October 26, 2012
Job Number: 11-1-052

Reclamation District No. 787
c/o River Garden Farms
Mr. Marty Stripling
41758 County Road 112
Knights Landing, CA 95645

SUBJECT: GROUNDWATER MANAGEMENT PLAN, RD 787, YOLO COUNTY

Dear Mr. Stripling:

Enclosed are five copies of the updated Groundwater Management Plan along with a CD containing an electronic version for your records. The Plan incorporates information on the recharge areas and a recharge map for RD 787 which will be required in all groundwater management plans beginning in 2013. We have also sent an electronic copy of the Plan to Andrea Clark of Downey Brand for her records.

It was a pleasure working with you on this update and if there is anything else I can provide, please let me know.

Sincerely,

LUHDORFF AND SCALMANINI
CONSULTING ENGINEERS

William L. Halligan

William L. Halligan, P.G.
Senior Hydrogeologist

Enclosures

Groundwater Management Plan
Reclamation District No. 787

Prepared for:
Reclamation District No. 787

Prepared by:
Luhdorff and Scalmanini, Consulting Engineers

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I. Introduction

This Groundwater Management Plan Update (Plan) is comprised of a number of planned actions related to groundwater supply and the long-term sustainability of groundwater and interrelated surface waters within Reclamation District No. 787 (District). This Plan provides information about Reclamation District No. 787, its relation to the groundwater basin that underlies it, the role of Groundwater Management Plans, and groundwater management objectives (goals) for the District. This plan describes existing groundwater conditions, as well as historical and projected water demands within the District. Finally, this Plan presents a set of groundwater management actions that form the central elements of this Groundwater Management Plan.

Reclamation District No. 787

Reclamation District No. 787 (RD 787, the District) is located in the northeastern portion of Yolo County, west of the town of Knights Landing and adjacent to the Sacramento River (**Figure 1**). The District covers approximately 8,950 acres, most of which is irrigated agricultural land. The majority landowner in the District is River Garden Farms, which covers approximately 7,400 acres (nearly 82%) of the District (**Figure 1**).

RD 787 was formed under the general reclamation district laws of 1908 for the purposes of providing drainage and reclamation of the lands within its boundary. Irrigation water is delivered to users within the District through a system of canals and ditches that are supplied primarily by surface water diversions from the Sacramento River. The respective landowners within the District (River Garden Farms, Cooling, Faye and Geer) have riparian and appropriative water rights, as well as water rights settlement contracts with the United States Bureau of Reclamation. Although the District does not own or operate water supply wells, there are private well owners within the District, including River Garden Farms, who operate several irrigation wells. The District landowners have historically met demands with surface water supplies, with intermittent supplemental groundwater use during dry years when surface water diversions from the Sacramento River were reduced.

In 2003, River Garden Farms (RGF) implemented a temporary water transfer whereby groundwater was used in lieu of surface water. The State Water Resources Control Board authorized the transfer of up to 1,800 acre-feet (af) of surface water to Metropolitan Water District of Southern California as part of this program. RGF pumped 1,581 af of groundwater during the transfer, which took place between July 3 and October 31, 2003. The California Department of Water Resources (DWR) monitored the response of the aquifer system during this

period, and determined that no measurable long-term impacts were created by increased groundwater pumpage during the transfer. More recently in 2009, RGF was allowed to transfer 3,795 af by pumping groundwater in lieu of diverting surface water as part of the 2009 Drought Water Bank program. Luhdorff and Scalmanini, Consulting Engineers (LSCE) monitored the response of the aquifer system during and after the transfer period, and also determined that no measurable long-term impacts were created by increased groundwater pumpage during the transfer (LSCE, 2010). As a result, the concept of future water transfers based on groundwater substitution is included in this Plan as a potential element within overall groundwater management in the District.

Sacramento Valley Groundwater Basin, Colusa Subbasin

RD 787 overlies the Sacramento Valley Groundwater Basin, Colusa Subbasin (**Figure 1**). The Colusa Subbasin is part of the larger Sacramento Valley Basin, which includes areas underlying the Sacramento Valley, the Sacramento River, and its tributaries as they flow south and west toward the Sacramento-San Joaquin Delta. The Colusa Subbasin is bounded on the east by the Sacramento River, on the north by Stony Creek, on the west by the Coast Ranges, and on the south by Cache Creek. The extent of the Colusa Subbasin, as mapped in Bulletin 118, is illustrated in **Figure 1**. The Colusa Subbasin is about 1,400 square miles in area, and underlies portions of Tehama, Glenn, Colusa and Yolo Counties.

Within the Colusa Subbasin, groundwater has historically been the primary source of water supply for domestic and municipal uses. Groundwater has also been used widely for irrigation purposes; however, surface water supplies are available for irrigation in many parts of the Subbasin. In addition to those within RD 787, there are numerous other water districts and suppliers within the Colusa Subbasin, including the various cities, County Service Areas, Community Service Districts, Water Districts/Companies, Irrigation Districts and Public Utilities Districts. For those entities and others, there are well completion reports on file with DWR for approximately 2,600 domestic and 1,500 irrigation wells within the Colusa Subbasin.

The north and east boundaries of RD 787 are formed by the Sacramento River. On the south and west sides of the District, the adjacent water districts and suppliers are Reclamation District No. 108, Colusa Drain Mutual Water Company, Yolo-Zamora Water District, and Knights Landing Community Service District (**Figure 2**). To the east across the Sacramento River, the nearest mutual water companies are the Pelger, Sutter, Pleasant Grove-Verona and Natomas Central Mutual Water Companies. Collectively, these purveyors supply groundwater and surface water for municipal and irrigation supply within their boundaries.

The Colusa Subbasin extends far beyond the boundary of the District; however, the focus of this Plan is on that portion of the overall Colusa Subbasin underlying RD 787. This Plan establishes a set of management objectives that the District intends to implement within its boundary. The goals and objectives set forth in this Plan are intended to provide for the long-term sustainable use of the resource within the District, and as such would preserve the resource as it relates to other users within the Colusa Subbasin and the greater Sacramento Valley Groundwater Basin.

Overview of Water Requirements and Supplies

Water demands within RD 787 have historically averaged between about 25,000 to 30,000 acre-feet per year (afy) over the last 40 years, and have been met mostly with surface water diversions from the Sacramento River. Historical and projected water requirements and supplies for RD 787 are discussed in more detail in Section IV of this Plan.

Legislation Related to Groundwater Management Plans

The Legislature enacted legislation in 1992 (AB 3030), 2002 (SB 1938), and 2011 (AB 359), which is now incorporated in the Water Code Section 10753, *et seq*. to encourage local public agencies to adopt plans to manage groundwater resources within their jurisdictions. RD 787 will adopt this Groundwater Management Plan by resolution of its board of trustees.

SB 1938 provided that adoption of a groundwater management plan will be a prerequisite to obtaining funding assistance for groundwater projects or groundwater quality projects from funds administered by DWR. To comply with SB 1938, a groundwater management plan must 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. There must be provisions to cooperatively work with other public (and presumably private) entities whose service areas or boundaries overly 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, and the boundaries of the local agencies that overlie the basin. This Plan focuses on that portion of the Colusa Subbasin that underlies RD 787 and, as a result, RD 787 is the only local "agency". Nearby and adjacent water districts and water suppliers within the Colusa Subbasin are shown in **Figure 2**. Finally with respect to SB 1938 requirements, 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.

New requirements for groundwater management plans have been adopted in Assembly Bill 359 (AB 359). The new requirements include a discussion of how recharge areas identified in the plan substantially contribute to the replenishment of the groundwater basin, and as of January 1, 2013 a map of recharge areas will be required for groundwater management plans. The Department of Water Resources to date has yet to publish guidance to address these new requirements, and as such this Plan may need to be updated at a later date, separate from another groundwater management plan update. Due to the vastness of the Colusa Groundwater Subbasin (over 1,400 square miles) in which RD 787 is located, it is impractical, without guidance from DWR, to discuss the replenishment of the entire basin in the context of RD 787. Absent DWR guidance, this Plan will qualitatively describe the primary sources of replenishment to RD 787 along with a map of recharge areas in Section III below.

The potential components of groundwater management plans are listed in Water Code Section 10753 and include:

- 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;
- the review of land use plans and coordination with land use planning agencies to assess activities that create a reasonable risk of groundwater contamination.

Not all of these potential components are relevant for this Plan. Because this Plan is intended to recognize the nature of the District and its included landowners, it includes a number of elements that are intended to accomplish a set of management objectives that, in turn, are focused on the occurrence and use of groundwater in the District. Exclusion of other potential components listed in the Water Code reflects an understanding that some are being separately accomplished by others (e.g. well construction practices and well abandonment/destruction programs which are administered by Yolo County), and some are not applicable to this basin (e.g. the control of saline water intrusion).

Public Outreach and Involvement

Public outreach and involvement efforts that occurred during development of the Reclamation District No. 787 Groundwater Management Plan included notifying landowners within the District and also Yolo County, Reclamation District No. 108, Knights Landing Community Service District, and the California Department of Water Resources.

II. Basin Management and Objectives

Prior and Current Groundwater Management

Reclamation District No. 787 (RD 787, the District) initially adopted a Groundwater Management Plan in February 1997 and an update to that Plan that was prepared in 2005 (**Appendix A**). The initial Plan was very limited in scope, but described three components whereby the District would collect information necessary for further analysis of its groundwater supply. These components were:

- compile and evaluate groundwater level data;
- sample and test groundwater quality to obtain background data;
- based on these data, make recommendations for the conjunctive use of groundwater and surface water.

The Plan described existing and planned monitoring efforts by DWR, which would encompass the first two Plan components. Since the adoption of the Plan in 1997, DWR has expanded and continued monitoring in and around RD 787. With regard to the third Plan component, and as described above, the majority landowner within the District implemented a groundwater substitution conjunctive use program in 2003 that included DWR analysis and reporting of aquifer response.

The Groundwater Management Plan prepared in 2005 (2005 Plan) expanded upon the 1997 Plan by complying with SB1938 and the 2005 Plan incorporated the following components that were related to the District's groundwater management activities:

- Groundwater and Surface Water Monitoring
- Management of Pumping and Avoidance of Overdraft
- Development of Groundwater Supply and Continued Participation in Conjunctive Use Programs
- Preservation of Water Quality
- Groundwater Management Reports
- Provisions to Update the Groundwater Management Plan

Of the potential groundwater management activities listed in Water Code Section 10753, those already being investigated and implemented within the Colusa Subbasin as part of groundwater management by various entities include:

- implementation of conjunctive use programs;
- construction of dedicated monitoring wells;
- monitoring of groundwater levels and quality in monitoring and production wells;
- monitoring of subsidence;
- analysis and reporting on basin conditions;
- investigation to assess potential pumping impacts of planned actions on surface water resources.

As will be described further in Section IV, RD 787 has historically obtained its water supply from diversions from the Sacramento River, with groundwater used as a supplemental supply during dry years when surface water diversions were reduced. A primary focus of recent groundwater management activities in the Sacramento Valley Basin has been on the conjunctive use, and the potential for sustainable development of additional groundwater, including increasing the amount of groundwater pumped to offset decreased surface water supplies during dry years. Several conjunctive use programs along the Sacramento River have been implemented, including the program implemented within RD 787 in 2003 and 2009.

RD 787 is participating in the Sacramento Valley Water Management Program (SVWMP), which is a collaborative effort to coordinate water management and plan for the beneficial use of water resources while providing for the long-term sustainability of those resources and improving water quality and supplies for a variety of uses throughout California. A primary goal of the SVWMP is maintaining surface water flows to the Sacramento-San Joaquin Delta to achieve water quality objectives. To maintain productive use of agricultural lands during selected years when diversions of surface waters would be reduced to maintain surface water flows, groundwater would be pumped as a substitute water supply. To assess the impacts of such pumping, and to ensure that the pumping does not adversely affect overall resources, dedicated monitoring programs are being developed for each area in the Valley that might be involved in SVWMP or other similar activities. The monitoring programs include pumpage, groundwater levels, groundwater quality, subsidence, and surface water flows. The data collected from these programs is intended to be interpreted and reported to ensure that pumping does not decrease surface flows, that other groundwater users are not impacted, and that groundwater and other resources are not depleted.

In cooperation with RGF, and in conjunction with the SVWMP, DWR installed and initiated a monitoring program at their Sacramento River Monitoring Well SR-1 in 2005. This exploratory borehole and monitoring well cluster was established by DWR to enhance successful water management planning through the understanding of the underlying groundwater basin's geology and hydrogeology with an emphasis on recharge sources and surface water-groundwater interaction (DWR, 2011).

Another focus of groundwater management within the Sacramento Valley Basin is the avoidance of overdraft. In several areas of the Basin (outside of the Colusa Subbasin), notably in parts of Sacramento County, water levels declined significantly in response to groundwater pumpage. Conjunctive use efforts are now being implemented in the northern Sacramento area to use surface water in lieu of groundwater to refill some of the vacant aquifer storage space for increased dry year water supply. Conjunctive use is also being implemented in the southern Sacramento County area to supplement groundwater supplies with surface water to stabilize groundwater levels and storage. Within the Colusa Subbasin, no such significant long-term groundwater level declines have been identified, and recent trends are toward higher groundwater levels within the Subbasin.

Although groundwater levels are generally stable and relatively shallow, in areas where surface water is not available and groundwater pumping is the sole source of water supply, subsidence has occurred. Subsidence is an identified problem within the Yolo-Zamora area, where well failures have resulted. Subsidence has not been observed or measured in the District. The Zamora extensometer has exhibited land surface displacement (subsidence) of about 0.5 feet between 1992 and 2011, and although the groundwater levels during the available period of record (late 1980s to present) do not show significant long-term groundwater level declines, they do show significant seasonal fluctuations of up to 120 feet. The large water level declines in the summer might provide the mechanism for subsidence in this area. Ongoing monitoring of surface elevation stations (including one within the District) and extensometers will provide data to evaluate future subsidence in Yolo County. As described in more detail below, a key component of this Groundwater Management Plan is the avoidance of subsidence through management of groundwater pumpage within the District to avoid creating conditions of overdraft.

Management Objectives

The goals and objectives set forth in this Plan are intended to provide for the long-term sustainable use of groundwater and interrelated surface water resources within the District. Although the objectives only consider the portion of the Colusa Subbasin underlying the District

and within its jurisdiction, they would also ensure that groundwater use within the District preserves the resource as it relates to other users within the Colusa Subbasin and the greater Sacramento Valley Groundwater Basin. The overall basin management objectives, or goals, for RD 787 are expressed as follows:

Development of Local Groundwater Supply. This objective includes the sustainable development of the groundwater resource, including conjunctive use of surface water and groundwater to provide a flexible and reliable water supply while maintaining the long-term sustainability of both resources. Included in this objective is the intent to participate in groundwater substitution or other similar water transfer opportunities, when possible. This objective would also include monitoring and evaluation of background and project data to evaluate impacts in the development of groundwater supplies.

Avoidance of Overdraft and Associated Undesirable Effects. In terms of basin goals, the assessment of groundwater conditions, and the development of operational yields for that portion of the overall Subbasin beneath the District, will have the primary objective of ensuring that groundwater development is at a rate that remains within perennial or sustainable yield, i.e. avoids overdraft and the undesirable effects associated with overdraft. In this case, chronic declines in water levels and/or water quality, depletion of local surface water resources, loss of groundwater storage, and permanent (inelastic) subsidence are examples of undesirable effects that are planned to be avoided.

Preservation of Groundwater Quality. This objective reflects a desire to maintain the utility of the portion of the Colusa Subbasin underlying the District for domestic, irrigation and other beneficial uses, and to avoid any significant loss of groundwater storage or availability due to degradation of groundwater quality.

Protection of Interrelated Surface Water Resources. This objective reflects the need for integrated management of surface water (primarily the Sacramento River) and groundwater to avoid undesirable effects to either resource. For the District's purposes, this objective will be related primarily to specific projects.

Quantitatively, the preceding objectives translate into general preservation of groundwater levels and quality within the District, including fluctuations through seasonal demands, through local hydrologic variations (wet and dry periods), and through short-term increases in groundwater pumpage. In terms of intended management as described in this Plan, understanding historic conditions is essential to achieving the above goals for the District. Historical data are somewhat

limited, particularly with regard to water quality, but the available data indicate that groundwater levels have fluctuated over time and that water quality has been stable. Neither water levels nor water quality exhibit any observable trend toward a degradation of the groundwater resource.

The 2003 and 2009 conjunctive use programs implemented by River Garden Farms served as a demonstration that such projects can be undertaken within the District without measurable long-term adverse impacts. Increased use of groundwater, if well-managed through integration of a number of complementary management actions designed to make beneficial use of groundwater while also maintaining the long-term sustainability of the resource, can be expected to accomplish all four of the basin objectives discussed above.

III. Groundwater Basin Conditions

Geologic Setting

The aquifer system of the Colusa Subbasin has been studied on a larger scale, but detailed studies of the portion of the Subbasin underlying Reclamation District No. 787 (RD 787, the District) have not previously been undertaken. Installation of monitoring and irrigation wells and the associated examination of subsurface materials at RGF, especially since 2009, has provided the ability to characterize the geologic conditions underlying RD787. RD 787 lies in the laterally central area of the Sacramento Valley Basin, where both western (Coast Range) and eastern (Sierra Nevada) sourced non-marine deposits can be encountered. Generally, the non-marine deposits extend to a depth of more than 2000 feet below ground surface (bgs). Below these depths, undifferentiated tertiary and cretaceous marine deposits are encountered.

A map showing the surficial geology of the RD 787 area is presented in **Figure 3**, which also includes cross section locations created for this Plan update. The majority of RD 787 is overlain by Holocene Basin Deposits (Qb unit on the geologic map), along with Holocene Alluvium (Qa) and some Holocene Stream Channel Deposits (Qsc) along the Sacramento River. Several boreholes on or near River Garden Farms provide insight into the heterogeneity and complexity of the subsurface materials beneath RD 787. DWR reported on the lithologic and stratigraphic units encountered in their exploratory borehole at SR-1A through SR-1C (located in the northern extent of the District), which drilled to a depth of over 1,400 feet (DWR, 2011). DWR identified four formations: Recent Alluvium, the Riverbank Formation, the Tehama Formation, and the Mehrten Formation. Due to the uncertainty of source materials (i.e. from the Sierra Nevada, the Coast Ranges, or both), for purposes of this report, the Laguna and Tehama Formations are considered to be contemporaneous and undifferentiated, as it is unclear if or how they are interfingered this close to the axis of the Central Valley. The Alluvium encountered at all borehole locations are characterized by dark-colored sand, gravel, and clay and are usually between 50 and 100 feet thick. Below this unit lies the Riverbank Formation of Pleistocene age, which consists of more fine-grained floodplain materials and is usually lighter in color (browns and tan) and spans between 150 to 200 feet thick. Underlying the Riverbank Formation is the Laguna/Tehama Formation of Pliocene to Pleistocene age. The top of this unit is generally marked by one or more coarse grained units occurring at depths of around 200 feet below ground surface and is about 1,000 feet thick, dominated by semi-consolidated clay and silt, some siltstone fragments, and interbedded units of sand and gravel. The Pliocene to Miocene age Mehrten Formation was encountered at 1,100 feet below ground surface by DWR and was described as semi-consolidated clay and silt, mudstone and siltstone chips, and interbedded

intervals of sand and gravel. Besides for the DWR exploratory borings, none of the RGF irrigation wells, monitoring wells, or testholes have been advanced deep enough to encounter the Mehrten Formation.

Two generalized geologic cross sections were created to transect RD 787 as seen in **Figure 3**. The first cross section runs approximately north to south (north-northwest to south-southeast) from the newly constructed DWR monitoring facility (SR-1A through SR-1C) to the Field 121 monitoring well site in the southeast corner of RD 787 (**Figure 4**). This cross section outlines the various formations encountered in the subsurface and interpolations between boreholes suggest some continuity between clay units in the Riverbank Formation, which most likely provide the majority of the confining unit for the deeper aquifer units. The second cross section (**Figure 5**), depicting geologic conditions in a west to east direction shows a significant coarsening of materials in the center of the District (at the Field 93 site). Sands and gravels are encountered at around -200 feet mean sea level (ft msl), as well as another unit at above -400 ft msl, suggesting channel deposits that can be correlated to similar coarse units at the Field 85 test hole found in the upper section of the Laguna/Tehama Formation.

Aquifer testing by the California Department of Water Resources (DWR) during the River Garden Farms water transfer in 2003 provided some information about aquifer characteristics within the District. The two main findings were lateral hydraulic continuity between wells in an aquifer zone located at a depth of approximately 350 to 600 feet bgs, and vertical hydraulic separation between this zone and a shallower (~200 foot bgs) aquifer zone. During the 2009 water transfer by RGF, similar observations were made, including similar drawdown and recovery curves seen in deep and shallow monitoring wells near irrigation wells. These findings are consistent with the conceptual geology presented above.

Subsidence

The most common form of subsidence resulting from groundwater pumping occurs when sustained groundwater withdrawals cause permanent dewatering of laterally extensive clay beds. Once dewatering begins to occur, the framework of the clay particles begins to collapse or becomes compacted, resulting in subsidence of the overall land surface. Yolo County has a network of surface elevation monitoring stations (including a station within the District) that were surveyed in 1999, 2002, and 2005 using global positioning system (GPS) equipment to measure land surface elevation. Findings of the Yolo County GPS Subsidence Network (D'Onofrio & Frame, 2006) indicate continuing subsidence in the Davis to Zamora corridor, south and west of the District. A map of the cumulative subsidence between the 1999 and 2005

surveys is seen in **Appendix B**, which shows that within the District, subsidence is not an issue. **Figure 6** shows subsidence monitoring benchmarks located in RD 787.

Additionally, the California Department of Water Resources (DWR) has installed and monitors the "Zamora" extensometer located approximately 2 miles southwest of the District (**Figure 6**). The Zamora extensometer has exhibited a net decline in vertical land elevation, resulting in a negative displacement of about 0.5 feet between 1992 and 2011. The extensometer data is accompanied with ongoing continuous water level monitoring (since the late 1980s) in a set of nested monitoring wells with screen depths between 180 feet and almost 800 feet below ground surface. The hydrographs of these monitoring wells are seen in **Figure 7** (the 24Q well cluster), which exemplify the significant seasonal fluctuations seen in these aquifer units, sometimes up to 120 feet of decline in the summer months before fully recovering in the winter and spring. This is a good indication that the aquifer is being exercised as there is no surface water available in this area and groundwater pumping is the primary source of water supply. Although the groundwater level trends in these monitoring wells do not show long-term decline, which would usually be associated with subsidence and overdraft, the magnitude of the groundwater level declines in the summer months might provide the opportunity for the pore pressure in the clay units to decrease to a degree in which inelastic subsidence occurs , resulting in an overall negative land displacement.

As mentioned above, the aquifer zones in the area of RD 787 consist of interbedded sands and clays. The gradation of deposits generally becomes finer with further distance from the source (the Coast Range and/or Sierra Nevada); as such, there may be significant fractions of clays within the finer deposits in the District area. These geologic conditions, combined with reported subsidence in the nearby Yolo-Zamora area, indicate that precautions should be taken by the District to avoid the depression of groundwater levels that lead to decreases in pore pressure, resulting in the potential for inelastic (irreversible) subsidence. These precautions are incorporated in this Plan in the form of ongoing monitoring of groundwater levels to ensure that pumpage within RD 787 is within rates that are renewable (recharged) such that it does not result in long-term groundwater level declines.

Historical Groundwater Development

The history of groundwater development within the District is unknown; however, records of groundwater levels in the area around the District indicate that wells were developed at least as early as the 1940's. Groundwater from private wells has historically met potable domestic demands within the District; however, these demands are considered negligible when compared

with irrigation demands. Irrigation demands within the District have historically been met with surface water supplies, with groundwater used as a supplemental supply during dry years when surface water deliveries were limited. The majority landowner in the District, River Garden Farms, currently owns seven production wells with a total capacity of approximately 17,000 to 17,500 gpm. **Table 1** contains capacity and construction information for RGF production and information pertaining to RGF monitoring wells in the District.

Groundwater Levels

Data for groundwater levels in the area surrounding RD 787 dates from the early 1950s, with a few measurements collected prior to this, between 1928 and 1930. The monitoring of groundwater levels in the surrounding area has been primarily conducted by DWR and USGS.

