-	13.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 05	1/1/1998	-	-	-	-	-	-	-	-	-	-	-	16.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 05	1/1/1999	-	-	-	-	-	-	-	-	-	-	-	19.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 05	6/3/1999	685	410	7.9	248	63.8	26.3	57.8	3.2	63	36.9	302	19.7	-	ND	1.6	-	ND	8.8	-	ND	ND	-	ND	-	ND	0.021
Well 05	11/1/2000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.1	3.3	-	-	-	-	-	-	-
Well 05	1/1/2001	-	430	-	-	-	-	-	-	-	32	-	15.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 05	5/17/2001	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	ND	3.2	-	-	-	-	-	-	-
Well 05	3/7/2002	672	430	7.5	244	62	25	54	2.9	60	32	297	15.84	-	ND	2	0.27	ND	6.8	4.1	ND	ND	-	ND	-	ND	ND
Well 05	5/27/2003	-	-	-	-	-	-	-	-	-	-	-	16.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 05	3/16/2005	615	440	7.6	243	65	26	58	3.2	64	32	-	17	-	-	<2	-	-	<10	-	<0.05	<0.1	-	<20	-	<5	<0.05
Well 05	1/25/2006	-	-	-	-	-	-	-	-	-	-	-	16.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 05	3/14/2007	-	-	-	-	-	-	-	-	-	-	-	19.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 05	1/31/2008	774	476	7.7	265	67	27	58	3.2	66	33	-	18.2	-	ND	1.2	0.31	0.072	2.9	-	ND	ND	-	ND	-	ND	ND
Well 06	3/16/1988	542	340	7.7	220	44	19	48	4.3	36	11	220	7	-	-	<4	-	<0.07	<10	-	<0.02	<0.03	-	<10	-	<2	<0.01

Table 2-5 (continued)
Groundwater Quality Northern Solano County

						Cations				Anions					Trace Elements												
Well Name	Date	EC (µmho/cm)	TDS (mg/L)	pH	Total Alkalinity[1] (mg/L)	Ca (mg/L)	Mg (mg/L)	Na (mg/L)	K (mg/L)	SO_4 (mg/L)	Cl (mg/L)	HCO_3[1] (mg/L)	NO_3[1] (mg/L)	F (mg/L)	Al (µg/L)	As (µg/L)	B (mg/L)	Ba (mg/L)	Cr (µg/L)	Cr (VI) (µg/L)	Cu (mg/L)	Fe (mg/L)	Fe (f) (mg/L)	Mn (µg/L)	Mn (f) (µg/L)	Se (µg/L)	Zn (mg/L)
		900[b]	500[b]	6.5/8.5[b]						250[b]	250[b]		45[a]	2[a]	1000[a]	10[a]	1[c]	1[a]	50[a]		1.3[a]	0.30[b]	0.30[b]	50[b]	50[b]	50[a]	5[a]
Well 06	2/6/1991	550	360	7.7	226	37	21	45	2.5	39	13	226	6.1	-	<100	<10	-	<0.1	11	-	<0.05	<0.1	-	<30	-	<5	<0.05
Well 06	1/1/1994	-	350	-	-	-	-	-	-	-	11	-	5.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 06	1/1/1997	-	380	-	-	-	-	-	-	-	14	-	7.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 06	1/1/1999	-	-	-	-	-	-	-	-	-	-	-	10.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 06	4/29/1999	610	340	7.7	240	49.9	18.9	55.8	3.3	49	16	292	10.6	-	ND	1.9	-	ND	16	-	ND	ND	-	2.6	-	ND	ND
Well 06	10/31/2000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9.3	-	-	-	-	-	-	-	-
Well 06	11/1/2000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	11	-	-	-	-	-	-	-
Well 06	1/1/2001	-	360	-	-	-	-	-	-	-	12	-	6.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 06	5/17/2001	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	ND	9.8	-	-	-	-	-	-	-
Well 06	3/7/2002	533	360	7.8	222	48	19	48	4.6	40	12	270	6.6	-	ND	3	0.15	ND	12	11.2	ND	ND	-	ND	-	ND	ND
Well 06	5/27/2003	-	-	-	-	-	-	-	-	-	-	-	6.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 06	3/16/2005	465	360	7.9	218	46	17	55	4.3	41	13	-	6.7	-	-	2.4	-	-	10	-	<0.05	<0.1	-	<20	-	<5	<0.05
Well 06	1/25/2006	-	-	-	-	-	-	-	-	-	-	-	7.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 06	1/31/2008	586	382	8	231	48	19	50	4.6	43	15	-	7.1	-	ND	2.1	0.16	0.067	8.9	-	ND	ND	-	ND	-	ND	ND
Well 07	3/16/1988	541	350	7.8	230	40	19	53	5.4	32	11	230	4	-	-	<4	-	<0.08	<10	-	<0.02	<0.03	-	<10	-	<2	<0.01
Well 07	6/17/1991	640	380	7.8	240	43	18	66	6.3	44	18	240	4.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 07	8/2/1994	-	-	-	-	-	-	-	-	40	-	-	4.4	-	-	4	-	-	-	-	-	-	-	-	-	-	-
Well 07	1/1/1996	-	380	-	-	-	-	-	-	-	14	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 07	1/1/1997	-	350	-	-	-	-	-	-	-	14	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 07	1/1/1998	-	-	-	-	-	-	-	-	-	-	-	5.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 07	1/1/1999	-	360	-	-	-	-	-	-	-	-	-	4.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 07	4/29/1999	540	360	7.8	226	41.3	16.9	52.4	5.2	42	13	275	ND	-	ND	3.9	-	ND	19	-	ND	ND	-	ND	-	ND	ND
Well 07	10/31/2000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8.1	-	-	-	-	-	-	-	-
Well 07	11/1/2000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9.9	-	-	-	-	-	-	-
Well 07	1/1/2001	-	360	-	-	-	-	-	-	-	12	-	4.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 07	5/17/2001	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	ND	8.5	-	-	-	-	-	-	-
Well 07	3/14/2002	521	360	8	228	41	17	57	5.8	41	12	277	4.224	-	ND	4.1	0.17	ND	8.3	9.5	ND	ND	-	ND	-	ND	ND
Well 07	5/27/2003	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 07	3/16/2005	458	360	7.8	218	42	18	56	5.6	41	13	-	4.3	-	-	3.5	-	-	11	-	<0.05	<0.1	-	<20	-	<5	<0.05
Well 07	1/25/2006	-	-	-	-	-	-	-	-	-	-	-	5.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 07	3/14/2007	-	-	-	-	-	-	-	-	-	-	-	4.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 07	1/31/2008	580	384	7.9	228	43	18	59	6.1	43	14	-	4.4	-	ND	3.1	0.19	0.082	8	-	ND	ND	-	ND	-	ND	ND
Well 08	3/16/1988	588	360	7.7	220	47	23	47	3	43	16	220	13	-	-	<4	-	<0.08	<10	-	<0.03	<0.03	-	<10	-	<2	<0.04
Well 08	2/6/1991	530	360	7.5	223	42	18	48	5	37	10	223	5.6	-	<100	<10	-	<0.1	<10	-	<0.05	<0.1	-	<30	-	<5	<0.05
Well 08	1/1/1993	-	-	-	-	-	-	-	-	-	-	-	3.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 08	3/29/1993	-	-	-	-	-	-	-	-	-	-	-	13.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 08	6/21/1993	-	-	-	-	-	-	-	-	37	-	-	4	-	-	-	-	-	15	-	-	-	-	-	-	-	-
Well 08	1/1/1994	-	430	-	-	-	-	-	-	-	-	-	6.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 08	5/2/1994	630	430	7.5	240	59	-	63	4.7	45	17	150	10	-	<50	<5	-	0.12	<10	-	<0.05	<0.1	-	<30	-	<5	<0.05
Well 08	1/1/1996	-	400	-	-	-	-	-	-	-	17	-	9.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 08	1/1/1997	-	-	-	-	-	-	-	-	-	11	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 08	1/1/1998	-	-	-	-	-	-	-	-	-	-	-	10.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 08	1/1/1999	-	-	-	-	-	-	-	-	-	-	-	5.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 2-5 (continued)
Groundwater Quality Northern Solano County

Well Name	Date	EC (µmho/cm)	TDS (mg/L)	pH	Total Alkalinity[1] (mg/L)	Cations: Ca (mg/L)	Mg (mg/L)	Na (mg/L)	K (mg/L)	Anions: SO_4 (mg/L)	Cl (mg/L)	HCO_3[1] (mg/L)	NO_3[1] (mg/L)	F (mg/L)	Trace Elements: Al (µg/L)	As (µg/L)	B (mg/L)	Ba (mg/L)	Cr (µg/L)	Cr (VI) (µg/L)	Cu (mg/L)	Fe (mg/L)	Fe (f) (mg/L)	Mn (µg/L)	Mn (f) (µg/L)	Se (µg/L)	Zn (mg/L)
		900 [b]	500 [b]	6.5/8.5 [b]						250 [b]	250 [b]		45[a]	2 [a]	1000 [a]	10[a]	1 [c]	1 [a]	50 [a]		1.3[a]	0.30[b]	0.30 [b]	50 [b]	50 [b]	50[a]	5[a]
Well 08	10/28/1999	550	340	7.5	222	41.3	17.7	49.5	4.9	37.9	12.1	271	ND	-	ND	4.2	-	ND	30	-	0.005	ND	-	ND	-	ND	ND
Well 08	8/24/2000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7	9	-	-	-	-	-	-	-
Well 08	10/31/2000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10	-	-	-	-	-	-	-	-
Well 08	11/1/2000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12	-	-	-	-	-	-	-
Well 08	1/1/2001	-	350	-	-	-	-	-	-	-	11	-	4.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 08	2/8/2001	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.6	-	-	-	-	-	-	-	-
Well 08	2/15/2001	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	ND	-	-	-	-	-	-	-	-
Well 08	5/17/2001	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	ND	6.4	-	-	-	-	-	-	-
Well 08	3/14/2002	504	350	7.7	222	43	18	52	5.7	37	11	270	4.4	-	170	5.4	0.16	0.1	17	12.8	ND	-	-	ND	-	ND	ND
Well 08	5/27/2002	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	ND	-	-	-	-	-
Well 08	3/16/2005	451	360	7.7	215	41	18	49	5.5	37	10	-	4	-	-	3.8	-	-	13	-	<0.05	<0.1	-	<20	-	<5	<0.05
Well 08	1/25/2006	-	-	-	-	-	-	-	-	-	-	-	8.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 08	3/14/2007	-	-	-	-	-	-	-	-	-	-	-	4.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 08	1/31/2008	552	270	8	222	42	19	50	5.8	38	11	-	4.1	-	ND	3	0.17	0.088	11	-	ND	ND	-	ND	-	ND	ND
Well 09	1/30/1989	524	300	7.8	210	39	21	45	4.2	37	17	210	4	-	-	<4	-	0.11	20	-	<0.02	0.12	-	<30	-	<1	0.07
Well 09	3/2/1992	690	480	7.2	240	60	28	57	<3	96	17	240	<0.4	-	<100	<10	-	<0.1	<10	-	<0.05	<0.1	-	<30	-	<5	<0.05
Well 09	3/3/1992	-	-	-	-	-	-	-	-	-	-	-	-	-	-	ND	-	-	ND	-	-	-	-	-	-	-	-
Well 09	3/29/1993	-	-	-	-	-	-	-	-	-	-	-	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 09	6/21/1993	-	-	-	-	-	-	-	-	33	-	-	4	-	-	ND	-	0.1	ND	-	-	-	-	-	-	3	-
Well 09	1/1/1994	-	-	-	-	-	-	-	-	-	-	-	7.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 09	1/26/1995	490	330	7.6	200	39	23	45	3	43	11	120	4.9	-	<50	2	-	0.11	15	-	<0.05	<0.1	-	<30	-	<5	<0.05
Well 09	1/1/1996	-	340	-	-	-	-	-	-	-	10	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 09	3/20/1996	-	-	-	-	-	-	-	-	-	-	-	4	-	-	ND	-	-	ND	-	-	ND	-	ND	-	-	-
Well 09	1/1/1997	-	-	-	-	-	-	-	-	-	-	-	7.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 09	1/1/1998	-	-	-	-	-	-	-	-	-	-	-	5.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 09	1/1/1999	-	-	-	-	-	-	-	-	-	-	-	5.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 09	4/29/1999	-	-	-	-	-	-	-	-	-	-	-	5.3	-	-	3	-	-	30	-	-	ND	-	ND	-	-	-
Well 09	10/28/1999	515	320	7.6	206	37.4	20.6	45.1	3.2	44.1	11.3	251	ND	-	ND	3.1	-	ND	30	-	ND	ND	-	ND	-	ND	ND
Well 09	8/24/2000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	18	23	-	-	-	-	-	-	-
Well 09	10/31/2000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	15	-	-	-	-	-	-	-	-
Well 09	11/1/2000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	17	-	-	-	-	-	-	-
Well 09	1/1/2001	-	300	-	-	-	-	-	-	-	8.6	-	4.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 09	2/15/2001	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	18	-	-	-	-	-	-	-	-
Well 09	5/17/2001	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	16	17.9	-	-	-	-	-	-	-
Well 09	3/14/2002	454	300	7.8	209	36	20	41	4.1	31	8.6	255	4.048	-	ND	4.4	0.13	0.11	22	20.4	ND	ND	-	ND	-	ND	ND
Well 09	5/27/2003	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 09	3/16/2005	429	300	7.8	200	36	20	42	4.2	32	8.5	-	3.9	-	-	3.3	-	-	19	-	<0.05	<0.1	-	<20	-	<5	<0.05
Well 09	1/25/2006	-	-	-	-	-	-	-	-	-	-	-	10.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 09	5/10/2007	-	-	-	-	-	-	-	-	-	-	-	16.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 13	6/7/1990	530	340	7.9	230	44	21	43	2.6	40	16	230	7.7	-	50	<5	0.1	<0.1	<10	-	<0.05	<0.1	-	<30	-	<5	<0.05
Well 13	9/30/1991	540	370	7.74	210	2.5	2.06	2	<3	41	18	210	6.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 13	1/1/1992	-	480	-	-	-	-	-	-	-	-	-	ND	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 13	1/1/1994	-	330	-	-	-	-	-	-	-	13	-	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 2-5 (continued)
Groundwater Quality Northern Solano County

						Cations				Anions					Trace Elements												
Well Name	**Date**	**EC** (µmho/cm) 900[b]	**TDS** (mg/L) 500[b]	**pH** 6.5/8.5[b]	**Total Alkalinity**[1] (mg/L)	**Ca** (mg/L)	**Mg** (mg/L)	**Na** (mg/L)	**K** (mg/L)	**SO_4** (mg/L) 250[b]	**Cl** (mg/L) 250[b]	**HCO_3**[1] (mg/L)	**NO_3**[1] (mg/L) 45[a]	**F** (mg/L) 2[a]	**Al** (µg/L) 1000[a]	**As** (µg/L) 10[a]	**B** (mg/L) 1[c]	**Ba** (mg/L) 1[a]	**Cr** (µg/L) 50[a]	**Cr (VI)** (µg/L)	**Cu** (mg/L) 1.3[a]	**Fe** (mg/L) 0.30[b]	**Fe (f)** (mg/L) 0.30[b]	**Mn** (µg/L) 50[b]	**Mn (f)** (µg/L) 50[b]	**Se** (µg/L) 50[a]	**Zn** (mg/L) 5[a]
Well 13	1/1/1997	-	330	-	-	-	-	-	-	-	20	-	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 13	1/1/1999	-	310	-	-	-	-	-	-	-	-	-	8.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 13	4/29/1999	490	310	8.1	172	45.6	8.42	46.1	3.1	43	18	209	ND	-	ND	1.9	-	ND	16	-	0.028	ND	-	ND	-	ND	ND
Well 13	10/31/2000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.4	-	-	-	-	-	-	-	-
Well 13	11/1/2000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.8	-	-	-	-	-	-	-
Well 13	1/1/2001	-	360	-	-	-	-	-	-	-	19	-	11.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 13	5/17/2001	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	ND	7.8	-	-	-	-	-	-	-
Well 13	3/7/2002	553	360	7.7	219	47	23	46	2.8	43	19	267	11	-	ND	2	0.15	ND	ND	7.8	ND	ND	-	ND	-	ND	ND
Well 13	5/27/2003	-	-	-	-	-	-	-	-	-	-	-	11.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 13	3/16/2005	511	350	7.8	208	45	24	48	2.8	47	21	-	12	-	-	2	-	-	<10	-	<0.05	<0.1	-	<20	-	<5	<0.05
Well 13	1/25/2006	-	-	-	-	-	-	-	-	-	-	-	11.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 13	3/14/2007	-	-	-	-	-	-	-	-	-	-	-	5.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 13	1/31/2008	615	372	7.9	229	49	25	47	3.1	45	21	-	12	-	ND	1.6	0.18	0.083	8.2	-	ND	ND	-	ND	-	ND	ND
Well 14	10/20/1993	452	290	8	-	16	10	58	3.1	23	<0.5	230	3.1	-	<50	4.1	-	0.14	13	-	<0.02	0.075	-	<5	-	<1	<0.005
Well 14	1/1/1997	-	-	-	-	-	-	-	-	-	-	-	2.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 14	8/4/1997	460	280	8.2	190	17	12	74	4	30	10	190	2	-	ND	7	-	0.11	10	-	ND	0.11	-	ND	-	ND	ND
Well 14	1/1/1998	-	-	-	-	-	-	-	-	-	-	-	ND	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 14	6/4/1998	450	290	7.9	190	18	12	70	4	25	9	230	2	-	ND	6	-	0.1	20	-	ND	ND	-	ND	-	ND	ND
Well 14	8/28/1998	440	330	7.9	190	18	13	59	3	29	10	230	-	-	ND	5	-	0.1	20	-	ND	ND	-	ND	-	ND	ND
Well 14	8/31/1998	-	-	-	-	-	-	-	-	-	-	-	ND	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 14	1/1/1999	-	-	-	-	-	-	-	-	-	-	-	3.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 14	4/29/1999	440	280	8.1	197	20.6	13.7	60.2	3.1	26	8.3	240	ND	-	ND	5.4	-	0.13	28	-	0.0029	ND	-	ND	-	ND	ND
Well 14	1/1/2000	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 14	8/24/2000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	21	23	-	-	-	-	-	-	-
Well 14	10/31/2000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	17	-	-	-	-	-	-	-	-
Well 14	11/1/2000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	19	-	-	-	-	-	-	-
Well 14	1/1/2001	-	290	-	-	-	-	-	-	-	8.8	-	3.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 14	2/15/2001	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	21	-	-	-	-	-	-	-	-
Well 14	5/17/2001	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	19	20.3	-	-	-	-	-	-	-
Well 14	3/14/2002	441	290	8.1	199	21	14	62	3.4	25	8.8	242	3	-	ND	6.2	0.15	0.12	18	22.2	ND	ND	-	ND	-	ND	ND
Well 14	5/27/2003	-	-	-	-	-	-	-	-	-	-	-	ND	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 14	3/16/2005	393	280	8.1	193	21	14	61	3.3	26	7.8	-	2.9	-	-	4.8	-	-	20	-	<0.05	<0.1	-	<20	-	<5	<0.05
Well 14	1/25/2006	-	-	-	-	-	-	-	-	-	-	-	3.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 14	5/10/2007	-	-	-	-	-	-	-	-	-	-	-	3.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 14	1/31/2008	471	288	8.2	199	22	14	62	3.5	27	8.1	-	3	-	ND	3.9	0.17	0.12	17	-	ND	ND	-	ND	-	ND	0.065
MW-14	3/25/1993	453	290	8.1	190	17	12	66	3.5	29	10	240	2.2	-	740	<10	-	0.11	<10	-	<0.05	**1.3**	<0.03	**64**	<10	1.4	<0.05
Well 15	2/22/2001	440	300	8.1	210	20	12	73	3.8	23	8.9	-	2.5	-	-	3.9	0.22	-	20	12	<0.05	<0.1	-	<10	-	<5	<0.05
Well 15	3/16/2005	395	300	8	198	26	14	55	5.1	21	7.9	-	3.5	-	-	3.8	-	-	13	-	<0.05	<0.1	-	<20	-	<5	<0.05
Well 15	1/25/2006	-	-	-	-	-	-	-	-	-	-	-	3.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 15	5/10/2007	-	-	-	-	-	-	-	-	-	-	-	2.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Well 15	1/31/2008	483	298	8.1	197	21	12	70	4.2	24	8.2	-	3.1	-	ND	3.5	0.22	0.11	11	-	ND	ND	-	ND	-	ND	ND
MW-15-1815ft	1/6/1999	458	277	7.91	-	23.1	9.91	53.6	4.17	16.7	10.8	210	3.73	-	<50	<2	0.109	0.0691	<5	-	<0.005	**2.2**	0.261	27.4	28.9	<4	-

Table 2-5 (continued)
Groundwater Quality Northern Solano County

Well Name	Date	EC (µmho/cm)	TDS (mg/L)	pH	Total Alkalinity[1] (mg/L)	Cations: Ca (mg/L)	Mg (mg/L)	Na (mg/L)	K (mg/L)	Anions: SO_4 (mg/L)	Cl (mg/L)	HCO_3[1] (mg/L)	NO_3[1] (mg/L)	F (mg/L)	Trace Elements: Al (µg/L)	As (µg/L)	B (mg/L)	Ba (mg/L)	Cr (µg/L)	Cr (VI) (µg/L)	Cu (mg/L)	Fe (mg/L)	Fe (f) (mg/L)	Mn (µg/L)	Mn (f) (µg/L)	Se (µg/L)	Zn (mg/L)
		900 b	500 b	6.5/8.5 b						250 b	250 b		45a	2 a	1000 a	10a	1 c	1 a	50 a		1.3a	0.30b	0.30 b	50 b	50 b	50a	5a
Well 16	12/28/2004	475	290	8.3	206	13	12	81	2.4	26	6.9	-	1.9	-	-	7.1	0.29	-	22	18.3	<0.05	0.043	-	<10	-	<25	0.055
Well 16	2/8/2007	506	350	8.3	208	7.5	4.4	98	1.9	38	9.3	-	ND	-	ND	**13**	0.41	0.073	5	-	ND	ND	-	ND	-	ND	ND
Well 16	4/13/2007	470	-	-	218	14	12	84	2.2	29.7	9	218	0.5	-	-	8.5	-	-	-	-	-	-	-	-	-	-	-
Well 16	6/18/2007	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7.8	-	-	-	-	-	-	-	-	-	-	-
Well 16	9/28/2007	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7.8	-	-	-	-	-	-	-	-	-	-	-
Well 16	10/30/2007	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8.5	-	-	-	-	-	-	-	-	-	-	-
Well 16	11/28/2007	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8.7	-	-	-	-	-	-	-	-	-	-	-
Well 16	11/30/2007	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8.6	-	-	-	-	-	-	-	-	-	-	-
Well 16	12/4/2007	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8.2	-	-	-	-	-	-	-	-	-	-	-
Well 16	1/24/2008	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9.7	-	-	-	-	-	-	-	-	-	-	-
Well 16	1/30/2008	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7.8	-	-	-	-	-	-	-	-	-	-	-
Well 16	1/31/2008	495	308	8.2	198	14	12	82	2.3	30	7.9	-	1.9	-	ND	7.8	0.31	0.12	21	-	0.0037	ND	-	ND	-	ND	ND
Well 16	2/12/2008	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9.7	-	-	-	-	-	-	-	-	-	-	-
Well 16	3/12/2008	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9.9	-	-	-	-	-	-	-	-	-	-	-
Well 16	4/14/2008	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8.1	-	-	-	-	-	-	-	-	-	-	-
Well 16	5/27/2008	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7.9	-	-	-	-	-	-	-	-	-	-	-
Well 16	6/29/2008	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7.8	-	-	-	-	-	-	-	-	-	-	-
Well 16	7/19/2008	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7.5	-	-	-	-	-	-	-	-	-	-	-
Well 16	9/19/2008	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8.3	-	-	-	-	-	-	-	-	-	-	-
Well 16	11/13/2008	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8.7	-	-	-	-	-	-	-	-	-	-	-
MW-16-1430ft	11/19/2002	460	280	7.8	230	18	19	63	2.7	19	6.5	230	2.1	-	<50	7.4	0.18	0.21	**50**	-	<0.05	<0.1	-	<10	-	<25	<0.05
MW-16-1430ft	7/5/2007	470	302	-	234	19	21	53.4	2.5	15.94	6.73	337	0.63	-	<20	2.3	-	0.2	**50**	-	<0.002	-	-	-	-	<5	<0.02
MW-16-1464-1604	9/20/2002	490	330	8.3	200	8.7	6.6	110	2.1	42	11	200	<1	-	-	**11**	-	-	-	-	-	-	-	-	-	-	-
MW-98A	11/16/1998	500	271	7.67	-	21	27.3	40.3	3.15	16.8	8.24	242	2.24	-	<50	<3	0.111	0.214	24.2	-	<0.005	**1**	**0.461**	35.1	37.6	<4	<0.005
MW-98A	11/23/1999	477	296	7.93	-	21.6	27.3	38.8	3.18	16.4	7.72	253	-	-	-	-	-	-	-	-	<0.005	**1.29**	0.197	34	33.8	-	<0.005
MW-98B	1/13/1999	494	362	8.02	-	13.6	6.01	84	5.22	25.6	7.88	259	<0.1	-	<50	4.7	0.28	0.0672	<5	-	<0.005	**1.01**	**0.813**	45.6	47	<4	0.0345
MW-98C	1/29/1999	506	302	8.32	-	11.1	8.4	93.9	1.86	43	7.41	238	0.32	-	<50	<2	0.42	0.107	<5	-	<0.005	**0.788**	**0.774**	34	34.5	<4	<0.005
SCWA-Meridian MW-1680	6/4/2008	540	320	7.55	220	24	18	74	3.9	41	13	220	3.6	-	<50	3.3	0.22	<0.1	17	12	<0.05	<0.1	-	38	-	<5	<0.05
SCWA-MainePrairie MW-2170	4/29/2008	600	380	7.9	260	10	5.3	130	1.6	35	16	260	<2	-	<50	5.2	0.31	0.12	<10	<1	<0.05	<0.1	<0.1	38	37	<5	<0.05
SCWA-Allendale MW-1925	3/26/2008	620	360	7.58	230	23	37	62	3.9	61	17	230	<2	-	<50	3	0.39	0.12	13	11	<0.05	<0.1	<0.1	**63**	**63**	<5	<0.05
SCWA-Dixon MW-2212	10/1/2009	530	310	8.25	200	7.8	4.3	110	1.3	47	20	200	<2	-	<50	3.5	0.74	<0.1	<10	<1	<0.05	<0.1	<0.1	21	24	<5	<0.05
RNVWD MW-1389ft	9/9/1998	533	344	7.67	-	29.2	18.7	54	4.51	34.2	8.99	248	6.07	-	<50	6.3	0.125	0.0865	<5	-	<0.005	**1.06**	**0.43**	41.2	39	<4	<0.005