There are approximately 87 wells monitoring water levels both in and around RD 787 (**Figure 6**), and 16 of these have recorded 5 or more water level measurements over the past 60 years. A number of these wells have measurements spanning only small blocks of time and do not provide a continuous record of groundwater levels in the area. However, there are 4 locations with wells that have been monitored for water levels with a continuous record, two of which span back to the 1950s, located within a few miles of the District boundary. **Figure 7** contains a map showing locations of all wells with water level data, along with hydrographs of historic water levels of these 4 well sites. Two of the well sites contain multiple wells completed at different depths. The depth of each well is specified on the corresponding hydrograph legend.

Another site containing multiple wells exists near the Sacramento River (SR-1) Monitoring Well location (DWR, 2011). This site contains three monitoring wells installed by DWR completed at different depths to identify different aquifer units, and is located adjacent to the Sacramento River and near a gaging station (Sacramento River at Byron Jackson Pumps, BJP). The proximity of the monitoring wells to the river allows for interpretation of groundwater-surface water interactions at this location. Groundwater levels and quality data were taken in the monitoring wells when constructed, and ongoing groundwater level measurements have been taken since 2006. The shallowest monitoring well, completed at a depth of 54 to 64 feet below ground surface appears to be in direct hydraulic connection to the Sacramento River, as significant water level increases occur during high stage and flow events in the Sacramento River. The groundwater elevations in the shallowest monitoring well indicate gaining conditions (groundwater levels are higher than the level in the river and therefore the river gains water from the groundwater aquifer) during most of the period of record, with the exception of significant high river stage events associated with high precipitation and runoff seen in the Sacramento

River when River stages are temporarily above the shallow groundwater levels (**Figure 8**).

There is some expected seasonal fluctuation due to groundwater pumping, with water levels declining anywhere from 20 to 100 feet during times of increased pumping. However, hydrographs of historic water levels show consistent recovery to previous water levels and no permanent declines resulting from dry periods with increased pumping and decreased recharge. Overall, the water levels surrounding RD 787 have remained stable over the past 60 years, with static water levels generally between 5 and 20 feet below the ground surface.

Beginning in 2009, recording of groundwater levels using transducers in monitoring wells located on River Garden Farms have allowed for accurate, continuous monitoring of water levels. While water levels in the deeper aquifer units decline during groundwater pumping, they also consistently rebound to pre-pumping static water levels once groundwater pumping stops. As described above, increased groundwater pumpage by River Garden Farms during the 2003 and 2009 water transfers did not result in any measurable long-term impacts, and it is reasonable to assume that the amount of groundwater pumping could seasonally increase in the future without resulting in long-term groundwater level declines. Groundwater level hydrographs of RGF monitoring wells groups are attached in **Appendix C**.

Groundwater Quality

Groundwater quality data for wells near RD 787 dates from 1949 and has been collected mainly by the United States Geological Survey and DWR. River Garden Farms has also monitored the water quality of those wells located on RGF property intermittently. **Figure 6** identifies 52 wells that have water quality data from the USGS or DWR. Specific conductance (SC) has been selected as in indicator of overall groundwater quality because of the number of records for that parameter, and because it generally reflects changes in water composition over time. **Figure 9** shows the maximum concentration of SC in wells in and near RD 787. The maximum concentrations of SC are mostly below the upper range of the secondary maximum contaminant level (MCL) of 1,600 umhos/cm, with the exception of six wells located outside the District. Within the District, water quality data from River Garden Farms indicates that SC ranges from 440 to 1090 umhos/cm, all well below the secondary MCL upper range. **Figure 10** presents available SC data for wells near RD 787. The only well with a long-term record is DWR well 11N/2E-14F4, located immediately southeast of the District in the Knights Landing area. Data from this well show that groundwater quality has remained stable for the last 35 years. Individual data points for other wells are shown to illustrate the range of SC values in the area, which may vary with location and aquifer zone.

The only wells within the District with available water quality data are the River Garden Farms wells, and data for these wells are summarized in **Table 2**. These wells are irrigation and monitoring wells, and are not required to comply with the State of California Department of Health Services (DHS) water quality standards for public drinking water wells. However, these standards, in the form of primary (health-based) and secondary (aesthetic) Maximum Contaminant Levels (MCLs), are a useful reference for characterizing overall water quality within the District. The limited water quality data for the River Garden Farms wells generally complies with both the DHS primary and secondary MCLs, except for manganese.

Elevated concentrations of manganese, exceeding the secondary (aesthetic) MCL, are present in wells in and near RD 787. These elevated levels are frequently encountered in deposits near the Sacramento River and its historic channel. However, the presence of manganese does not constrain the use of groundwater for agricultural irrigation; such as it might exceed the secondary MCL for municipal supply (e.g. near the District), conventional treatment is commonly used to remove dissolved manganese prior to municipal distribution.

There are two known leaking underground fuel tank cleanup sites near the District, in the town of Knights Landing, one of which has reportedly resulted in localized contamination to the groundwater and is currently being remediated. The other site in Knights Landing has been under site assessment since 2008. Another leaking underground fuel tank cleanup site is located in Robbins and is currently being remediated and has affected the drinking water aquifer. Nothing associated with the leaking tank affects or constrains the use of groundwater within the District for agricultural irrigation.

Groundwater Recharge

The primary sources of groundwater recharge for RD 787 consist of the following:

- regional groundwater recharge from the Coast Ranges to the west,
- irrigation return flows from RD 787 fields and neighboring fields including recharge from irrigation canals and ditches, and
- surface water seepage from major surface water courses including Cache Creek drainage canal and the Sacramento River.

Figure 11 illustrates the potential areas that contribute recharge to groundwater at RD 787. Figure 11 contains the most recent published groundwater elevation contours (Spring 1997) created by DWR for the entire Sacramento Valley, including the Colusa Groundwater Subbasin (DWR, http://www.cd.water.ca.gov/reports/SV_GWE_CONT_S97_11x17.pdf). The regional

groundwater elevation contours show that groundwater inflow, one of the primary sources of recharge to RD 787, originates from the west and north in the foothills of the Coast Range mountains stretching just north of the Colusa/Yolo County boundary to Cache Creek in the south. Groundwater flow directions seen in Figure 11 help delineate the area that contributes to the replenishment of RD 787's groundwater. In addition, irrigation return flows on farms located north and west of RD 787 augment groundwater that originates in the Coast Ranges. Local sources of recharge to RD 787 include percolation of irrigation return flows within the District where crops are grown. Rice is rotated through most of the District, and there are only small areas that are not irrigated or contain waterways, delivery ditches or drainage ditches. Surface water features such as the Sacramento River on the north and east of the District and the Cache Creek Drainage Canal located west of RD 787 also contribute to seepage and eventual vertical recharge to the District.

IV. Current and Projected Water Requirements and Supplies

Water Demands

For all practical purposes, historical and projected water requirements in the District can be considered to be essentially constant. Since essentially all water demand (aside from negligible potable demand) is for agricultural irrigation, total water requirements on the approximately 8,950 acres of land within the District could potentially be as great as about 36,000 acre-feet per year (afy) if all land is in production. Obviously, if less than the full area of the District is planted in any given year, and depending on exact cropping patterns, total water requirements in any given year could be less than the full potential water demand.

Forty-seven years of available record (from 1964 through 2010) of surface water diversions by River Garden Farms (**Table 3**), which represents nearly 82 percent of the total area in the District, show that its diversions from the Sacramento River have averaged about 22,000 afy, and have been as great as about 30,000 af in a single year. On an average basis, the historical diversions represent, for the entire River Garden Farms area, a unit water demand in the range of 3 to 4 afy per acre.

With no plans for permanent change of land use in the District, it is reasonable to project that total water demands will remain comparable to those of the last several decades. Thus, on an average basis, water requirements for River Garden Farms can be expected to be on the order of 22,000 afy; for the entire District, average water requirements can be expected to be on the order of 26,250 afy. If all lands are in production in any given year, total water demands could be on the order of 30,000 afy for River Garden Farms, and on the order of 36,000 afy for the entire District.

Water Supplies

Practically all the water requirements in the District are met by diversions of surface water from the Sacramento River. River Garden Farms has a Contract Total Supply of 29,800 afy, of which almost all (29,300 afy) is Base Supply and the balance (500 afy) is CVP Project Water. The Base Supply and Project Water components of River Garden Farms' contract supply are limited to specific months; the entire amount is limited to the months of April through October, and is further limited to a total of 12,700 af in the critical months of July through September. Total surface water supply is also limited in Shasta critical years to 75 percent of total contract amount.

Most of the other land within the District is riparian to the Sacramento River and thus has water supply availability subject only to reasonable, beneficial use.

There are currently seven production wells in the District that are available to complement surface water supplies in addition to one supply well used for RGF's headquarters (the "Shop PW" with a capacity of about 3,000 gpm). Commonly known by names that denote their locations relative to the field numbering system, the wells have approximate capacities as follows:

Well	***Capacity (gpm)***
Field 65	2,500
Field 71	1,700
Field-91-09	2,840
Field 93	*To Be Constructed (Spring 2012)*
Field 98	2,500 – 3,000
Field 104	2,500
Field 104-09	2,990
F-117	1,965

At those capacities, the seven production wells have the capability to produce a combined total of about 17,000 to 17,500 gpm, which equates to a maximum of about 13,700 to just over 14,000 af over a six-month irrigation season. An additional production well, at Field 93, is expected to be constructed in Spring 2012, which will incrementally increase the overall supply.

The seven production wells can be used for regular irrigation water supply, or can provide a substitute water supply for some of the Total Contract Supply from the Sacramento River. As the latter, they represent a water supply that has made possible the kind of water transfer that was completed in 2009, and that can make possible similar groundwater substitution based transfers in the future as envisioned in this Plan.

V. Elements of the Groundwater Management Plan

Introduction

As developed in Section II above, the management objectives, or goals, for that portion of the groundwater basin beneath Reclamation District No. 787 include the following:

- Development of Local Groundwater Supply
- Avoidance of Overdraft and Associated Undesirable Effects
- Preservation of Groundwater Quality
- Protection of Interrelated Surface Water Resources

To accomplish those goals, this Plan incorporates a number of components, which are divided into six specific elements. These elements consist of existing and planned management activities that the District intends to undertake within its boundary, including assessment of the ongoing effectiveness of these activities. They also recognize the probability of additional groundwater development as part of conjunctive use activities within the District, including those planned as part of the Sacramento Valley Water Management Program (SVWMP). Collectively, they reflect the focus on local groundwater management actions the District can take to ensure that its activities do not compromise the long-term sustainable use of the portion of the Colusa Subbasin underlying the District, and thus the greater Colusa Subbasin.

Plan Elements

The six elements of the District's Groundwater Management Plan include:

1. Groundwater and Surface Water Monitoring
2. Management of Pumping and Avoidance of Overdraft
3. Development of Groundwater Supply and Continued Participation in Conjunctive Use Programs
4. Preservation of Water Quality
5. Groundwater Management Reports
6. Provisions to Update the Groundwater Management Plan

Plan Element 1 – Groundwater and Surface Water Monitoring

Plan Element 1 consists of monitoring groundwater levels, groundwater quality, production (pumping rates and volumes), land subsidence, and surface water flows. Monitoring locations and data provided by SVWMP, DWR, and the USGS will be used for ongoing monitoring in combination with data from RGF.

Because the primary water supply within the District has historically been surface water diversions from the Sacramento River, long-term records of groundwater levels and quality are limited. However, as discussed above in Section III of this Plan, available records for wells in the area are sufficiently extensive to indicate that no long-term change in groundwater levels or quality is evident. Since 2003, and again in 2009, as part of one-year conjunctive use projects, local monitoring has been expanded. DWR has installed dedicated monitoring wells and an extensometer near the District, and plans to continue monitoring of groundwater levels, groundwater quality and subsidence. River Garden Farms and DWR have also cooperated on the installation of a dedicated multiple-completion monitoring well that, in addition to conventional groundwater level monitoring, will be used in combination with adjacent Sacramento River gaging at Byron-Jackson Pumps (BJP) to interpret River-aquifer connection and streambed leakage. The first report from DWR indicates that there is moderate to significant surface water-groundwater interaction in the shallow aquifer (at depths between 54-64 feet), after which the hydraulic connection decreases with depth (DWR, 2011).

Groundwater data collection (water levels, water quality and production) within RD 787 has historically occurred in conjunction with planned activities, such as the 2003 and 2009 RGF water transfers. However, as the District becomes more involved in developing its groundwater supply and participating in conjunctive use programs, collection and analysis of baseline data from existing wells will be key to accomplishing management goals. RGF currently has ongoing monitoring in monitoring wells on their property, using dedicated water level pressure transducers which record water levels on a regular basis. Monitored groundwater levels, quality, and pumping will collectively be the bases for defining conditions within the District and developing and managing groundwater within the District to ensure the long-term sustainability of the resource.

The District has participated in the Sacramento Valley Water Management Program (SVWMP), which is a collaborative effort to coordinate water management and planning for the beneficial use of water resources while providing for the long-term sustainability of those resources and improving water quality and supplies for a variety of uses throughout California. As part of the

SVWMP, dedicated monitoring programs are being developed for each area in the Valley (including RD 787) that might be involved in that Program or other similar activities. The monitoring programs include pumpage, groundwater levels, groundwater quality, subsidence, and surface water flows. Monitoring data collected as part of the SVWMP will be publicly available, and will be evaluated in conjunction with numerical modeling to assess the effectiveness of the Program and any potential impact claims. RD 787's participation in the SVWMP, and consequent involvement in the implementation of a formal monitoring program for its area, will comprise its primary activities with regard to this Plan Element.

Additional monitoring will be undertaken as necessary for specific planned projects, as further described in Plan Element 3.

Plan Element 2 – Management of Pumping and Avoidance of Overdraft

In order to accomplish the management objectives described above, it will be essential to determine what yield can be developed within the District on both a regular and a short-term or intermittent basis. Such a determination of yield will be made to accomplish the main objective of sustainably operating within the yield of the basin, i.e. avoidance of overdraft.

Data are inadequate to analytically quantify the yield of the portion of the Colusa Subbasin underlying the District. Additionally, because the District overlies only a small portion of the Subbasin, any such formal effort would need to include other groundwater users on a more regional basis that is outside the scope of this Plan. However, an operational yield for the District can be empirically developed on an ongoing basis by observing the effect of pumpage within the District on groundwater conditions (water levels, water quality), and establishing a level of pumpage that does not result in long-term adverse impacts to the groundwater resource. Observations of this nature began during the 2003 RGF water transfer, which can be interpreted to indicated that at least 1,581 afy of groundwater can be pumped for use with surface water deliveries to collectively meet in-District water requirements without short-term or long-term impacts. For the subsequent 2009 water transfer, RGF was allowed to transfer 3,795 af which resulted in no short-term or long-term impacts. Observations are expected to continue during future projects that include increases in groundwater pumpage. This type of operational understanding of basin yield will be adequate to accomplish the objectives of operating within the sustainable yield of the basin and avoiding overdraft.

Overall, groundwater levels in the area around RD 787 have remained fairly stable over the past 50 years, with temporary declines during dry periods, followed by groundwater level recovery in

subsequent periods. Available data do not indicate any degradation of groundwater conditions that might be indicative of overdraft, i.e. decrease in groundwater levels or storage as a result of pumping in excess of the yield of the basin. Expansion of pumping within the District during future projects may result in greater groundwater level fluctuations; however, as long as these fluctuations remain short-term and include subsequent recovery, and also as long as short-term fluctuations do not cause inelastic subsidence, pumpage can be considered to be within the operational yield of the basin.

Plan Element 3 - Development of Groundwater Supply and Continued Participation in Conjunctive Use Programs

As previously described herein, the District's primary water supply has historically been diversions from the Sacramento River, with limited private groundwater use for domestic and irrigation purposes. In recent years, desire to engage in conjunctive use activities has driven increased groundwater development within the District, most notably by RGF. As also noted above, RD 787 is a participant in the SVWMP, which includes the conjunctive use of groundwater and surface water for the primary goal of maintaining surface water flows to the Sacramento-San Joaquin Delta to achieve water quality objectives. RD 787 plans to continue to participate in the sustainable development of the groundwater resource, through conjunctive use and other activities. Such participation is anticipated to consist of District involvement in specific groundwater development projects, with associated monitoring programs to ensure that the projects to not result in long-term adverse impacts to groundwater or surface water resources.

Plan Element 4 – Preservation of Water Quality

This plan element reflects a goal of maintaining the utility of the basin, primarily for irrigation supply, and for all other beneficial uses as well, and to avoid any significant loss of groundwater storage or availability due to degradation of groundwater quality. Water quality will be maintained in part through the avoidance of overdraft, as described in Plan Element 2. An additional consideration will be the distribution of pumpage within the District as it relates to groundwater gradients and potential contamination sources. Part of the SVWMP planning has identified and analyzed the occurrence of poorer quality groundwater and the potential for its movement in response to periodically increased pumping. While that is not expected to result in any adverse impacts, this Plan includes plans to operate generally consistent with the SVWMP concepts such that groundwater movement does not result in movement of poorer groundwater quality to degrade water quality beneath the District.

Plan Element 5 – Groundwater Management Reports

Because of the limited historic groundwater use within the District, there has been no regular historical analysis and reporting on groundwater conditions within the District. Effective management of the portion of the Colusa Subbasin underlying the District, as described in this Plan, is based on planning and evaluation of projects that would represent an increase or expansion of groundwater pumpage within the District.

It is intended that future reporting will be related to these types of planned projects within the District, and their associated monitoring programs. Additional reporting will be done as part of the District's participation in the SVWMP, and by other entities within the Sacramento Valley Groundwater Basin for various studies. RD 787 plans to make monitoring data available to other entities to facilitate the preparation of studies and reports that cover the District area.

Plan Element 6 – Provisions to Update the Groundwater Management Plan

The elements of this Plan reflect the current understanding of the occurrence of groundwater in the portion of the Colusa Subbasin underlying RD 787. The Plan elements are designed to achieve specified objectives to develop local groundwater and engage in conjunctive use and other activities in a manner that ensures the long-term sustainability of the groundwater and surface water resources. While the Groundwater Management Plan provides a framework for present and future actions, new data will be developed as a result of implementing the Plan. That new data could define conditions that will require modifications to current management actions. As a result, this Plan is intended to be a flexible document which can be updated to modify existing elements and/or incorporate new elements as appropriate in order to recognize and respond to future groundwater and surface water conditions. Although not intended to be a rigid schedule, review and updating of this Plan will occur every five years or as appropriate.

VI. References

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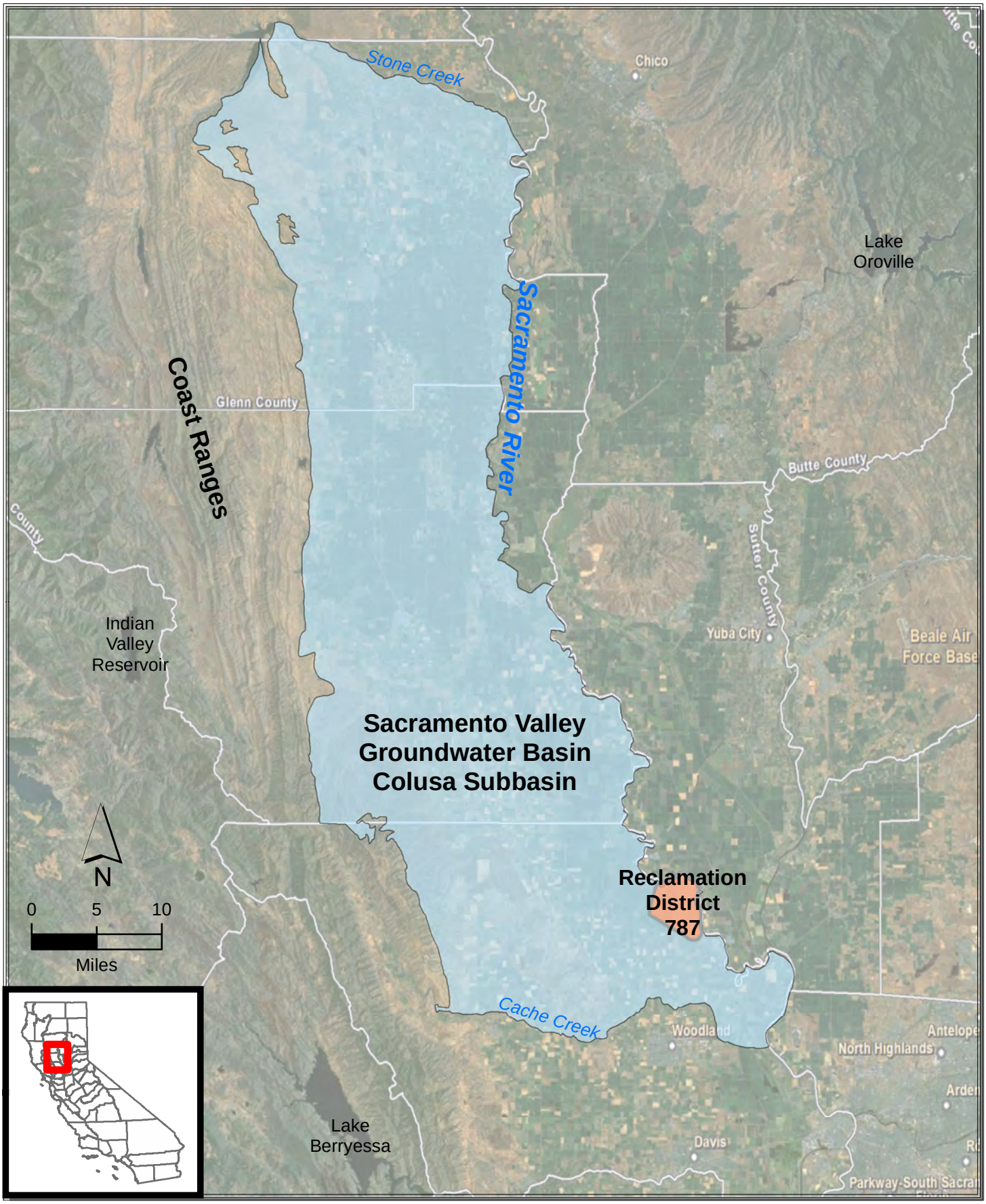
Figures