Table 2-5 (continued)
Groundwater Quality Northern Solano County

						Cations				Anions					Trace Elements												
Well Name	Date	EC (µmho/cm)	TDS (mg/L)	pH	Total Alkalinity[1] (mg/L)	Ca (mg/L)	Mg (mg/L)	Na (mg/L)	K (mg/L)	SO_4 (mg/L)	Cl (mg/L)	HCO_3[1] (mg/L)	NO_3[1] (mg/L)	F (mg/L)	Al (µg/L)	As (µg/L)	B (mg/L)	Ba (mg/L)	Cr (µg/L)	Cr (VI) (µg/L)	Cu (mg/L)	Fe (mg/L)	Fe (f) (mg/L)	Mn (µg/L)	Mn (f) (µg/L)	Se (µg/L)	Zn (mg/L)
		900 b	500 b	6.5/8.5 b						250 b	250 b		45a	2 a	1000 a	10a	1 c	1 a	50 a		1.3a	0.30b	0.30 b	50 b	50 b	50a	5a

1. HCO3 , Total Alkalinity and NO3 reported as HCO3 , CaCO3 and NO3 respectively.

a) Primary Drinking Water Standards for California and Federal Maximum Contaminant Levels

b) Secondary Drinking Water Standards for California and Federal Maximum Contaminant Levels

c) California State Notification Level

"-" Not Analyzed; ND = Non-Detect (Reporting Limit unknown)
For repeated sampling within a day, the maximum result for each constituent for the day is shown
Bold indicates value exceeds Water Quality Limit

Table 3-1
City of Vacaville Groundwater Monitoring Program[1]

Well Type	Well ID	Formation	Perforated Interval[2] (ft)	Water Levels		Water Quality[3]				Production	
				Manual	Electronic	General Mineral/ Physical	Inorganics	Organics	Nitrate	Manual	Electronic
	Well 1	Markley	Depth = 605	Semi-annual	-					-	SCADA
	Well 2	Basal & Middle Tehama	335-710	-	-					Daily	-
	Well 3	Basal & Middle Tehama	420-900	-	-					Daily	-
	Well 5	Basal Tehama	588-793							-	
	Well 6	Basal Tehama	752-932							-	
	Well 7	Basal Tehama	964-1004							-	
Production	Well 8	Basal Tehama	952-1192			Triennial	Triennial	Triennial	Annual	-	
	Well 9	Basal Tehama	1100-1430	Semi-annual	SCADA					-	SCADA
	Well 13	Basal & Middle	560-840							-	
	Well 14	Basal Tehama	1108-1663							-	
	Well 15	Basal Tehama	1206-1816							-	
	Well 16	Basal Tehama	1165-1610							-	
	DeMello	Upper Tehama	372-572		-					Daily	-
	MW-14	Basal Tehama	1100-1650		Transducer						
	MW-15-188'	Qal & Upper Tehama	158-178		-						
	MW-15-508'	Upper Tehama	438-498		-						
	MW-15-1815'	Basal Tehama	1207-1785		Transducer						
	MW-16-117'	Upper Tehama	97-107		-						
Monitoring[4]	MW-16-1176'	Basal Tehama	1136-1166	Semi-annual	-	NA	NA	NA	NA	NA	NA
	MW-16-1430'	Basal Tehama	1264-1374		Transducer						
	MW-98A	Basal Tehama	1727-1830		Transducer						
	MW-98B	Basal Tehama	1559-1798		-						
	MW-98C	Basal Tehama	2152-2305		Transducer						
	DeMello-MW-95'	Qal	65-85		-						

1. Does not include shallow monitoring wells at wastewater treatment plants.
2. Depth to top and bottom of perforated interval, if available. Otherwise, total well depth shown.
3. Does not include weekly monitoring of the distribution system for coliform bacteria, chloride residual, etc..
4. Transducers to be installed in monitoring wells before January 1, 2011.

NA - Not applicable

Table 3-2
Summary of SCWA Monitoring Well Construction

Well ID [1]	*Depth (ft)*	*Perforated Interval (ft)*	*Diameter (in)*	*Began Monitoring Water Levels*
Allendale 1235	1235	1205-1225	2.5	8/7/2008
Allendale 1345	1345	1315-1335	2.5	8/7/2008
Allendale 1925	1925	1877-1917	4/2[2]	8/7/2008
Dixon 1200	1200	1180-1190	2.5	11/13/2009
Dixon 2212	2212	2182-2202	4/2	11/13/2009
Dixon 2370	2370	2340-2360	4/2	11/13/2009
Maine Prairie 840	841	811-831	2.5	8/7/2008
Maine Prairie 1960	1960	1930-1950	4/2	8/7/2008
Maine Prairie 2170	2170	2140-2160	4/2	8/7/2008
Meridian 400	400	360-370	2.5	8/7/2008
Meridian 825	824	794-814	2.5	8/7/2008
Meridian 1680	1680	1650-1670	4/2	8/7/2008

1. See Appendix X for as-built construction drawings and additional construction details.
2. Four-inch diameter with reduction to two-inch diameter.

Table 3-3
Summary of Action Items

Plan Components and Action Items	Short-term[1]	Long-term[2]	Continuing[3]
CATEGORY 1: MONITORING PROGRAM			
1A. Elements of Monitoring Program			
• Continue City's existing monitoring program and complement with information gathered by other agencies			X
• Expand regional monitoring programs			
◦ Coordinate with SCWA regarding adequacy of regional groundwater monitoring networks and programs	X		
◦ Coordinate with SCWA on planned construction of additional monitoring facilities in northern Solano County	X		
◦ Coordinate with SCWA on implementation of land subsidence monitoring program	X		
1B. Evaluation and Reporting of Monitoring			
• Prepare brief annual summary of groundwater and land subsidence data collected through March 31st in groundwater management report to be completed each year by June 30th	X		
• Coordinate with SWA-4 on maintenance and utilization of regional monitoring database, including regular transfer of City data. Also coordinate with SWA on monitoring protocols used to evaluate data	X		
• Coordinate with SWA-4 regarding adequacy of regional evaluation and reporting of groundwater data (see Sect. 3.3.2)	X		
CATEGORY 2: WATER RESOURCE SUSTAINABILITY			
2A. Maintaining Stable Groundwater Levels			
• Continue to manage groundwater and surface water conjunctively to ensure that groundwater levels in Elmira Road wells recover to spring 1992-1993 "base year" levels during normal years			X
• Manage pumping away from Elmira Road to prevent progressive groundwater level declines		X	
• Continue groundwater development programs that optimize pumping distribution in City's urban planning area			X
2B. Determination of Sustainable Pumpage			
• Assess pumpage relative to sustainable yield of principal aquifer system			
◦ Update sustainable pumpage estimates with expanded monitoring data		X	
• Refine assessment of hydrogeologic conditions and conceptual model in preparation for future development of regional numerical groundwater flow model (see Section 3.4.2)		X	
• Discuss joint development of regional numerical groundwater flow model with SCWA and other entitles that overlie subbasin		X	

Table 3-3 (continued)
Summary of Action Items

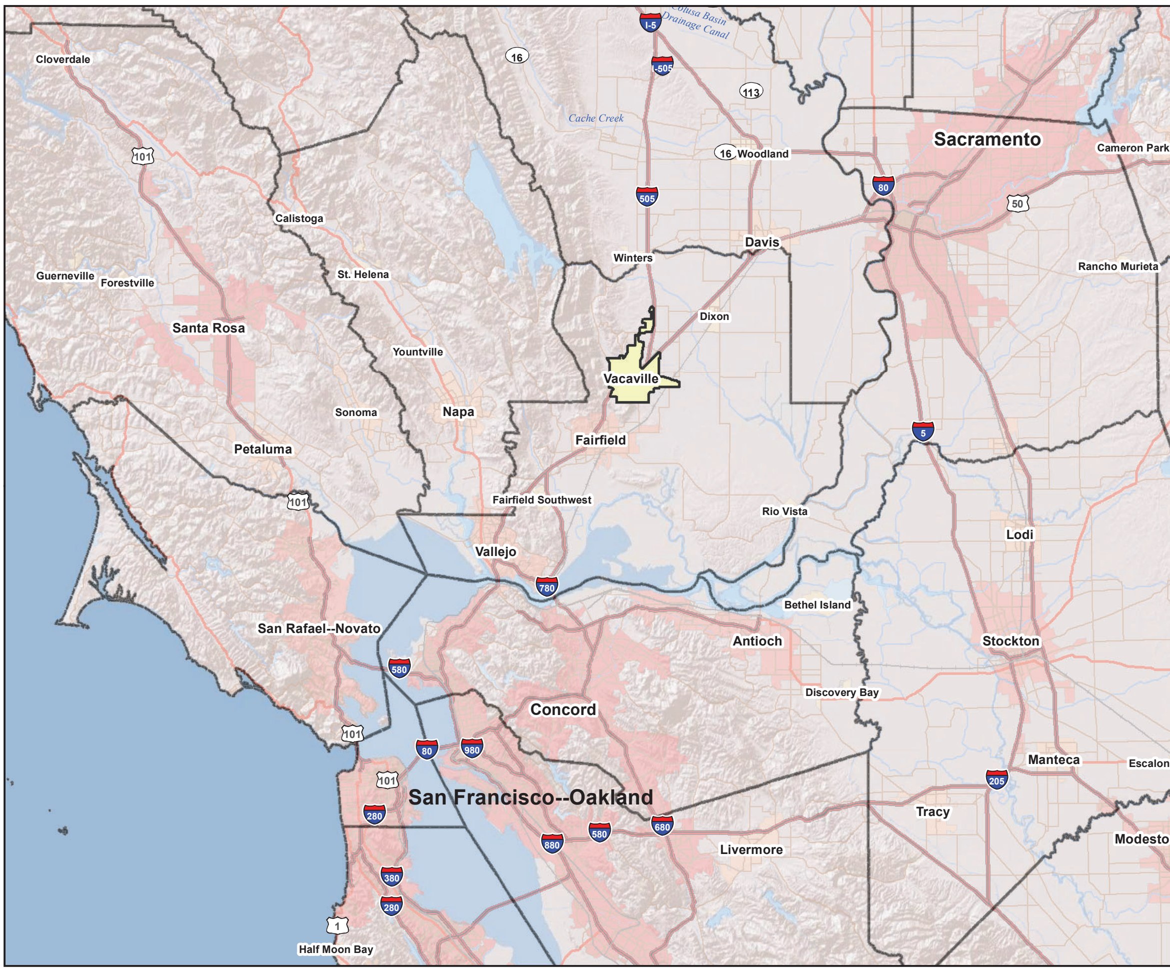
Plan Components and Action Items	Short-term	Long-term	Continuing
2C. Continuation of Conjunctive Use Operations			
• Continue City's conjunctive management of available water resources			X
• Coordinate with SCWA to explore other conjunctive use opportunities			
2D. Water Conservation			
• Continue to implement and promote water conservation programs			X
CATEGORY 3: GROUNDWATER RESOURCE PROTECTION			
3A. Well Construction and Destruction Policies			
• Continue current well construction and destruction policies			X
• Coordinate with other SCWA members on well construction and future resource utilization		X	
3B. Identification and Management of Recharge Areas and Wellhead Protection Areas			
• Employ wellhead protection measures to ensure long-term sustainability of good quality water			
○ Use DWSAP information, including delineation of source area and protection zones	X		
○ Require deep sanitary seal construction standards for municipal supply wells			X
○ Employ well destruction policy to prevent groundwater contamination			X
• Coordinate with other SCWA members regarding DWSAP analyses and other environmental assessments		X	
• Promote recharge area protection to mitigate impacts of urban infrastructure and sources of groundwater contamination		X	
3C. Management and Mitigation of Contaminated Groundwater			
• Identify short and longer-term water quality trends and actions needed to sustain supply of good quality groundwater		X	
• Employ BMPs to limit potential sources of contamination	X		
• Coordinate with County Environmental Health Services Division and other land use/regulatory agencies to identify and mitigate any public water supply contamination	X		
• Coordinate with SCWA members and County Environmental Health Services Division to assess quality of groundwater used by private well owners in subbasin		X	
3D. Long-Term Salinity Management Programs			
• Implement measures to avoid salt accumulation and other adverse changes in groundwater chemistry		X	

Table 3-3 (continued)
Summary of Action Items

Plan Components and Action Items	Short-term	Long-term	Continuing
CATEGORY 4: AGENCY COORDINATION AND PUBLIC OUTREACH			
4A. Continuation of Local, State, and Federal Agency Relationships			
• Continue relationships with local, state, and federal agencies to achieve broader local and regional benefits			X
• Continue to pursue grant opportunities with SCWA to fund basin management activities and regional water projects			X
4B. Public Outreach			
• Continue public involvement through City Council meetings that include updates on water resource management			X
• Continue public outreach on Plan activities through web site, bill inserts, radio spots, and printed media			X
4C. Water Awareness Education			
• Continue water awareness education programs			X
CATEGORY 5: PLAN IMPLEMENTATION AND UPDATES			
5A. Plan Implementation and Reports			
• Cooperate with other agencies			
○ Provide copies of adopted Plan, and related reports, to SCWA/SWA members	X		
○ Continue to support IRWMP, including implementation of priority objectives			X
• Prepare groundwater management reports			
○ Prepare annual groundwater management reports to be completed by August 1st. Reports will summarize activities conducted to implement Plan and include summary of monitoring data collected through March 31st	X		
○ Coordinate with SWA to prepare update of groundwater conditions in subbasin every five years		X	
5B. Provisions to Update the Groundwater Management Plan			
• Review and update plan every five years or more often as needed		X	

1. Short-term actions are items to be completed within two years.
2. Long-term actions are items expected to require more than two years.
3. Continuing are items that are ongoing groundwater management activities.

FIGURES



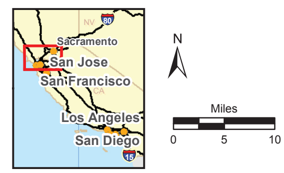


Figure 1-1
City of Vacaville
Location Map

LUHDORFF & SCALMANINI
CONSULTING ENGINEERS

File: Y:\Casey_Meirovitz\10-1-124 Vacaville GWMP Update\Report\GIS\Figure 1-1 City of Vacaville Location Map.mxd Date: 12/15/2010

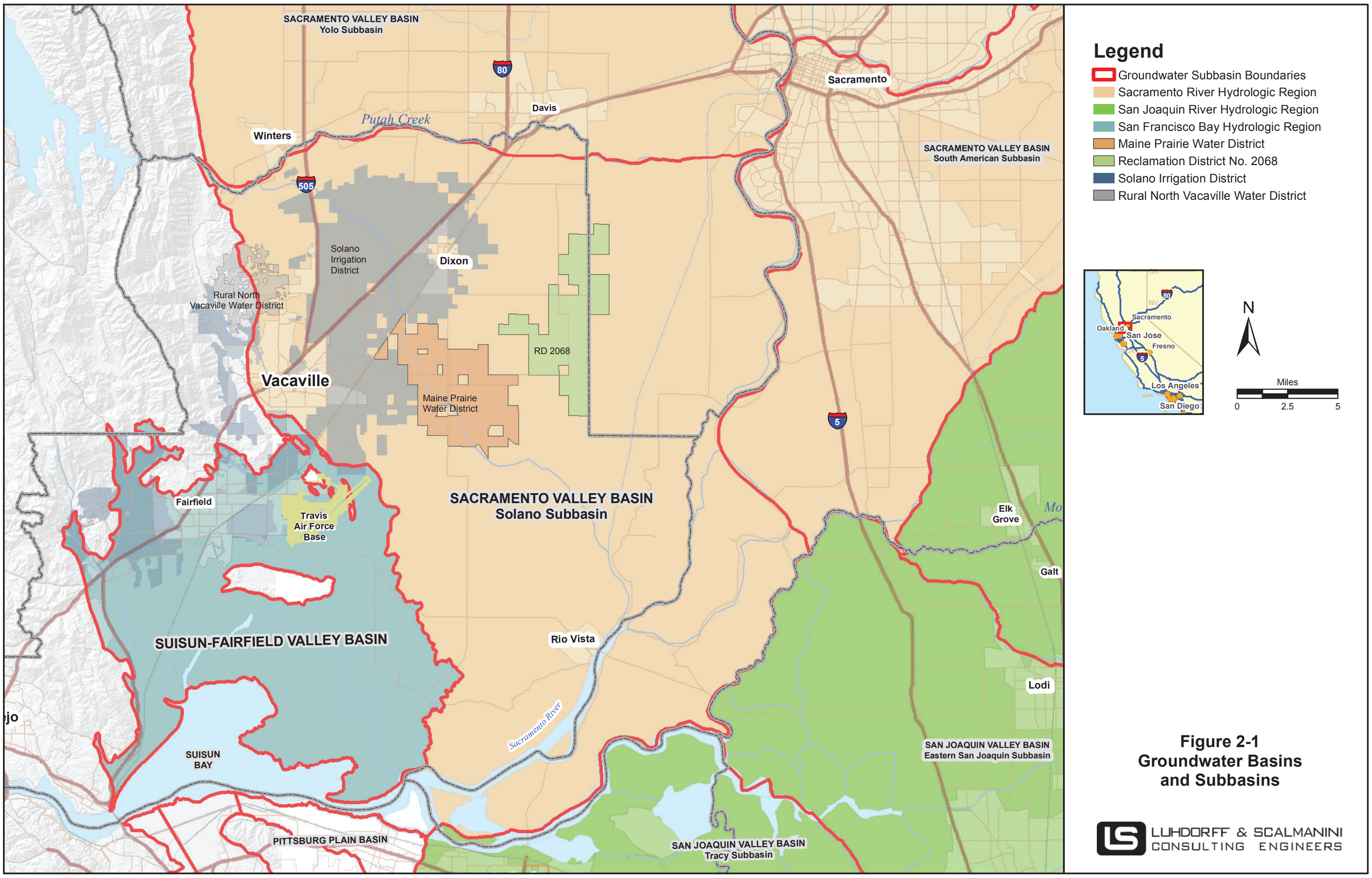


Figure 2-1
Groundwater Basins and Subbasins

File: Y:\Casey_Meirovitz\10-1-124 Vacaville GWMP Update\Report\GIS\Figure 2-1 Groundwater Basins and Subbasins.mxd Date: 12/15/2010

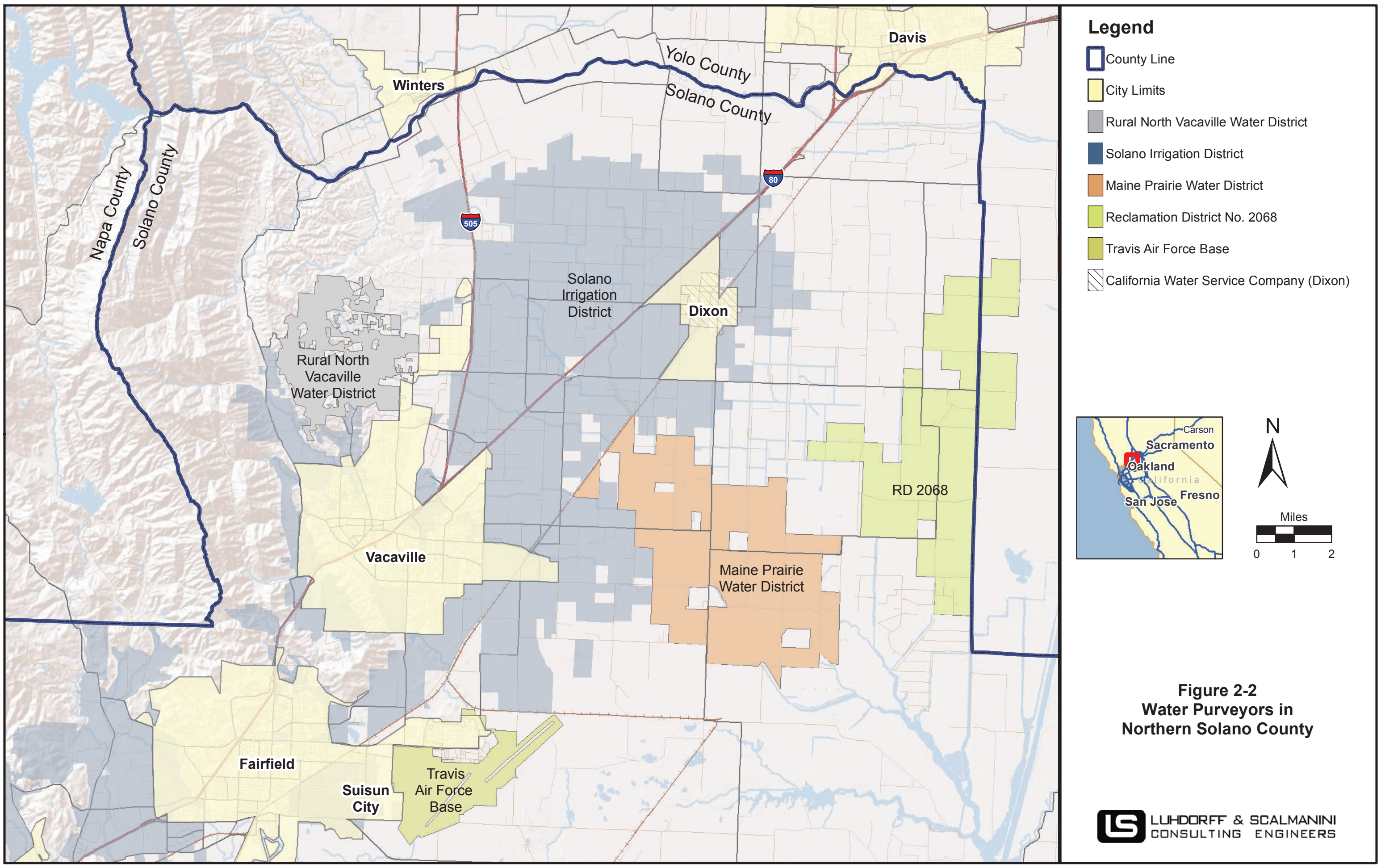


Figure 2-2
Water Purveyors in Northern Solano County

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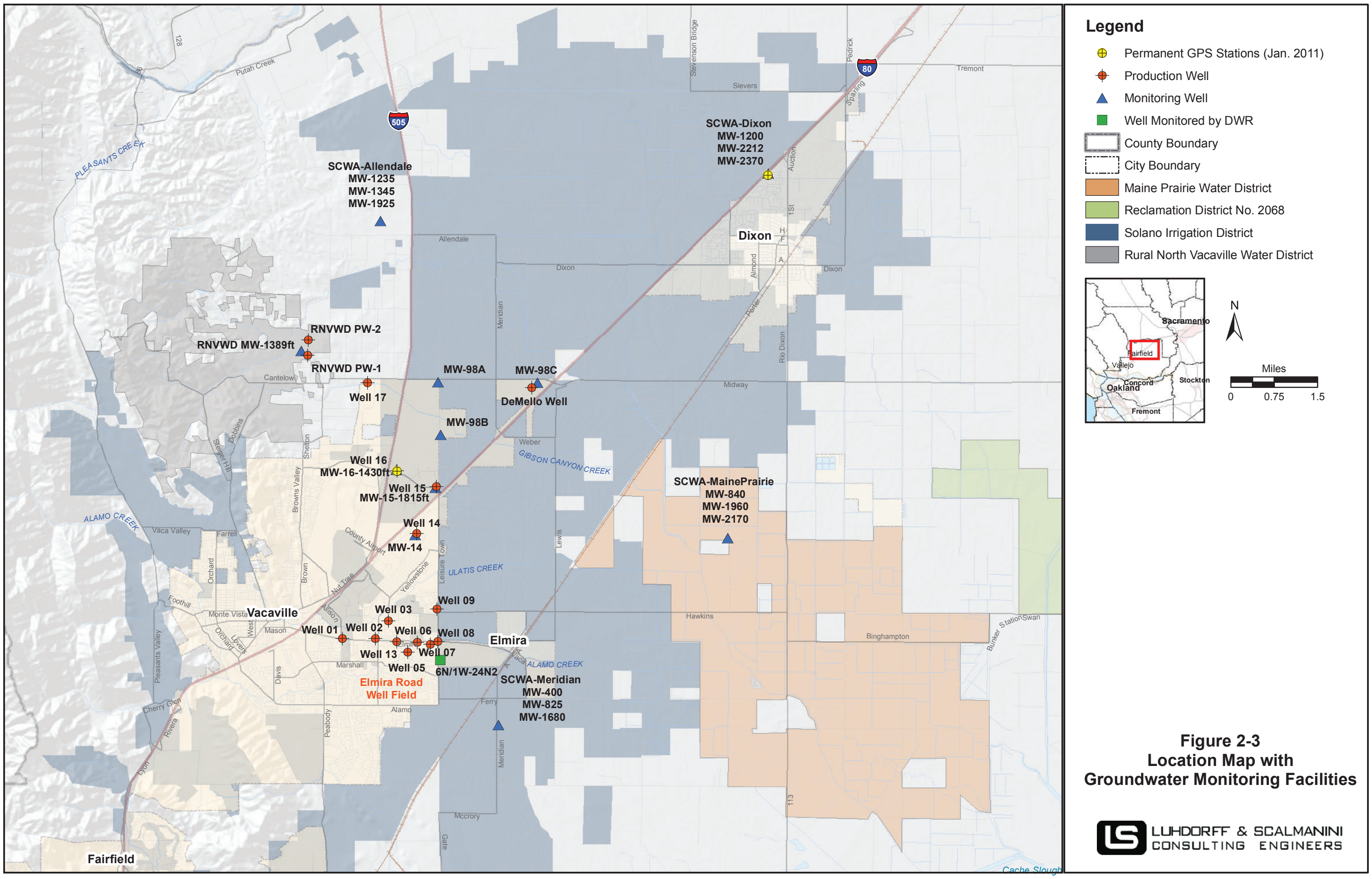

Figure 2-3
Location Map with Groundwater Monitoring Facilities

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File: Y:\Casey_Meirovitz\10-1-124 Vacaville GWMP Update\Report\GIS\Figure 2-3 Well Location Map.mxd Date: 12/15/2010

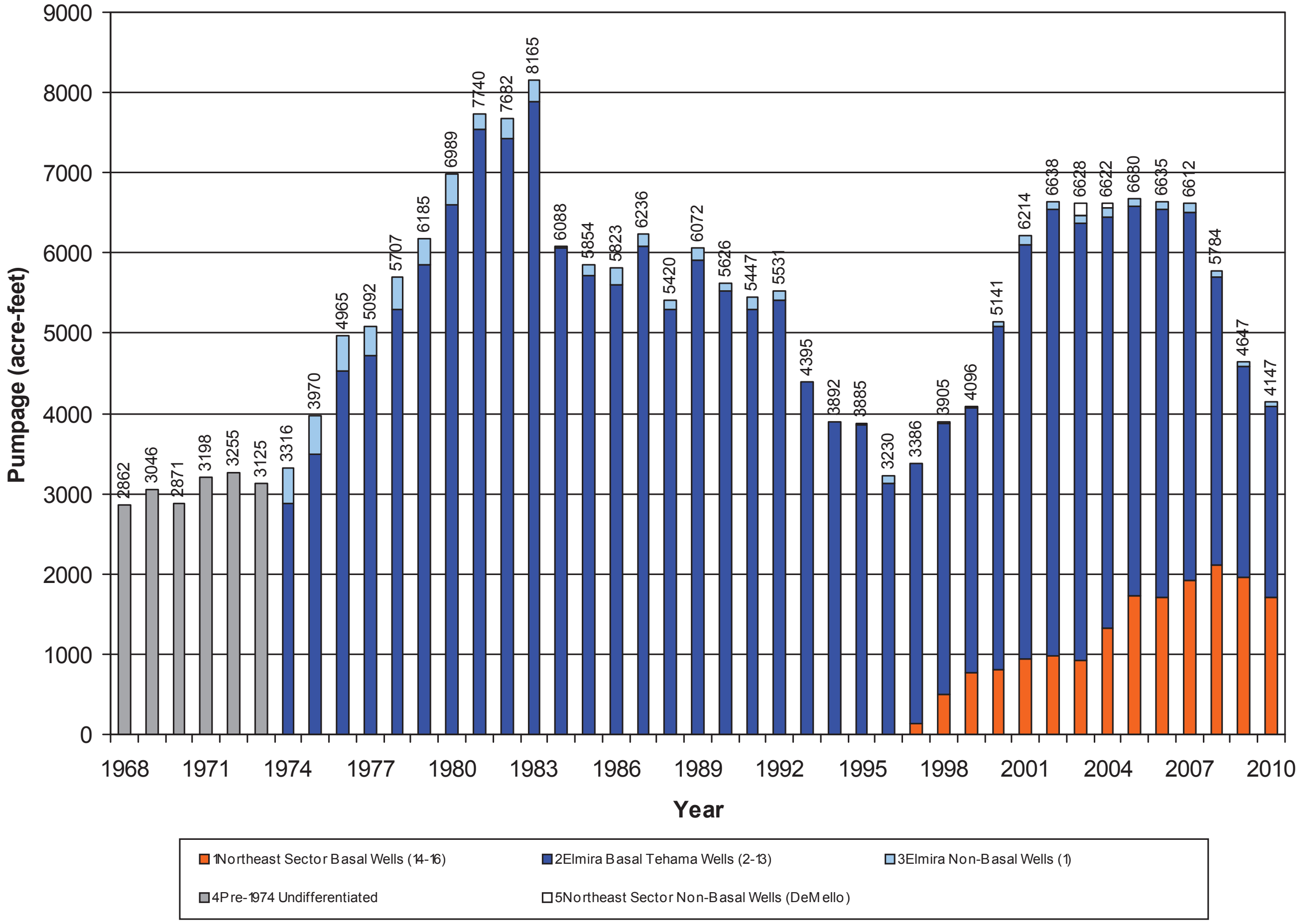

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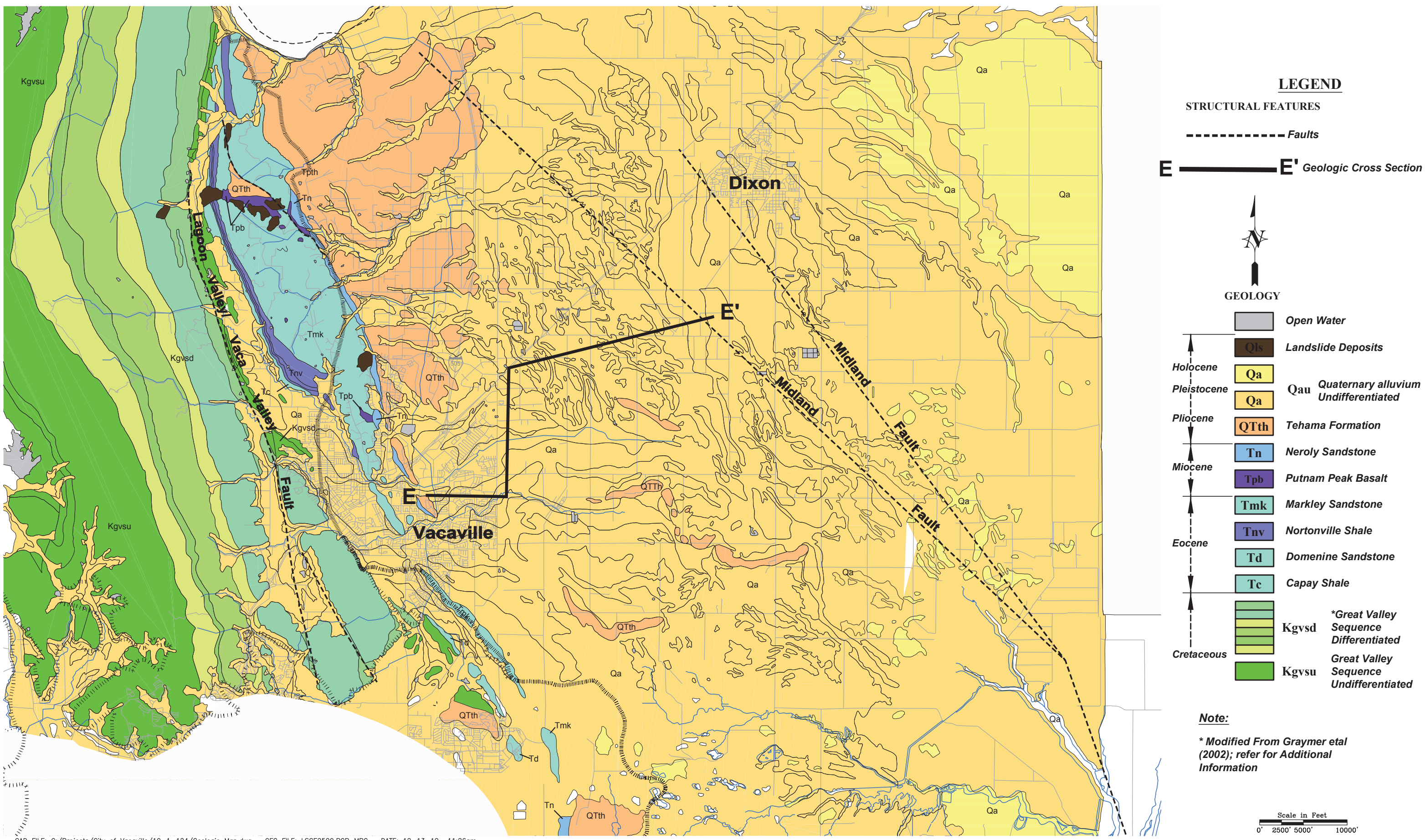
Figure 2-4
City of Vacaville Annual Groundwater Pumpage



CAD FILE: G:/Projects/City of Vacaville/10-1-124/Geologic Map.dwg CFG FILE: LSCE2500.PCP_MRG DATE: 12-13-10 11:26am

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Figure 2-5
Surficial Geologic Map of Solano County

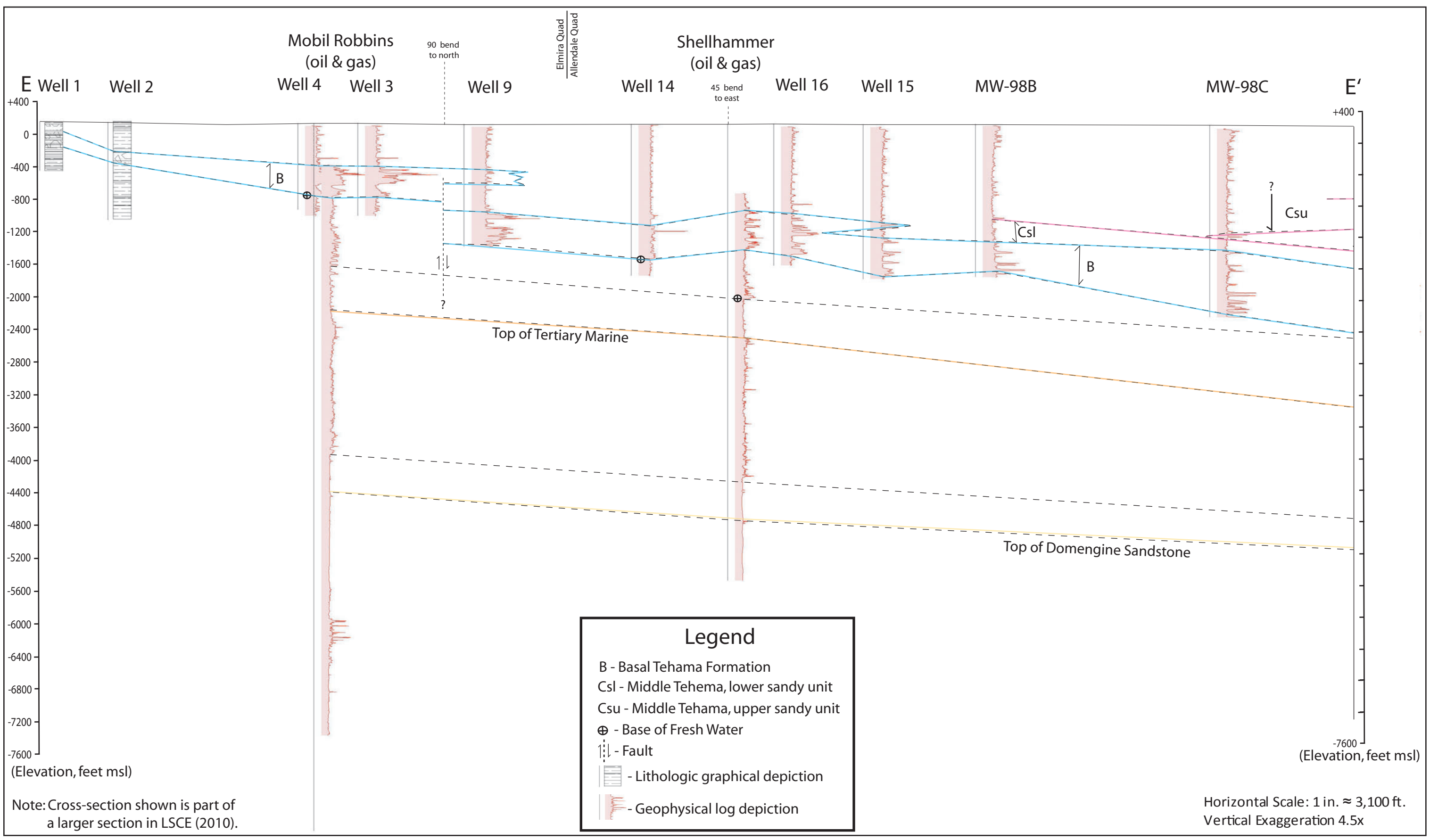

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Figure 2-6
Cross-Section E-E'

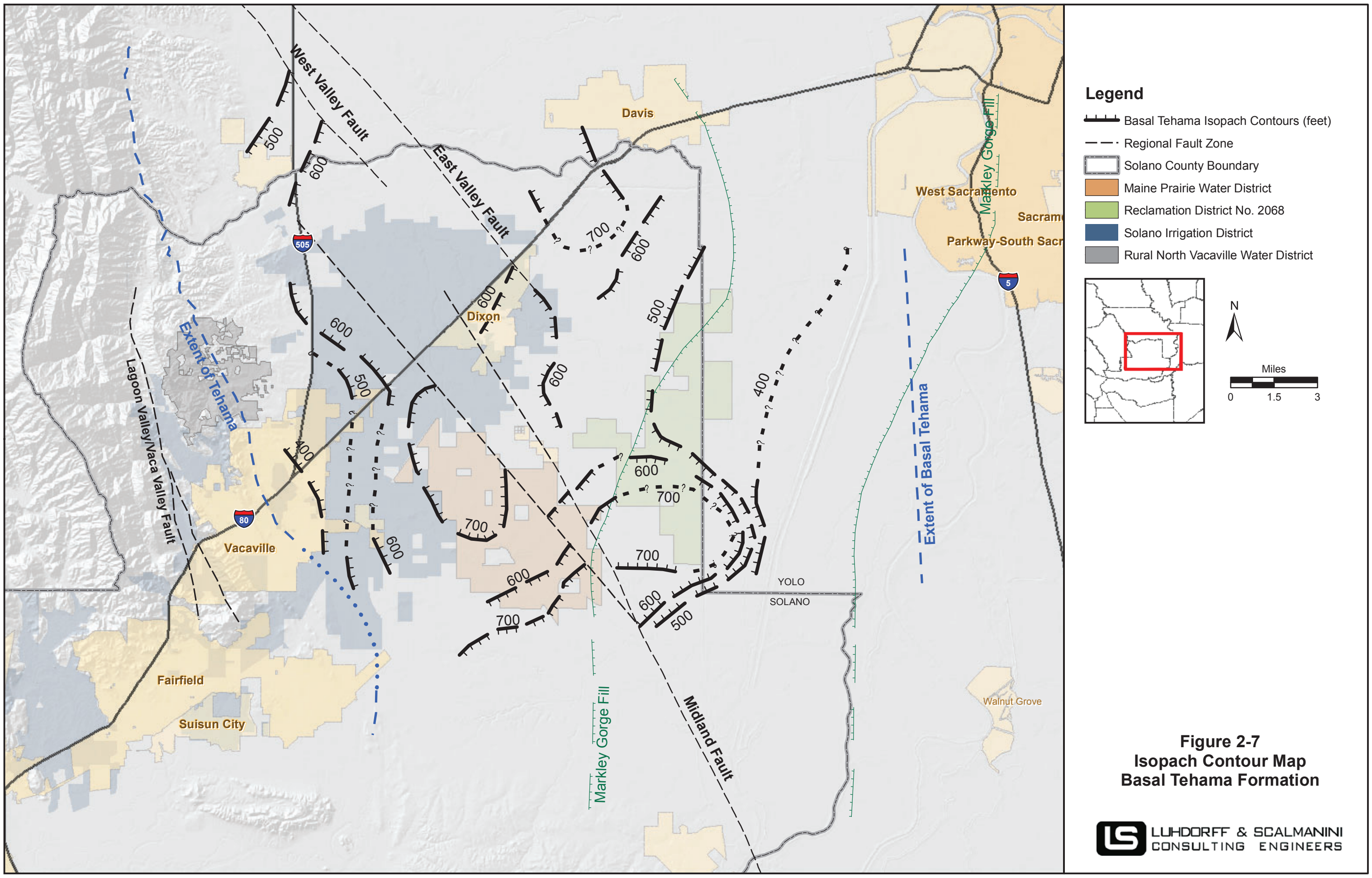

Figure 2-7
Isopach Contour Map
Basal Tehama Formation

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File: X:\2010 Job Files\10-124\Report\GIS\Figure 2-7 Isopach Map of Basal Tehama Formation.mxd

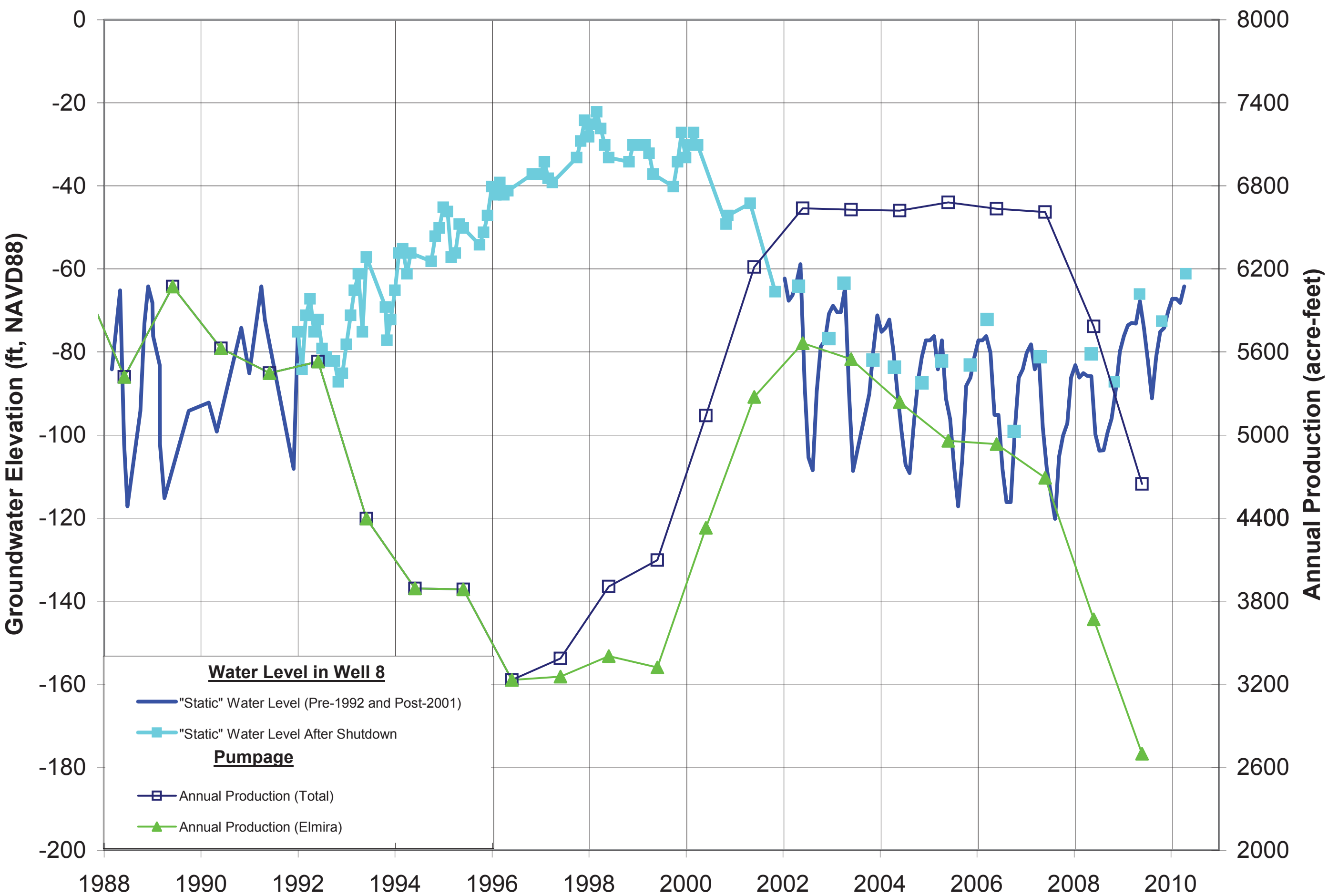

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Figure 2-8
Groundwater Level Hydrograph
City of Vacaville, Well No. 8