FILE: Figure 1 RD787 and Nearby WDMap.mxd Date: 11/1/2011

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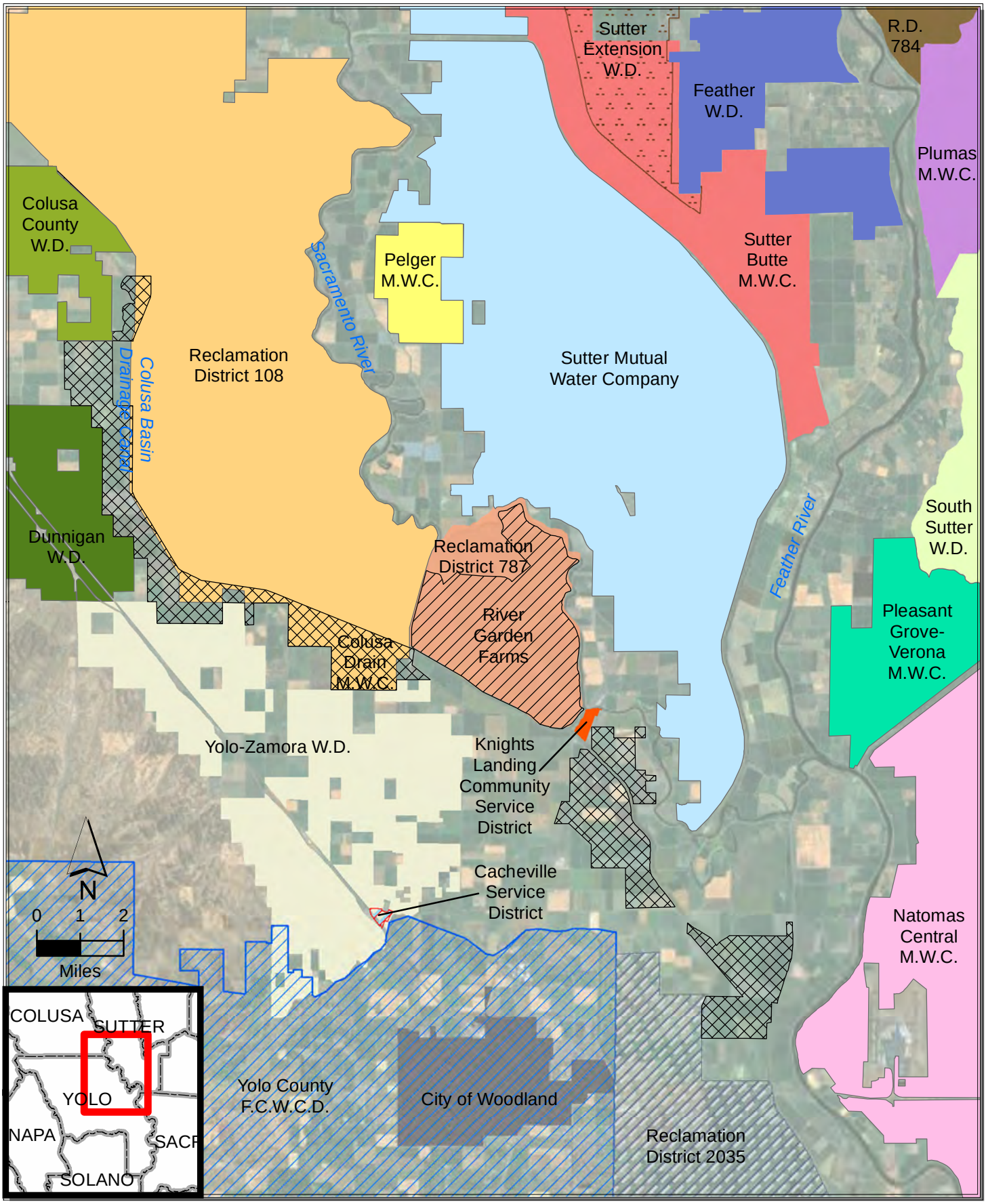
Figure 1
Colusa Groundwater Subbasin and RD 787



FILE: Figure2 RD787 and Nearby WDMap.mxd Date: 11/1/2011

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Figure 2
RD 787 and Nearby Water Districts and Suppliers

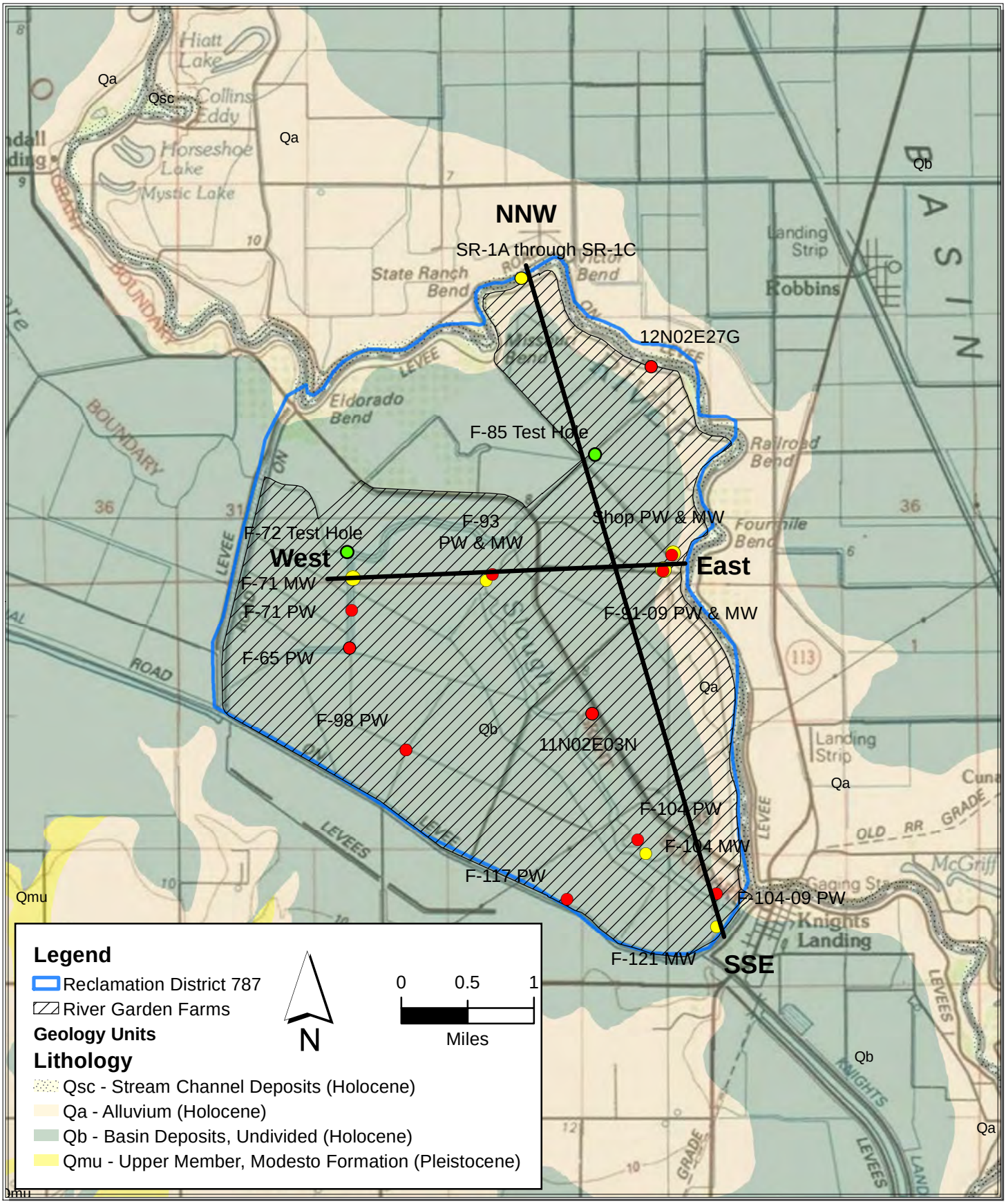

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Figure 3
Geologic Map and Cross Section Locations
RD 787

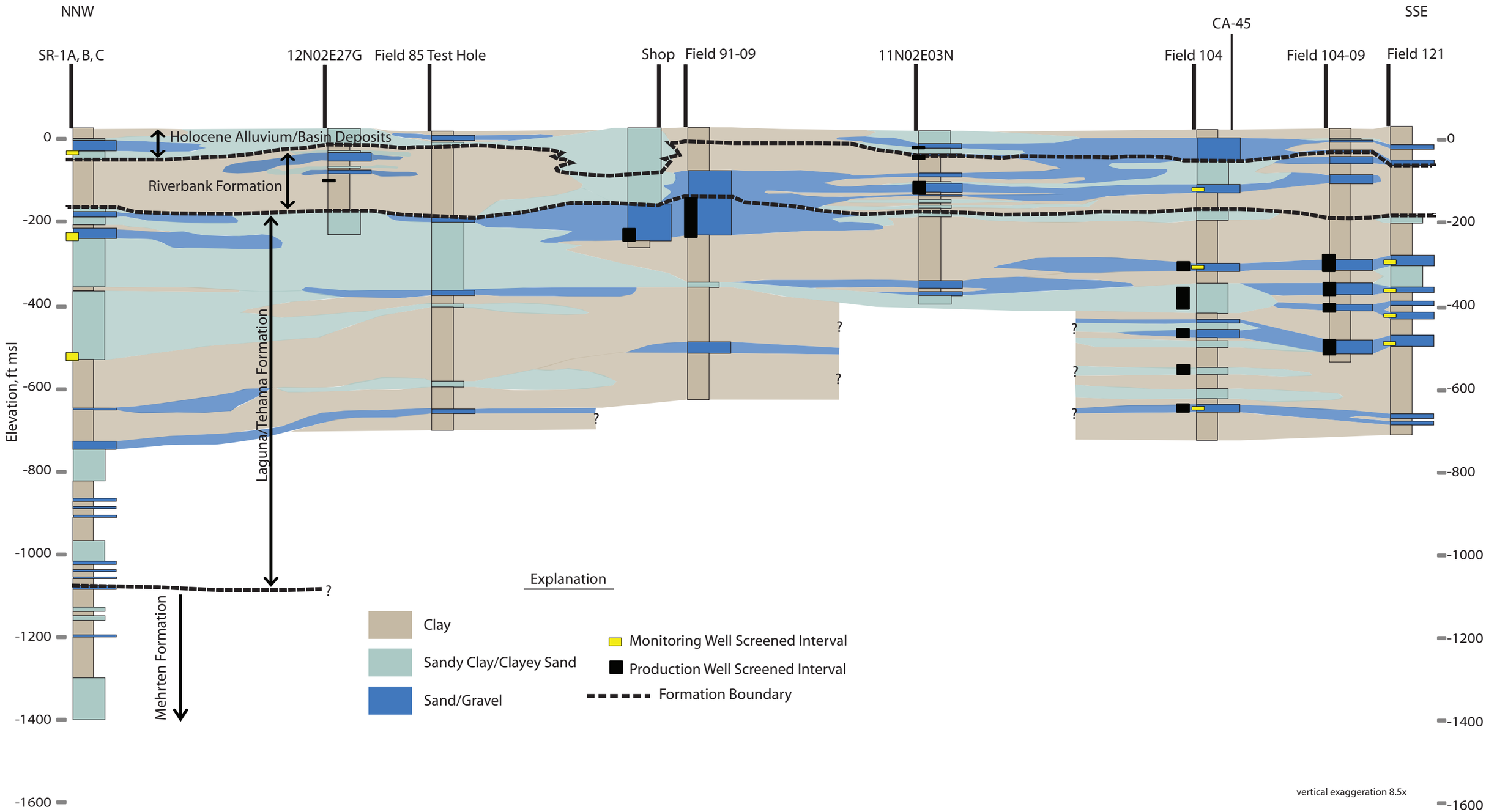

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Figure 4
North-northwest to South-southeast Generalized Geologic Cross Section
RD 787

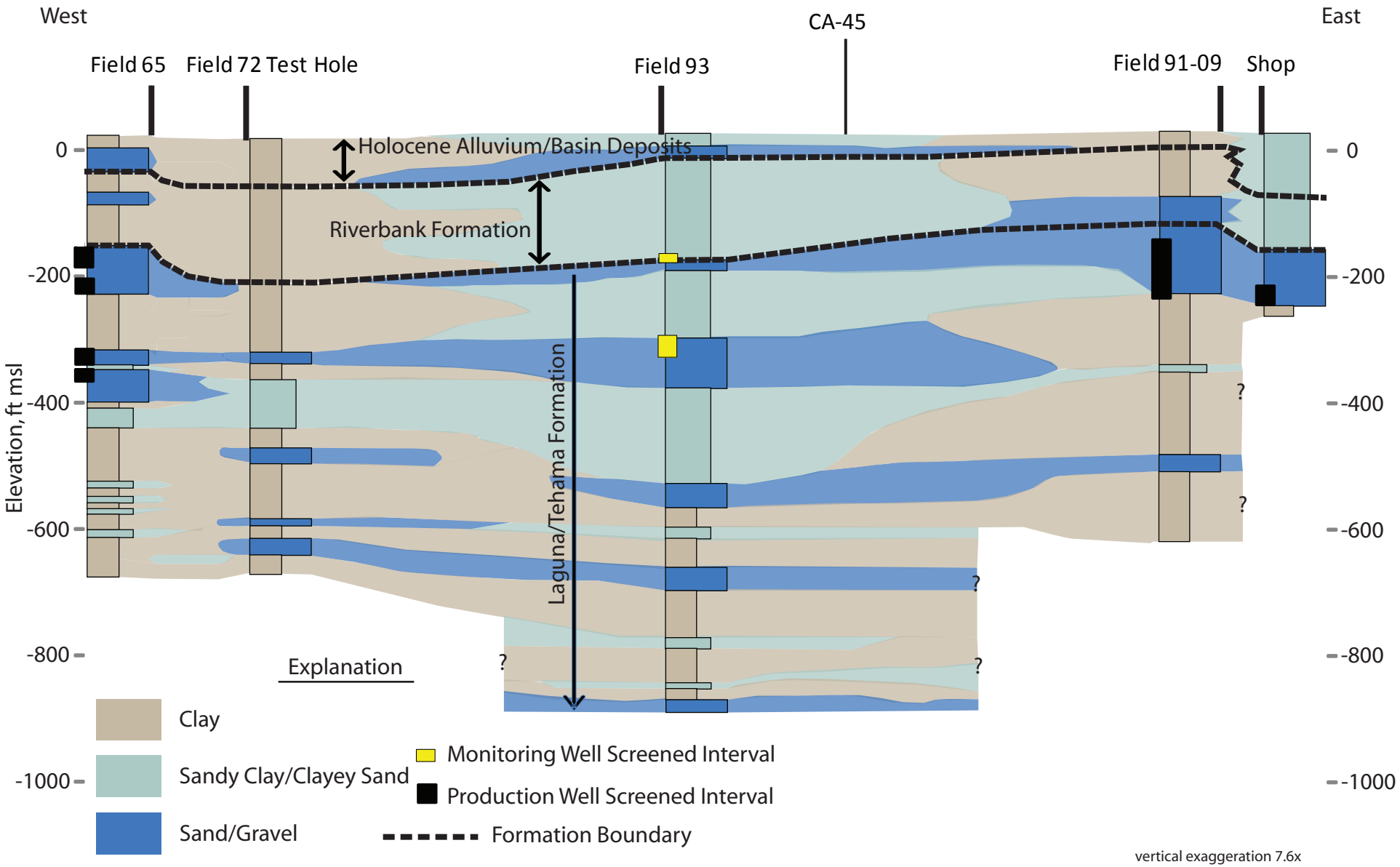

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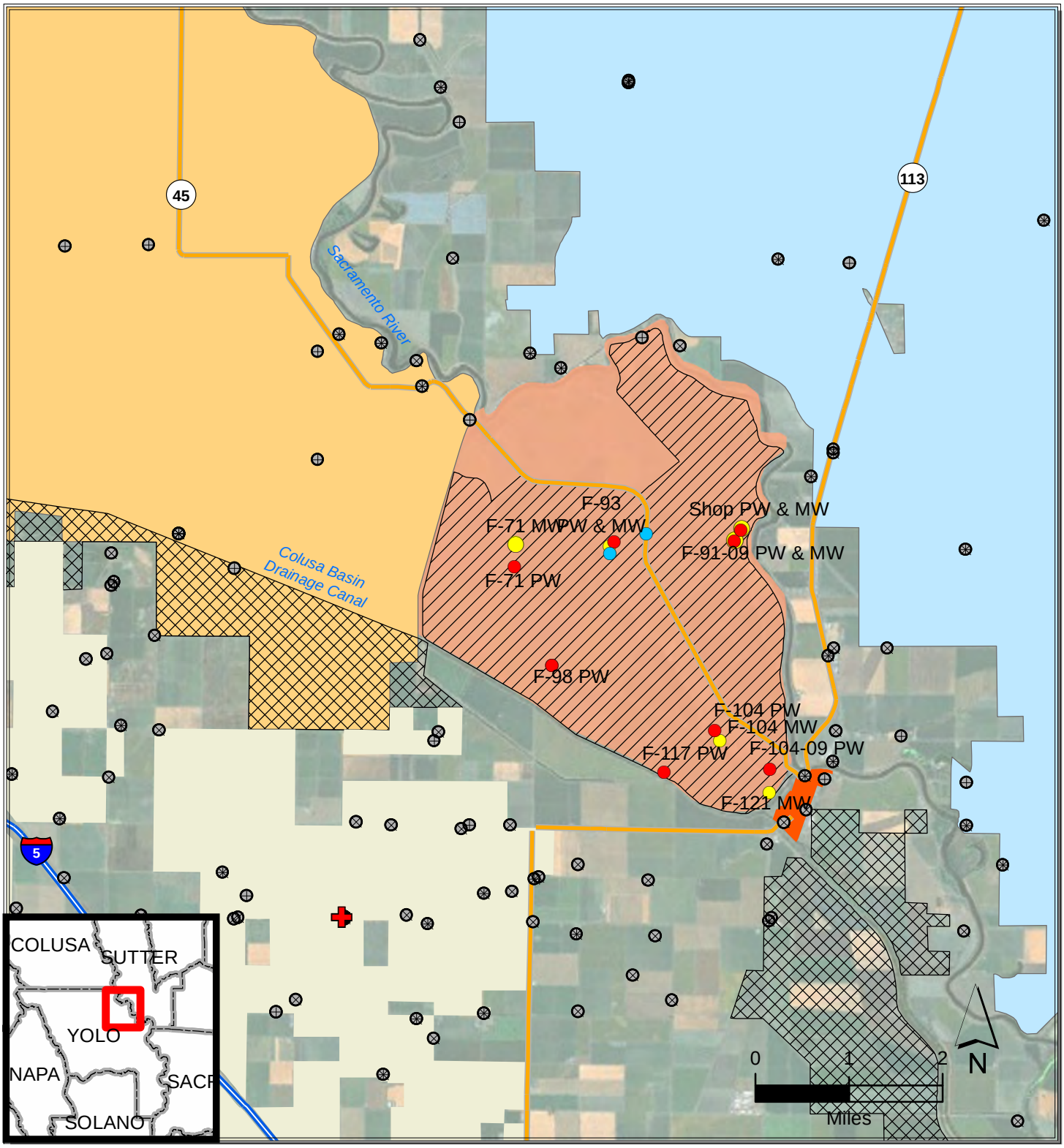
Figure 5
West to East Generalized Geologic Cross Section
RD 787



Legend

- Land Subsidence Benchmark
- Zamora Extensometer
- Well with Water Quality Data
- Well with Water Level Data
- Well with Water Quality & Level Data
- RGF Production Wells
- RGF Monitoring Wells
- Reclamation District 787
- Knights Landing Service Dist.
- Yolo-Zamora W.D.
- Colusa Drain M.W.C.
- Reclamation District 108
- River Garden Farms
- Sutter Mutual W.C.

Figure 6
Monitoring Locations
In and Near RD 787

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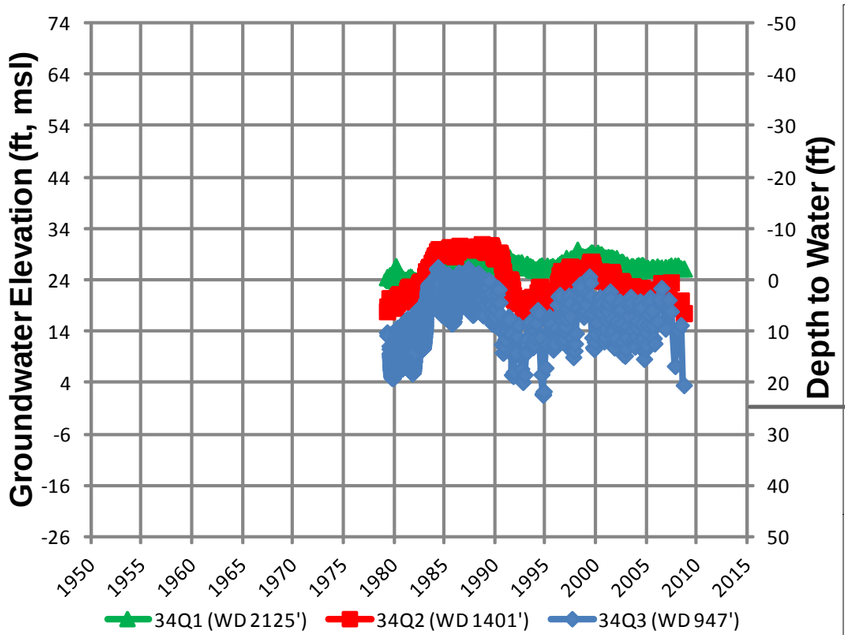
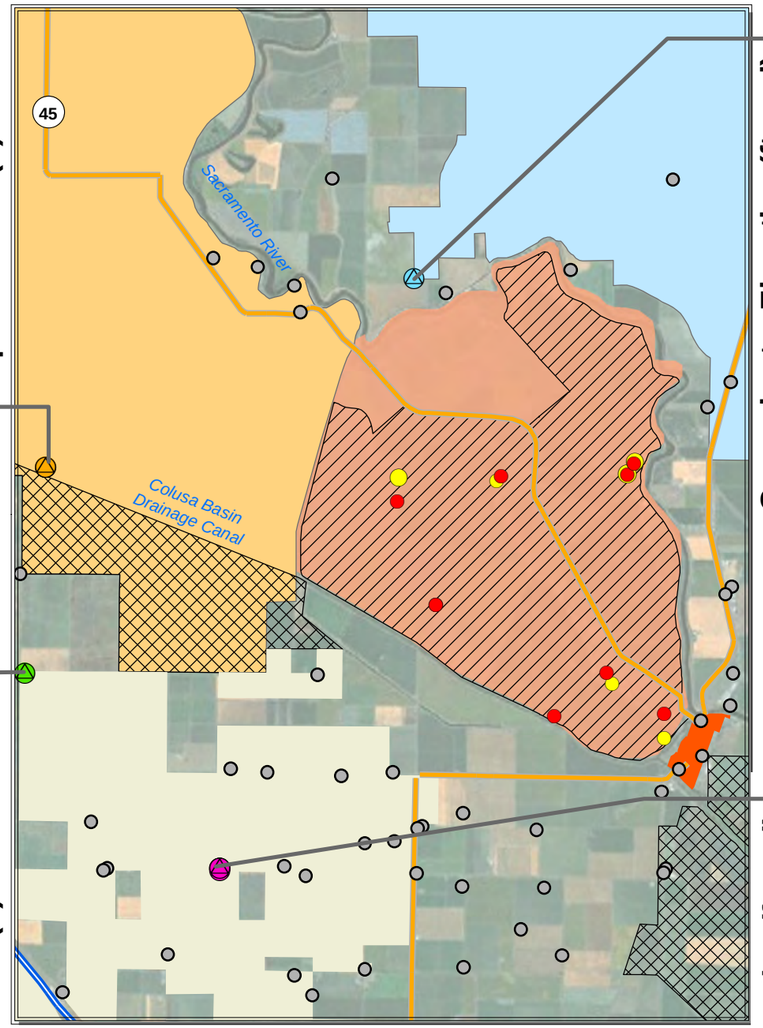
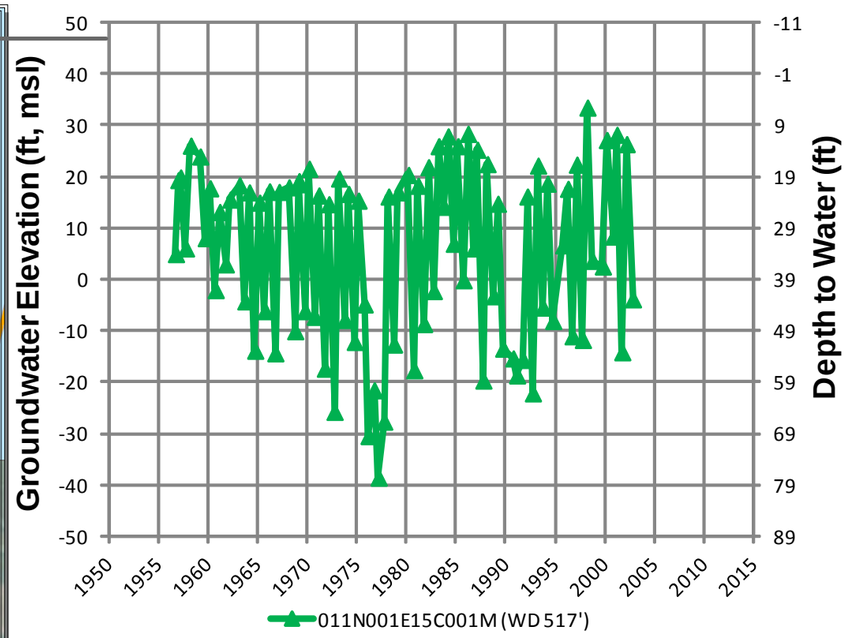
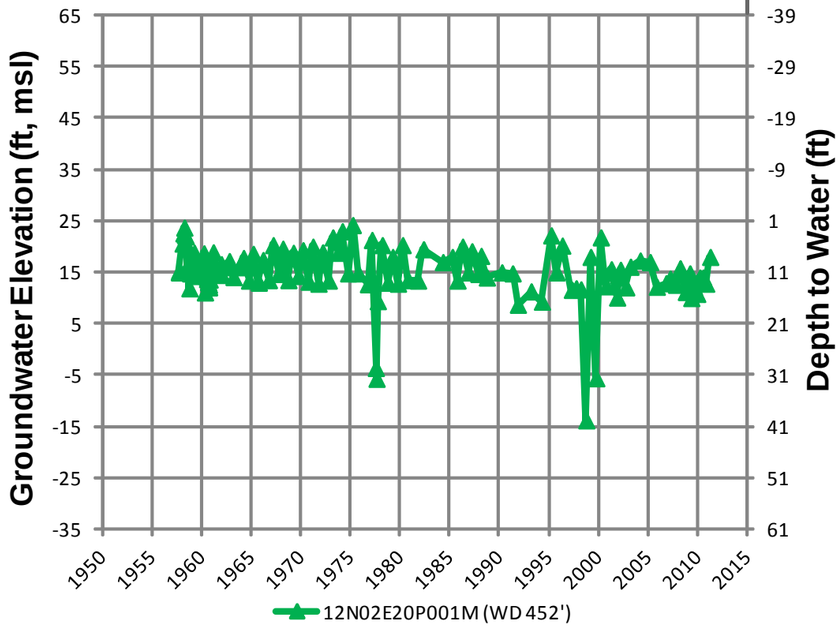
FILE: Figure 2 MonLocations.mxd Date: 11/1/2011