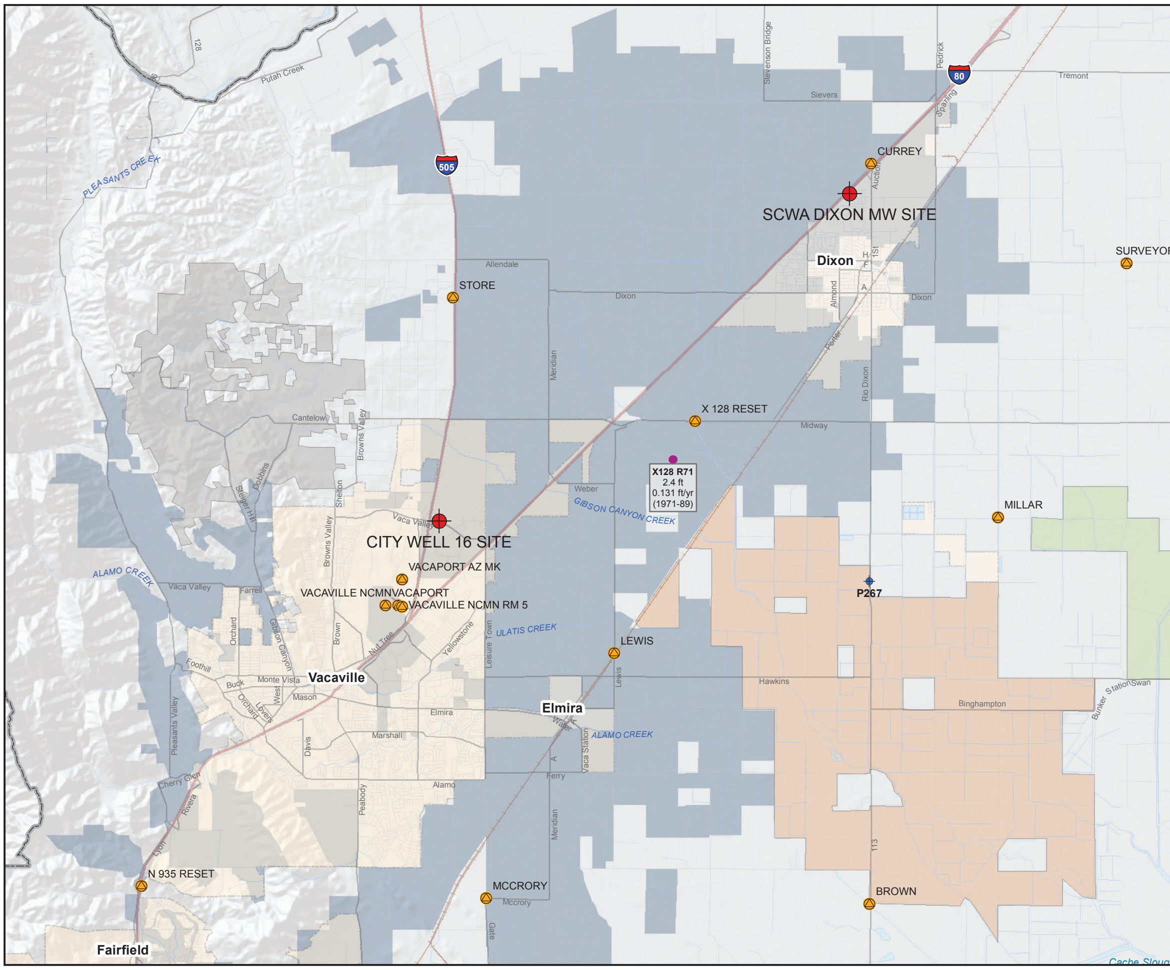

Figure 2-9
Subsidence Monitoring
Vacaville Area

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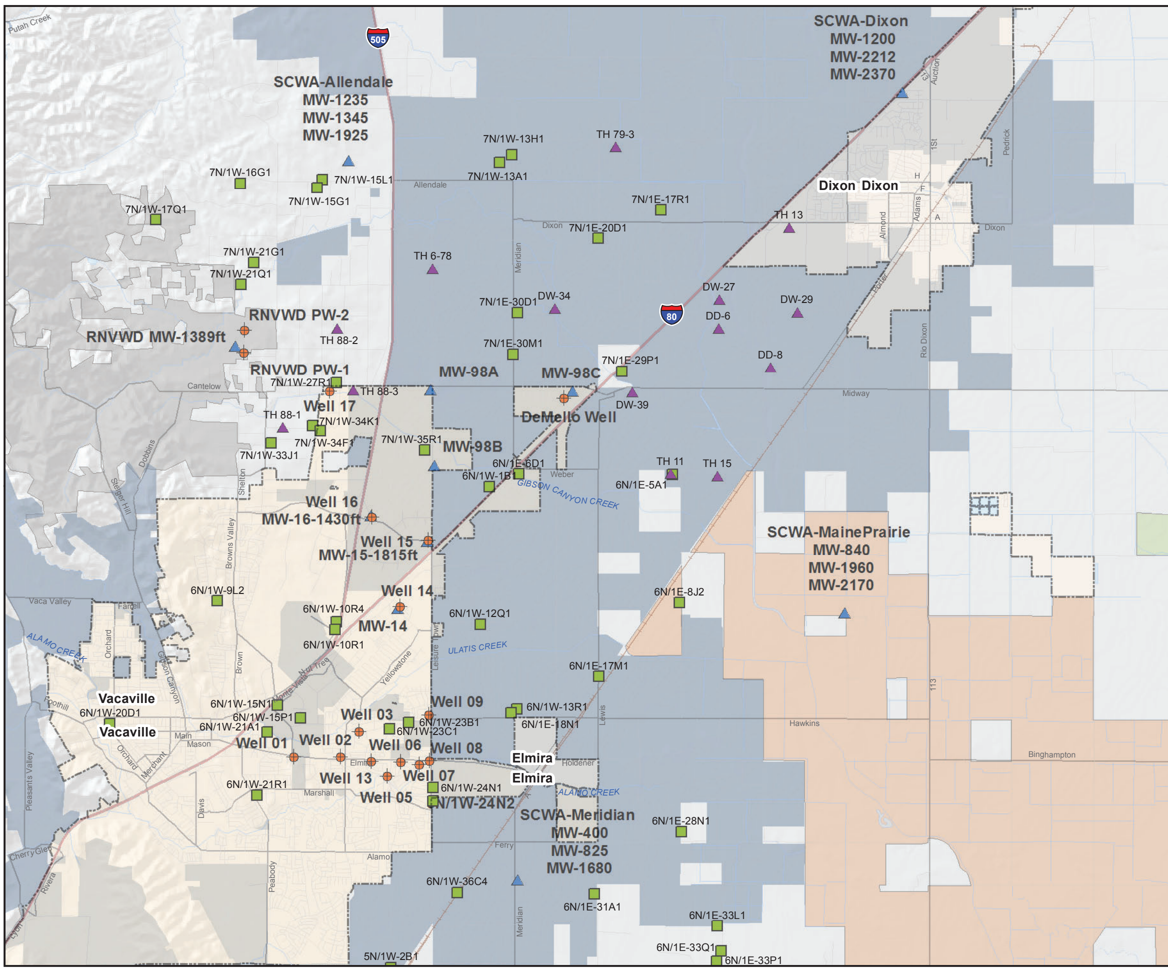
File: Y:\Casey_Meirovitz\10-1-124 Vacaville GWMP Update\Report\GIS\Figure 2-9 Subsidence monitoring.mxd Date: 12/16/2010

APPENDIX A



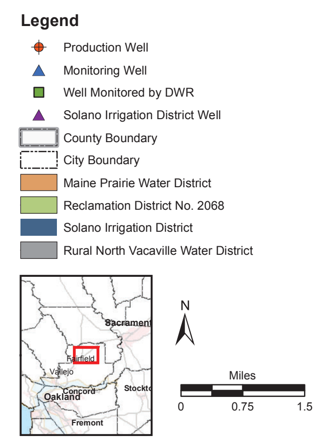


Figure A-1
Well Location Map

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File: Y:\Casey_Meirovitz\10-1-124 Vacaville GWMP Update\Report\GIS\Figure A-1 Well Location Map.mxd Date: 12/15/2010

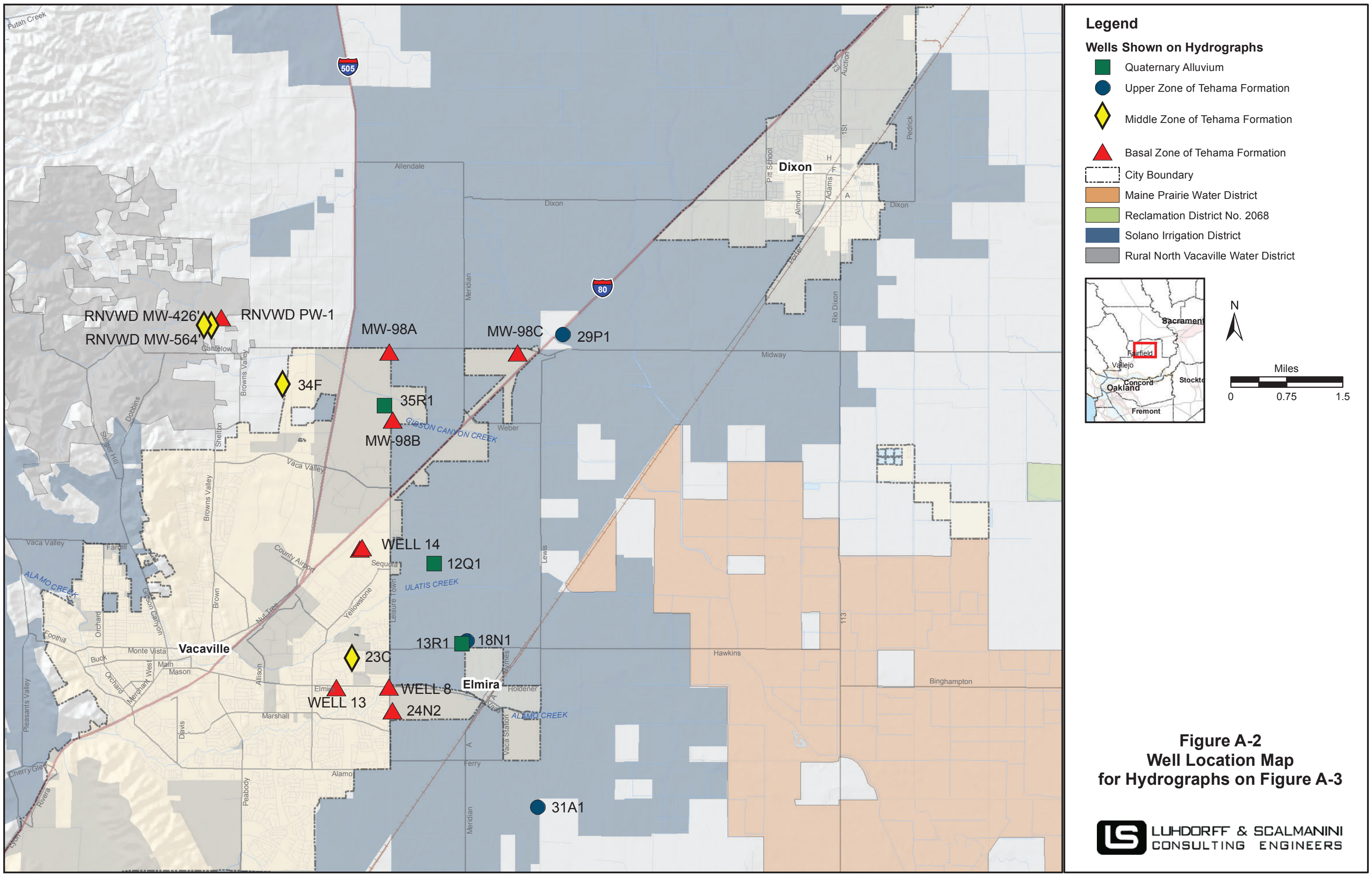
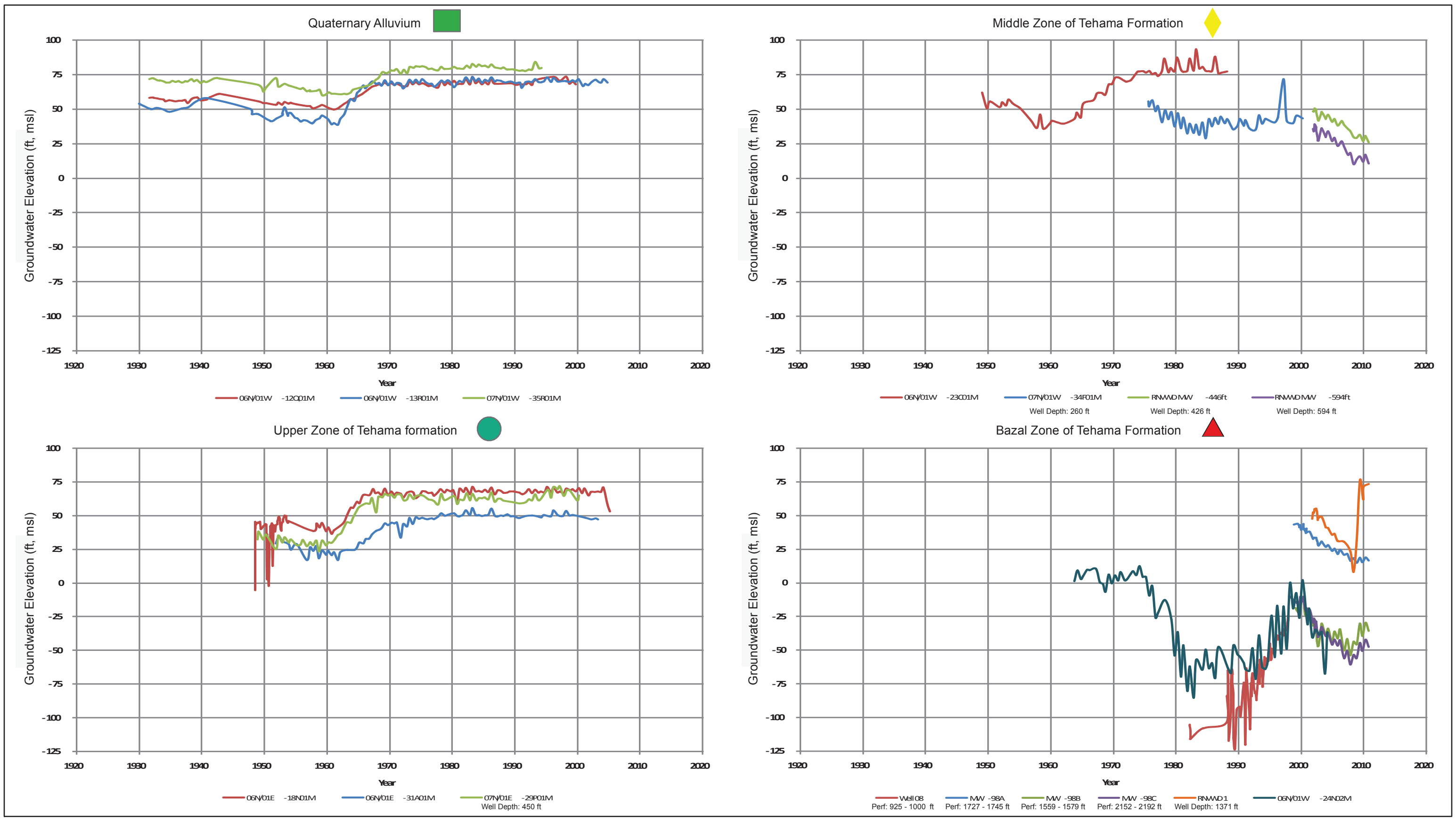


Figure A-2
Well Location Map
for Hydrographs on Figure A-3

File: Y:\Casey_Meirovitz\10-1-124 Vacaville GWMP Update\Report\GIS\Figure A-2 Well Location Map for hydrographs.mxd Date: 12/15/2010



File: Y:\Casey_Meirovitz\10-1-124 Vacaville GWMP Update\Report\GIS\Figure A-3 WL Hydrograph for all zones.mxd Date: 12/15/2010

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Figure A-3
Hydrographs of Groundwater Elevations by Zone

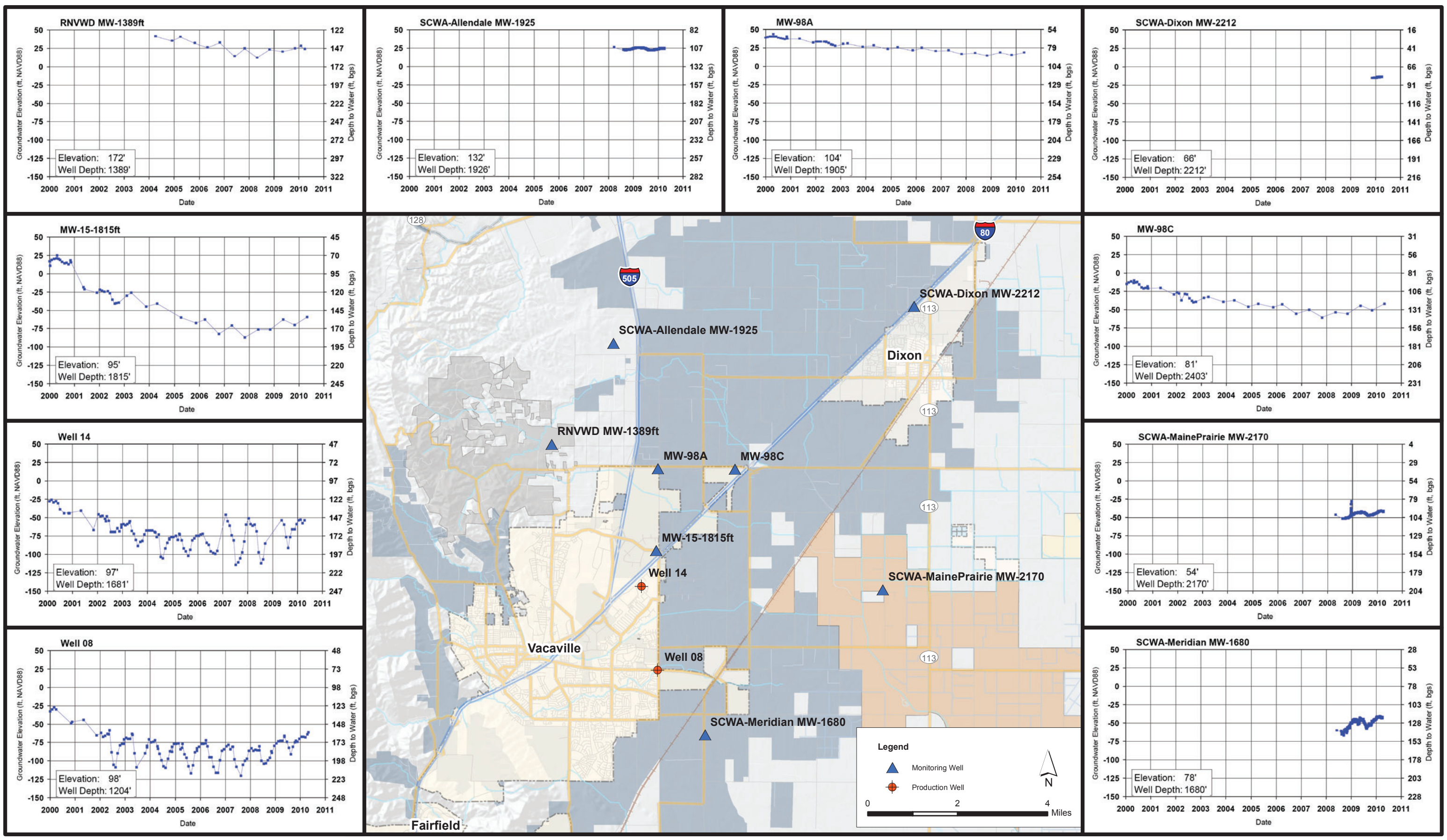

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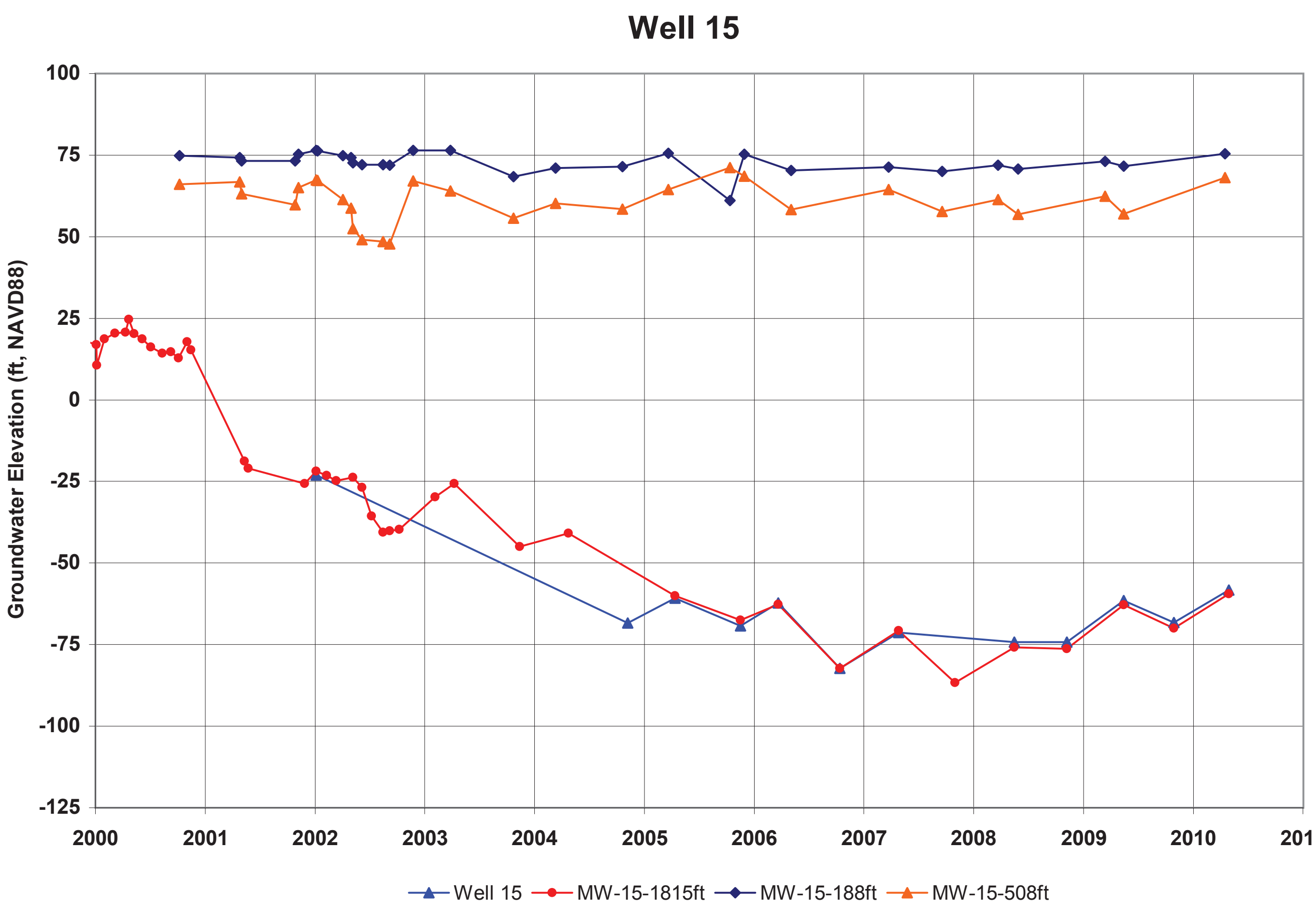
Figure A-4
Representative Hydrographs of Basal Zone Wells



File: Y:\Casey_Meirovitz\10-1-124 Vacaville GWMP Update\Report\Figures|Figure A-5 Well 15 Hydrograph Date: 12/9/2010