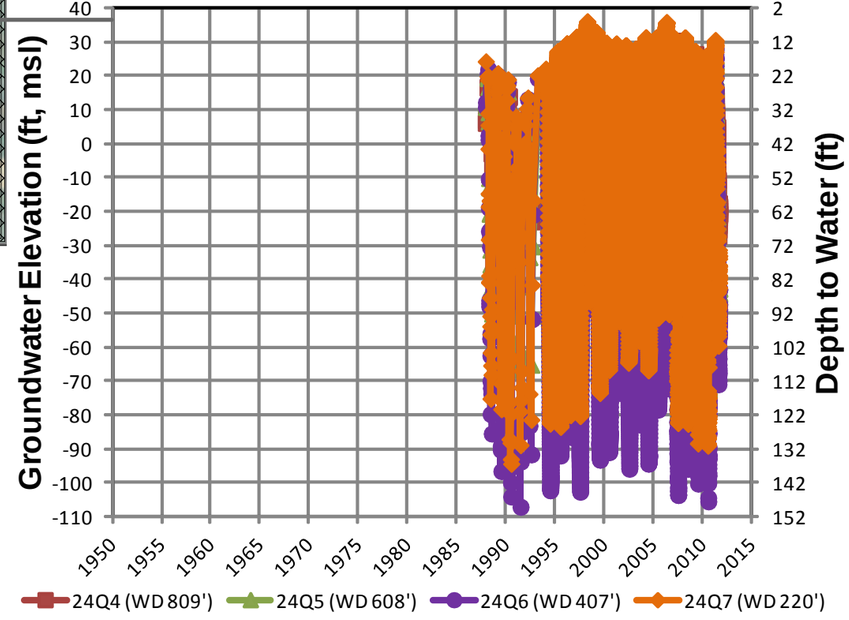


Legend

- 12N/1E-34Q1, Q2, and Q3
- 11N/1E-15C1
- 12N/2E-20P1
- Zamora Extensometer
- Well with Water Level Data
- RGF Production Wells
- RGF Monitoring Wells
- Knights Landing Service Dist.
- Yolo-Zamora W.D.
- Colusa Drain M.W.C.
- Reclamation District 108
- River Garden Farms
- Sutter Mutual W.C.
- Reclamation District 787

0 1 2
Miles

N



FILE: Figure 2 MonLocations.mxd Date: 11/1/2011

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Figure 7
Water Level Monitoring Locations and Representative Hydrographs

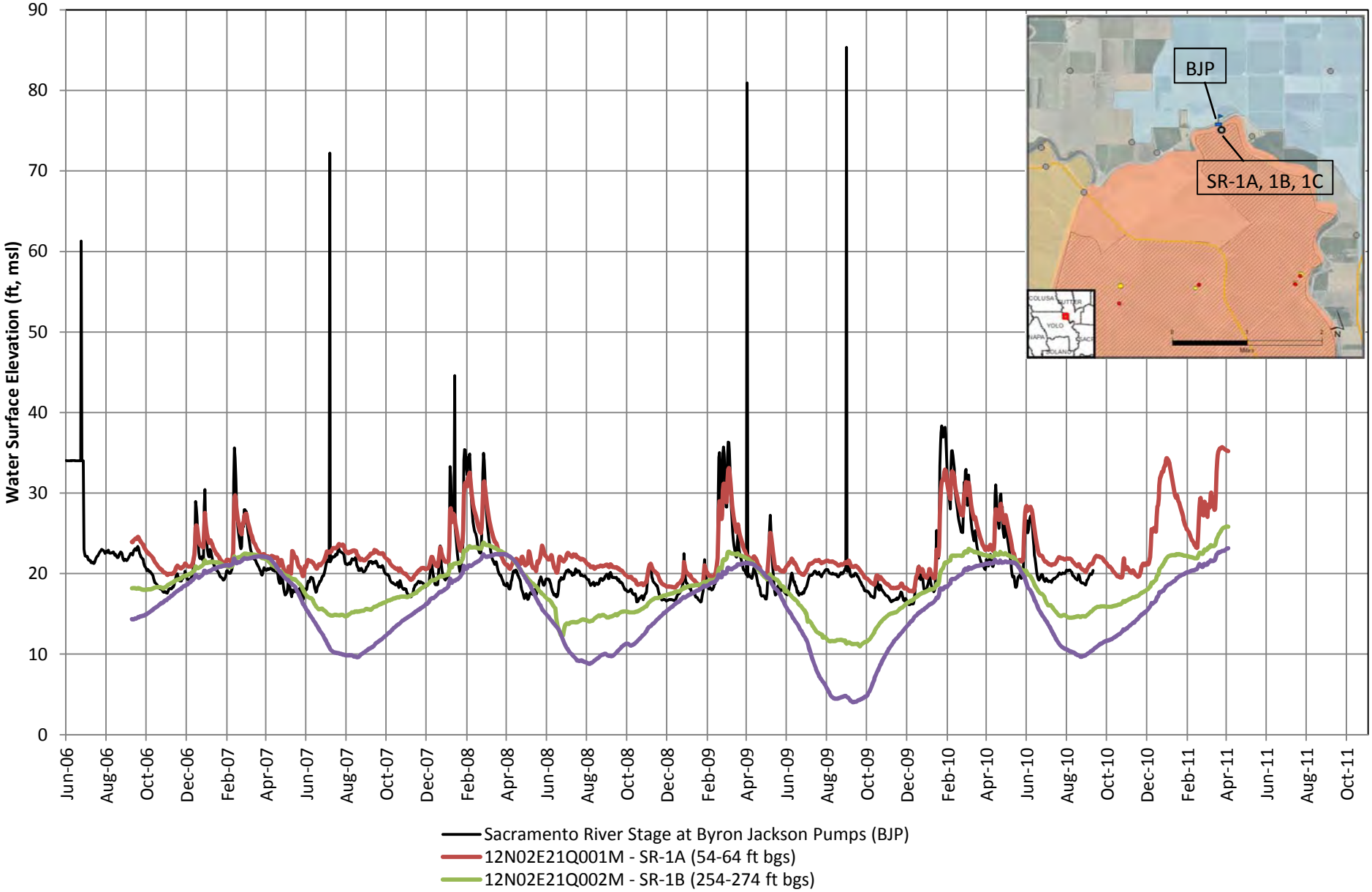

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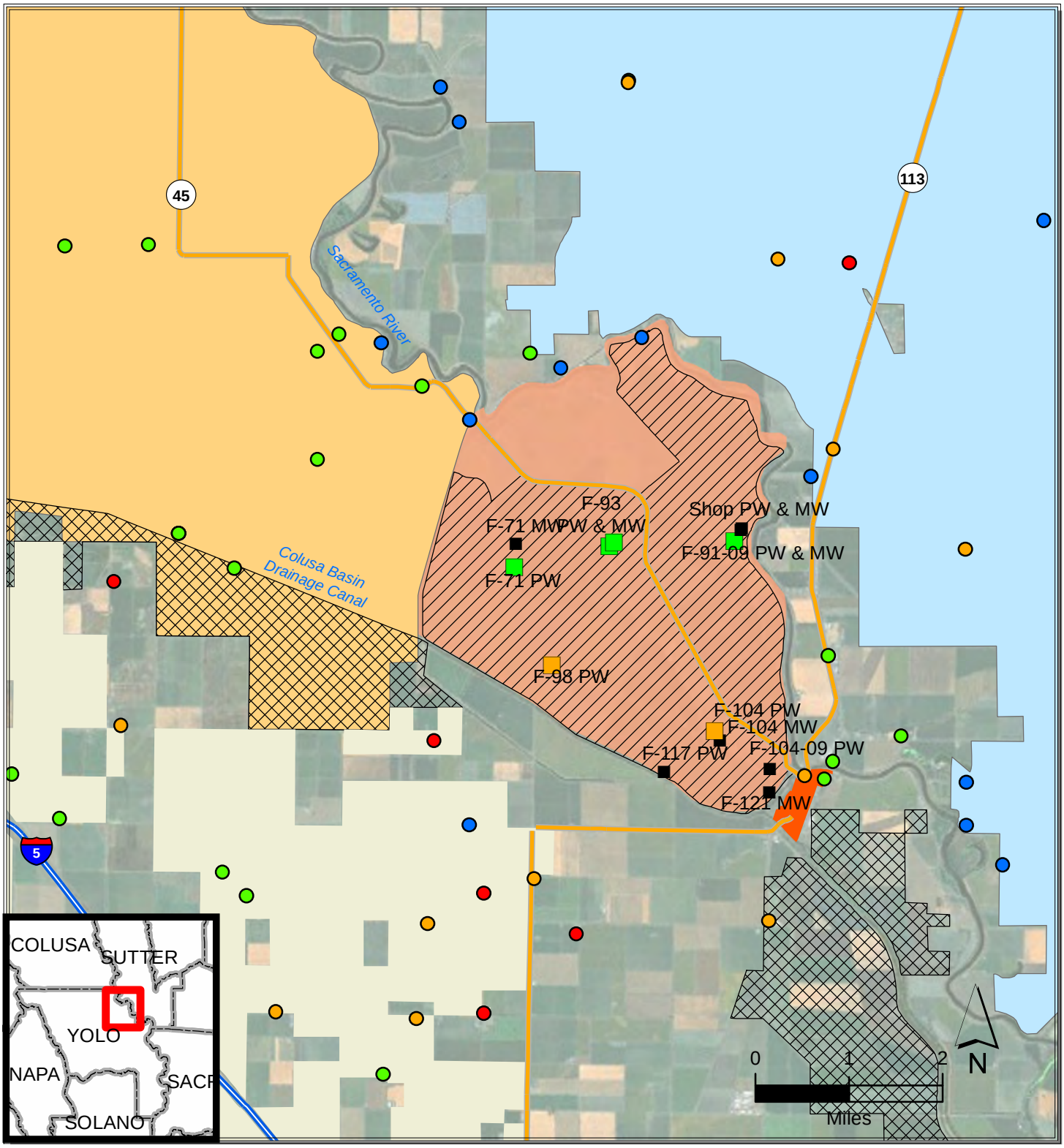
Figure 8

Groundwater Levels and Sacramento River Stage at SR-1 site



Legend

Maximum SC

- 138 - 500
- 501 - 900
- 901 - 1600
- 1601 - 2550
- RGF Wells

- Reclamation District 787
- Knights Landing Service Dist.
- Yolo-Zamora W.D.
- Colusa Drain M.W.C.
- Reclamation District 108
- River Garden Farms
- Sutter Mutual W.C.

Figure 9
Maximum Specific Conductivity (mmhos/cm)
In and Near RD 787

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FILE: Figure 2 MonLocations.mxd Date: 11/1/2011

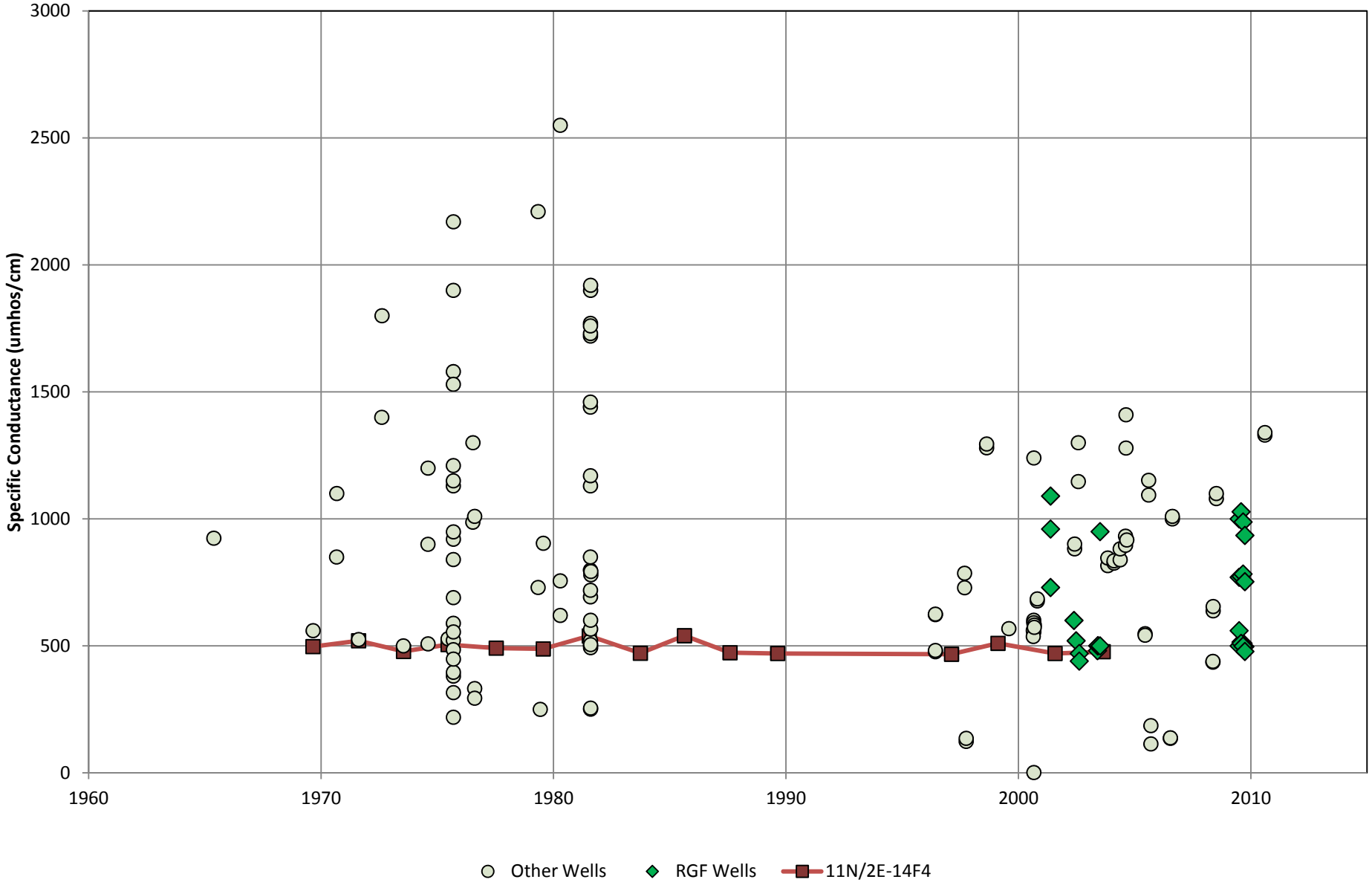

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Figure 10
Groundwater Quality In and Near RD 787

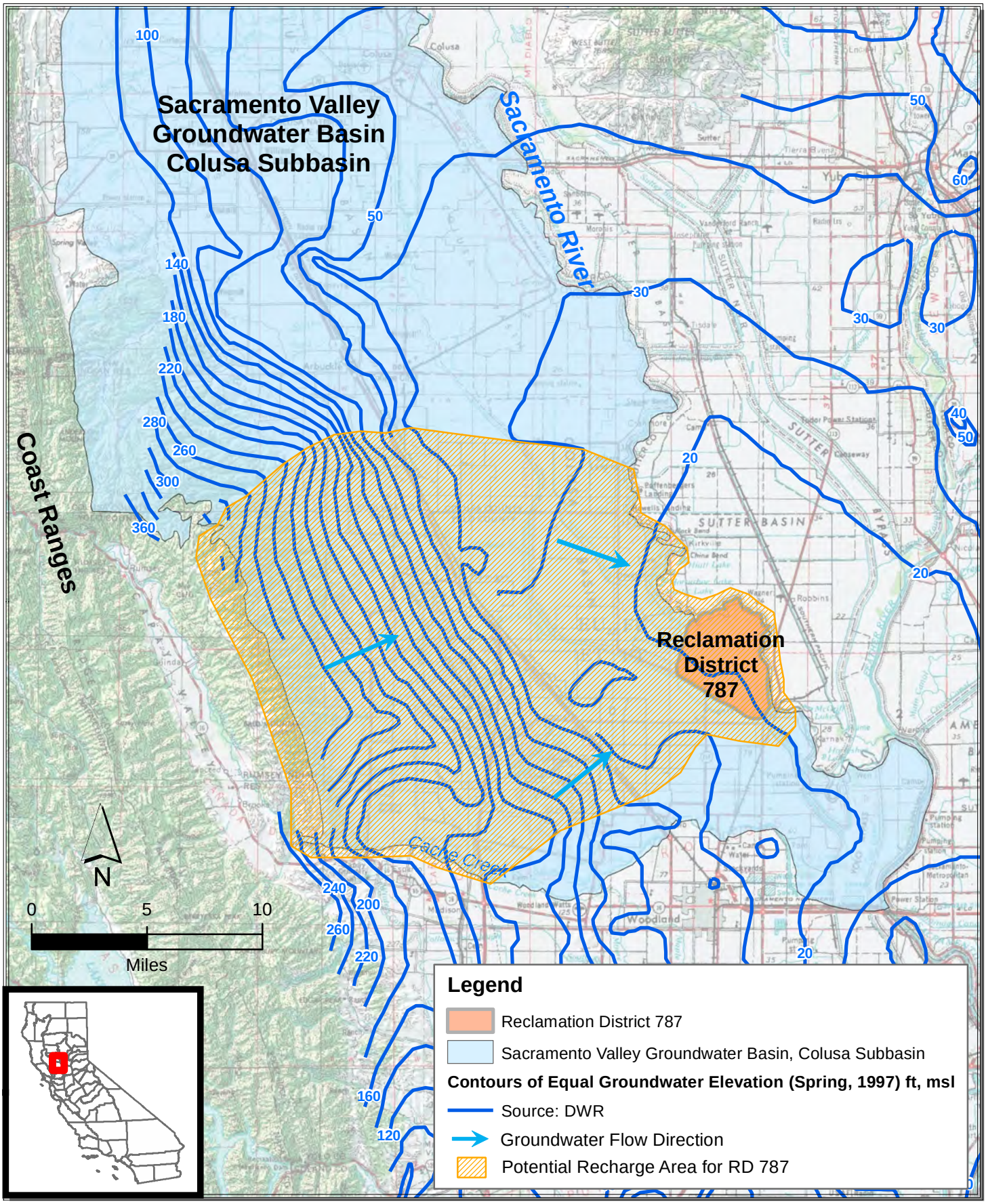

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Figure 11
Potential Recharge Areas for RD 787

Tables

Table 1 River Garden Farms Well Data

Well Name	Township/Range	Date Constructed	Well Depth (ft)	Screened Interval	Slot Size (in)	Capacity (gpm)	Casing Diameter (in)	Annular Seal Depth (ft)
Field 65 MW	11N/02E-05L	1963	550	101-116, 175-210, 222-254, 329-363, 488-502, 542-550	-	-	-	-
Field 65 PW	11N/02E-05F1	2008	420	178-208, 226-250, 338-363, 370-390	0.08	2,500	18.625	121
Field 71 MW's	11N/02E-05C1 & 05C2	2001	240	56-66, 216-226	0.02	-	2	43
Field 71 PW	11N/02E-05C3	2001	600	365-572	0.08	1,700	18 to 330'; 16 to 582'	282
Field 91 MW	12N/02E-34Q	1963	270	160-264	1/8 x 2	900 - 1,000	18/16	15
Field 91-09 PW	12N/02E-34Q1	2009	290	170-262	0.06	2,840	18	153
Field 93 MW's	12N/02E-33P1 & 33P2	2001	370	188-198, 320-350	0.02	-	2.5	170
Field 98 PW	11N/02E-08G1	1963(?)	-	315-385	-	2,500 - 3,000	-	-
Field 104 MW's	11N/02E-15	2008	702	140-150, 330-340, 672-682	0.03	-	2	111
Field 104 PW	11N/02E-15C1	2008	715	323-343, 383-435, 485-503, 572-594, 666-686	0.05	2,500	28	216
Field 104-09 PW	11N/02E-15H1	2009	555	298-338, 368-393, 418-433, 505-534	0.05	2,990	18	248
Field 117 PW	11N/02E-16H1	2009	465	310-384, 412-440	0.06	1,965	18	270
Field 121 MW's	11N/02E-14M1	2009	552	320-330, 388-398, 448-458, 515-525	0.03	-	2	101
Shop MW's	12N/02E-34	2009	440	120-130, 200-210, 310-320	0.03	-	2	80
Shop PW	11N/02E-03	2010	350	186-230, 295-330	0.08	3,010	18	155

Table 2
Summary of Groundwater Quality Data
River Garden Farms Wells

Analyte	Units	MCL	Field 65 Well					Field 71 Well									Field 91 Well	Field 93 MW 210'	Field 93 MW 360'	Field 93 MW 900'	Field 98 Well						Field 104 Well			
			5/21/01	7/1/09	8/1/09	9/1/09	9/30/09	6/27/02	5/29/03	6/2/03	6/6/03	7/8/03	7/1/09	8/1/09	9/1/09	9/30/09	5/21/01	8/15/02	8/15/02	5/24/02	5/21/01	7/8/03	7/1/09	8/1/09	9/1/09	9/30/09	7/1/09	8/1/09	9/1/09	9/30/09
Cations																														
Calcium	mg/L		55	37				16					11				47	33	19	16	68		63				13			
Magnesium	mg/L		47	32				7.8					3.9				36	24	15	5.3	43		44				5.3			
Potassium	mg/L			2.2				3.9					4					2.6	3.1	9.2			2.3				3.9			
Sodium	mg/L		98	48				100					92				62	47	71	130	52		52				94			
Total Hardness	mg/L		330	220				72					44				265	180	110	62	348		340				55			
Anions																														
Bicarbonate Alkalinity	mg/L			200				240					230					200	230	250			190				260			
Carbonate Alkalinity	mg/L			<5				<1.0					<5					16	14	<1.0			<5				<5			
Chloride	mg/L	250/500[2]	130	99				11					14				21	33	9.5	36			190				23			
Fluoride	mg/L	2.0[1]	0.12	<0.10				0.24					<0.10				0.15	0.24	0.23	0.16			0.11				<0.10			
Hydroxide Alkalinity	mg/L			<5				<1.0					<5					<1.0	<1.0	<1.0			<5				<5			
Nitrate (as NO3)	mg/L	45[1]	<2.0	<2				<2.0					<2				<2.0	<2.0	<2.0	<2.0			<2				<2			
Sulfate	mg/L	250/500[2]	110	44				8.9					13				48	15	7.9	25	64		64				17			
Total Alkalinity	mg/L		205	200				240					230				287	220	250	250	181		190				260			
Physical Parameters																														
pH	pH units	6.5/8.5[4]	7.8	7.76	8.25	8.2	8.2	8.2	8.25	**8.7**	**8.66**	**8.65**	8.1	8.4	8.5	8.4	7.6	8.2	8.1	8.2	7.9	**8.6**	7.71	8	8.2	8.2	8	**8.6**	8.4	8.5
Specific Conductivity	mmhos/cm	900/1600[2]	**1090**	770	774	783	753	520	481	500	501	500	500	515	510	497	730	470	440	600	**960**	**950**	**1000**	**1028**	**988**	**935**	560	510	499	478
Total Dissolved Solids	mg/L	500/1000[2]	**690**	450				330					330				420	300	320	410	**850**		**590**				350			
Inorganics																														
Aluminum	ug/L	1000[1]/200[3]	100														<50				<50									
Arsenic	ug/L	10[1]	6.9														5.7				<2.0									
Barium	ug/L	1000[1]	<100														140				220									
Boron	ug/L	1000[3]						970										1300	590	<50										
Chromium	ug/L	50[1]	<1.0														<1.0				3.4									
Copper	ug/L	1000[2]	<50														<50				<50									
Iron	ug/L	300[2]	140														<100				<100									
Lead	ug/L	15[3]	<5.0														<5.0				<5.0									
Manganese	ug/L	50[2]	**79**														**400**				<20									