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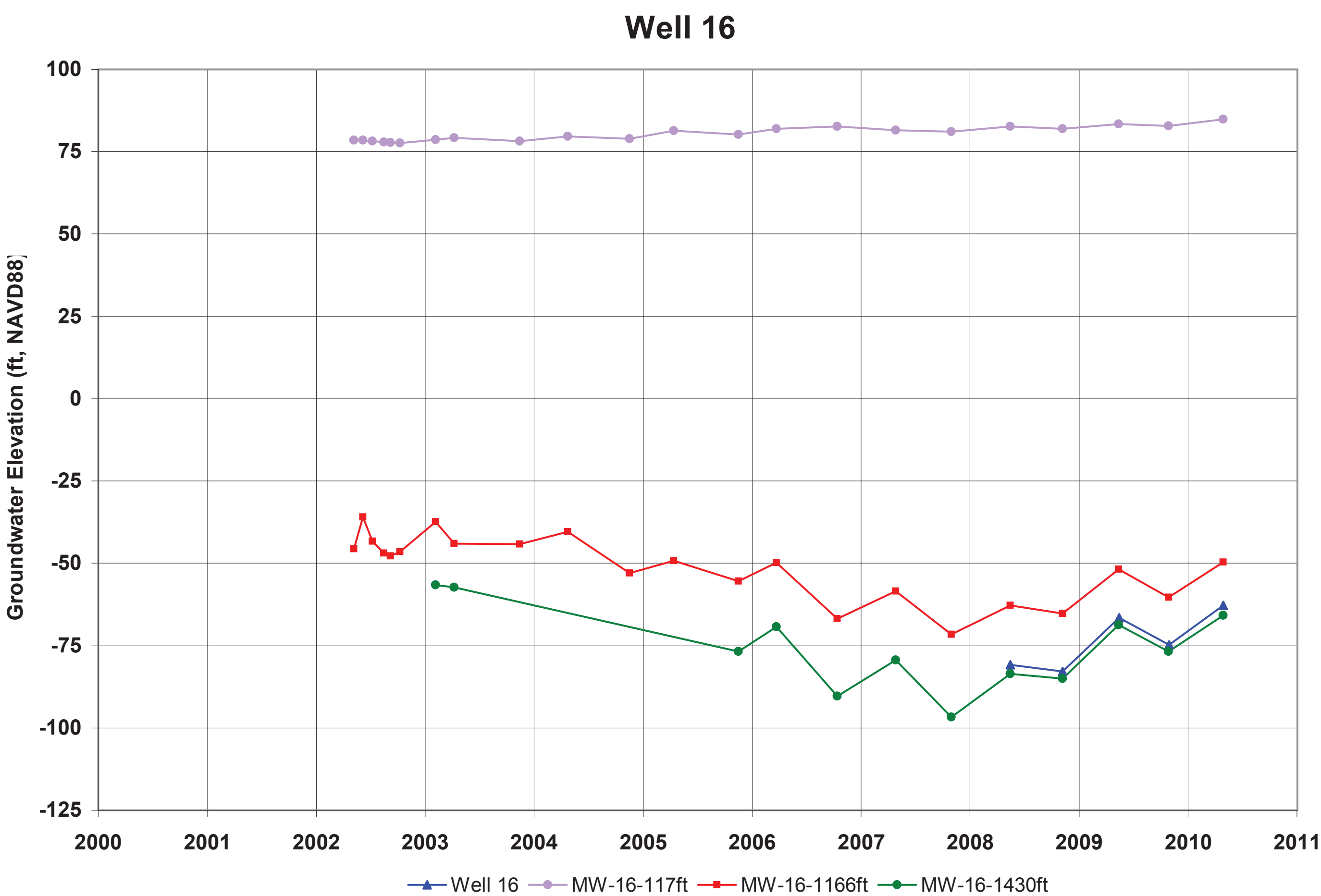
Figure A-5
Hydrographs, City Well No. 15
and Nearby Monitoring Wells



File: Y:\Casey_Meirovitz\10-1-124 Vacaville GWMP Update\Report\Figures|Figure A-6 Well 16 Hydrograph Date: 12/9/2010

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Figure A-6
Hydrographs, City Well No. 16
and Nearby Monitoring Wells

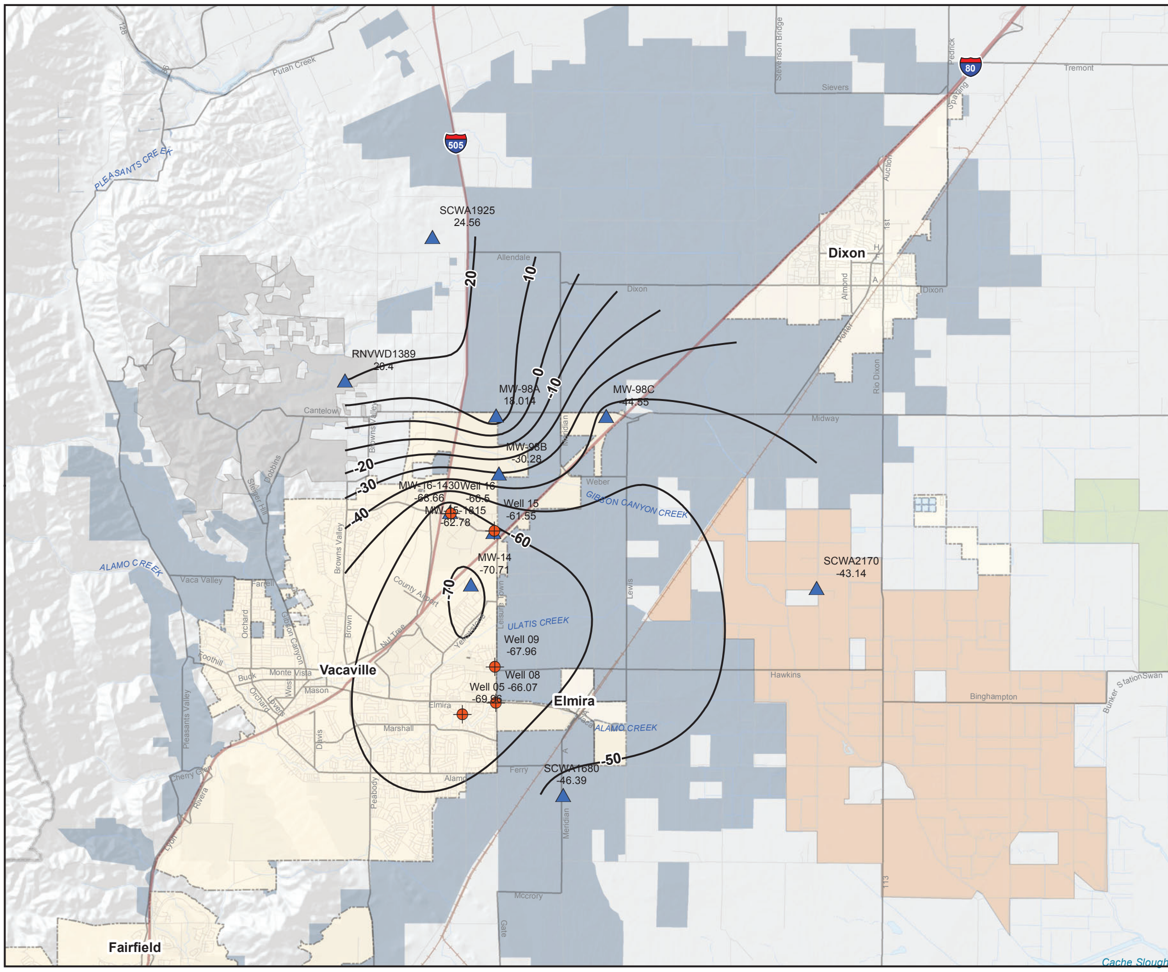

Figure A-7
Contours of Equal Groundwater Elevation
Spring 2009

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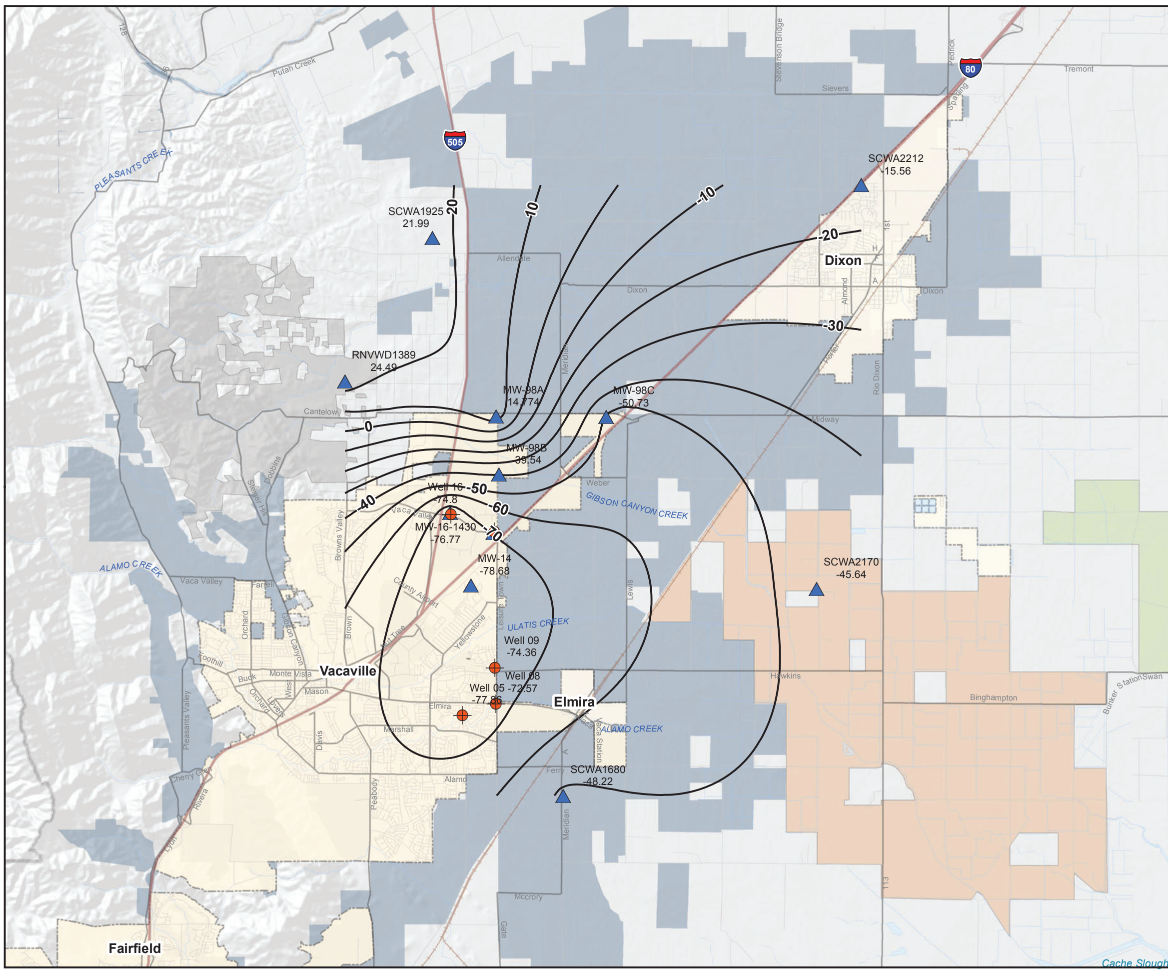
File: Y:\Casey_Meirovitz\10-1-124 Vacaville GWMP Update\Report\GIS\Figure A-7 WL Contours Spring 2009.mxd Date: 12/9/2010



Legend

WELL_NAME

- Production Well
- Monitoring Well
- Groundwater Elevation Contour (ft., msl)
- County Boundary
- City Boundary
- Maine Prairie Water District
- Reclamation District No. 2068
- Solano Irrigation District
- Rural North Vacaville Water District

N

Miles
0 0.75 1.5

Figure A-8
Contours of Equal Groundwater Elevation
Fall 2009

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CONSULTING ENGINEERS

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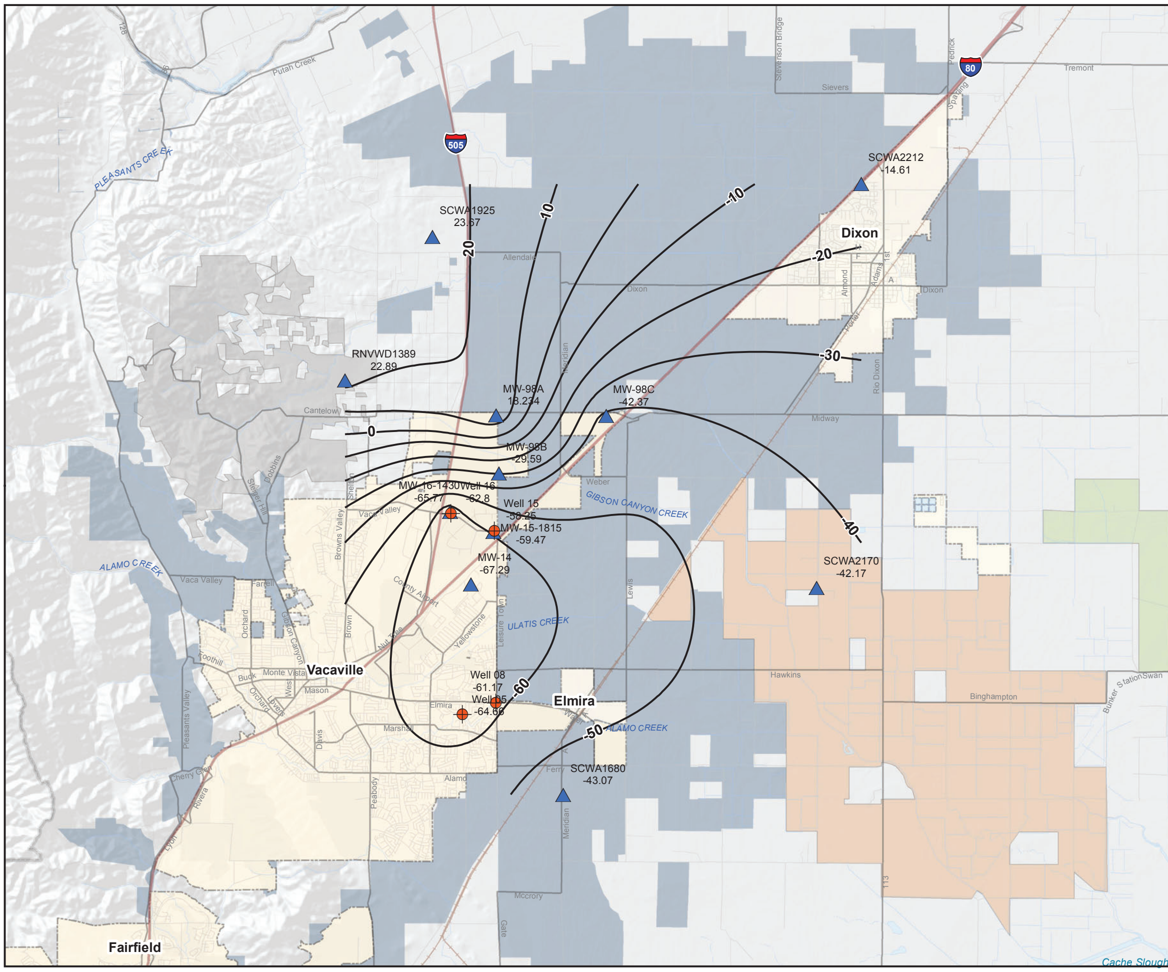

Figure A-9
Contours of Equal Groundwater Elevation
Spring 2010

LUHDORFF & SCALMANINI CONSULTING ENGINEERS

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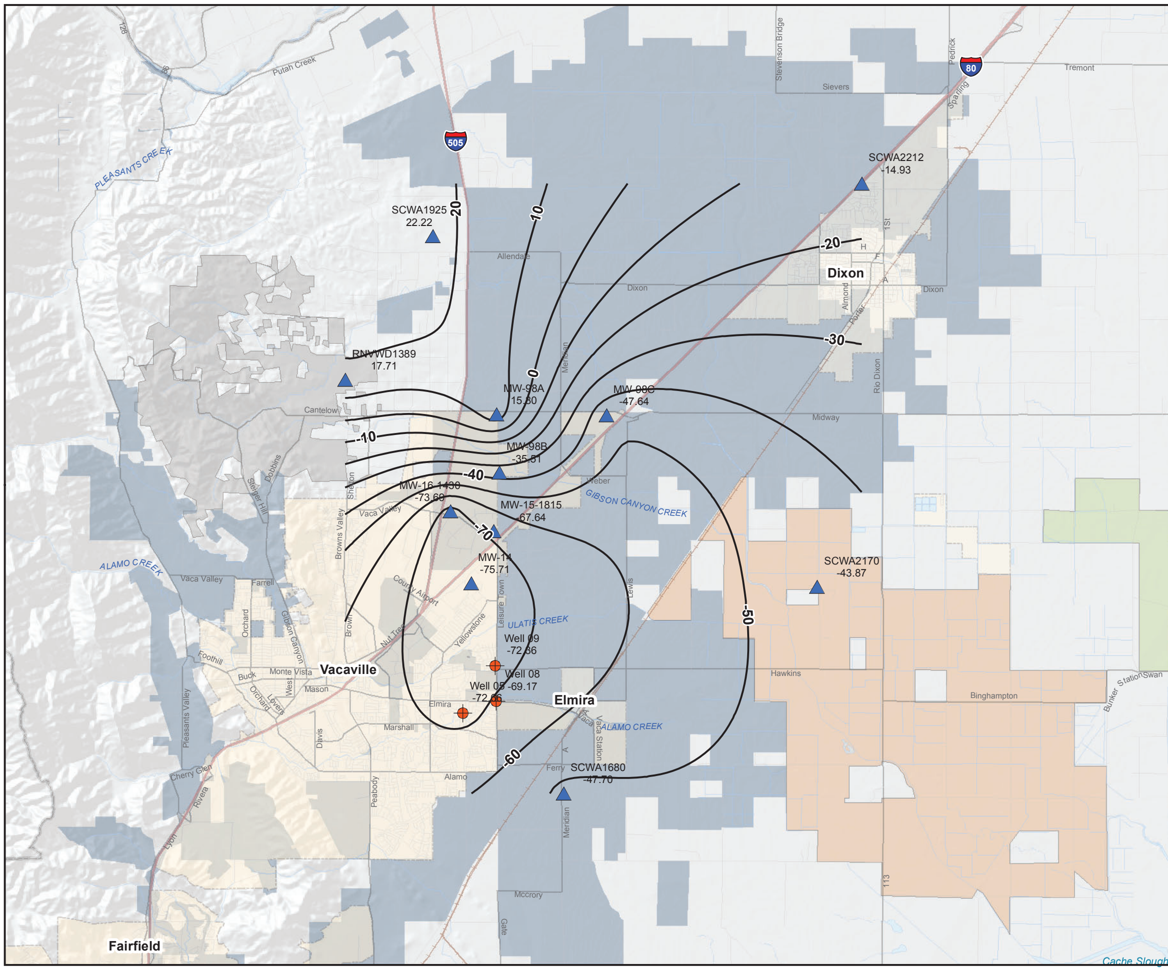

Figure A-10
Contours of Equal Groundwater Elevation
Fall 2010

LUHDORFF & SCALMANINI CONSULTING ENGINEERS

File: Y:\Casey_Meirovitz\10-1-124 Vacaville GWMP Update\Report\GIS\Figure A-10 WL Contours Fall 2010.mxd Date: 12/9/2010

Appendix I:

SCWA Water Supply Reliability Technical Memorandum

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26 April 2021

Technical Memorandum (April 2021 Revision)

To: Jeff Barich, Solano County Water Agency

From: Allison Fry, Kennedy/Jenks Consultants

CC: Sachi Itagaki and Alex Page, Kennedy/Jenks Consultants

Subject: SCWA Water Supply Reliability
KJ 2170001*00

Introduction

This Technical Memorandum (TM) is part of Task 3 of the Solano County Water Agency (SCWA) 2020 Urban Water Management Plan (UWMP) Population and Reliability Support. This TM will help SCWA provide technical support for the SCWA Participating Agencies to address water supply reliability for their 2020 Urban Water Management Plans. This TM provides:

- A review of 2019 California Department of Water Resources (DWR) State Water Project (SWP) Delivery Capability Report (DCR) for applicable delivery reliability assumptions, particularly for SCWA. This analysis has been updated to reflect input from retail agencies.
- A review and summary of Solano Project Reliability.

SCWA supplies untreated water from the Solano Project and the SWP for agriculture, and municipal and industrial uses. SCWA Participating Agencies that are also urban water suppliers include:

- City of Benicia
- City of Dixon
- City of Fairfield
- City of Rio Vista
- Suisun City
- City of Vacaville
- City of Vallejo

State Water Project Supply

SCWA has a long-term water master water supply contract with DWR for water supply from the SWP that currently expires in 2035 but is renewable. SCWA is a North of Delta SWP Contractor and receives SWP water via the North Bay Aqueduct (NBA), which is owned and operated by DWR to deliver wholesale water supply for municipal and industrial uses from the Barker Slough Pumping Plant in the Sacramento-San Joaquin Delta to Napa and Solano Counties. SCWA's contract with DWR includes a maximum allocation of 47,756 acre-feet per year (AFY), known as Table A water. Supplemental SWP water, "Advanced Table A" (ATA), under specific conditions, is available to SCWA. Additional supplemental water, Non-SWP Settlement Water (SW), is also available from year to year with some restrictions.

Attachments 1-9 provide additional SWP supply materials for retail agencies to utilize during the development of their 2020 Urban Water Management Plans (UWMPs).

State Water Project Capability Report

DWR prepares a biennial report to assist SWP contractors assess the availability of supplies from the SWP. The most recent update, the 2019 DWR State Water Project DCR was finalized in August 2020 (excerpts in Attachment 10). In this 2019 update, DWR provides SWP supply estimates for SWP contractors to use in their planning efforts, including for use in their 2020 UWMPs. The 2019 DCR includes DWR's estimates of SWP water supply availability under both current and future conditions using the CalSim II model; a CalSim III model is currently under development. Further details on modeling assumptions can be found in the DCR and its appendices which are available at: https://water.ca.gov/Library/Modeling-and-Analysis/Central-Valley-models-and-tools/CalSim-2/DCR2019.

Terms and Definitions

Table A Water (Table A Amounts)

Each SWP contractor's State Water Supply Contract (SWP Contract) contains a "Table A," which lists the maximum amount of annual allocated water supply, or "Table A water," an agency may request each year throughout the life of the contract. The Table A Amounts in each contractor's SWP Contract ramp up over time, based on projections at the time the contracts were signed and considerate of future increases in population and water demand, until they reach a maximum Table A Amount. Table A Amounts are used in determining each contractor's proportionate share, or "allocation," of the total SWP water supply DWR determines to be available each year. Table 1 below shows SCWA's active Participating Agencies' Table A allocation. Vacaville and Fairfield numbers include the permanent Table A transfer to Kern County Water Agency that began in 2001; the 5,756 AF transfer is split evenly between the two cities, assuming 100% South of Delta (SOD) allocation (discussed below in "SWP Allocation").

Table 1: SCWA Participating Agency Maximum SWP Table A Amounts (AF)

SCWA Participating Agency	Maximum Table A Amounts (AF)
City of Benicia	17,200
City of Fairfield	14,678
Suisun City	1,300
City of Vacaville	8,978
City of Vallejo	5,600
TOTAL	**47,756**

The cities of Dixon and Rio Vista have a right to obtain a specified portion of SCWA Table A supply (1,500 AF each) in the future. However, they currently do not have a means to deliver the water into their service areas but may call upon their water with a 5-year notice. This allocation is currently being utilized by Benicia (1,125 AF), Fairfield (750 AF), and Vallejo (1,125 AF).

SWP Allocation

The amount of water that is allocated and delivered by the SWP to each contractor in a given year is determined annually by DWR. Table A Amounts determine the maximum amount of water a contractor may request in any year from DWR. SWP allocations are based on CALSIM modeling runs that take into consideration SWP storage in Oroville and San Luis reservoirs, SOD Contractor demand, hydrology, operational requirements and regulatory constraints. The allocation is typically reported as a percentage of maximum Table A amounts and is finalized by May 1 each year.

North of Delta Allocation

As a result of the North of Delta Settlement (December 31, 2013), DWR issues a separate SWP annual allocation for SCWA, Napa, and Yuba City ("the North of Delta (NOD) Contractors"), defined as the NOD Allocation. The NOD Allocation cannot exceed the Annual Table A Amounts. The NOD Allocation amounts to an additional increment of annual allocation above the current SWP Allocation described above. The other SOD contractors receive the baseline SWP allocation.

The concept of the NOD is to not penalize the NBA for conveyance restrictions exclusive to the SOD pumping plants. Currently, DWR's D1641 CALSIM model run is used as a surrogate for determining the NOD Allocation. All regulatory requirements under D1641 are met before allocations are met, so all contractors share in the responsibility to meet those regulatory requirements. D1641 was what the SWP operated to prior to the new ESA regulations, the 2008 and 2009 Biological Opinions. The Old-Middle River restrictions (OMR) part of the ESA regulations greatly impact the SOD pumping plant, but do not impact NOD diversions. However, the NOD allocation does provide an equitable share of any additional Delta outflow and water quality requirements, such as Fall X2. If Delta regulations change in the future, the NOD Allocation may be affected commensurately.

Since the implementation of the NOD Allocation in 2014, SCWA has received an additional increment of: 0% (2017), 10% (2018), 10% (2019) and 10% (2020 as of April 1). Analysis performed by DWR estimated that SCWA could receive an additional 11 TAF in approximately 50% of years compared to existing Table A deliveries.[1] The actual differential varies each year and is less in drier years. For the purposes of this analysis, the Table A allocations have been increased by 10% in all but the driest years to account for incremental reliability associated with the NOD Allocation.

[1] California Department of Water Resources State Water Project Analysis Office, *Initial Study/Proposed Negative Declaration State Water Project Supply Allocation Settlement Agreement*. Prepared by AECOM. July 2013.

Carryover Water

Carryover is unused Table A water "stored" in SWP reservoirs, when storage capacity is available, for use in the following years. SCWA Carryover is accounted for in San Luis Reservoir and may be partially or completely lost when San Luis "spills" meaning that carryover is displaced by higher priority, new State Water Project water pumped into storage. The amount of Table A that can be converted and added to storage at the end of each year as new Carryover is governed by Article 56 of the SWP Contract. The amount of new Carryover allowed each year by Article 56 ranges from 25% to 50%, with interpolation in between, depending on the SWP Allocation for that year. There is no limit to the amount of accumulated carryover that can be stored.

Advanced Table A (ATA)

Another component of the North of Delta Settlement (December 31, 2013), Advanced Table A (ATA), is supplemental SWP water that can be used to make up shortfalls of the NOD Allocation in a given year under specific conditions. The annual NOD Allocation plus Advanced Table A requested cannot exceed SCWA contract amount of 47,756 acre-feet per year. ATA is limited to a maximum of 15,000 acre feet per year and a cumulative balance of 60,000 acre feet. ATA is only accessible when the SWP Allocation is greater than 20% and all available SCWA Table A and Carryover is used. Computer simulations show that a 20% or lower allocation would occur only once in the 82 years of record. In these years of less than 20% Table A allocation, the cumulative ATA limit is temporarily increased by 16,800 acre feet (or the current Advanced Table A balance, whichever is lessor) for use in future years. The ATA limit and cumulative balance resets when Oroville Reservoir spills and has limited pay-back provisions after 5 years. All active SCWA Participating Agencies have access to proportional allocation of ATA, at a minimum, when available.

Article 21 Water

Water identified in Article 21 of SWP Contract is additional unregulated water above the annual NOD Allocation available for diversion at the NBA when the Delta is in "excess" conditions. Solano, as a North Bay contractor, can access this water when DWR and the US Bureau of Reclamation mutually agree and declare that the Delta is in "excess" conditions which typically occur in winter and spring with storm runoff. The Delta is considered in "excess" conditions when the SWP and Central Valley Project (CVP) are pumping the maximum amount allowed, all Delta standards are met, and there is still water available for export. "Balanced" conditions in the Delta occur when the SWP and CVP are releasing stored water into the Delta to meet their obligations and there is no extra water available in the system.

Non-SWP Settlement Water

Non-SWP Settlement Water (SW) is additional non-project water provided by a settlement agreement (executed May 19, 2003) among DWR, SCWA, and the cities of Fairfield, Vacaville, and Benicia. The agreement provides for delivery of up to 31,620 AFY of SW to SCWA for delivery through the NBA, a SWP facility, to the three cities to help meet their current and future municipal and industrial water needs. SW is not available when the Standard Water Right Term 91 is in effect. The Settlement expires December 31, 2035 with the option to renew.[2]

Standard Water Right Term 91 (Term 91)

Term 91 is declared by the State Water Resources Control Board when it is determined that the SWP and CVP are releasing stored water into the Delta in excess of natural flow ("natural" flow is the flow that would have been present if the dams did not exist) to meet in-Delta demands and Delta water standards.

2014, 2020 and 2021 SWP Water Supply Allocation

The extremely dry sequence from the beginning of January 2013 through the end of 2014 was one of the driest two-year periods in the historical record. Water year 2013 was a year with two hydrologic extremes.[3] October through December 2012 was one of the wettest fall periods on record but was followed by the driest consecutive 12 months on record. Accordingly, the 2013 SWP supply allocation was a low 35% of Table A Amounts. The 2013 hydrology ended up being even drier than DWR's conservative hydrologic forecast, so the SWP began 2014 with reservoir storage lower than targeted levels and less stored water available for 2014 supplies. Compounding this low storage situation, 2014 also was an extremely dry year, with runoff for water year 2014 the fourth driest on record. Due to extraordinarily dry conditions in 2013 and 2014, the 2014 SWP water supply allocation was a historically low 5% of Table A Amounts. The 2020 SWP allocation was initially 10% and increased to 20% while the 2021 SWP allocation was reduced from 10% to 5%.

The dry hydrologic conditions that led to the low 2014 SWP water supply allocation were unusual, and to date hydrology through 2014 has not been included in the CalSim II modeling that estimates future SWP delivery presented in DWR's 2019 Delivery Capability Report.[4] It is anticipated that the hydrologic record used in the DWR model will be extended to include the period through 2021 during one of the next updates of the model. For the reasons stated above, the SCWA UWMP uses a conservative assumption that a 5% allocation of SWP Table A Amounts represents the "worst case" scenario.

SCWA SWP Reliability

Table A-28 from the 2019 DCR, found in Appendix A of the DCR (excerpted and shown in Attachment 10) provides a scenario that represents existing supply conditions for SCWA. Table A-28 was agreed upon by the SWP Contractors as an appropriate scenario to estimate existing supply availability. Therefore, existing SWP supply availability presented in Table 2 is based on the 2019 DCR Table A-28 and includes 10% to account for the NOD Allocation

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[2] DWR. 2014. *Management of the California State Water Project: Bulletin 132-14*. <http://www.water.ca.gov/swpao/bulletin_home.cfm>

[3] A water year begins in October and runs through September. For example, water year 2013 is October 2012 through September 2013.

[4] SWP delivery estimates from DWR's 2019 SWP Delivery Capability Report are from computer model studies which use 82 years of historical hydrologic inflows from 1922 through 2003.

available to SCWA. The single dry year availability is based on single dry years 2015 and 2021. This was determined to be a realistic and conservative estimate for single dry year SWP supply. The multiple dry year availability is based on actual percentage deliveries that have occurred in the last ten years which reflect current SWP operating conditions. All but the driest year in the multiple dry year have been augmented by 10% to account for the NOD Allocation. Therefore, the percentage deliveries represent a realistic and conservative estimate of single and multiple dry year reliability.

Table 2: SWP SCWA Table A Supply Reliability (AF)[(a)(b)]

DWR (SWP) Table A Supply	% of Table A Amount[(c)]	2025	2030	2035	2040-2045
Average Water Year[(d)]	83%	39,637	39,637	39,637	39,637
Single Dry Year[(e)]	5%	2,388	2,388	2,388	2,388
Multiple-Dry Year					
Year 1[(f)]	45%	21,490	21,490	21,490	21,490
Year 2[(f)]	30%	14,327	14,327	14,327	14,327
Year 3	5%	2,388	2,388	2,388	2,388
Year 4[(f)]	15%	7,163	7,163	7,163	7,163
Year 5[(f)]	30%	14,327	14,327	14,327	14,327

Notes:
(a) Supplies to SCWA are based on DWR analyses presented in its “2019 State Water Project Delivery Capability Report” (2019 DCR), assuming existing SWP facilities and current regulatory and operational constraints.
(b) Table A supplies include supplies allocated in one year that are carried over for delivery the following year.
(c) Supply as a percentage of SCWA’s Table A Amount of 47,756 AF per 2019 DCR and adjust per narrative above.
(d) Based on average deliveries over a repeat of the study’s historic hydrologic period of 1922 through 2003. The 2014 North of Delta Settlement allocation of 10% is included in this percentage.
(e) Based on a repeat of single dry years 2015 and 2021.
(f) Supplies shown are annual average percentage deliveries that have occurred in the last ten years. The 2014 North of Delta Settlement allocation of 10% is included in this percentage

SCWA has subsequent long term water service contracts for SWP water supply deliveries with Participating Agencies. The SWP Table A Supply Reliability values in Table 2 can be applied directly to SCWA supply reliability and need to be adjusted to reflect individual SCWA Participating Agencies contract terms with SCWA. The following tables show the SCWA Participating Agency SWP allocations based on Table 2 and Participating Agency maximum SCWA contract allocations in Table 1:

**Table 3a: SWP SCWA Participating Agency Supply Reliability (AF)[(a)(b)]
City of Benicia**

DWR (SWP) Table A Supply	% of Table A Amount[(c)]	2025	2030	2035	2040-2045
Average Water Year[(d)]	83%	14,276	14,276	14,276	14,276
Single Dry Year[(e)]	5%	860	860	860	860
Multiple-Dry Year					
Year 1[(f)]	45%	7,740	7,740	7,740	7,740
Year 2[(f)]	30%	5,160	5,160	5,160	5,160
Year 3	5%	860	860	860	860
Year 4[(f)]	15%	2,580	2,580	2,580	2,580
Year 5[(f)]	30%	5,160	5,160	5,160	5,160

Notes:
(a) Supplies to SCWA are based on DWR analyses presented in its "2019 State Water Project Delivery Capability Report" (2019 DCR), assuming existing SWP facilities and current regulatory and operational constraints.
(b) Table A supplies include supplies allocated in one year that are carried over for delivery the following year.
(c) Supply as a percentage of City of Benicia's SCWA contract amount for SWP supply of 17,200 AF, not including Advanced Table A Water or Rio Vista Water.
(d) Based on average SWP deliveries over a repeat of the study's historic hydrologic period of 1922 through 2003. The 2014 North of Delta Settlement allocation of 10% is included in this percentage.
(e) Based on a repeat of single dry years 2015 and 2021.
(f) Supplies shown are annual average percentage deliveries that have occurred in the last ten years. The 2014 North of Delta Settlement allocation of 10% is included in this percentage.

In addition to SWP supplies, the City of Benicia has access to 10,500 AFY of Non-SWP Settlement Water delivered through the North Bay Aqueduct when available.

Table 3b: SWP SCWA Participating Agency Supply Reliability (AF)[(a)(b)]
City of Fairfield

DWR (SWP) Table A Supply	% of Table A Amount[(c)]	2025	2030	2035	2040-2045
Average Water Year[(d)]	83%	12,183	12,183	12,183	12,183
Single Dry Year[(e)]	5%	734	734	734	734
Multiple-Dry Year					
Year 1[(f)]	45%	6,605	6,605	6,605	6,605
Year 2[(f)]	30%	4,403	4,403	4,403	4,403
Year 3	5%	734	734	734	734
Year 4[(f)]	15%	2,202	2,202	2,202	2,202
Year 5[(f)]	30%	4,403	4,403	4,403	4,403

Notes:
(a) Supplies to SCWA are based on DWR analyses presented in its "2019 State Water Project Delivery Capability Report" (2019 DCR), assuming existing SWP facilities and current regulatory and operational constraints.
(b) Table A supplies include supplies allocated in one year that are carried over for delivery the following year.
(c) Supply as a percentage of City of Fairfield's SCWA contract amount for SWP supply of 14,678 AF, not including Advanced Table A Water or Rio Vista Water.
(d) Based on average SWP deliveries over a repeat of the study's historic hydrologic period of 1922 through 2003. The 2014 North of Delta Settlement allocation of 10% is included in this percentage.
(e) Based on a repeat of single dry years 2015 and 2021.
(f) Supplies shown are annual average percentage deliveries that have occurred in the last ten years. The 2014 North of Delta Settlement allocation of 10% is included in this percentage.

In addition to SWP supplies, the City of Fairfield has access to 11,800 AFY of Non-SWP Settlement Water, delivered through the North Bay Aqueduct when available.

Table 3c: SWP SCWA Participating Agency Supply Reliability (AF)[(a)(b)]
City of Suisun City

DWR (SWP) Table A Supply	% of Table A Amount[(c)]	2025	2030	2035	2040-2045
Average Water Year[(d)]	83%	1,079	1,079	1,079	1,079
Single Dry Year[(e)]	5%	65	65	65	65
Multiple-Dry Year					
Year 1[(f)]	45%	585	585	585	585
Year 2[(f)]	30%	390	390	390	390
Year 3	5%	65	65	65	65
Year 4[(f)]	15%	195	195	195	195
Year 5[(f)]	30%	390	390	390	390

Notes:
(a) Supplies to SCWA are based on DWR analyses presented in its “2019 State Water Project Delivery Capability Report” (2019 DCR), assuming existing SWP facilities and current regulatory and operational constraints.
(b) Table A supplies include supplies allocated in one year that are carried over for delivery the following year.
(c) Supply as a percentage of Suisun City's SCWA contract amount for SWP supply of 1,300 AF.
(d) Based on average SWP deliveries over a repeat of the study’s historic hydrologic period of 1922 through 2003. The 2014 North of Delta Settlement allocation of 10% is included in this percentage.
(e) Based on a repeat of single dry years 2015 and 2021.
(f) Supplies shown are annual average percentage deliveries that have occurred in the last ten years. The 2014 North of Delta Settlement allocation of 10% is included in this percentage.

**Table 3d: SWP SCWA Participating Agency Supply Reliability (AF)[(a)(b)]
City of Vacaville**

DWR (SWP) Table A Supply	% of Table A Amount[(c)]	2025	2030	2035	2040-2045
Average Water Year[(d)]	83%	7,452	7,452	7,452	7,452
Single Dry Year[(e)]	5%	449	449	449	449
Multiple-Dry Year					
Year 1[(f)]	45%	4,040	4,040	4,040	4,040
Year 2[(f)]	30%	2,693	2,693	2,693	2,693
Year 3	5%	449	449	449	449
Year 4[(f)]	15%	1,347	1,347	1,347	1,347
Year 5[(f)]	30%	2,693	2,693	2,693	2,693

Notes:
(a) Supplies to SCWA are based on DWR analyses presented in its “2019 State Water Project Delivery Capability Report” (2019 DCR), assuming existing SWP facilities and current regulatory and operational constraints.
(b) Table A supplies include supplies allocated in one year that are carried over for delivery the following year.
(c) Supply as a percentage of City of Vacaville's SCWA contract amount for SWP supply of 8,978 AF, not including Advanced Table A Water.
(d) Based on average SWP deliveries over a repeat of the study’s historic hydrologic period of 1922 through 2003. The 2014 North of Delta Settlement allocation of 10% is included in this percentage.
(e) Based on a repeat of single dry years 2015 and 2021.
(f) Supplies shown are annual average percentage deliveries that have occurred in the last ten years. The 2014 North of Delta Settlement allocation of 10% is included in this percentage.

In addition to SWP supplies, the City of Vacaville has access to 9,320 AFY of Non-SWP Settlement Water delivered through the North Bay Aqueduct when available.

Table 3e: SWP SCWA Participating Agency Supply Reliability (AF)[(a)(b)]
City of Vallejo

DWR (SWP) Table A Supply	% of Table A Amount[(c)]	2025	2030	2035	2040-2045
Average Water Year[(d)]	83%	4,648	4,648	4,648	4,648
Single Dry Year[(e)]	5%	280	280	280	280
Multiple-Dry Year					
Year 1[(f)]	45%	2,520	2,520	2,520	2,520
Year 2[(f)]	30%	1,680	1,680	1,680	1,680
Year 3	5%	280	280	280	280
Year 4[(f)]	15%	840	840	840	840
Year 5[(f)]	30%	1,680	1,680	1,680	1,680

Notes:
(a) Supplies to SCWA are based on DWR analyses presented in its "2019 State Water Project Delivery Capability Report" (2019 DCR), assuming existing SWP facilities and current regulatory and operational constraints.
(b) Table A supplies include supplies allocated in one year that are carried over for delivery the following year.
(c) Supply as a percentage of City of Vallejo's SCWA contract amount for SWP supply of 5,600 AF, not including Rio Vista Water.
(d) Based on average SWP deliveries over a repeat of the study's historic hydrologic period of 1922 through 2003. The 2014 North of Delta Settlement allocation of 10% is included in this percentage.
(e) Based on a repeat of single dry years 2015 and 2021.
(f) Supplies shown are annual average percentage deliveries that have occurred in the last ten years. The 2014 North of Delta Settlement allocation of 10% is included in this percentage.

Solano Project

The Solano Project is a federal facility owned by the Bureau of Reclamation (USBR) that stores water in Lake Berryessa for delivery to agriculture and municipal and industrial users throughout Solano County. SCWA has a long-term master water supply agreement with USBR that currently expires in 2025 but is renewable. The Solano Project first delivered water in 1959. The major facilities are:

- Monticello Dam, which captures water from Putah Creek in Lake Berryessa;
- Putah Diversion Dam, which diverts water out of Lower Putah Creek just downstream of Monticello Dam; and
- Putah South Canal, which delivers water to local agencies. The Putah South Canal is 33 miles long, concrete lined and has a maximum capacity of 956 cubic feet per second.

The annual firm yield of the Solano Project is 207,350 AFY. Solano Project water is designated for Agricultural (AG) and Municipal and Industrial (M&I) uses allocated to Participating Agencies as follows in Table 4:

Table 4: SCWA Participating Agency Maximum Solano Project Allocation (AF)

Participating Agency	Maximum Allocation (AFY)	Use
City of Fairfield	9,200	M&I
City of Suisun	1,600	M&I
City of Vacaville	5,750	M&I
City of Vallejo	14,600	M&I
Solano Irrigation District	141,000	AG+M&I
Maine Prairie Water District	15,000	AG
University of California - Davis	4,000	AG
California State Prison - Solano	1,200	AG+M&I
SCWA	15,000	Operating Loss
TOTAL	**207,350**	

Reliability estimates for the Solano Project are developed based on historic hydrology from 1906-2019, Lake Berryessa inflows, and the Sacramento Valley Index (SVI) for hydrologic year types (wet, above normal, below normal, dry, critically dry). The SVI was further categorized into Average Year (above normal, below normal), Single Dry Year, and Multi-Dry Year. The update of the Solano Project reliability analysis from 2015-2020 (Attachment 11) resulted in a slight change to the reliability since 2016, therefore, it is recommended that the updated reliability estimates be utilized for the 2020 SCWA UWMP. The recommended 2020 Solano Project Reliability estimates are presented in Table 5 below.

Table 5: Solano Project Supply Reliability (AF)

Solano Project Supply[a]	2025	2030	2035	2040-2045
Average Water Year[b]	206,021	206,021	206,021	206,021
% of Contract Amount[b]	99.4%	99.4%	99.4%	99.4%
Single Dry Year[c]	204,326	204,326	204,326	204,326
% of Contract Amount[c]	98.5%	98.5%	98.5%	98.5%
Multi-Dry Year[d]	192,375	192,375	192,375	192,375
% of Contract Amount[d]	92.8%	92.8%	92.8%	92.8%

Notes:
(a) SCWA's Total Participating Agency Contract Amounts equal 207,350 AF and includes 15,000 AF of canal losses.
(b) Based on average percent allocation (including canal losses) during Average Years over the study's historic hydrologic period of 1906 through 2020, rounded to the nearest whole percent.
(c) Based on the average percent allocation (including canal losses) during Single Dry Years over the study's historic hydrologic period of 1906 through 2020, rounded to the nearest whole percent.
(d) Supplies shown are average percent allocation (including canal losses) over four consecutive dry years, based on a repeat of the historic five-year dry period with low inflow to Lake Berryessa of 1990-1994, rounded to the nearest whole percent.

SCWA has subsequent long-term water service contracts for Solano Project water supply deliveries with Participating Agencies. Similar to the SWP Table A Supply Reliability, Solano Project Reliability shown in Table 5 are for SCWA and need to be adjusted to reflect individual Participating Agencies contract terms. The following tables show the SCWA Participating Agency Solano Project allocations based on Table 5 and Participating Agency maximum contract allocations in Table 4:

Table 6a: City of Fairfield Solano Project Supply Reliability (AF)

Solano Project Supply[(a)]	2025	2030	2035	2040-2045
Average Water Year[(b)]	9,141	9,141	9,141	9,141
% of Contract Amount[(b)]	99.4%	99.4%	99.4%	99.4%
Single Dry Year[(c)]	9,066	9,066	9,066	9,066
% of Contract Amount[(c)]	98.5%	98.5%	98.5%	98.5%
Multi-Dry Year[(d)]	8,536	8,536	8,536	8,536
% of Contract Amount[(d)]	92.8%	92.8%	92.8%	92.8%

Notes:

(a) City of Fairfield's Solano Project Contract Amount is 9,200 AF, not including canal losses.

(b) Based on average percent allocation (including canal losses) during Average Years over the study's historic hydrologic period of 1906 through 2020, rounded to the nearest whole percent.

(c) Based on the average percent allocation (including canal losses) during Single Dry Years over the study's historic hydrologic period of 1906 through 20120, rounded to the nearest whole percent.

(d) Supplies shown are average percent allocation (including canal losses) over four consecutive dry years, based on a repeat of the historic five-year dry period with low inflow to Lake Berryessa of 1990-1994, rounded to the nearest whole percent.

(e) The City of Fairfield may have additional water supply agreements in place with other agencies. See the City of Fairfield's most recently adopted UWMP for descriptions of their water supply portfolio.

Table 6b: City of Suisun City Solano Project Supply Reliability (AF)

Solano Project Supply[a]	2025	2030	2035	2040-2045
Average Water Year[b]	1,590	1,590	1,590	1,590
% of Contract Amount[b]	99.4%	99.4%	99.4%	99.4%
Single Dry Year[c]	1,577	1,577	1,577	1,577
% of Contract Amount[c]	98.5%	98.5%	98.5%	98.5%
Multi-Dry Year[d]	1,484	1,484	1,484	1,484
% of Contract Amount[d]	92.8%	92.8%	92.8%	92.8%

Notes:

(a) Suisun City's Solano Project Contract Amount is 1,600 AF, not including canal losses.

(b) Based on average percent allocation (including canal losses) during Average Years over the study's historic hydrologic period of 1906 through 2020, rounded to the nearest whole percent.

(c) Based on the average percent allocation (including canal losses) during Single Dry Years over the study's historic hydrologic period of 1906 through 2020, rounded to the nearest whole percent.

(d) Supplies shown are average percent allocation (including canal losses) over four consecutive dry years, based on a repeat of the historic five-year dry period with low inflow to Lake Berryessa of 1990-1994, rounded to the nearest whole percent.

(e) Suisun City may have additional water supply agreements in place with other agencies. See Suisun City's most recently adopted UWMP for descriptions of their water supply portfolio.

Table 6c: City of Vacaville Solano Project Supply Reliability (AF)

Solano Project Supply[(a)]	2025	2030	2035	2040-2045
Average Water Year[(b)]	5,713	5,713	5,713	5,713
% of Contract Amount[(b)]	99.4%	99.4%	99.4%	99.4%
Single Dry Year[(c)]	5,666	5,666	5,666	5,666
% of Contract Amount[(c)]	98.5%	98.5%	98.5%	98.5%
Multi-Dry Year[(d)]	5,335	5,335	5,335	5,335
% of Contract Amount[(d)]	92.8%	92.8%	92.8%	92.8%

Notes:

(a) City of Vacaville's Solano Project Contract Amount is 5,750 AF, not including canal losses.
(b) Based on average percent allocation (including canal losses) during Average Years over the study's historic hydrologic period of 1906 through 2020, rounded to the nearest whole percent.
(c) Based on the average percent allocation (including canal losses) during Single Dry Years over the study's historic hydrologic period of 1906 through 2020, rounded to the nearest whole percent.
(d) Supplies shown are average percent allocation (including canal losses) over four consecutive dry years, based on a repeat of the historic five-year dry period with low inflow to Lake Berryessa of 1990-1994, rounded to the nearest whole percent.
(e) The City of Vacaville may have additional water supply agreements in place with other agencies. See the City of Vacaville's most recently adopted UWMP for descriptions of their water supply portfolio.

Table 6d: City of Vallejo Solano Project Supply Reliability (AF)

Solano Project Supply[(a)]	2025	2030	2035	2040-2045
Average Water Year[(b)]	14,506	14,506	14,506	14,506
% of Contract Amount[(b)]	99.4%	99.4%	99.4%	99.4%
Single Dry Year[(c)]	14,387	14,387	14,387	14,387
% of Contract Amount[(c)]	98.5%	98.5%	98.5%	98.5%
Multi-Dry Year[(d)]	13,546	13,546	13,546	13,546
% of Contract Amount[(d)]	92.8%	92.8%	92.8%	92.8%

Notes:
(a) City of Vallejo's Solano Project Contract Amount is 14,600 AF, not including canal losses.
(b) Based on average percent allocation (including canal losses) during Average Years over the study's historic hydrologic period of 1906 through 2020, rounded to the nearest whole percent.
(c) Based on the average percent allocation (including canal losses) during Single Dry Years over the study's historic hydrologic period of 1906 through 2020, rounded to the nearest whole percent.
(d) Supplies shown are average percent allocation (including canal losses) over four consecutive dry years, based on a repeat of the historic five-year dry period with low inflow to Lake Berryessa of 1990-1994, rounded to the nearest whole percent.
(e) The City of Vallejo may have additional water supply agreements in place with other agencies. See the City of Vallejo's most recently adopted UWMP for descriptions of their water supply portfolio.