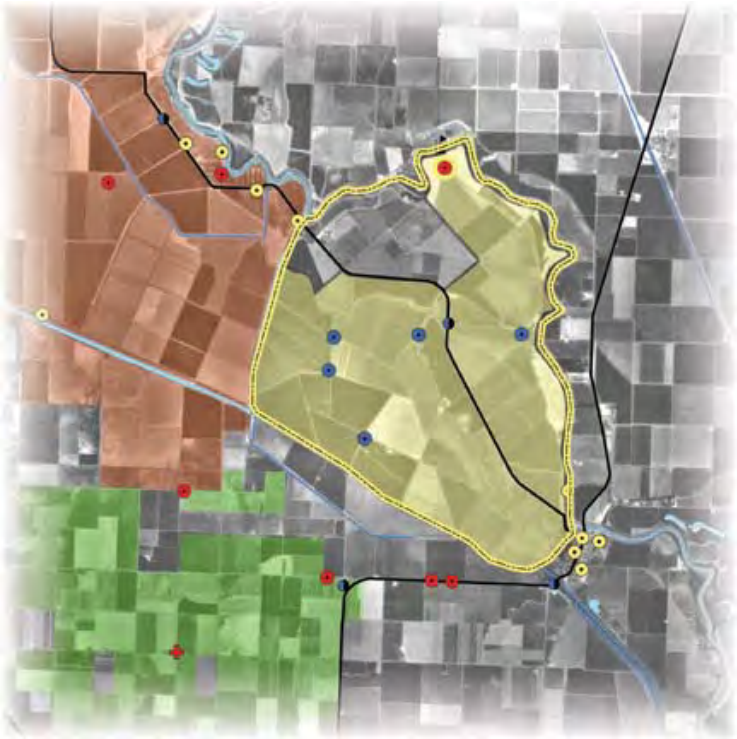
1 - Primary MCL
2 - Secondary MCL (recommended/upper range)
3 - Action Level
4 - Suggested lower/upper acceptable range

Table 3
River Garden Farms

Sacramento River Diversions

Year	Actual Monthly Diversions (AF)							Total Annual Div.
				Critical Months				
	Apr	May	Jun	Jul	Aug	Sep	Oct	
1964	4,586	4,406	4,033	4,022	4,127	509	0	21,683
1965	769	7,305	5,335	6,125	4,810	1,868	0	26,212
1966	4,206	5,912	4,665	4,481	3,001	338	0	22,603
1967	0	4,633	4,962	4,313	4,439	1,253	0	19,600
1968	4,045	6,593	6,507	5,092	3,930	1,054	0	27,221
1969	2,096	5,763	5,008	5,653	5,457	622	0	24,599
1970	3,534	6,922	6,608	5,804	5,260	1,230	0	29,358
1971	2,419	3,935	4,723	4,649	4,532	877	0	21,135
1972	4,274	5,662	5,261	4,843	4,533	2,684	0	27,257
1973	839	6,442	5,638	5,825	5,091	1,759	0	25,594
1974	1,883	6,818	5,096	4,600	4,026	212	0	22,635
1975	1,942	6,585	6,319	5,492	5,258	1,454	0	27,050
1976	3,648	7,460	5,751	5,304	5,151	1,527	0	28,841
1977 *	2,365	3,193	5,585	3,970	4,016	572	1,288	20,989
1978	317	4,591	4,415	5,234	4,018	827	97	19,499
1979	1,614	5,238	5,558	4,695	4,122	1,407	0	22,634
1980	3,131	4,804	5,028	5,578	6,051	854	0	25,446
1981	1,483	6,233	5,037	5,819	6,051	1,626	0	26,249
1982	0	3,825	3,823	4,942	4,805	1,003	0	18,398
1983	18	1,757	2,299	1,481	558	194	0	6,307
1984	1,528	4,589	4,941	4,216	2,329	93	0	17,696
1985	2,923	5,604	6,976	5,120	3,715	139	0	24,477
1986	563	4,694	4,622	5,068	4,245	0	0	19,192
1987	2,809	6,247	4,602	3,651	3,024	768	549	21,650
1988	2,484	2,325	3,170	3,264	1,848	1	76	13,168
1989	2,546	2,943	3,078	3,064	5,328	757	0	17,716
1990	1,488	2,510	3,367	4,217	4,595	574	0	16,751
1991 *	1,809	3,267	4,586	5,283	3,878	549	0	19,372
1992 *	633	6,172	4,953	3,860	3,274	154	0	19,046
1993	140	3,790	3,438	6,272	6,272	900	0	20,812
1994 *	2,049	3,773	5,393	6,138	4,194	324	0	21,871
1995	144	1,885	2,858	5,026	5,025	968	0	15,906
1996	169	2,672	3,484	4,569	3,715	1,574	0	16,183
1997	2,781	6,732	6,897	7,272	4,972	1,550	38	30,242
1998	501	2,309	3,766	8,767	8,910	1,999	0	26,252
1999	1,663	7,776	6,000	5,965	4,728	1,224	1,638	28,994
2000	1,338	6,182	6,309	6,136	4,939	1,549	1,268	27,721
2001	322	5,501	5,617	5,095	3,899	1,224	253	21,911
2002	146	3,649	6,097	5,684	4,180	1,382	555	21,693
2003	396	4,160	4,473	4,350	3,782	1,084	337	18,582
2004	808	5,266	5,167	5,832	4,653	773	1,522	24,021
2005	672	3,958	4,443	5,037	3,993	1,256	607	19,966
2006	0	3,206	4,704	4,987	4,215	1,270	488	18,870
2007	1,823	4,870	5,422	5,394	4,082	1,181	0	22,772
2008	1,921	4,729	4,076	3,955	3,235	186	236	18,338
2009	1,537	4,990	5,015	2,899	2,432	306	59	17,238
2010	0	3,731	3,694	3,772	3,173	1,098	0	15,468
Average	1,625	4,800	4,868	4,954	4,295	952	192	21,685

Ground-Water Management Plan
Reclamation District No. 787



November 2005

LUHDORFF & SCALMANINI
CONSULTING ENGINEERS

Ground-Water Management Plan
Reclamation District No. 787

Prepared for:
Reclamation District No. 787

Prepared by:
Luhdorff and Scalmanini, Consulting Engineers

November 2005
File No. 04-1-115

Table of Contents

List of Figures and Tables

I. Introduction

This Ground-Water Management Plan (Plan) is comprised of a number of planned actions related to ground-water supply and the long-term sustainability of ground water and interrelated surface waters within Reclamation District No. 787. This Plan provides information about Reclamation District No. 787, its relation to the ground-water basin that underlies it, the role of Ground-Water Management Plans, and ground-water management objectives (goals) for the District. This plan describes existing ground-water conditions, as well as historical and projected water demands within the District. Finally, this Plan presents a set of ground-water management actions that form the central elements of this Ground-Water Management Plan.

Reclamation District No. 787

Reclamation District No. 787 (RD 787, the District) is located in the northeastern portion of Yolo County, west of the town of Knights Landing and adjacent to the Sacramento River (Figure I-1). The District covers approximately 8,950 acres, most of which is irrigated agricultural land. The majority landowner in the District is River Garden Farms, which covers approximately 7,400 acres (nearly 82%) of the District (Figure I-2).

RD 787 was formed under the general reclamation district laws of 1908 for the purposes of providing drainage and reclamation of the lands within its boundary. Irrigation water is delivered to users within the District through a system of canals and ditches that are supplied primarily by surface water diversions from the Sacramento River. The respective landowners within the District (River Garden Farms, Cooling, Faye and Geer) have riparian and appropriative water rights, as well as water rights settlement contracts with the United States Bureau of Reclamation. Although the District does not own or operate water supply wells, there are private well owners within the District, including River Garden Farms, who operate several irrigation wells. The District landowners have historically met demands with surface water supplies, with intermittent supplemental ground-water use during dry years when surface water diversions from the Sacramento River were reduced.

In 2003, River Garden Farms (RGF) implemented a temporary water transfer whereby ground water was used in lieu of surface water. The State Water Resources Control Board authorized the transfer of up to 1,800 acre-feet (af) of surface water to Metropolitan Water District of Southern California as part of this program. RGF pumped 1,581 af of ground water during the transfer, which took place between July 3 and October 31, 2003. The California Department of

Water Resources (DWR) monitored the response of the aquifer system during this period, and determined that no measurable long-term impacts were created by increased ground-water pumpage during the transfer. As a result, the concept of future water transfers based on ground-water substitution is included in this Plan as a potential element within overall ground-water management in the District.

Sacramento Valley Ground-Water Basin, Colusa Subbasin

RD 787 overlies the Sacramento Valley Ground-Water Basin, Colusa Subbasin (Figure I-1). The Colusa Subbasin is part of the larger Sacramento Valley Basin, which includes areas underlying the Sacramento Valley, the Sacramento River, and its tributaries as they flow south and west toward the Sacramento-San Joaquin Delta. The Colusa Subbasin is bounded on the east by the Sacramento River, on the north by Stony Creek, on the west by the Coast Range, and on the south by Cache Creek. The extent of the Colusa Subbasin, as mapped in Bulletin 118, is illustrated in Figure I-1. The Colusa Subbasin is about 1,400 square miles in area, and underlies portions of Tehama, Glenn, Colusa and Yolo Counties.

Within the Colusa Subbasin, ground water has historically been the primary source of water supply for domestic and municipal uses. Ground water has also been used widely for irrigation purposes; however, surface water supplies are available for irrigation in many parts of the Subbasin. In addition to those within RD 787, there are numerous other water districts and suppliers within the Colusa Subbasin, including the various cities, County Service Areas, Community Service Districts, Water Districts/Companies, Irrigation Districts and Public Utilities Districts. For those entities and others, there are well completion reports on file with DWR for approximately 2,600 domestic and 1,500 irrigation wells within the Colusa Subbasin.

The north and east boundaries of RD 787 are formed by the Sacramento River. On the south and west sides of the District, the adjacent water districts and suppliers are Reclamation District No. 108, Colusa Drain Mutual Water Company, Yolo-Zamora Water District, and Knights Landing Community Service District (Figure I-2). To the east across the Sacramento River, the nearest water districts are the Pelger, Sutter, Pleasant Grove-Verona and Natomas Mutual Water Companies. Collectively, these purveyors supply ground water and surface water for municipal and irrigation supply within their boundaries.

The Colusa Subbasin extends far beyond the boundary of the District; however, the focus of this Plan is on that portion of the overall Colusa Subbasin underlying RD 787. This Plan establishes

a set of management objectives that the District intends to implement within its boundary. The goals and objectives set forth in this Plan are intended to provide for the long-term sustainable use of the resource within the District, and as such would preserve the resource as it relates to other users within the Colusa Subbasin and the greater Sacramento Valley Ground-Water Basin.

Overview of Water Requirements and Supplies

Historically, the majority of water demands within RD 787, which have averaged about 25,000 to 30,000 acre-feet per year (afy) over the last 40 years, have been met with surface water diversions from the Sacramento River. Historical and projected water requirements and supplies for RD 787 are discussed in more detail in Section IV of this Plan.

Legislation Related to Ground-Water Management Plans

The Legislature enacted legislation in 1992 (AB 3030) and 2002 (SB 1938), now incorporated in the Water Code Section 10753, *et seq*. to encourage local public agencies to adopt plans to manage ground-water resources within their jurisdictions. RD 787 will adopt this Ground-Water Management Plan by resolution of its board of trustees.

SB 1938 provided that adoption of a ground-water management plan will be a prerequisite to obtaining funding assistance for ground-water projects or ground-water quality projects from funds administered by DWR. To comply with SB 1938, a ground-water management plan must include ground-water management components that address monitoring and management of water levels, ground-water quality degradation, inelastic land subsidence, and changes in surface flows and quality that either affect ground water or are affected by ground-water pumping. There must be provisions to cooperatively work with other public (and presumably private) entities whose service areas or boundaries overly the ground-water basin. Provisions must also be made to allow participation by interested parties in development of the Plan. The Plan must include mapping of the ground-water basin, as defined in DWR's Bulletin 118, and the boundaries of the local agencies that overlie the basin. This Plan focuses on that portion of the Colusa Subbasin that underlies RD 787 and, as a result, RD 787 is the only local "agency". Nearby and adjacent water districts and water suppliers within the Colusa Subbasin are shown in Figure I-2. Finally with respect to SB 1938 requirements, monitoring protocols must be designed to detect changes in ground-water levels, ground-water 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 ground water, or are directly affected by

ground-water pumping.

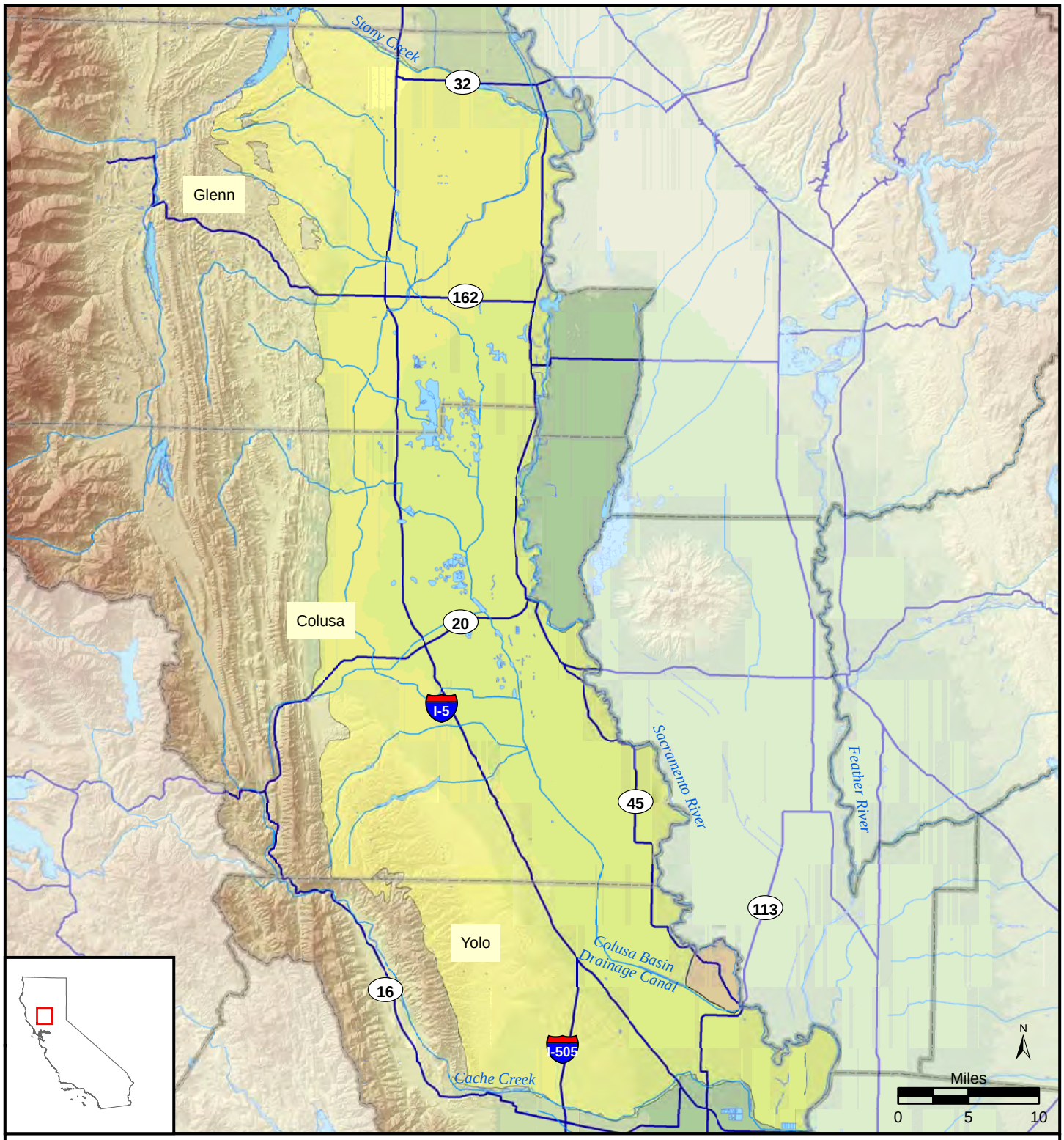
The potential components of ground-water management plans are listed in Water Code Section 10753:

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

Not all of these potential components are included in this Plan. Because this Plan is intended to recognize the nature of the District and its included landowners, it includes a number of elements that are intended to accomplish a set of management objectives that, in turn, are focused on the occurrence and use of ground water in the District. Exclusion of other potential components listed in the Water Code reflects an understanding that some are being separately accomplished by others (e.g. well construction practices and well abandonment/destruction programs which are administered by Yolo County), and some are not applicable to this basin (e.g. the control of saline water intrusion).

Public Outreach and Involvement

Public outreach and involvement efforts that occurred during development of the Reclamation District No. 787 Ground-Water Management Plan included notifying landowners within the District and also Yolo County, Reclamation District No. 108, Knights Landing Community Service District, and the California Department of Water Resources.



Legend

- Sacramento Valley Ground-Water Basin, Colusa Subbasin
- Reclamation District No. 787
- County Boundaries

Figure I-1
Location Map

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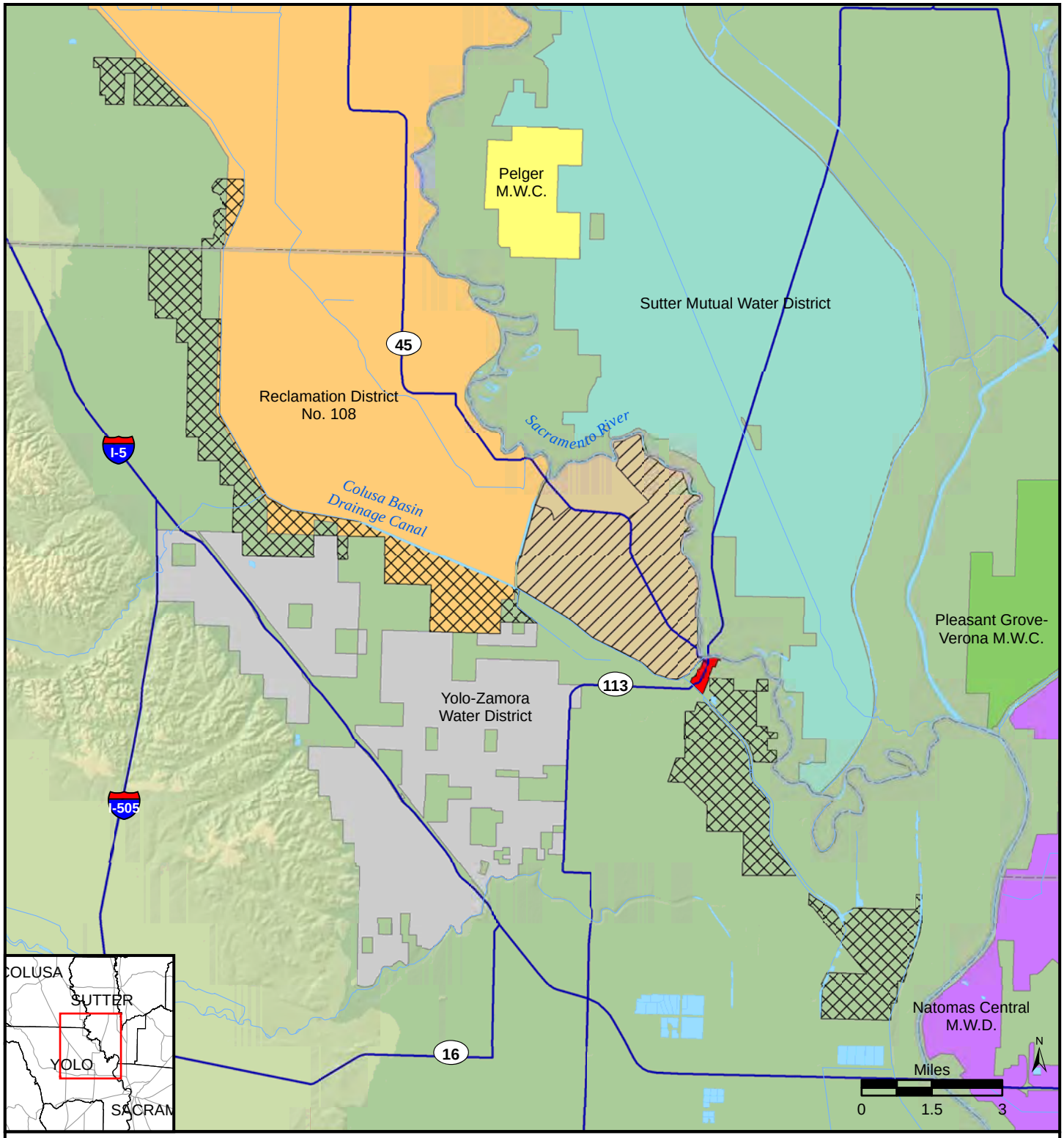

Legend

- River Garden Farms
- Colusa Drain M.W.C.
- Knights Landing C.S.D.
- Reclamation District No. 787

Figure I-2
RD 787 and Nearby Water Districts and Suppliers

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II. Basin Management and Objectives

Prior and Current Ground-Water Management

Reclamation District No. 787 (RD 787, the District) initially adopted a Groundwater Management Plan in February 1997. That Plan, which is included as Appendix A, was very limited in scope, but described three components whereby the District would collect information necessary for further analysis of its ground-water supply. These components were:

- compile and evaluate ground-water level data;
- sample and test ground-water quality to obtain background data;
- based on these data, make recommendations for the conjunctive use of ground water and surface water.

The Plan described existing and planned monitoring efforts by DWR, which would encompass the first two Plan components. Since the adoption of the Plan in 1997, DWR has expanded and continued monitoring in and around RD 787. With regard to the third Plan component, and as described above, the majority landowner within the District implemented a ground-water substitution conjunctive use program in 2003 that included DWR analysis and reporting of aquifer response.

Of the potential ground-water management activities listed in Water Code Section 10753, those already being investigated and implemented within the Colusa Subbasin as part of ground-water management by various entities include:

- implementation of conjunctive use programs;
- construction of dedicated monitoring wells;
- monitoring of ground-water levels and quality in monitoring and production wells;
- monitoring of subsidence;
- analysis and reporting on basin conditions;
- investigation to assess potential pumping impacts of planned actions on surface water resources.

As described in Section IV, RD 787 has historically obtained its water supply from diversions from the Sacramento River, with ground water used as a supplemental supply during dry years when surface water diversions were reduced. A primary focus of recent ground-water

management activities in the Sacramento Valley Basin has been on the conjunctive use, and the potential for sustainable development of additional ground water, including increasing pumpage to offset decreased surface water supplies during dry years. Several conjunctive use programs along the Sacramento River have been implemented, including the program implemented within RD 787 in 2003. RD 787 is participating in the Sacramento Valley Water Management Program (SVWMP), which is a collaborative effort to coordinate water management and plan for the beneficial use of water resources while providing for the long-term sustainability of those resources and improving water quality and supplies for a variety of uses throughout California. A primary goal of the SVWMP is maintaining surface water flows to the Sacramento-San Joaquin Delta to achieve water quality objectives. To maintain productive use of agricultural lands during selected years when diversions of surface waters would be reduced to maintain surface water flows, ground water would be pumped as a substitute water supply. To assess the impacts of such pumping, and to ensure that the pumping does not adversely affect overall resources, dedicated monitoring programs are being developed for each area in the Valley that might be involved in SVWMP or other similar activities. The monitoring programs include pumpage, ground-water levels, ground-water quality, subsidence, and surface water flows. The data collected from these programs is intended to be interpreted and reported to ensure that pumping does not decrease surface flows, that other ground-water users are not impacted, and that ground water and other resources are not depleted.