Table 6e: California State Prison Solano Project Supply Reliability (AF)

Solano Project Supply[a]	2025	2030	2035	2040-2045
Average Water Year[b]	1,192	1,192	1,192	1,192
% of Contract Amount[b]	99.4%	99.4%	99.4%	99.4%
Single Dry Year[c]	1,183	1,183	1,183	1,183
% of Contract Amount[c]	98.5%	98.5%	98.5%	98.5%
Multi-Dry Year[d]	1,113	1,113	1,113	1,113
% of Contract Amount[d]	92.8%	92.8%	92.8%	92.8%

<u>**Notes:**</u>
(a) California State Prison's Solano Project Contract Amount is 1,200 AF, not including canal losses.
(b) Based on average percent allocation (including canal losses) during Average Years over the study's historic hydrologic period of 1906 through 2020, rounded to the nearest whole percent.
(c) Based on the average percent allocation (including canal losses) during Single Dry Years over the study's historic hydrologic period of 1906 through 2020, rounded to the nearest whole percent.
(d) Supplies shown are average percent allocation (including canal losses) over four consecutive dry years, based on a repeat of the historic five-year dry period with low inflow to Lake Berryessa of 1990-1994, rounded to the nearest whole percent.

Table 6f: Maine Prairie Water District Solano Project Supply Reliability (AF)

Solano Project Supply[(a)]	2025	2030	2035	2040-2045
Average Water Year[(b)]	14,904	14,904	14,904	14,904
% of Contract Amount[(b)]	99.4%	99.4%	99.4%	99.4%
Single Dry Year[(c)]	14,781	14,781	14,781	14,781
% of Contract Amount[(c)]	98.5%	98.5%	98.5%	98.5%
Multi-Dry Year[(d)]	13,917	13,917	13,917	13,917
% of Contract Amount[(d)]	92.8%	92.8%	92.8%	92.8%

Notes:

(a) Maine Prairie Water District's Solano Project Contract Amount is 15,000 AF, not including canal losses.

(b) Based on average percent allocation (including canal losses) during Average Years over the study's historic hydrologic period of 1906 through 2020, rounded to the nearest whole percent.

(c) Based on the average percent allocation (including canal losses) during Single Dry Years over the study's historic hydrologic period of 1906 through 2020, rounded to the nearest whole percent.

(d) Supplies shown are average percent allocation (including canal losses) over four consecutive dry years, based on a repeat of the historic five-year dry period with low inflow to Lake Berryessa of 1990-1994, rounded to the nearest whole percent.

(e) Maine Prairie Water District may have additional water supply agreements in place with other agencies, which are not shown in this table.

Table 6g: Solano Irrigation District Solano Project Supply Reliability (AF)

Solano Project Supply[(a)]	2025	2030	2035	2040-2045
Average Water Year[(b)]	140,096	140,096	140,096	140,096
% of Contract Amount[(b)]	99.4%	99.4%	99.4%	99.4%
Single Dry Year[(c)]	138,944	138,944	138,944	138,944
% of Contract Amount[(c)]	98.5%	98.5%	98.5%	98.5%
Multi-Dry Year[(d)]	130,817	130,817	130,817	130,817
% of Contract Amount[(d)]	92.8%	92.8%	92.8%	92.8%

Notes:

(a) Solano Irrigation District's Solano Project Contract Amount is 141,000 AF, not including canal losses.

(b) Based on average percent allocation (including canal losses) during Average Years over the study's historic hydrologic period of 1906 through 2020, rounded to the nearest whole percent.

(c) Based on the average percent allocation (including canal losses) during Single Dry Years over the study's historic hydrologic period of 1906 through 2020, rounded to the nearest whole percent.

(d) Supplies shown are average percent allocation (including canal losses) over four consecutive dry years, based on a repeat of the historic five-year dry period with low inflow to Lake Berryessa of 1990-1994, rounded to the nearest whole percent.

(e) Solano Irrigation District may have additional water supply agreements in place with other agencies, which are not shown in this table.

Table 6h: University of California, Davis Solano Project Supply Reliability (AF)

Solano Project Supply[a]	2025	2030	2035	2040-2045
Average Water Year[b]	3,974	3,974	3,974	3,974
% of Contract Amount[b]	99.4%	99.4%	99.4%	99.4%
Single Dry Year[c]	3,942	3,942	3,942	3,942
% of Contract Amount[c]	98.5%	98.5%	98.5%	98.5%
Multi-Dry Year[d]	3,711	3,711	3,711	3,711
% of Contract Amount[d]	92.8%	92.8%	92.8%	92.8%

<u>**Notes:**</u>
(a) University of California, Davis's Solano Project Contract Amount is 4,000 AF, not including canal losses.
(b) Based on average percent allocation (including canal losses) during Average Years over the study's historic hydrologic period of 1906 through 2020, rounded to the nearest whole percent.
(c) Based on the average percent allocation (including canal losses) during Single Dry Years over the study's historic hydrologic period of 1906 through 2020, rounded to the nearest whole percent.
(d) Supplies shown are average percent allocation (including canal losses) over four consecutive dry years, based on a repeat of the historic five-year dry period with low inflow to Lake Berryessa of 1990-1994, rounded to the nearest whole percent.

Suggested Language for UWMP and WSCP

Language that could be used by each member agency to aid in the preparation of 2020 Water Shortage Contingency Plans might include the following:

> "Solano County Water Agency evaluates Solano Project reservoir conditions each spring and will provide agency-specific supply estimates by April of each year. SCWA also monitors the SWP delivery estimates throughout the winter and can provide an estimated SWP supply to each agency by February of each year. Both of these water supplies' delivery estimates will be updated throughout the year as hydrologic conditions change, and SCWA will provide updated estimates as they become available."

As noted earlier, SWP specific language regarding UWMP preparation is provided in Attachments 1-9.

Suggested SWP Availability for DWR Table 7-5 – Drought Risk Assessment

It is suggested that Table 7-5 Five Year Drought Risk Assessment of the DWR UWMP Submittal tables be modified to reflect changes made during the preparation of this technical memorandum. It is suggested for the 5-year Drought Risk Assessment table that the SWP availability be adjusted such that 5% is moved to the first year (2021 actual), 45% moved to year two, 30% moved to year three, 15% moved to year four, and 30% moved to year five to simulate if the next five years reflect the 5-year dry period.

Attachments:

1. 5%_SWP_Allocation_UWMP_Insert_011721_c1
2. 2019_BiOp_ITP_write_up_for_UWMP_012721_c1
3. ACP_WP_SWP_Contract_Extension_WMP_DCP-AIP_UWMP_Inserts _011721_c1
4. COA_UWMP_Insert_012721_c1
5. Emergency_Freshwater_Pathway_Description_UWMP_Insert_011721_c1
6. Sisk_UWMP_Insert_011721_c1
7. SWP_Seismic_Improvements_UWMP_Insert_011721_c1
8. SWP_Water_Supply_Estimates_UWMP_Insert_011721_c1
9. WQCP_VA_UWMP_Insert_012721_c1
10. 2019 SWP Delivery Capability Report Excerpt of Appendices A & B
11. Appendix C – Solano Project Water Supply Reliability – LBI Index_2020

ACP/WP/Subject to Common Interest Agreement

Insert for 2020 UWMP

Lowest SWP Water Supply Allocation

DWR's 2019 Delivery Capability Report indicates that the modeled single dry year SWP water supply allocation is 7% under the existing conditions. However, historically the lowest SWP allocations were at 5% in 2014. Due to extraordinarily dry conditions in 2013 and 2014, the initial 2014 SWP allocation was a historically low 5% of Table A Amounts, was later reduced to 0% in January 2014, and was later raised back to 5%, the lowest ever final total SWP water supply allocation. The circumstances that led to the low 2014 SWP water supply allocation were unusual, and although possible, likely have a low probability of occurrence.

Each year by October 1, SWP contractors submit their requests for SWP supplies for the following calendar year. By December 1, DWR estimates the available water supply for the following year and sets an initial supply allocation based on: the total of all contractors' requests, current reservoir storage, forecasted hydrology through the next year, and target reservoir storage for the end of the next year. The most uncertain of these factors is the forecasted hydrology. In setting water supply allocations, DWR uses a conservative 90% hydrologic forecast, where nine out of ten years will be wetter and one out of ten years drier than assumed. DWR re-evaluates its estimate of available supplies throughout the runoff season of winter and early spring, using updated reservoir storage and hydrologic forecasts, and revises SWP supply allocations as warranted. Since most of California's annual precipitation falls in the winter and early spring, by the end of spring the supply available for the year is much more certain, and in most years DWR issues its final SWP allocation by this time. While most of the water supply is certain by this time, runoff in the late fall remains somewhat variable as the next year's runoff season begins. A drier than forecasted fall can result in not meeting end-of-year reservoir storage targets, which means less water available in storage for the following year.

Water year 2013 was a year with two hydrologic extremes.[1] October through December 2012 was one of the wettest fall periods on record, but was followed by the driest consecutive 12 months on record. The supply allocation for 2013 was a low 35% allocation. However, the 2013 hydrology ended up being even drier than DWR's conservative hydrologic forecast, so the SWP began 2014 with reservoir storage lower than targeted levels and less stored water available for 2014 supplies. Compounding this low storage situation, 2014 also was a critically dry year, with runoff for water year 2014 the fourth driest on record.

The exceedingly dry sequence from the beginning of January 2013 through the end of 2014 was one of the driest two-year periods in the historical record. As noted above, the circumstances that led to the low 2014 SWP water supply allocation were unusual, and likely have a low probability of occurrence in the future. Thus, the assumption for SWP contractors such as AGENCY NAME is that a 5% allocation represents the "worst-case" scenario.

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[1] A water year begins in October and runs through September. For example, water year 2013 is October 2012 through September 2013.

2019 BiOp / 2020 ITP Litigation Write Up for 2020 UWMP

In late 2019, the U.S. Fish and Wildlife Service (FWS) and National Marine Fisheries Service (NMFS) issued new Biological Opinions for the Long-Term Operation of the Central Valley Project (CVP) and State Water Project (SWP). Reinitiation of consultation on the Biological Opinions began in 2016 to update the prior 2008 and 2009 Biological Opinions and provide Federal Endangered Species Act (ESA) compliance for the CVP and SWP. Additionally, in early 2020, the California Department of Fish and Wildlife (DFW) issued DWR an Incidental Take Permit for the Long-Term Operation of the SWP pursuant to the California Endangered Species Act (CESA) with regards to state-protected longfin smelt and state- and federally-protected delta smelt, winter-run Chinook and spring-run Chinook. Previously, DFW had issued the SWP an Incidental Take Permit for the state-listed longfin smelt and Consistency Determinations with the 2008 and 2009 Biological Opinions for the state and federally listed species, not a separate permit. Some of the operational restrictions in the 2019 Biological Opinions differ from those in the 2020 Incidental Take Permit. Specifically, even though the projects' operations are coordinated, the SWP is subject to additional operational constraints that reduce SWP supplies and create operational conflicts. Both the 2019 Biological Opinions and the 2020 Incidental Take Permit are subject to multiple court challenges.

ESA Biological Opinion Litigation. Two cases were filed challenging the Biological Opinions under the ESA, Administrative Procedure Act, and National Environmental Policy Act. The first case filed, *Pacific Coast Federation of Fisherman's Association, et al. v. Ross (Case No. 1:20-CV-00431-DAD-SAB ("PCFFA v. Ross")*, was brought by six environmental organizations. The second case, *California Natural Resources Agency, et al. v. Ross* (Case No. 1:20) ("*CNRA v. Ross*"), was brought by the California Natural Resources Agency, the California Environmental Protection Agency and the California Attorney General. The State's case includes a cause of action under CESA alleging that the federal CVP must comply with CESA. The cases were coordinated and transferred to the Eastern District. State and federal water contractors have intervened as defendants in both cases.

In Spring of 2020, plaintiffs in both cases brought motions for preliminary injunction. The environmental organizations sought broad relief, asking the court to require the federal defendants to abide by the 2008 and 2009 Biological Opinions pending a determination on the merits. The State sought a narrow injunction requiring the federal defendants to operate pursuant to the inflow to export ratio in the 2009 NMFS Biological Opinion for the final 20 days of May based on alleged irreparable harm to delta smelt, longfin smelt and San Joaquin River steelhead. The court issued an order on May 11, 2020 granting the State's narrow injunction on limited grounds for the protection of steelhead. The court denied the other elements of the *PCFFA v. Ross* plaintiffs' motion for preliminary injunction finding the evidence presented was insufficient to show irreparable harm to the species or that the requested injunction was likely to materially improve conditions for the species during the specified period.

In *CNRA v. Ross*, the Federal Defendants and several intervenors filed motions to dismiss the State's CESA cause of action for lack of subject matter jurisdiction or, alternatively, failure to state a claim. As of this date, the court has not scheduled a hearing or ruled on the motion.

CESA Incidental Take Permit Litigation. Eight cases, listed below, have been filed in state court by public agencies, environmental organizations, and a Native American tribe challenging DWR's approval of the Long Term Operations of the SWP and associated environmental review. Most of the cases also challenge CDFW's issuance of an Incidental Take Permit for the SWP.

- *North Coast Rivers Alliance, et al. v. Department of Water Resources, et al.*, County of San Francisco Superior Court Case No. CPF-20-517078, filed April 28, 2020;
- *State Water Contractors, et al. v. California Department of Water Resources, et al.*, County of Fresno Superior Court Case No. 20CECG01302, electronically filed April 28, 2020;
- *Tehama-Colusa Canal Authority, et al. v. California Department of Water Resources, et al.*, County of Fresno Superior Court Case No. 20CECG01303, electronically filed April 28, 2020;
- *The Metropolitan Water District of Southern California, et al. v. California Department of Water Resources, et al.*, County of Fresno Superior Court Case No. 20CECG01347, electronically filed April 28, 2020;
- *Sierra Club, et al. v. California Department of Water Resources*, County of San Francisco Superior Court Case No. CPF-20-517120, filed April 29, 2020;
- *Central Delta Water Agency, et al. v. California Department of Fish and Wildlife, et al.*, County of Sacramento Superior Court Case No. 34-2020-80003368, filed May 6, 2020;
- *San Bernardino Valley Municipal Water District v. California Department of Water Resources, et al.*, County of Fresno Superior Court Case No. 20CECG01556, filed May 28, 2020;
- *San Francisco Baykeeper, et al. v. California Department of Water Resources, et al.*, County of Alameda Superior Court Case No. RG20063682, filed June 5, 2020.

The challenges are raised on several legal grounds, including CESA, California Environmental Quality Act, the Delta Reform Act, Public Trust Doctrine, area of origin statutes, breach of contract, and breach of covenant of good faith and fair dealing. All eight cases have been coordinated in Sacramento County Superior Court.

Litigation over the 2019 Biological Opinions and 2020 Incidental Take Permit will likely take several years. The projects began operating to the new requirements in 2020. Throughout implementation any party may seek preliminary injunctive relief during the litigation, such as that sought by the plaintiffs in the 2019 Biological Opinion cases. It is likely that the 2019 Biological Opinions and 2020 Incidental Take Permit will govern operations until final judicial determinations on the merits are made. Thus, it is unlikely that SWP water supply would increase beyond that resulting from the limitations in the 2019 BiOps and 2020 ITP during this timeframe.

ACP/WP/Subject to Common Interest Agreement
Insert for 2020 UWMP

SWP Contract Amendments for 2020 UMWP

Contract Extension

The Department of Water Resources (DWR) provides water supply from the State Water Project (SWP) to 29 SWP Contractors (Contractors) in exchange for Contractor payment of all costs associated with providing that supply. DWR and each of the Contractors entered into substantially uniform long-term water supply contracts (Contracts) in the 1960s with 75-year terms. The first Contract terminates in 2035, and most of the remaining Contracts terminate within three years after that.

The majority of the capital costs associated with the development and maintenance of the SWP is financed using revenue bonds. These bonds have historically been sold with 30-year terms. It has become more challenging in recent years to affordably finance capital expenditures for the SWP because bonds used to finance these expenditures are limited to terms that only extend to the year 2035, less than 30 years from now. To ensure continued affordability of debt service to Contractors, it was necessary to extend the termination date of the Contracts to allow DWR to continue to sell bonds with 30-year terms.

Public negotiations to extend the Contracts took place between DWR and the Contractors during 2013 and 2014. An AIP was reached and was the subject of analysis under the requirements of the California Environmental Quality Act (CEQA) (Notice of Preparation dated September 12, 2104). On December 11, 2018 DWR Director approved the Water Supply Contract Extension Project. In accordance with CEQA, DWR also filed its Notice of Determination for the project with the Governor's Office of Planning and Research. In addition, DWR filed an action in Sacramento County Superior Court to validate the Contract Extension Amendments (https://water.ca.gov/Programs/State-Water-Project/Management/Water-Supply-Contract-Extension). After CEQA was completed and contract language was finalized, DWR and 18 contractors have executed the Extension Amendment. The Extension Amendment would extend the contracts through 2085 and improve the project's overall financial integrity and management. The Extension Amendment is the subject to a validation action and two CEQA lawsuits.

Water Management Tools

In a December 2017 Notice to Contractors, DWR indicated its desire to supplement and clarify the water management tools through this public process. Seeking greater flexibility to manage the system in order to address changes in hydrology and further constraints placed on DWR's operation of the SWP, PWAs and DWR conducted public negotiations in 2017 to improve water management tools (WMT Amendment). The goal of the negotiations was to develop concepts to supplement and clarify the existing SWP Contract's water transfer and exchange provisions to provide improved water management amongst the PWAs. Importantly, the transfers and exchanges provided for in the contract amendment are limited to those transfers and exchanges amongst the PWAs with SWP Contracts.

In June 2018, PWAs and DWR completed an AIP which included specific principles to accomplish this goal. These principles included adding contract language to include a process for transparency for transfers and exchanges. The principles also include amending existing contract provisions to provide new flexibility for single and multi-year non-permanent water transfers, allowing PWAs to set terms of compensation for transfers and exchanges, and providing for the limited transfer of carryover and Article 21 water.

In October 2018, a Draft Environmental Impact Report (DEIR) was circulated for the contract amendments. The AIP at that time included cost allocation for the California WaterFix project (WaterFix). In early 2019, the Governor decided not to move forward with WaterFix and DWR rescinded its approvals for WaterFix. After this shift, the PWAs and DWR held a public negotiation session and agreed to remove the WaterFix cost allocation sections from AIP, but to keep all the water management provisions in the AIP. The AIP for water management provisions was finalized on May 20, 2019. In February 2020, DWR amended and recirculated the Partially Recirculated DEIR for the State Water Project Supply Contract Amendments for Water Management and in August 2020, DWR certified the Final EIR. The EIR is being challenged in court. The WMT Amendment is effective when 24 SWP PWAs approve the amendment. The transfer and exchange tools will be available during litigation unless there is a final court order prohibiting their implementation.

Delta Conveyance Project

The third set of amendments would allocate Delta Conveyance Project costs and benefits among the SWP PWAs. Public negotiations between Department of Water Resources ("DWR") and Public Water Agencies ("PWA's") for the Delta Conveyance Project began in 2019 and were completed in April 2020. These negotiations led to an Agreement in Principle ("AIP") for an Amendment to the State Water Contract regarding the Delta Conveyance Project. The Parties' goal was to equitably allocate costs and benefits of a Delta Conveyance Facility and to preserve State Water Project operational flexibility. A decision by each participating PWA for approving a contract amendment with DWR would not occur until after the environmental review for the Delta Conveyance Project is completed. That decision would likely occur in 2023, at the earliest.

ACP/WP/Subject to Common Interest Agreement:

2020 UWMP Insert

Coordinated Operations Agreement (COA)

The Coordinated Operation Agreement (COA) was originally signed in 1986 and defines how the state and federal water projects share the available water supply and the obligations including senior water right demands, water quality and environmental flow requirements imposed by regulatory agencies. The agreement calls for periodic review to determine whether updates are needed in light of changed conditions. After completing a joint review process, DWR and Reclamation agreed to an addendum to the COA in December 2018, to reflect water quality regulations, biological opinions and hydrology updated since the agreement was signed.

The COA Addendum includes changes to the percentages for sharing responsibilities for in basin uses, sharing available export capacity, and the review process. The 1986 Agreement required CVP to meet 75% of the in basin uses and the SWP to meet 25%. The COA Addendum now distinguishes responsibility based on water year type and CVP responsibilities range from 80% in wet years to 60% in critical years. SWP responsibility ranges from 20% in wet years to 40% in critical years. Additionally, the COA Addendum changed sharing export capacity. Previously, export capacity was shared 50% to CVP and 50% to SWP. The COA addendum changed this formula to be 65% CVP and 35% SWP during balanced conditions and 60% CVP and 40 % SWP during excess conditions. Overall, based on modeling, these change results in an approximately 115,000 AFY on average reduction in SWP supplies.

Finally, the 2018 COA Addendum updated the review process to require review of the COA Agreement and Addendum every 5 years. Litigation regarding the COA addendum environmental review is ongoing. The litigation is unlikely to change the negotiated COA addendum and implementation has already begun.

ACP/WP/Subject to Common Interest Agreement

Insert for 2020 UWMP

Emergency Freshwater Pathway Description (Sacramento-San Joaquin Delta)

It has been estimated by the California Department of Water Resources (DWR) that in the event of a major earthquake in or near the Delta, water supplies could be interrupted for up to three years, posing a significant and unacceptable risk to the California business economy. A post-event strategy would provide necessary water supply protections to avert this catastrophe. Such a plan has been coordinated through DWR, Corps of Engineers (Corps), Bureau of Reclamation (Reclamation), California Office of Emergency Services (Cal OES), the Metropolitan Water District of Southern California and the State Water Contractors.

DWR Delta Flood Emergency Management Plan. The Delta Flood Emergency Management Plan (DWR, 2018) provides strategies for response to Delta levee failures, up to and including earthquake-induced multiple island failures during dry conditions when the volume of flooded islands and salt water intrusion are large, resulting in curtailment of export operations. Under these severe conditions, the plan includes a strategy to establish an emergency freshwater pathway from the central Delta along Middle River and Victoria Canal to the export pumps in the south Delta. The plan includes the prepositioning of emergency construction materials at existing and new stockpile and warehouse sites in the Delta, and development of tactical modeling tools (DWR Emergency Response Tool) to predict levee repair logistics, timelines of levee repair and suitable water quality to restore exports. The Delta Flood Emergency Management Plan has been extensively coordinated with state, federal and local emergency response agencies. DWR, in conjunction with local agencies, the Corps and Cal OES, conduct tabletop and field exercises to test and revise the plan under real time conditions.

DWR and the Corps provide vital Delta region response to flood and earthquake emergencies, complementary to Cal OES operations. These agencies perform under a unified command structure and response and recovery framework. The Northern California Catastrophic Flood Response Plan (Cal OES, 2018) incorporates the DWR Delta Flood Emergency Management Plan. The Delta Emergency Operations Integration Plan (DWR and USACE, 2019) integrates personnel and resources during emergency operations.

Pathway Implementation Timeline. The Delta Flood Emergency Management Plan has found that using pre-positioned stockpiles of rock, sheet pile and other materials, multiple earthquake-generated levee breaches and levee slumping along the freshwater pathway can be repaired in less than six months. A supplemental report (Levee Repair, Channel Barrier and Transfer Facility Concept Analyses to Support Emergency Preparedness Planning, M&N, August 2007) evaluated among other options, the placement of sheet pile to close levee breaches, as a redundant method if availability of rock is limited by possible competing uses. The stockpiling of sheet pile is vital should more extreme emergencies warrant parallel and multiple repair techniques for deep levee breaches. Stockpiles of sheet pile and rock to repair deep breaches and an array of levee slumping restoration materials are stored at DWR and Corps stockpile sites and warehouses in the Delta.

Emergency Stockpile Sites and Materials. DWR has acquired lands at Rio Vista and Stockton as major emergency stockpile sites, which are located and designed for rapid response to levee emergencies. The sites provide large loading facilities, open storage areas and new and existing warehousing for emergency flood fight materials, which augment existing warehousing facilities throughout the Delta. The Corps maintains large warehousing facilities in the Delta to store materials for levee freeboard restoration, which can be augmented upon request of other stockpiles in the United States. Pre-positioned rock and sheet pile are used for closure of deep levee breaches. Warehoused materials for rapid restoration of slumped levees include muscle (k-rail) walls, super sacks, caged rock containers, sand bags, stakes and plastic tarp. Stockpiles will be augmented as materials are used.

Emergency Response Drills. Earthquake-initiated multiple island failures will mobilize DWR and Corps resources to perform Delta region flood fight activities within an overall Cal OES framework. In these events, DWR and the Corps integrate personnel and resources to execute flood fight plans through the Delta Emergency Operations Integration Plan (DWR and USACE, 2019). DWR, the Corps and local agencies perform emergency exercises focusing on communication readiness and the testing of mobile apps for information collection and dissemination. The exercises train personnel and test the readiness of emergency preparedness and response capabilities under unified command, and provide information to help to revise and improve plans.

Levee Improvements and Prioritization. The DWR Delta Levees Subventions and Special Projects Programs have prioritized, funded and implemented levee improvements along the emergency freshwater pathway and other water supply corridors in the central and south Delta. These efforts are complementary to the Delta Flood Emergency Management Plan, which along with pre-positioned emergency flood fight materials, ensures reasonable seismic performance of levees and timely pathway restoration after a severe earthquake. These programs have been successful in implementing a coordinated strategy of emergency preparedness to the benefit of SWP and CVP export systems.

Significant improvements to the central and south Delta levees systems along Old and Middle Rivers began in 2010 and are continuing to the present time. This complements substantially improved levees at Mandeville and McDonald Islands and portions of Victoria and Union Islands. Levee improvements along the Middle River emergency freshwater pathway and Old River consist of crest raising, crest widening, landside slope fill and toe berms, which improve seismic stability, reduce levee slumping and create a more robust flood-fighting platform. Urban agencies, including Metropolitan, Contra Costa Water District, East Bay Municipal Utility District, and others have participated in levee improvement projects along or near the Old and Middle River corridors.

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Insert for 2020 UWMP

B. F. Sisk Dam Raise and San Luis Reservoir Expansion

U. S. Bureau of Reclamation (Reclamation) and San Luis & Delta Mendota Water Authority (SLDMWA) are proposing to raise Sisk Dam and increase storage capacity in San Luis Reservoir. The proposed 10-foot dam raise is in addition to the ongoing 12-foot raise of Sisk Dam to improve dam safety and would expand San Luis Reservoir storage by 130 TAF. The final supplemental EIS/EIR released on December 18, 2020, estimated that the SWP exports could potentially reduce by about 23 TAF per year on average under the preferred alternative. This project is currently undergoing design, environmental planning and permitting. Construction is estimated to complete by 2030 following environmental planning and permitting.

DWR estimates of SWP supply reliability in its 2019 Delivery Capability Report are based on existing facilities, and do not include this project.

[if necessary, additional text for individual participating SWP PWAs]

ACP/WP/Subject to Common Interest Agreement

Insert for 2020 UWMP

SWP Seismic Improvements

DWR's recent SWP seismic resiliency efforts have focused heavily on SWP Dam Safety. The most prominent is the joint USBR/DWR corrective action study of Sisk Dam which will result in a massive seismic stability alteration project, which is expected to begin construction in 2021. Similarly, Perris Dam had a major foundation modification and stability berm added to the downstream face which has resulted in the removal of the DSOD imposed storage restriction. Several analyses have been conducted on SWP dam outlet towers/access bridges which has resulted in seismic upgrades (some completed/some on-going). Updated dam seismic safety evaluations are being performed on the Oroville Dam embankment and the radial gate control structure on the flood control spillway.

In addition to the dam safety elements, DWR has procured and stockpiled spare pipe sections for the South Bay Aqueduct to increase recovery times following seismic induced damage (as part of the 2015 South Bay Aqueduct Reliability Improvement Project). Seismic retrofits have also been completed on 23 SWP bridges located in four Field Divisions with additional retrofits in various development stages. DWR has also updated the earthquake notification procedures and has replaced and expanded instrumentation for the SWP's seismic network.

ACP/WP/Subject to Common Interest Agreement

Insert for 2020 UWMP

SWP Water Supply Estimates

DWR prepares a biennial report to assist SWP contractors and local planners in assessing the availability of supplies from the SWP. DWR issued its most recent update, the 2019 DWR State Water Project Delivery Capability Report (DCR), in August 2020. In this update, DWR provides SWP supply estimates for SWP contractors to use in their planning efforts, including for use in their 2020 UWMPs. The 2019 DCR includes DWR's estimates of SWP water supply availability under both existing (2020) and future conditions (2040).

DWR's estimates of SWP deliveries are based on a computer model that simulates monthly operations of the SWP and Central Valley Project systems. Key inputs to the model include the facilities included in the system, hydrologic inflows to the system, regulatory and operational constraints on system operations, and contractor demands for SWP water. In conducting its model studies, DWR must make assumptions regarding each of these key inputs.

In the 2019 DCR for its model study under existing conditions, DWR assumed: existing facilities, hydrologic inflows to the model based on 82 years of historical inflows (1922 through 2003), current regulatory and operational constraints including 2018 COA Amendment, 2019 biological opinions and 2020 Incidental Take Permit, and contractor demands at maximum Table A Amounts. The long-term average allocation reported in the 2019 DCR for the existing conditions study provide appropriate estimate of the SWP water supply availability under current conditions.

To evaluate SWP supply availability under future conditions, the 2019 DCR included a model study representing hydrologic and sea level rise conditions at 2040. The future condition study used all of the same model assumptions as the study under existing conditions, but reflected changes expected to occur from climate change, specifically, projected temperature and precipitation changes centered around 2035 (2020 to 2049) and a 45 cm sea level rise. For the long-term planning purposes of this UWMP, the long-term average allocations reported for the future conditions study from 2019 DCR is the most appropriate estimate of future SWP water supply availability.

[Additional guidance for water supply estimates:

- SWP PWAs can rely on the main contractor tables or alternate tables in DCR. When reporting the final long-term average allocation for the entire SWP ensure to report 58% for the Existing Conditions and 52% for future conditions.
- For supply estimates in the years between 2020 and 2040, PWAs are free to use the approach that suits their need: SWP PWAs can linearly interpolate long-term average allocations between 2020 and 2040, hold them constant (2020 to 2039 use 2020 allocation and for 2040 use 2040 allocation), or use 2040 allocation for 2020 through 2040. Whatever the approach is it is important to describe your assumptions for the selected approach, since these values cannot be ascribed to the DCR.
- For water supply estimates beyond 2040, PWAs should use 2040 allocations.]

ACP/WP/Subject to Common Interest Agreement

Insert for 2020 UWMP

Water Quality Control Plan/Voluntary Agreement

The State Water Board is responsible for adopting and updating the Water Quality Control Plan for the San Francisco Bay/Sacramento–San Joaquin Delta Estuary (Bay-Delta Plan), which establishes water quality control objectives and flow requirements needed to provide reasonable protection of beneficial uses in the watershed. The State Water Board has been engaged for many years in updating the Bay Delta Plan.

The Bay-Delta Plan is being updated through phases. Phase 1 is updating the Bay-Delta Plan objectives for the San Joaquin River and its major tributaries and the southern Delta salinity objectives. Phase 2 is updating the objectives for the Sacramento River and Delta and their major tributaries. (Plan amendments). On December 12, 2018, through State Water Board Resolution No. 2018-0059, the State Water Board adopted the Phase 1 Plan amendments and Final SED establishing the Lower San Joaquin River flow objectives and revised southern Delta salinity objectives. On February 25, 2019, the Office of Administrative Law approved the Plan amendments. This plan requires an adaptive range of 30-50 percent of the unimpaired flow to be maintained from February through June in the Stanislaus, Tuolumne, and Merced Rivers, with a starting point of 40 percent of the unimpaired flow. During this same time period, the flows at Vernalis on the San Joaquin River, as provided by the unimpaired flow objective, are required to be no lower than a base flow of 1,000 cubic feet per second (cfs), with an adaptive range between 800 and 1,200 cfs, inclusive.

The State Water Board is also considering Phase 2 Plan amendments focused on the Sacramento River and its tributaries, Delta eastside tributaries (including the Calaveras, Cosumnes, and Mokelumne rivers), Delta outflows, and interior Delta flows. Staff is recommending an adaptive range of 45-65 percent Unimpaired Flow (UIF) objective with a starting point of 55 percent. Once the State Water Board adopts Phase 2 Plan amendments, the Board will need to conduct hearings to determine, consistent with water rights, water users' responsibilities for meeting the objectives in both Phase 1 and 2. At this time, the potential impacts to the SWP are unknown but this objective would have a large impact on water users in the Phase 2 planning area.

The State and several water users began working on an alternative to the Bay-Delta Plan update in 2018, known as the Voluntary Agreement process. The Voluntary Agreement process offers an alternative to the State Water Board staff's flow only approach. A Voluntary Agreement, if agreed to by the State Water Board, would be a substitute for the UIF approach and would become the Program of Implementation for the Plan amendments. Implementing the Voluntary Agreement would not require a water rights hearing because the parties are agreeing to take the actions. The Voluntary Agreement approach provides flow, and funding for flows, habitat actions, and a robust science program. The Voluntary Agreement approach provides an opportunity to combine flow and habitat actions to protect public trust resources, while providing certainty for water users. It offers a chance to avoid years of hearings and litigation and to instead begin early implementation of Voluntary Agreement actions.

Table A-28. Solano County WA: Existing Conditions

SWP Table A Deliveries for 2019 Study					Probability Curve			
Year	Delivery w/o Article 56 Carryover (TAF)	Article 56 Carryover (TAF)	Total Table A Delivery (TAF)	Percent of Maximum Table A	Year	Total Table A Delivery (TAF)	Exceedance Frequency (%)	Percent of Maximum Table A
1922	22	0	22	47%	1942	48	0%	100%
1923	20	22	42	88%	1943	48	0%	100%
1924	11	20	31	66%	1953	48	0%	100%
1925	20	1	21	43%	1970	48	0%	100%
1926	20	3	23	48%	1971	48	0%	100%
1927	24	3	27	56%	1975	48	0%	100%
1928	22	24	46	96%	1983	48	0%	100%
1929	11	22	34	70%	1984	48	0%	100%
1930	20	1	21	43%	1996	48	0%	100%
1931	11	3	14	30%	1997	48	0%	100%
1932	20	1	21	43%	1998	48	0%	100%
1933	11	3	14	30%	1999	48	0%	100%
1934	11	1	12	25%	1941	46	15%	97%
1935	20	1	21	43%	1952	46	15%	97%
1936	20	20	40	84%	1958	46	15%	97%
1937	20	20	40	84%	1974	46	15%	97%
1938	24	20	44	92%	1928	46	20%	96%
1939	20	24	44	92%	1954	46	20%	96%
1940	22	3	25	53%	1957	46	20%	96%
1941	24	22	46	97%	2000	46	20%	96%
1942	24	24	48	100%	1938	44	25%	92%
1943	24	24	48	100%	1963	44	25%	92%
1944	20	24	44	92%	1967	44	25%	92%
1945	20	3	23	48%	1969	44	25%	92%
1946	20	20	40	84%	1959	44	30%	92%
1947	20	20	40	84%	1966	44	30%	92%
1948	20	3	23	48%	1968	44	30%	92%
1949	20	20	40	84%	1972	44	30%	92%
1950	20	3	23	48%	1939	44	35%	92%
1951	22	20	42	89%	1944	44	35%	92%
1952	24	22	46	97%	1964	44	35%	92%
1953	24	24	48	100%	1985	44	35%	92%
1954	22	24	46	96%	1987	44	35%	92%
1955	20	22	42	88%	1951	42	41%	89%
1956	24	3	27	56%	1973	42	41%	89%
1957	22	24	46	96%	1980	42	41%	89%
1958	24	22	46	97%	1923	42	44%	88%
1959	20	24	44	92%	1979	42	44%	88%
1960	20	20	40	84%	1955	42	47%	88%
1961	20	3	23	48%	1981	42	47%	88%
1962	20	3	23	48%	2001	42	47%	88%
1963	24	20	44	92%	1936	40	51%	84%
1964	20	24	44	92%	1937	40	51%	84%
1965	24	3	27	56%	1946	40	51%	84%

SWP Table A Deliveries for 2019 Study						Probability Curve			
Year	Delivery w/o Article 56 Carryover (TAF)	Article 56 Carryover (TAF)	Total Table A Delivery (TAF)	Percent of Maximum Table A		Year	Total Table A Delivery (TAF)	Exceedance Frequency (%)	Percent of Maximum Table A
1966	20	24	44	92%		1947	40	54%	84%
1967	24	20	44	92%		1949	40	54%	84%
1968	20	24	44	92%		1960	40	54%	84%
1969	24	20	44	92%		1976	35	58%	74%
1970	24	24	48	100%		1929	34	59%	70%
1971	24	24	48	100%		1994	34	59%	70%
1972	20	24	44	92%		1924	31	62%	66%
1973	22	20	42	89%		1927	27	63%	56%
1974	24	22	46	97%		1956	27	63%	56%
1975	24	24	48	100%		1965	27	63%	56%
1976	11	24	35	74%		1982	27	63%	56%
1977	11	1	12	25%		1986	27	63%	56%
1978	22	1	23	48%		2003	26	69%	54%
1979	20	22	42	88%		1940	25	70%	53%
1980	22	20	42	89%		1995	24	72%	51%
1981	20	22	42	88%		1945	23	73%	48%
1982	24	3	27	56%		1948	23	73%	48%
1983	24	24	48	100%		1950	23	73%	48%
1984	24	24	48	100%		1962	23	73%	48%
1985	20	24	44	92%		1961	23	78%	48%
1986	24	3	27	56%		1926	23	78%	48%
1987	20	24	44	92%		2002	23	78%	48%
1988	11	3	14	30%		1978	23	81%	48%
1989	20	1	21	43%		1993	23	81%	48%
1990	11	3	14	30%		1922	22	84%	47%
1991	11	1	12	25%		1935	21	85%	43%
1992	11	1	12	25%		1925	21	86%	43%
1993	22	1	23	48%		1930	21	86%	43%
1994	11	22	34	70%		1932	21	86%	43%
1995	24	1	24	51%		1989	21	86%	43%
1996	24	24	48	100%		1931	14	91%	30%
1997	24	24	48	100%		1933	14	91%	30%
1998	24	24	48	100%		1988	14	91%	30%
1999	24	24	48	100%		1990	14	91%	30%
2000	22	24	46	96%		1992	12	96%	25%
2001	20	22	42	88%		1934	12	96%	25%
2002	20	3	23	48%		1977	12	96%	25%
2003	23	3	26	54%		1991	12	96%	25%
Average	**20**	**15**	**35**	**73%**			**35**		**73%**
Maximum	**24**	**24**	**48**	**100%**			**48**		**100%**
Minimum	**11**	**0**	**12**	**25%**			**12**		**25%**

Table B-30. Solano County WA: Future Conditions

SWP Table A Deliveries for 2019 Study					Probability Curve			
Year	Delivery w/o Article 56 Carryover (TAF)	Article 56 Carryover (TAF)	Total Table A Delivery (TAF)	Percent of Maximum Table A	Year	Total Table A Delivery (TAF)	Exceedance Frequency (%)	Percent of Maximum Table A
1922	22	0	22	47%	1942	48	0%	100%
1923	20	22	42	88%	1943	48	0%	100%
1924	11	20	31	66%	1952	48	0%	100%
1925	20	1	21	43%	1953	48	0%	100%
1926	20	3	23	48%	1970	48	0%	100%
1927	24	3	27	56%	1971	48	0%	100%
1928	22	24	46	96%	1975	48	0%	100%
1929	11	22	34	70%	1983	48	0%	100%
1930	20	1	21	43%	1984	48	0%	100%
1931	11	3	14	30%	1996	48	0%	100%
1932	20	1	21	43%	1997	48	0%	100%
1933	11	3	14	30%	1998	48	0%	100%
1934	11	1	12	25%	1999	48	0%	100%
1935	20	1	21	43%	1941	46	16%	97%
1936	20	20	40	84%	1974	46	16%	97%
1937	20	20	40	84%	1928	46	19%	96%
1938	24	20	44	92%	1954	46	19%	96%
1939	20	24	44	92%	2000	46	19%	96%
1940	22	3	25	53%	1938	44	22%	92%
1941	24	22	46	97%	1951	44	22%	92%
1942	24	24	48	100%	1958	44	22%	92%
1943	24	24	48	100%	1963	44	22%	92%
1944	20	24	44	92%	1967	44	22%	92%
1945	20	3	23	48%	1969	44	22%	92%
1946	20	20	40	84%	1957	44	30%	92%
1947	20	20	40	84%	1959	44	30%	92%
1948	20	3	23	48%	1966	44	30%	92%
1949	20	20	40	84%	1968	44	30%	92%
1950	20	3	23	48%	1972	44	30%	92%
1951	24	20	44	92%	1939	44	36%	92%
1952	24	24	48	100%	1944	44	36%	92%
1953	24	24	48	100%	1964	44	36%	92%
1954	22	24	46	96%	1985	44	36%	92%
1955	20	22	42	88%	1987	44	36%	92%
1956	24	3	27	56%	1973	42	42%	89%
1957	20	24	44	92%	1980	42	42%	89%
1958	24	20	44	92%	1923	42	44%	88%
1959	20	24	44	92%	1979	42	44%	88%
1960	20	20	40	84%	1955	42	47%	88%
1961	20	3	23	48%	1981	42	47%	88%
1962	20	3	23	48%	2001	42	47%	88%
1963	24	20	44	92%	1936	40	51%	84%
1964	20	24	44	92%	1937	40	51%	84%
1965	24	3	27	56%	1946	40	51%	84%

SWP Table A Deliveries for 2019 Study						Probability Curve			
Year	Delivery w/o Article 56 Carryover (TAF)	Article 56 Carryover (TAF)	Total Table A Delivery (TAF)	Percent of Maximum Table A		Year	Total Table A Delivery (TAF)	Exceedance Frequency (%)	Percent of Maximum Table A
1966	20	24	44	92%		1947	40	54%	84%
1967	24	20	44	92%		1949	40	54%	84%
1968	20	24	44	92%		1960	40	54%	84%
1969	24	20	44	92%		1976	35	58%	74%
1970	24	24	48	100%		1929	34	59%	70%
1971	24	24	48	100%		1994	34	59%	70%
1972	20	24	44	92%		1924	31	62%	66%
1973	22	20	42	89%		1927	27	63%	56%
1974	24	22	46	97%		1956	27	63%	56%
1975	24	24	48	100%		1965	27	63%	56%
1976	11	24	35	74%		1982	27	63%	56%
1977	11	1	12	25%		1986	27	63%	56%
1978	22	1	23	48%		2003	26	69%	54%
1979	20	22	42	88%		1940	25	70%	53%
1980	22	20	42	89%		1995	24	72%	51%
1981	20	22	42	88%		1945	23	73%	48%
1982	24	3	27	56%		1948	23	73%	48%
1983	24	24	48	100%		1950	23	73%	48%
1984	24	24	48	100%		1962	23	73%	48%
1985	20	24	44	92%		1926	23	78%	48%
1986	24	3	27	56%		1961	23	78%	48%
1987	20	24	44	92%		2002	23	78%	48%
1988	11	3	14	30%		1978	23	81%	48%
1989	20	1	21	43%		1993	23	81%	48%
1990	11	3	14	30%		1922	22	84%	47%
1991	11	1	12	25%		1935	21	85%	43%
1992	11	1	12	25%		1925	21	86%	43%
1993	22	1	23	48%		1930	21	86%	43%
1994	11	22	34	70%		1932	21	86%	43%
1995	24	1	24	51%		1989	21	86%	43%
1996	24	24	48	100%		1931	14	91%	30%
1997	24	24	48	100%		1933	14	91%	30%
1998	24	24	48	100%		1988	14	91%	30%
1999	24	24	48	100%		1990	14	91%	30%
2000	22	24	46	96%		1992	12	96%	25%
2001	20	22	42	88%		1934	12	96%	25%
2002	20	3	23	48%		1977	12	96%	25%
2003	23	3	26	54%		1991	12	96%	25%
Average	**20**	**15**	**35**	**73%**			**35**		**73%**
Maximum	**24**	**24**	**48**	**100%**			**48**		**100%**
Minimum	**11**	**0**	**12**	**25%**			**12**		**25%**

Appendix A Solano Project Reliability

Ultimate level of development-of Lake Berryessa watershed @ 30,000 AF/yr - 2009 Study

Lake Berryessa Index

Value	Year Type
W	Wet
N	Below Normal
N	Above Normal
D	Dry
D	Critically Dry

Year	Index Value	% Full Alloc	% Full Alloc for Normal Year (N)	% Full Alloc for Single Dry Year (D) *	% Full Alloc for Multiple Dry Years (3 or more Dry years)
1906	W	100%	-	-	-
1907	W	100%	-	-	-
1908	D	100%	-	100%	-
1909	W	100%	-	-	-
1910	N	100%	100%	-	-
1911	W	100%	-	-	-
1912	D	100%	-	100%	-
1913	D	100%	-	-	-
1914	W	100%	-	-	-
1915	W	100%	-	-	-
1916	W	100%	-	-	-
1917	N	100%	100%	-	-
1918	D	100%	-	100%	-
1919	N	100%	100%	-	-
1920	D	100%	-	100%	-
1921	N	100%	100%	-	-
1922	N	100%	100%	-	-
1923	N	100%	100%	-	-
1924	D	95%	-	95%	-
1925	N	95%	95%	-	-
1926	N	95%	95%	-	-
1927	W	95%	-	-	-
1928	N	100%	100%	-	-
1929	D	95%	-	95%	-
1930	N	95%	95%	-	-
1931	D	100%	-	100%	100%
1932	D	100%	-	-	100%
1933	D	45%	-	-	45%
1934	D	45%	-	-	45%
1935	N	100%	100%	-	-
1936	N	100%	100%	-	-
1937	N	100%	100%	-	-
1938	W	100%	-	-	-
1939	D	95%	-	95%	-

1940	W	100%	-	-	-
1941	W	100%	-	-	-
1942	W	100%	-	-	-
1943	N	100%	100%	-	-
1944	D	100%	-	100%	-
1945	N	100%	100%	-	-
1946	N	100%	100%	-	-
1947	D	100%	-	100%	100%
1948	D	95%	-	-	95%
1949	D	95%	-	-	95%
1950	D	95%	-	-	95%
1951	N	95%	95%		-
1952	W	100%	-	-	-
1953	N	100%	100%	-	-
1954	N	100%	100%	-	-
1955	D	95%	-	95%	-
1956	W	100%	-	-	-
1957	D	100%	-	100%	-
1958	W	100%	-	-	-
1959	D	100%		100%	-
1960	N	100%	100%	-	-
1961	D	100%	-	100%	-
1962	N	100%	100%	-	-
1963	W	100%	-	-	-
1964	D	100%	-	100%	-
1965	W	100%	-	-	-
1966	N	100%	100%	-	-
1967	W	100%	-	-	-
1968	N	100%	100%	-	-
1969	W	100%	-	-	-
1970	W	100%	-	-	-
1971	N	100%	100%	-	-
1972	D	100%	-	100%	-
1973	W	100%	-	-	-
1974	W	100%	-	-	-
1975	N	100%	100%	-	-
1976	D	100%	-	100%	-
1977	D	100%	-	-	-
1978	W	100%	-	-	-
1979	N	100%	100%	-	-
1980	W	100%	-	-	-
1981	D	100%		100%	-
1982	W	100%	-	-	-
1983	W	100%	-	-	-
1984	N	100%	100%	-	-
1985	D	100%	-	100%	-
1986	W	100%	-	-	-
1987	D	100%	-	100%	100%
1988	D	100%	-	-	100%
1989	D	100%	-	-	100%
1990	D	95%	-	-	95%
1991	N	95%	95%	-	-

1992	D	90%	-	90%	-
1993	W	95%	-	-	-
1994	D	95%	-	95%	-
1995	W	100%	-	-	-
1996	W	100%	-	-	-
1997	W	100%	-	-	-
1998	W	100%	-	-	-
1999	N	100%	100%	-	-
2000	N	100%	100%	-	-
2001	D	100%	-	100%	-
2002	N	100%	100%	-	-
2003	N	100%	100%	-	-
2003	W	100%	-	-	-
2004	N	100%	100%	-	-
2005	N	100%	100%	-	-
2006	W	100%	-	-	-
2007	D	100%	-	100%	100%
2008	D	100%	-	-	100%
2009	D	100%	-	-	100%
2010	N	100%	100%	-	-
2011	W	100%	-	-	-
2012	N	100%	100%	-	-
2013	D	100%	-	100%	100%
2014	D	100%	-	-	100%
2015	D	100%	-	-	100%
2016	N	100%	100%	-	-
2017	W	100%	-	-	-
2018	N	100%	100%	-	-
2019	W	100%	-	-	-
2020	N	100%	100%	-	-
2021					
	Average	98.3%	99.4%	98.5%	92.8%

*Includes first year of consecutive dry years

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