Another focus of ground-water management within the Sacramento Valley Basin is the avoidance of overdraft. In several areas of the Basin (outside of the Colusa Subbasin), notably in parts of Sacramento County, water levels declined significantly in response to ground-water pumpage. Conjunctive use efforts are now being implemented in the northern Sacramento area to use surface water in lieu of ground water to refill some of the vacant aquifer storage space for increased dry year water supply. Conjunctive use is also being implemented in the southern Sacramento County area to supplement ground-water supplies with surface water to stabilize ground-water levels and storage. Within the Colusa Subbasin, no such significant ground-water level declines have been identified, and recent trends are toward higher ground-water levels within the Subbasin.

Subsidence is an identified problem within some portions of the Colusa Subbasin, particularly in the Yolo-Zamora area, where well failures have resulted. Ongoing monitoring of surface elevation stations (including one within the District) and extensometers will provide data to evaluate future subsidence, if any. As described in more detail below, a key component of this Ground-Water Management Plan is the avoidance of subsidence through management of ground-

water pumpage within the District to avoid creating conditions of overdraft.

Management Objectives

The goals and objectives set forth in this Plan are intended to provide for the long-term sustainable use of ground water and interrelated surface water resources within the District. Although the objectives only consider the portion of the Colusa Subbasin underlying the District and within its jurisdiction, they would also ensure that ground-water use within the District preserves the resource as it relates to other users within the Colusa Subbasin and the greater Sacramento Valley Ground-Water Basin. The overall basin management objectives, or goals, for RD 787 can be expressed as follows:

Development of Local Ground-Water Supply. This objective includes the sustainable development of the ground-water resource, including conjunctive use of surface water and ground water to provide a flexible and reliable water supply while maintaining the long-term sustainability of both resources. Included in this objective is the intent to participate in ground-water substitution or other similar water transfer opportunities, when possible. This objective would also include monitoring and evaluation of background and project data to evaluate impacts.

Avoidance of Overdraft and Associated Undesirable Effects. In terms of basin goals, the assessment of ground-water conditions, and the development of operational yields for that portion of the overall Subbasin beneath the District, will have the primary objective of ensuring that ground-water development is at a rate that remains within perennial or sustainable yield, i.e. avoids overdraft and the undesirable effects associated with overdraft. In this case, chronic declines in water levels and/or water quality, depletion of local surface water resources, loss of ground-water storage, and permanent (inelastic) subsidence are examples of undesirable effects that are planned to be avoided.

Preservation of Ground-Water Quality. This objective reflects a desire to maintain the utility of the portion of the Colusa Subbasin underlying the District for domestic, irrigation and other beneficial uses, and to avoid any significant loss of ground-water storage or availability due to degradation of ground-water quality.

Protection of Interrelated Surface Water Resources. This objective reflects the need for integrated management of surface water (primarily the Sacramento River) and ground

water to avoid undesirable effects to either resource. For the District's purposes, this objective will be related primarily to specific projects.

Quantitatively, the preceding objectives translate into general preservation of ground-water levels and quality within the District, including fluctuations through seasonal demands, through local hydrologic variations (wet and dry periods), and through short-term increases in ground-water pumpage. In terms of intended management as described in this Plan, understanding historic conditions is essential to achieving the above goals for the District. Historical data are somewhat limited, particularly with regard to water quality, but the available data indicate that ground-water levels have fluctuated over time and that water quality has been stable. Neither water levels nor water quality exhibit any observable trend toward a degradation of the ground-water resource.

The 2003 conjunctive use program implemented by River Garden Farms served as a demonstration that such projects can be undertaken within the District without measurable long-term adverse impacts. Increased use of ground water, if well-managed through integration of a number of complementary management actions designed to make beneficial use of ground water while also maintaining the long-term sustainability of the resource, can be expected to accomplish all four of the basin objectives discussed above.

III. Ground-Water Basin Conditions

Geologic Setting

The aquifer system of the Colusa Subbasin has been studied on a larger scale, but detailed studies of the portion of the Subbasin underlying Reclamation District No. 787 (RD 787, the District) have not been undertaken. RD 787 lies in the laterally central area of the Sacramento Valley Basin, where both western (Coast Range) and eastern (Sierra Nevada) sourced non-marine deposits can be encountered. Generally, the non-marine deposits extend to a depth of more than 2000 feet below ground surface (bgs). Below these depths, undifferentiated tertiary and cretaceous marine deposits are encountered. The geologic description presented herein is as described by LSCE, 2004.

The non-marine deposits are comprised of alluvial, flood plain and fluvial deposits to a depth of approximately 200 feet bgs, overlying the upper and lower zones of eastern- or western-sourced deposits. These upper and lower zones generally consist of lenses of interbedded sands and clays associated with historic river channels or alluvial fan/plains. The upper zone lies directly beneath the alluvium and extends to a depth of approximately 1500 feet bgs. This zone is comprised of alluvial plain to tributary fluvial deposits that are thought to be the Pliocene upper Laguna Formation to Pleistocene lower River Bank Formation. The lower zone generally extends to a depth of more than 2000 feet bgs, and is comprised of alluvial fan to plain deposits that are thought to be the Late Miocene-Pliocene Mehrten and the Pliocene Laguna Formations. These formations are significant water sources in Sacramento County; however, they are not known to be utilized within the Colusa Subbasin, and thus have not been characterized in the District area.

Aquifer testing by the California Department of Water Resources (DWR) during the River Garden Farms water transfer in 2003 provided some information about aquifer characteristics within the District. The two main findings were lateral hydraulic continuity between wells in an aquifer zone located at a depth of approximately 350 to 600 feet bgs, and vertical hydraulic separation between this zone and a shallower (~200 foot bgs) aquifer zone. These findings are consistent with the conceptual geology presented above.

Subsidence

The most common form of subsidence resulting from ground-water pumping occurs when

sustained ground-water withdrawals cause a permanent dewatering of laterally extensive clay beds. Once dewatered, the framework of the clay particles collapses or becomes compacted, resulting in subsidence of the overall land surface. Yolo County has a network of surface elevation monitoring stations (including a station within the District) that were surveyed in 1999 and 2002 using global positioning system (GPS) equipment to measure land surface elevation. Figure III-1 shows the stations located in and near RD 787. Further monitoring (including a planned 2005 survey) will provide information about surface deformation over time. Additionally, the California Department of Water Resources (DWR) has installed and monitors an extensometer located approximately 2 miles southwest of the District.

As mentioned above, the aquifer zones in the area of RD 787 consist of interbedded sands and clays. The gradation of deposits generally becomes finer with further distance from the source (the Coast Range and/or Sierra Nevada); as such, there may be significant fractions of clays within the finer deposits in the District area. These geologic conditions, combined with reported subsidence in the nearby Yolo-Zamora area, indicate that precautions should be taken by the District to avoid the depression of ground-water levels that would allow dewatering of significant clay beds, resulting in the potential for inelastic (irreversible) subsidence. These precautions are incorporated in this Plan in the form of ongoing monitoring of ground-water levels to ensure that pumpage within RD 787 is within rates that are renewable (recharged) such that it does not result in long-term ground-water level declines.

Historical Ground-Water Development

The history of ground-water development within the District is unknown; however, records of ground-water levels in the area around the District indicate that wells were developed at least as early as the 1940's. Ground water from private wells has historically met potable domestic demands within the District; however, these demands are considered negligible when compared with irrigation demands. Irrigation demands within the District have historically been met with surface water supplies, with ground water used as a supplemental supply during dry years when surface water deliveries were limited. The majority landowner in the District, River Garden Farms, currently owns three production wells with a total capacity of approximately 5,000 to 5,700 gpm. As part of the Sacramento Valley Water Management Program, construction of two new production wells within the District is planned.

Ground-Water Levels

Available ground-water level data in the vicinity of the District dates from 1941. For the wells nearest the District, there is no single well with a long-term record of ground-water levels; however, periods of record from different wells overlap to provide a 'continuous' record from 1941 to present. Wells further from the District, but still within the Colusa Subbasin, do provide longer-term ground-water level records. Most of the ground-water level monitoring in the area has been conducted by DWR. More recently, Yolo County Flood Control and Water Conservation District (YCFCWCD) has taken over monitoring of some wells within Yolo County on a periodic basis. DWR has also constructed dedicated monitoring wells within the adjoining Reclamation District No. 108; these wells have replaced historic monitoring locations and provide static ground-water level data for discrete aquifer zones. River Garden Farms has several wells within the District that were monitored during the 2003 water transfer. The locations of historic ground-water level monitoring are shown in Figure III-1.

A hydrograph of historic water levels as measured in Well 10N/2E-12R1, the well nearest the District with available long-term ground-water level records, is shown in Figure III-2. The collection of ground-water levels from other wells with different periods of record but closer to the District (Figure III-3) indicates that well 10N/2E-12R1 exhibits ground-water level responses similar to those nearer to the District. Ground-water levels exhibit seasonal pumping fluctuations of about 20 feet. Overall, however, ground-water levels have remained fairly stable over the past 50 years, with declines during dry periods when pumpage increases and available recharge decreases. However, these declines have not been permanent, and ground-water levels have recovered following short-term declines. As described above, increased ground-water pumpage during 2003 River Garden Farms water transfer did not result in any measurable long-term impacts, and it is reasonable to assume that pumpage could seasonally increase in the future without resulting in long-term ground-water level declines.

Ground-Water Quality

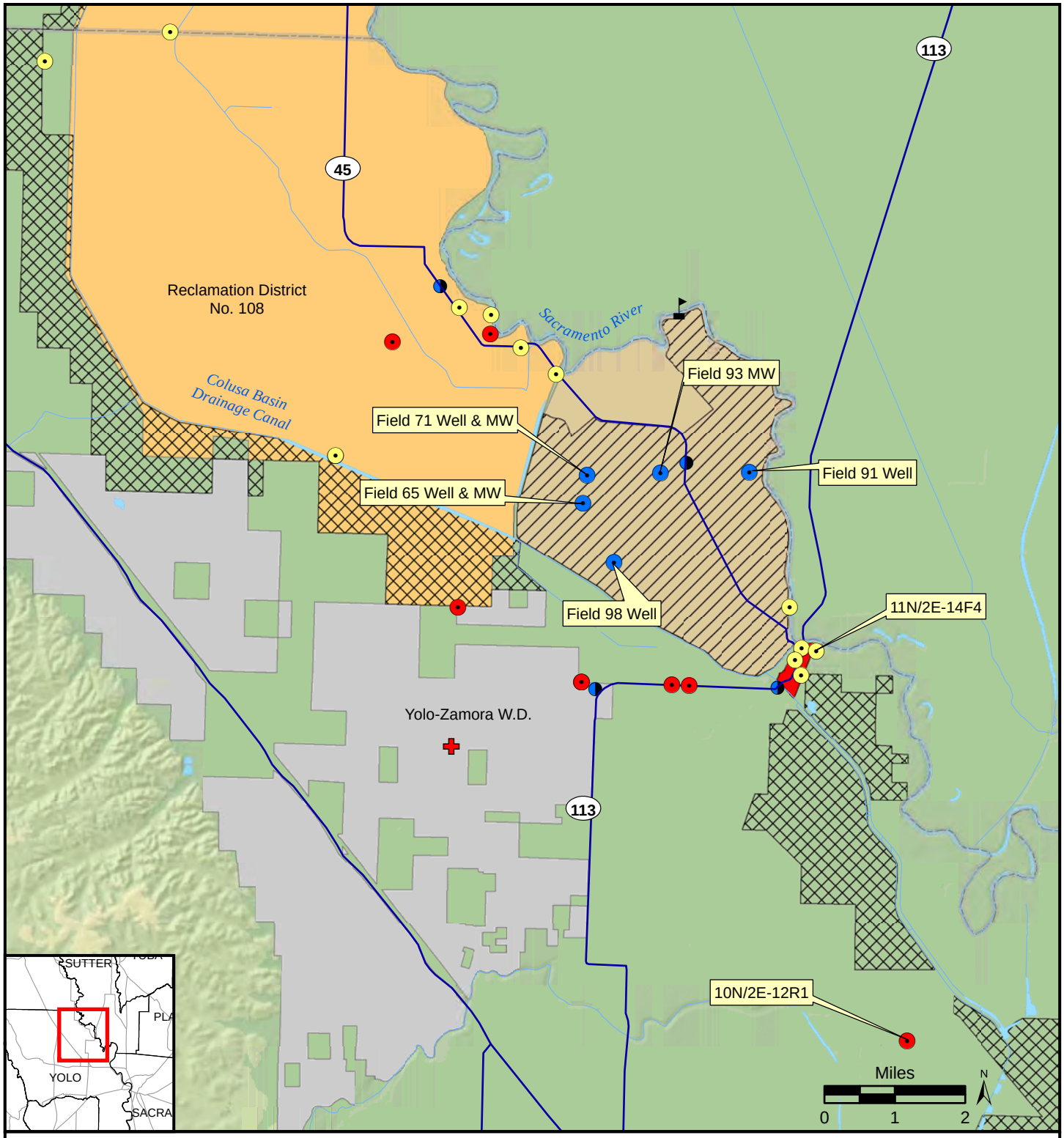
Ground-water quality data for wells near RD 787 dates from 1957 and has been collected mainly by the United States Geological Survey, DWR, and the Knights Landing Community Service District (CSD). Specific conductance has been selected as in indicator of overall ground-water quality because of the number of records for that parameter, and because it generally reflects changes in water composition over time. Figure III-4 presents available specific conductance data for wells near RD 787. The only well with a long-term record is DWR well 11N/2E-14F4,

located immediately southeast of the District. Data from this well show that ground-water quality has remained stable for the last 35 years. Individual data points for other wells are shown to illustrate the range of specific conductance values in the area, which may vary with location and aquifer zone.

The only wells within the District with available water quality data are the River Garden Farms wells, and data for these wells are summarized in Table III-1. These wells are irrigation and monitoring wells, and are not required to comply with the State of California Department of Health Services (DHS) water quality standards for public drinking water wells. However, these standards, in the form of primary (health-based) and secondary (aesthetic) Maximum Contaminant Levels (MCLs), are a useful reference for characterizing overall water quality within the District. The limited water quality data for the River Garden Farms wells generally complies with both the DHS primary and secondary MCLs, except for manganese.

Elevated concentrations of manganese, exceeding the secondary (aesthetic) MCL, are present in wells in and near RD 787. These elevated levels are frequently encountered in deposits near the Sacramento River and its historic channel. However, the presence of manganese does not constrain the use of ground water for agricultural irrigation; such as it might exceed the secondary MCL for municipal supply (e.g. near the District), conventional treatment is commonly used to remove dissolved manganese prior to municipal distribution.

There is one known leaking underground fuel tank near the District, in the town of Robbins, which has reportedly resulted in localized contamination to the drinking water aquifer. Nothing associated with the leaking tank affects or constrains the use of ground water within the District for agricultural irrigation.



Legend

- River Garden Farms Wells
- Water Level Monitoring Location
- Water Quality Monitoring Location
- Stream Gage
- Surface Subsidence
- Zamora Extensometer
- Knights Landing C.S.D.
- River Garden Farms
- Colusa Drain M.W.C.
- Reclamation District No. 787

Figure III-1
Historic Monitoring Locations In and Near RD 787

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Figure III-2
Long-Term Ground-Water Levels Near RD 787
(DWR Well 10N/2E-12R1)

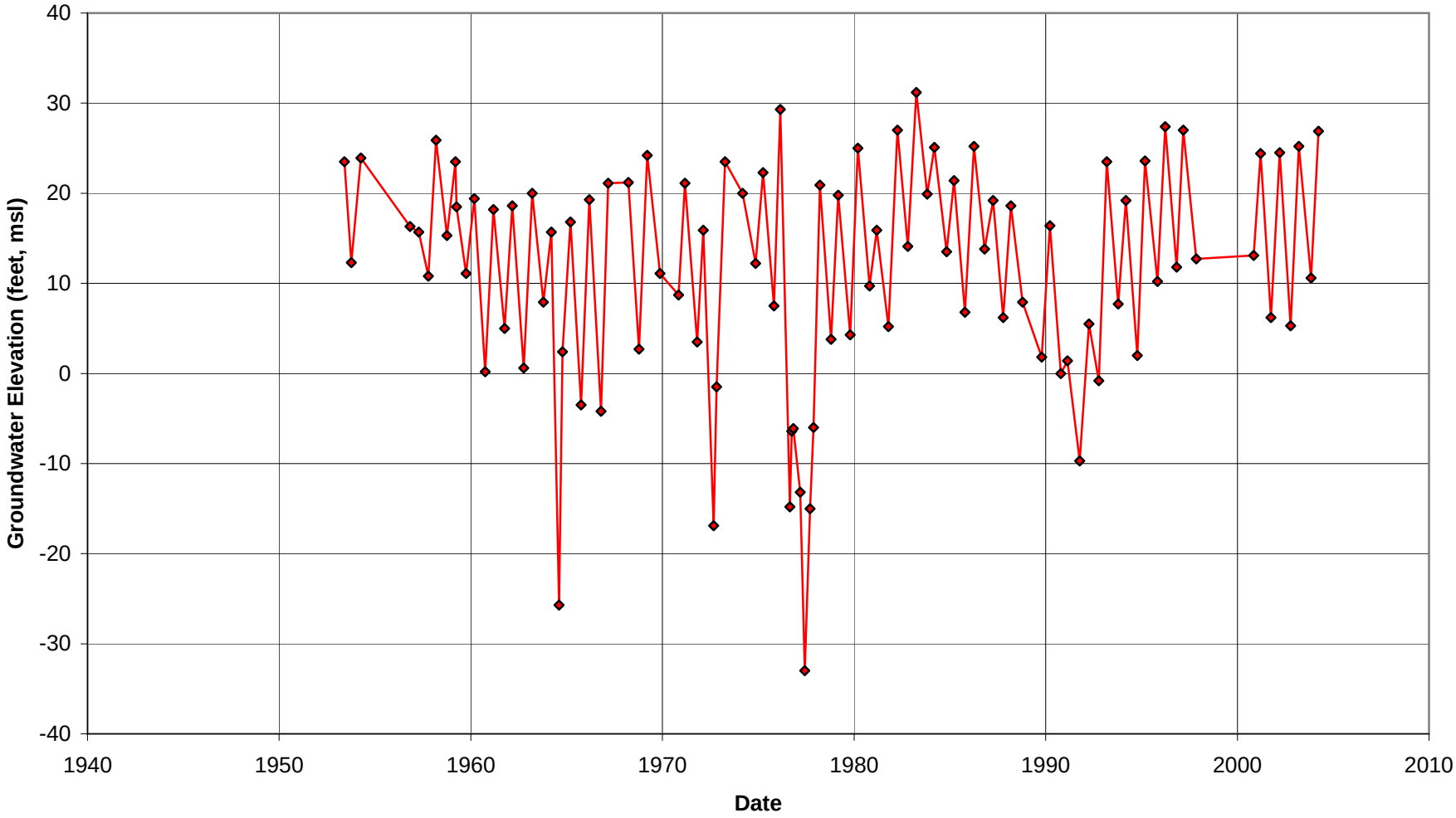


Figure III-3
Combined Record of Historic Ground-Water Levels Near RD 787
(DWR Wells)

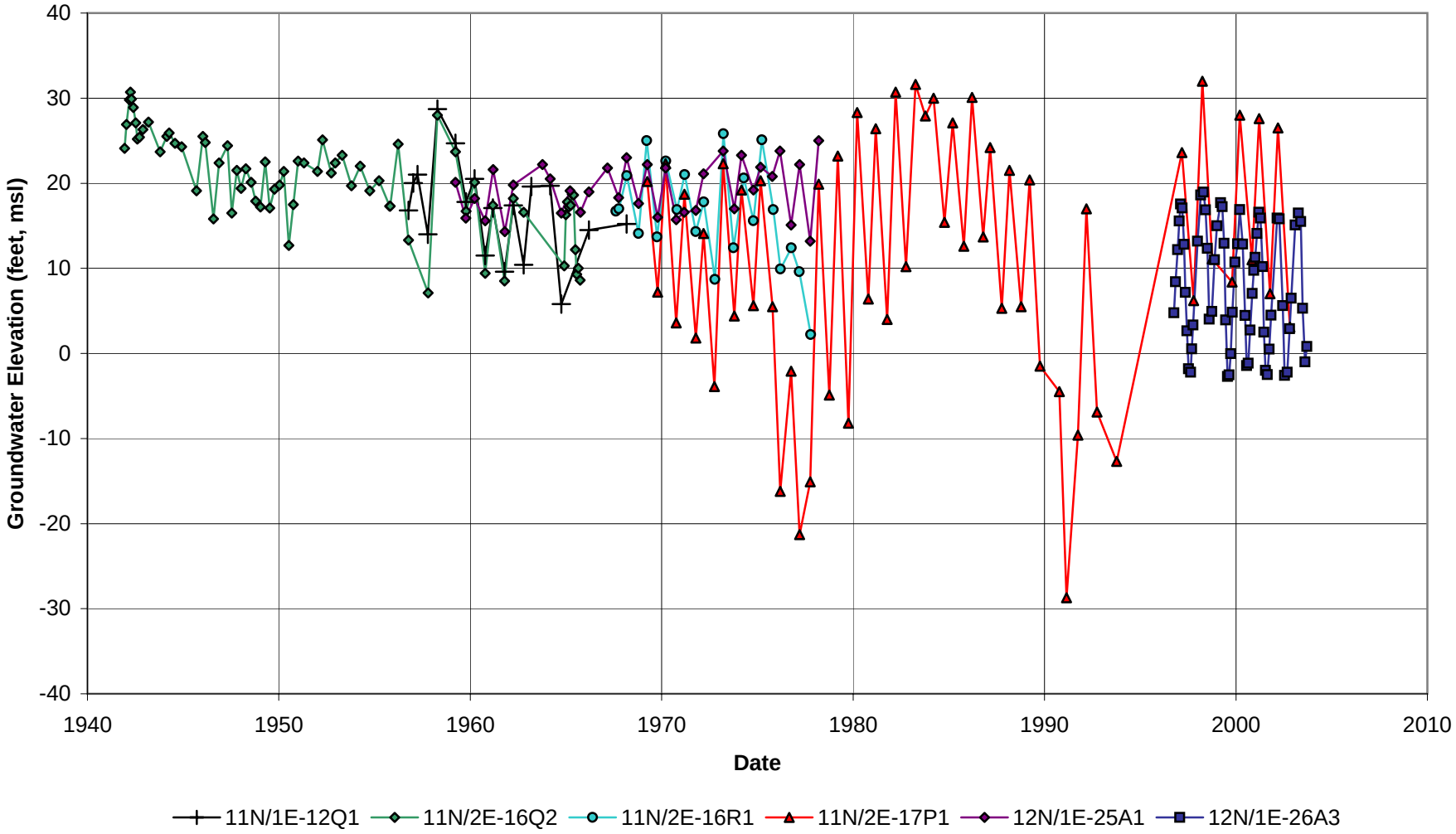


Figure III-4
Ground-Water Quality In and Near RD 787

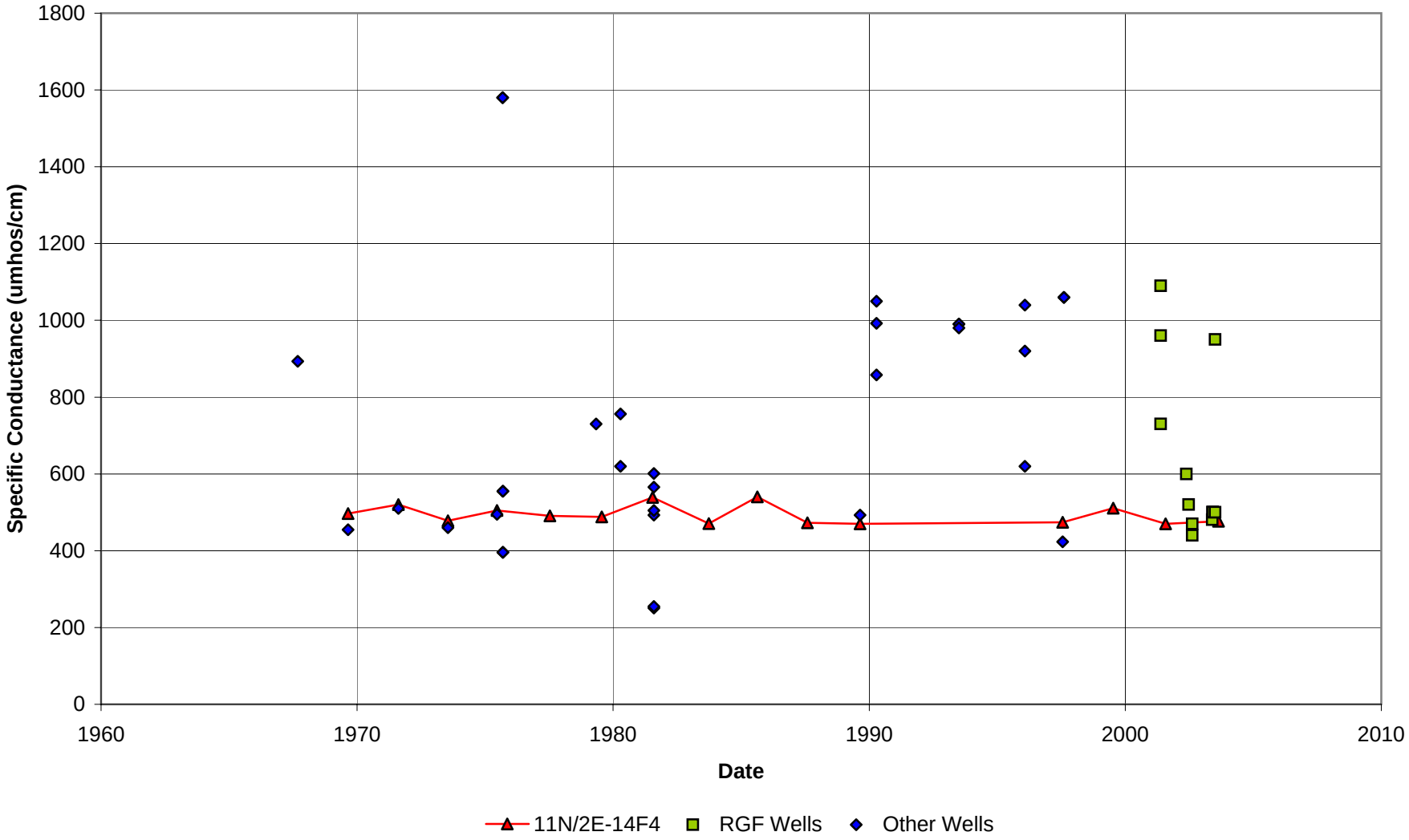


Table III-1
Summary of Ground-Water Quality Data
River Garden Farms Wells

ANALYTE	UNITS	MCL	Field 65 Well	Field 71 Well					Field 91 Well	Field 93 MW-210'	Field 93 MW-360'	Field 93 MW-900'	Field 98 Well	
			5/21/01	6/27/02	5/29/03	6/2/03	6/6/03	7/8/03	5/21/01	8/15/02	8/15/02	5/24/02	5/21/01	7/8/03
CATIONS														
Calcium	mg/L		55	16					47	33	19	16	68	
Magnesium	mg/L		47	7.8					36	24	15	5.3	43	
Potassium	mg/L			3.9						2.6	3.1	9.2		
Sodium	mg/L		98	100					62	47	71	130	52	
Total Hardness	mg/L		330	72					265	180	110	62	348	
ANIONS														
Bicarbonate Alkalinity	mg/L			240						200	230	250		
Carbonate Alkalinity	mg/L			<1.0						16	14	<1.0		
Chloride	mg/L	250/500[2]	130	11					21	33	9.5	36		
Fluoride	mg/L	2.0[1]	0.12	0.24					0.15	0.24	0.23	0.16		
Hydroxide Alkalinity	mg/L			<1.0						<1.0	<1.0	<1.0		
Nitrate (as NO3)	mg/L	45[1]	<2.0	<2.0					<2.0	<2.0	<2.0	<2.0		
Sulfate	mg/L	250/500[2]	110	8.9					48	15	7.9	25	64	
Total Alkalinity	mg/L		205	240					287	220	250	250	181	
PHYSICAL PARAMETERS														
pH	pH units	6.5/8.5[4]	7.8	8.2	8.25	**8.7**	**8.66**	**8.65**	7.6	8.2	8.1	8.2	7.9	8.6
Specific Conductivity	mmhos/cm	900/1600[2]	**1090**	520	481	500	501	500	730	470	440	600	**960**	**950**
Total Dissolved Solids	mg/L	500/1000[2]	**690**	330					420	300	320	410	**850**	
INORGANICS														
Aluminum	µg/L	1000[1]/200[3]	100						<50				<50	
Arsenic	µg/L	10[1]	6.9						5.7				<2.0	
Barium	µg/L	1000[1]	<100						140				220	
Boron	µg/L	1000[3]		970						**1300**	590	<50		
Chromium	µg/L	50[1]	<1.0						<1.0				3.4	
Copper	µg/L	1000[2]	<50						<50				<50	
Iron	µg/L	300[2]	140						<100				<100	
Lead	µg/L	15[3]	<5.0						<5.0				<5.0	
Manganese	µg/L	50[2]	**79**						**400**				<20	

[1] *- Primary MCL*

[2] *- Secondary MCL (recommended/upper range)*

[3] *- Action Level*

[4] *- Suggested lower/upper acceptable range*

IV. Current and Projected Water Requirements and Supplies

Water Demands

For all practical purposes, historical and projected water requirements in the District can be considered to be essentially constant. Since essentially all water demand (aside from negligible potable demand) is for agricultural irrigation, total water requirements on the approximately 8,950 acres of land within the District could potentially be as great as about 36,000 acre-feet per year (afy) if all land is in production. Obviously, if less than the full area of the District is planted in any given year, and depending on exact cropping patterns, total water requirements in any given year could be less than the full potential water demand.

Forty years of available record (from 1964 through 2003) of surface water diversions by River Garden Farms, which represents nearly 82 percent of the total area in the District, show that its diversions from the Sacramento River have averaged about 22,000 afy, and have been as great as about 30,000 af in a single year. On an average basis, the historical diversions represent, for the entire River Garden Farms area, a unit water demand in the range of 3 to 4 afy per acre.

With no plans for permanent change of land use in the District, it is reasonable to project that total water demands will remain comparable to those of the last several decades. Thus, on an average basis, water requirements for River Garden Farms can be expected to be on the order of 22,000 afy; for the entire District, average water requirements can be expected to be on the order of 26,250 afy. If all lands are in production in any give year, total water demands could be on the order of 30,000 afy for River Garden Farms, and on the order of 36,000 afy for the entire District.

Water Supplies

Practically all the water requirements in the District are met by diversions of surface water from the Sacramento River. River Garden Farms has a Contract Total Supply of 29,800 afy, of which almost all (29,300 afy) is Base Supply and the balance (500 afy) is CVP Project Water. The Base Supply and Project Water components of River Garden Farms' contract supply are limited to specific months; the entire amount is limited to the months of April through October, and is further limited to a total of 12,700 af in the critical months of July through September. Total surface water supply is also limited in Shasta critical years to 75 percent of total contract amount.

Most of the other land within the District is riparian to the Sacramento River and thus has water supply availability subject only to reasonable, beneficial use.

There are also three production wells in the District that are available to complement surface water supplies. Commonly known by names that denote their locations relative to the field numbering system, the wells have approximate capacities as follows:

Well	*Capacity (gpm)*
Field 71	1,700
Field 91	900 – 1,000
Field 98	2,500 – 3,000

At those capacities, the three wells have the capability to produce a combined total of about 5,000 to 5,700 gpm, which equates to a maximum of about 4,000 to 4,500 af over a six-month irrigation season.

The three production wells can be used for regular irrigation water supply, or can provide a substitute water supply for some of the Total Contract Supply from the Sacramento River. As the latter, they represent a water supply that has made possible the kind of water transfer that was completed in 2003, and that can make possible similar ground-water substitution based transfers in the future as envisioned in this Plan.

V. Elements of the Ground-Water Management Plan

Introduction

As developed in Section II above, the management objectives, or goals, for that portion of the ground-water basin beneath Reclamation District No. 787 include the following:

- Development of Local Ground-Water Supply
- Avoidance of Overdraft and Associated Undesirable Effects
- Preservation of Ground-Water Quality
- Protection of Interrelated Surface Water Resources

To accomplish those goals, this Plan incorporates a number of components, which are divided into six specific elements. These elements consist of existing and planned management activities that the District intends to undertake within its boundary, including assessment of the ongoing effectiveness of these activities. They also recognize the probability of additional ground-water development as part of conjunctive use activities within the District, including those planned as part of the Sacramento Valley Water Management Program (SVWMP). Collectively, they reflect the focus on local ground-water management actions the District can take to ensure that its activities do not compromise the long-term sustainable use of the portion of the Colusa Subbasin underlying the District, and thus the greater Colusa Subbasin.

Plan Elements

The six elements of the District's Ground-Water Management Plan include:

1. Ground-Water and Surface Water Monitoring
2. Management of Pumping and Avoidance of Overdraft
3. Development of Ground-Water Supply and Continued Participation in Conjunctive Use Programs
4. Preservation of Water Quality
5. Ground-Water Management Reports
6. Provisions to Update the Ground-Water Management Plan

Plan Element 1 – Ground-Water and Surface Water Monitoring

Plan Element 1 consists of monitoring ground-water levels, ground-water quality, production (pumping rates and volumes), land subsidence, and surface water flows. Planned locations for ongoing monitoring are shown in Figure V-1.

Because the primary water supply within the District has historically been surface water diversions from the Sacramento River, long-term records of ground-water levels and quality are limited. However, as discussed above in Section III of this Plan, available records for wells in the area are sufficiently extensive to indicate that no long-term change in ground-water levels or quality is evident. Recently, as part of a one-year conjunctive use project, local monitoring has been expanded. DWR has installed dedicated monitoring wells and an extensometer near the District, and plans to continue monitoring of ground-water levels, ground-water quality and subsidence. River Garden Farms and DWR are also cooperating on the installation of a dedicated multiple-completion monitoring well that, in addition to conventional ground-water level monitoring, will be used in combination with adjacent Sacramento River gaging to interpret River-aquifer connection and streambed leakage.

Ground-water data collection (water levels, water quality and production) within RD 787 has historically occurred in conjunction with planned activities, such as the 2003 RGF water transfer. Other than has been necessary to provide data related to the impacts of increased pumpage, a program of ongoing monitoring has not been implemented. However, as the District becomes more involved in developing its ground-water supply and participating in conjunctive use programs, collection and analysis of baseline data from existing wells will be key to accomplishing management goals. Monitored ground-water levels, quality, and pumping will collectively be the bases for defining conditions within the District and developing and managing ground water within the District to ensure the long-term sustainability of the resource.

The District is participating in the Sacramento Valley Water Management Program (SVWMP), which is a collaborative effort to coordinate water management and planning for the beneficial use of water resources while providing for the long-term sustainability of those resources and improving water quality and supplies for a variety of uses throughout California. As part of the SVWMP, dedicated monitoring programs are being developed for each area in the Valley (including RD 787) that might be involved in that Program or other similar activities. The monitoring programs include pumpage, ground-water levels, ground-water quality, subsidence, and surface water flows. Monitoring data collected as part of the SVWMP will be publicly

available, and will be evaluated in conjunction with numerical modeling to assess the effectiveness of the Program and any potential impact claims. RD 787's participation in the SVWMP, and consequent involvement in the implementation of a formal monitoring program for its area, will comprise its primary activities with regard to this Plan Element.

Additional monitoring will be undertaken as necessary for specific planned projects, as further described in Plan Element 3.

Plan Element 2 – Management of Pumping and Avoidance of Overdraft

In order to accomplish the management objectives described above, it will be essential to determine what yield can be developed within the District on both a regular and a short-term or intermittent basis. Such a determination of yield will be made to accomplish the main objective of sustainably operating within the yield of the basin, i.e. avoidance of overdraft.

Data are inadequate to analytically quantify the yield of the portion of the Colusa Subbasin underlying the District. Additionally, because the District overlies only a small portion of the Subbasin, any such formal effort would need to include other ground-water users on a more regional basis that is outside of the scope of this Plan. However, an operational yield for the District can be empirically developed on an ongoing basis by observing the effect of pumpage within the District on ground-water conditions (water levels, water quality), and establishing a level of pumpage that does not result in long-term adverse impacts to the ground-water resource. Observations of this nature began during the 2003 RGF water transfer, which can be interpreted to indicated that at least 1,581 afy of ground water can be pumped for use with surface water deliveries to collectively meet in-District water requirements without short-term or long-term impacts. Observations are expected to continue during future projects that include increases in ground-water pumpage. This type of operational understanding of basin yield will be adequate to accomplish the objectives of operating within the sustainable yield of the basin and avoiding overdraft.

Overall, ground-water levels in the area around RD 787 have remained fairly stable over the past 50 years, with temporary declines during dry periods, followed by ground-water level recovery in subsequent periods. Available data do not indicate any degradation of ground-water conditions that might be indicative of overdraft, i.e. decrease in ground-water levels or storage as a result of pumping in excess of the yield of the basin. Expansion of pumping within the District during future projects may result in greater ground-water level fluctuations; however, as long as

these fluctuations remain short-term and include subsequent recovery, and also as long as short-term fluctuations do not cause inelastic subsidence, pumpage can be considered to be within the operational yield of the basin.

Plan Element 3 - Development of Ground-Water Supply and Continued Participation in Conjunctive Use Programs

As previously described herein, the District's primary water supply has historically been diversions from the Sacramento River, with limited private ground-water use for domestic and irrigation purposes. In recent years, desire to engage in conjunctive use activities has driven increased ground-water development within the District, most notably by RGF. As also noted above, RD 787 is a participant in the SVWMP, which includes the conjunctive use of ground water and surface water for the primary goal of maintaining surface water flows to the Sacramento-San Joaquin Delta to achieve water quality objectives. RD 787 plans to continue to participate in the sustainable development of the ground-water resource, through conjunctive use and other activities. Such participation is anticipated to consist of District involvement in specific ground-water development projects, with associated monitoring programs to ensure that the projects to not result in long-term adverse impacts to ground-water or surface water resources.

Plan Element 4 – Preservation of Water Quality

This plan element reflects a goal of maintaining the utility of the basin, primarily for irrigation supply, and for all other beneficial uses as well, and to avoid any significant loss of ground-water storage or availability due to degradation of ground-water quality. Water quality will be maintained in part through the avoidance of overdraft, as described in Plan Element 2. An additional consideration will be the distribution of pumpage within the District as it relates to ground-water gradients and potential contamination sources. Part of the SVWMP planning has identified and analyzed the occurrence of poorer quality ground water and the potential for its movement in response to periodically increased pumping. While that is not expected to result in any adverse impacts, this Plan includes plans to operate generally consistent with the SVWMP concepts such that ground-water movement does not result in movement of poorer ground-water quality to degrade water quality beneath the District.

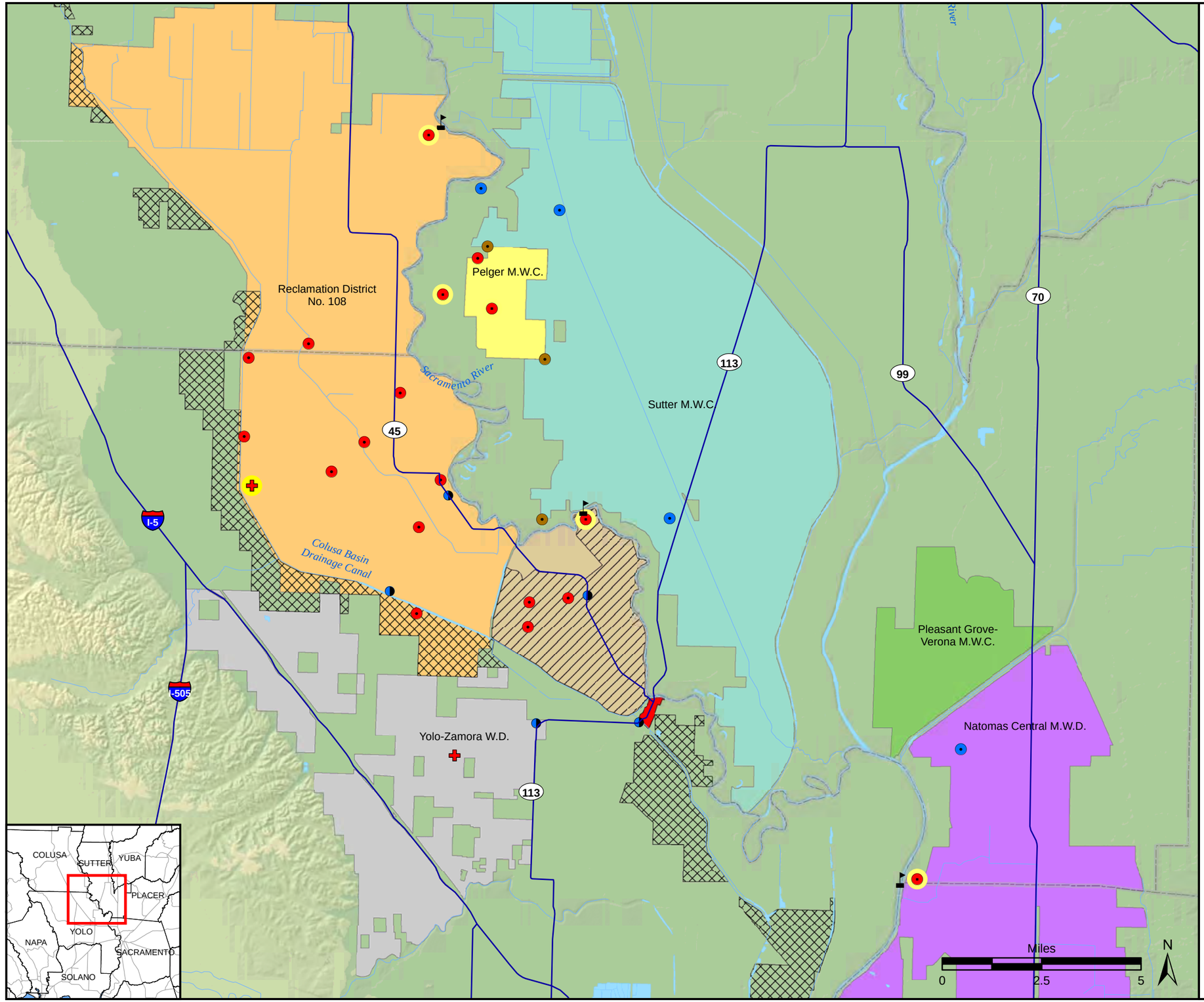
Plan Element 5 – Ground-Water Management Reports

Because of the limited historic ground-water use within the District, there has been no regular historical analysis and reporting on ground-water conditions within the District. Effective management of the portion of the Colusa Subbasin underlying the District, as described in this Plan, is based on planning and evaluation of projects that would represent an increase or expansion of ground-water pumpage within the District.

It is intended that future reporting will be related to these types of planned projects within the District, and their associated monitoring programs. Additional reporting will be done as part of the District's participation in the SVWMP, and by other entities within the Sacramento Valley Ground-Water Basin for various studies. RD 787 plans to make monitoring data available to other entities to facilitate the preparation of studies and reports that cover the District area.

Plan Element 6 – Provisions to Update the Ground-Water Management Plan

The elements of this Plan reflect the current understanding of the occurrence of ground water in the portion of the Colusa Subbasin underlying RD 787. The Plan elements are designed to achieve specified objectives to develop local ground water and engage in conjunctive use and other activities in a manner that ensures the long-term sustainability of the ground-water and surface water resources. While the Ground-Water Management Plan provides a framework for present and future actions, new data will be developed as a result of implementing the Plan. That new data could define conditions that will require modifications to current management actions. As a result, this Plan is intended to be a flexible document which can be updated to modify existing elements and/or incorporate new elements as appropriate in order to recognize and respond to future ground-water and surface water conditions. Although not intended to be a rigid schedule, review and updating of this Plan will initially be conducted in five years, with subsequent future updates scheduled as appropriate.



Legend

SVWMP Proposed Monitoring Network

- DWR Domestic Well
- DWR Irrigation Well
- DWR Observation Well
- SVWMP New Extensometer
- SVWMP New Monitoring Well
- Stream Gage
- Surface Subsidence
- Zamora Extensometer
- Reclamation District No. 787
- Knights Landing C.S.D.
- River Garden Farms
- Colusa Drain M.W.C.

Figure V-1
Planned Ongoing Monitoring Locations
In and Near RD 787

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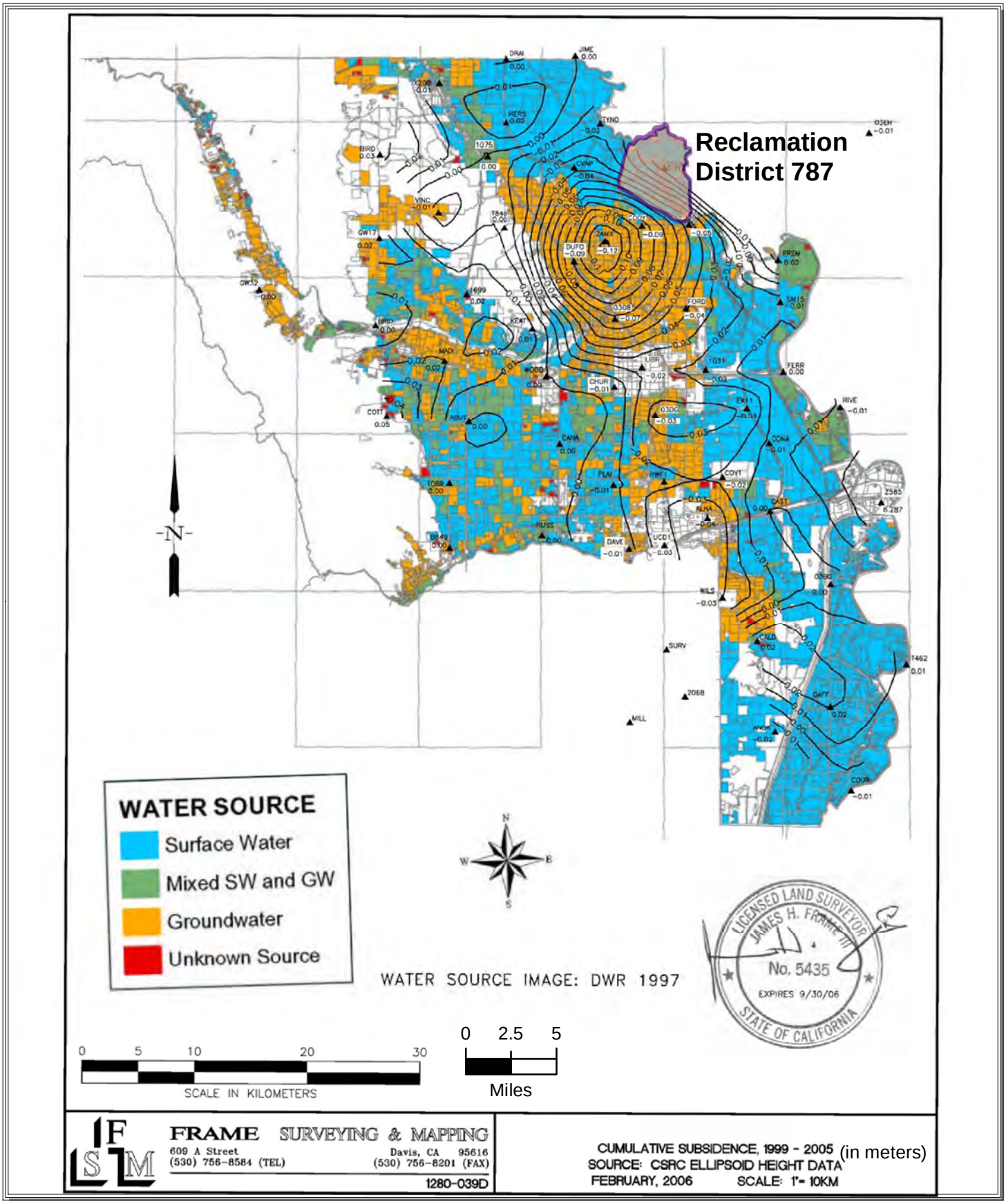
Appendix A

2005 Groundwater Management Plan

Appendix B

Contours of Cumulative Land Subsidence
Between 1999-2005 (in meters), From D'Onofrio & Frame, 2006



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Appendix B
Contours of Cumulative Land Subsidence
Between 1999-2005 (in meters), From D'Onofrio & Frame, 2006

Appendix C

Groundwater Level Hydrographs, River Garden Farms Monitoring Wells

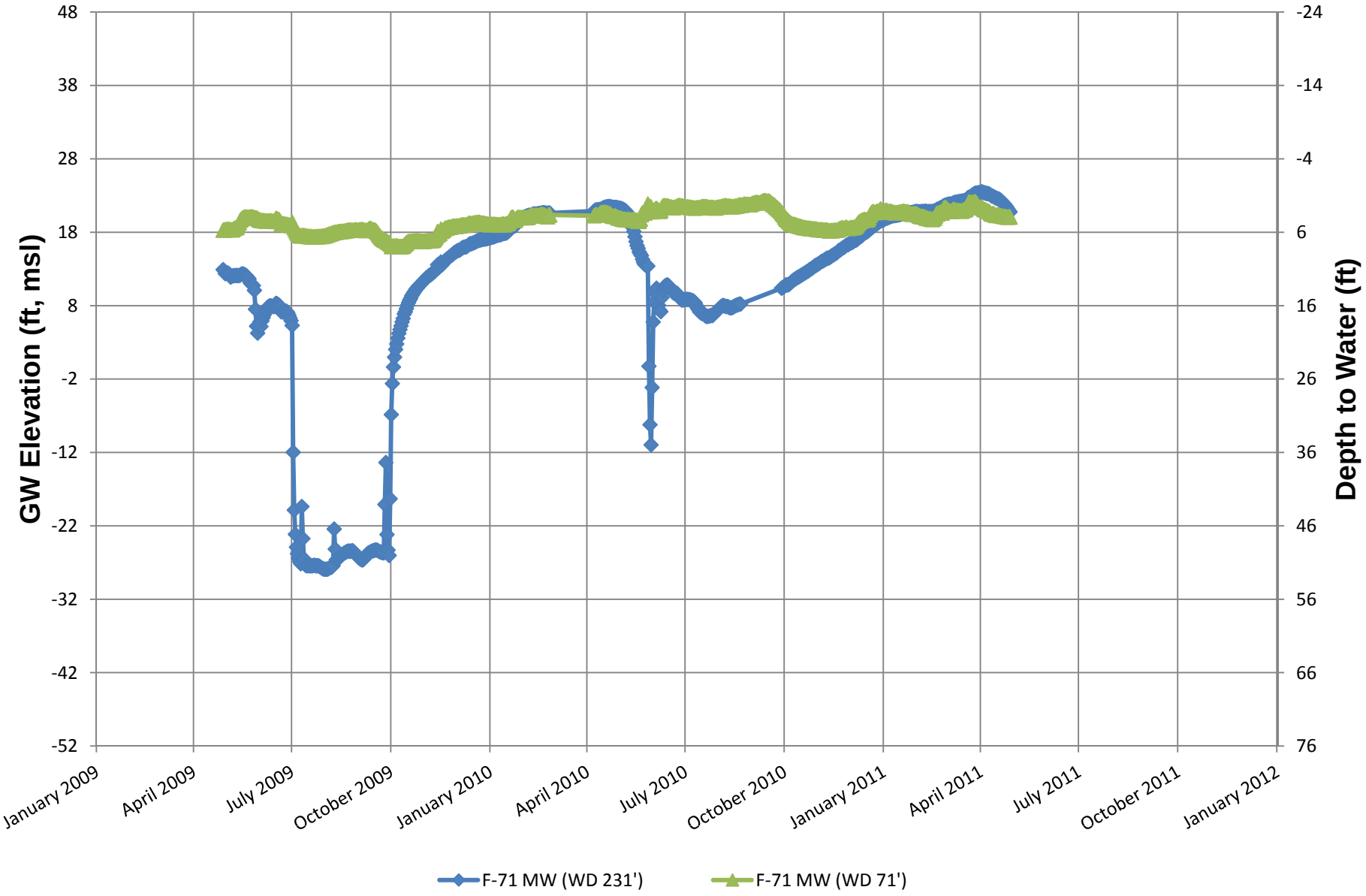

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Figure C-1
F-71 Monitoring Wells
2009-2012

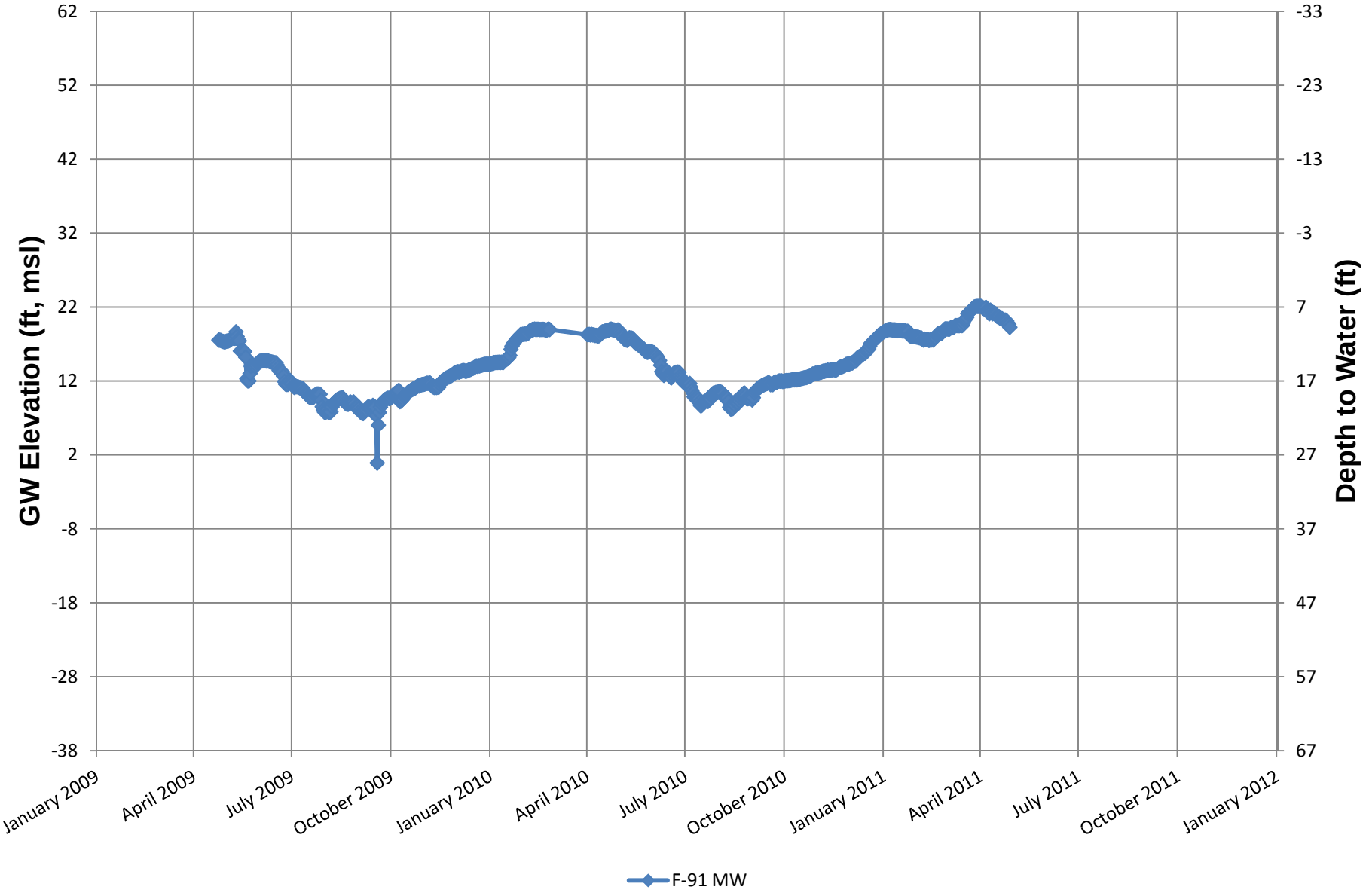

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Figure C-2
F-91 Monitoring Well
2009-2012

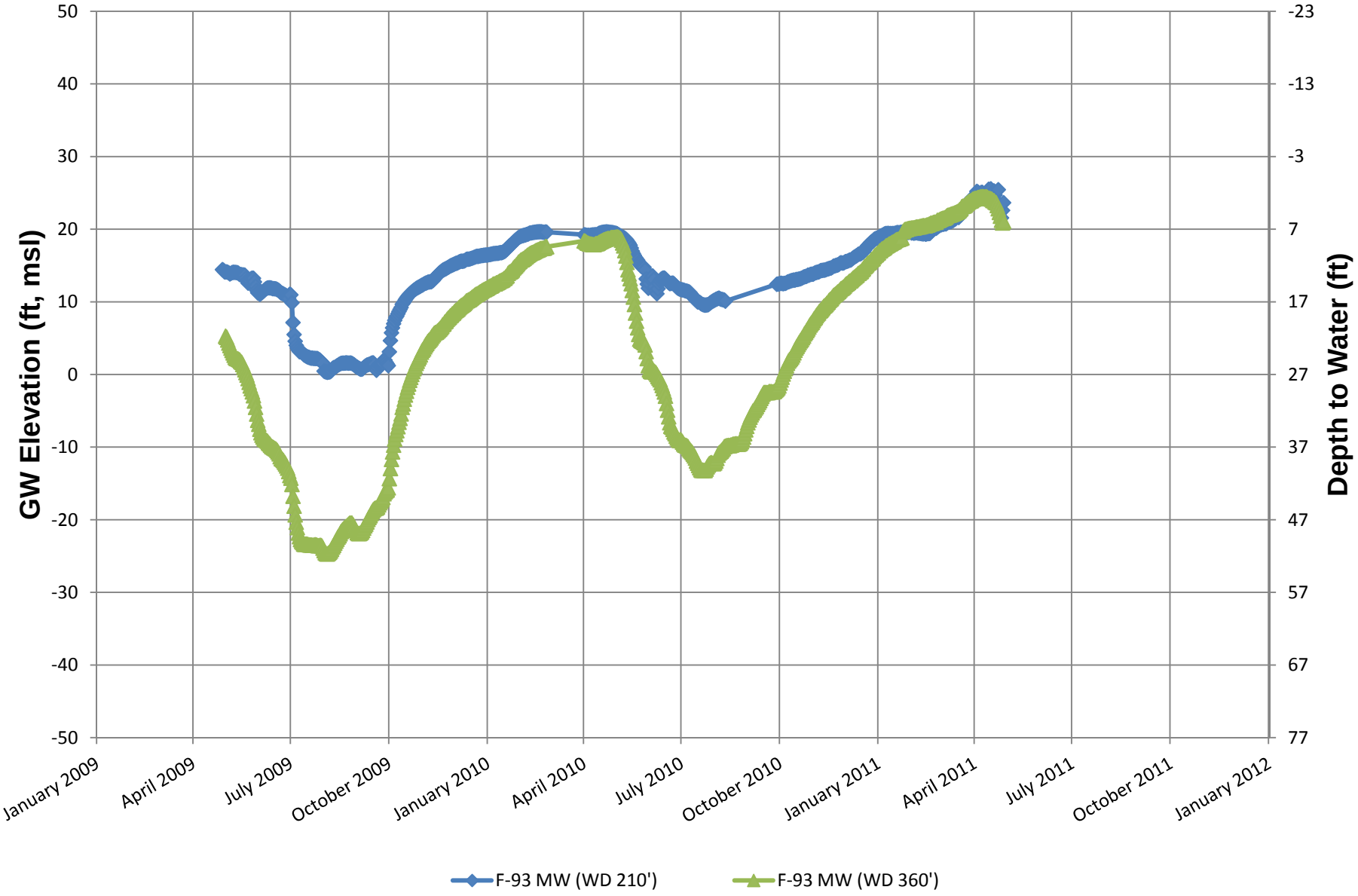

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Figure C-3
F-93 Monitoring Wells
2009-2012

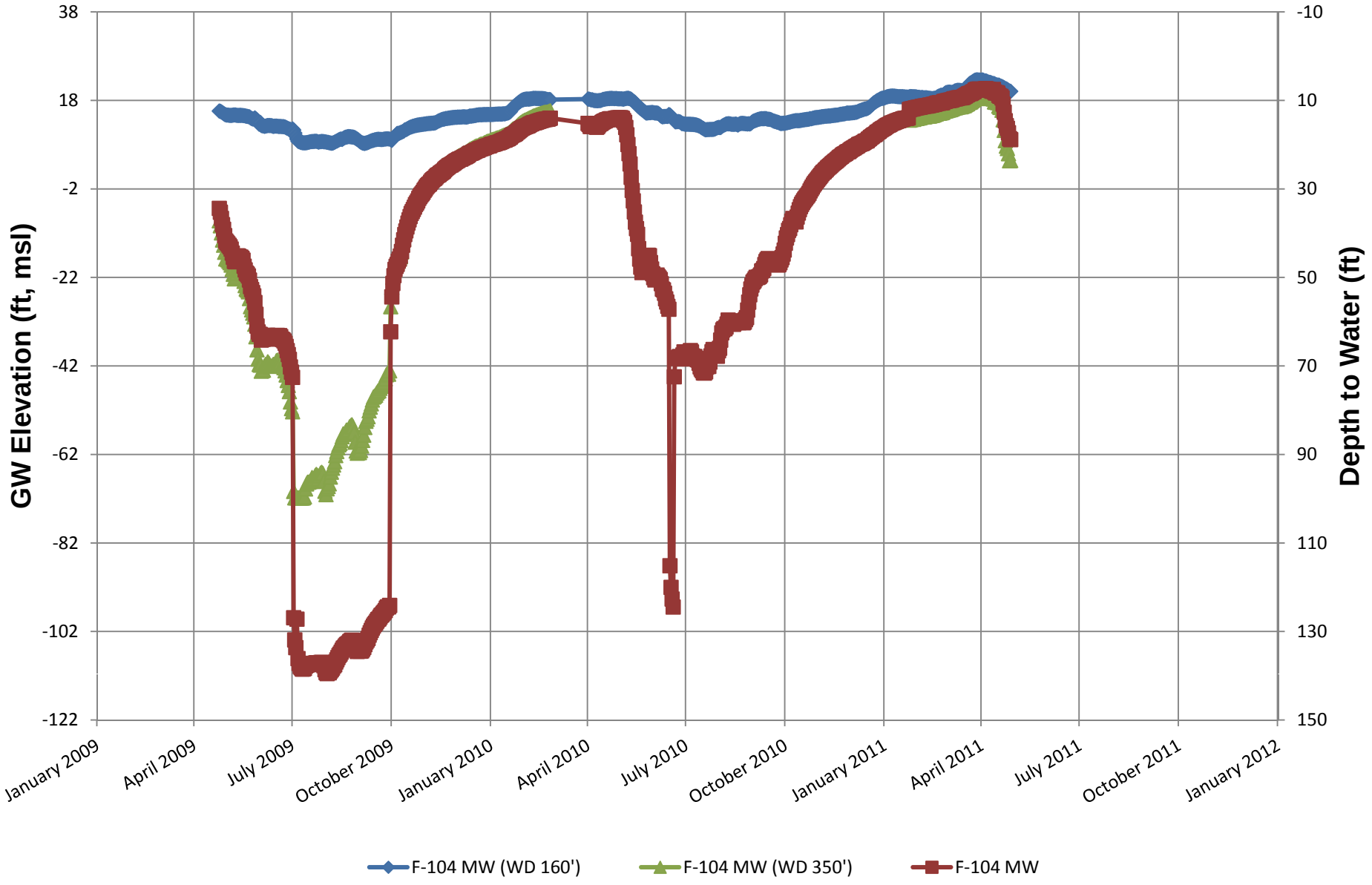

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Figure C-4
F-104 Monitoring Wells
2009-2012

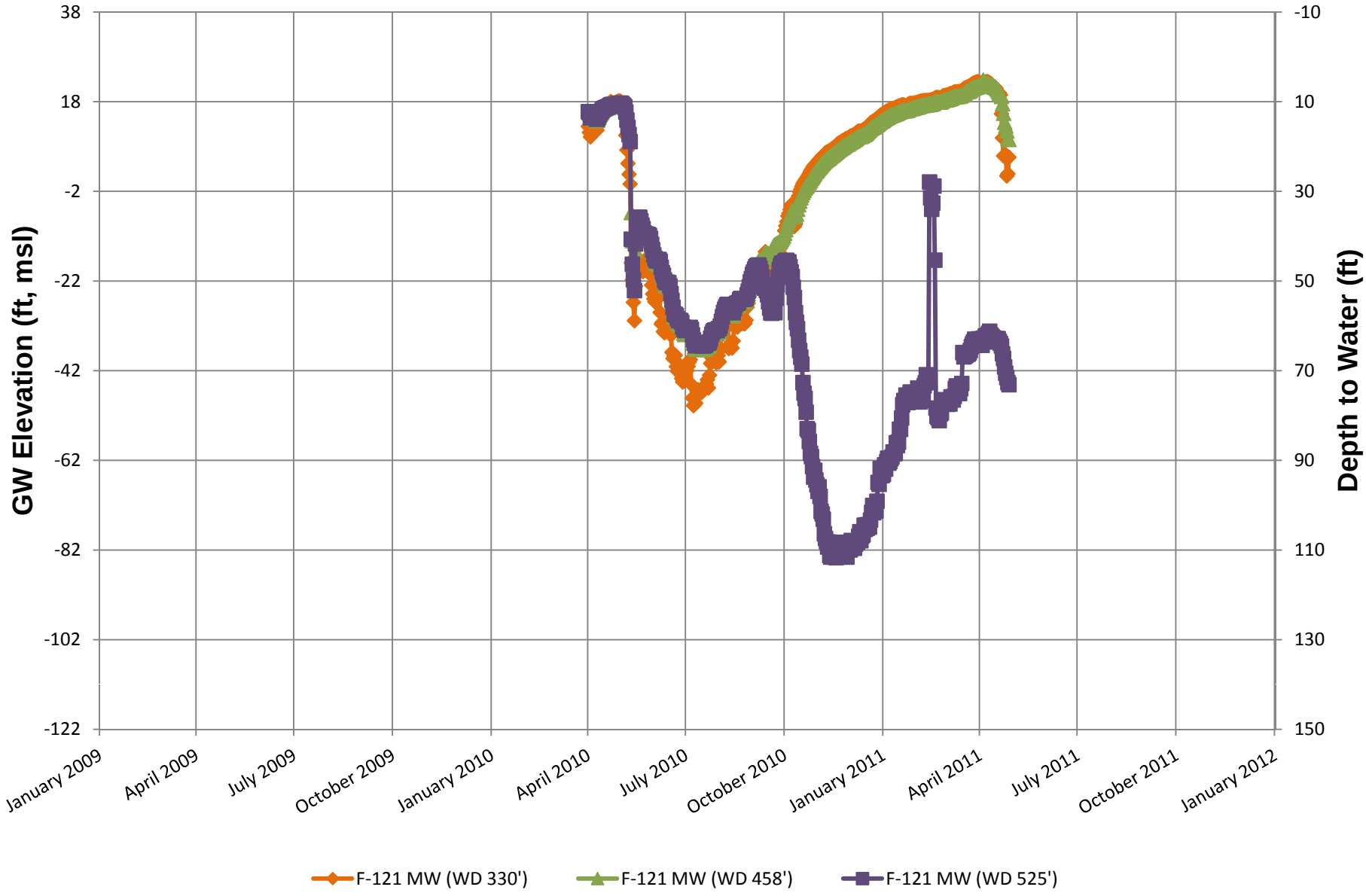

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Figure C-5
F-121 Monitoring Wells
2009-2012

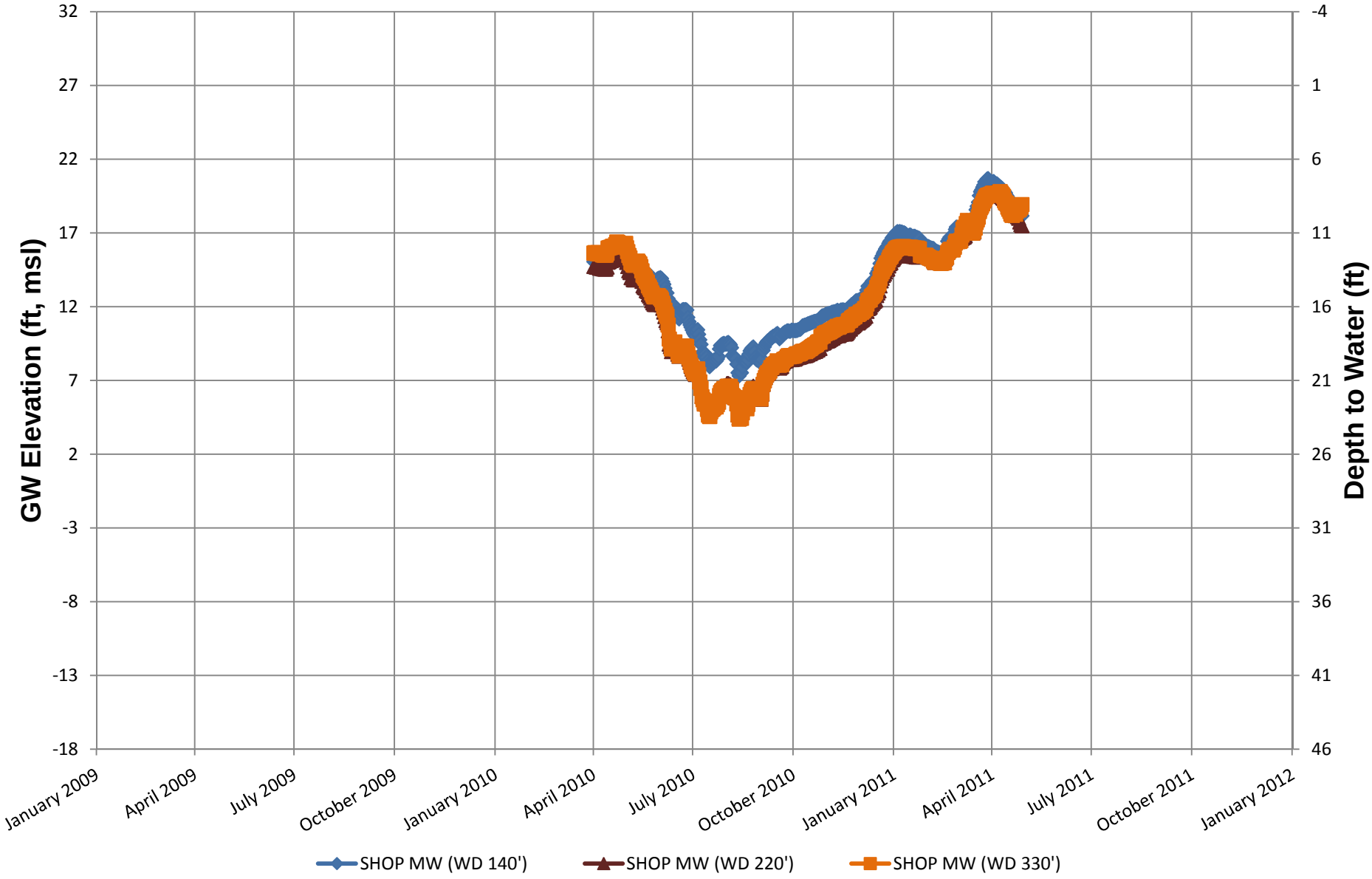

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Figure C-6
SHOP Monitoring Wells
2009-2012