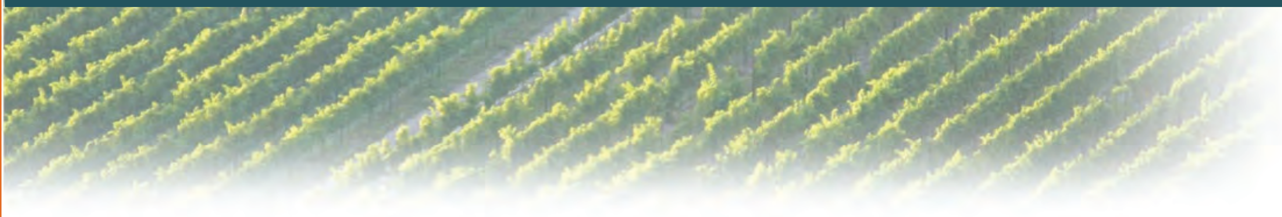
Demonstration Recharge Extraction and Aquifer Management *(DREAM)* Project

GROUNDWATER SUSTAINABILITY IN THE EASTERN SAN JOAQUIN REGION



Demonstration Recharge Extraction and Aquifer Management (DREAM) Project Summary Report

March 15, 2017

San Joaquin County Department of Public Works

East Bay Municipal Utility District

GEI Consultants, Inc.

Fugro Consultants, Inc.

Kjeldsen, Sinnock & Neudeck, Inc.

Environmental Science Associates, Inc.

Consulting Engineers and Scientists

Final

Contents

List of Acronyms

ASR	Aquifer Storage and Recovery
CASGEM	California Statewide Groundwater Elevation Monitoring Program
CEQA	California Environmental Quality Act
CNDDB	California Natural Diversity Database
DMS	Data Management System
DREAM	Demonstration Recharge Extraction and Aquifer Management
DWR	California Department of Water Resources
EBMUD	East Bay Municipal Utility District
EBMUDSIM	EBMUD water supply simulation model
EIR	Environmental Impact Report
FEMA	Federal Emergency Management Agency
GBA	Eastern San Joaquin Groundwater Basin Authority
GEI	GEI Consultants, Inc.
GIS	Geographic Information System
ICU	Integrated Conjunctive Use Program
NRCS	Natural Resources Conservation Service
NSJWCD	North San Joaquin Water Conservation District
PDA	Protest Dismissal Agreement
PDT	Project Development Team
SEWD	Stockton East Water District
SSURGO	NRCS Soil Survey Geographic Database
TAC	Technical Advisory Committee
USCS	Unified Soil Classification System
USGS	United States Geological Survey

1 Introduction

The Demonstration Recharge, Extraction and Aquifer Management (DREAM) Project is a multi-agency effort that will establish the feasibility of storing available wet year water supplies in the groundwater aquifers underlying San Joaquin County, and extraction of a portion of these banked supplies for use in dry years. The project is funded by the San Joaquin County Department of Public Works and the East Bay Municipal Utility District (EBMUD) in cooperation with the North San Joaquin Water Conservation District (NSJWCD).

This demonstration project is a short-term (approximately 3 year) effort that will recharge up to 1,000 acre-feet of EBMUD water from the Mokelumne River through the south distribution system of the North San Joaquin Water Conservation District. Participating landowners will use this surface water in-lieu of pumping groundwater, reducing pumping costs and groundwater overdraft. Up to 500 acre-feet will be subsequently pumped into the Mokelumne Aqueduct for delivery to EBMUD.

Improvements to the surface water distribution system and additions to the groundwater recovery system needed for the project will be funded by EBMUD.

If this short-term demonstration project is successful in recharging and extracting water, planning for a larger groundwater recharge project may commence. A larger project would enable local districts, like North San Joaquin Water Conservation District and Stockton East Water District, to bring additional surface water supplies into the area to augment and sustainably manage groundwater resources. Such a larger project would require additional study and a separate environmental analysis.

This section describes the factors considered in developing the project description and related operating criteria and constraints, including those included in the water rights Protest Dismissal Agreement.

1.1 Objectives, Feasibility Criteria, and Project Development Principles

The DREAM Project has evolved considerably since it was first outlined in the cost sharing agreement between San Joaquin County and EBMUD in 2013. Originally envisioned as a put-and-take direct groundwater recharge and extraction project supplied from the EBMUD Mokelumne Aqueduct, the ultimate project is an in-lieu recharge project with water supplied from the Mokelumne River via the NSJWCD south distribution system. The primary driver of this change is the Protest Dismissal Agreement (see Section 1.2) signed in November 2014.

An early deliverable was a consensus agreement on the project objectives, feasibility criteria, and development principles.[1] These were summarized as follows:

Overall Objectives:

- Improve supply reliability and sustainability for all parties

[1] Developed September 2014

- Improve groundwater basin conditions

Demonstration Project Phase 1 Objective:

- Develop substantial evidence that a groundwater recharge, storage and extraction project is feasible prior to investment of large-scale capital facilities

Feasibility will be established by:

- Project Consensus
- Technical Feasibility
- Implementation Agreement

Project Development Principles:

1) Overlying water rights will be respected and protected
2) Affected overlying water users will receive benefit
3) Water banking operations will result in a net recharge
4) Recognize the higher value of dry-year supply
5) Recognize benefits of improved basin conditions
6) Groundwater bankers will receive a right to recover banked water in dry years
    - Subject to specified volume, extraction rate and other contractual provisions
    - Allowing bankers to pump when overliers cannot is politically untenable

1.2 Protest Dismissal Agreement

On November 26, 2014, San Joaquin County, EBMUD, NSJWCD and other water interests executed a Protest Dismissal Agreement regarding EBMUD water right Permit 10478[2] which enumerates specific provisions to promote regional groundwater banking. These provisions include:

- Dry year water for NSJWCD
- Wet year water for NSJWCD (& SEWD)
- EBMUD extraction of banked water
- EBMUD and NSJWCD coordinated operations
- Groundwater Banking Demonstration Project funding
- Recognition of:
    - San Joaquin County Mokelumne River Application 29835
    - Tracy Lakes Coordinated Operation Agreement

[2] In 1956, the State Water Resources Control Board issued water right Permit 10478 to EBMUD to support East Bay water needs and allow diversion of 125 million gallons per day of water from the Mokelumne River to the East Bay. In 1964, EBMUD built Camanche Reservoir to store and use water diverted under Permit 10478. This water supplements EBMUD's senior water right which was issued in 1926 and licensed in 1981.

Key provisions of the Protest Dismissal Agreement are summarized below. The success of the Demonstration (DREAM) Project is a condition of several of these provisions. The complete text of the agreement is included as Section 8.

1.2.1 Dry year water for NSJWCD

EBMUD will provide up to 6,000 acre-feet when projected end-of-September (EOS) EBMUD total system storage (TSS)[3] is greater than 550,000 acre-feet. Up to 3,000 acre-feet will be provided when projected TSS is greater than 525,000 acre-feet, but less than 550,000 acre-feet. Scheduling provisions are to be developed.[4] Releases are conditioned on:[5]

- Stable Camanche quality (28,000 acre-foot hypolimnion through October)
- Releases do not trigger "dry" or "critically dry" year types
- NSJWCD submits its water request by May 1st
- Water must be used for direct or in-lieu recharge
- Maximum release of 6,000 acre-feet per drought sequence (projected November 1st Pardee/Camanche carry-over less than maximum flood control, ending when carry-over recovers to maximum storage levels)[6]
- 50 percent of the supplied Dry Year Water is credited to the EBMUD banked water account and subject to Export Permit terms
    - If there is no Export Permit by December 31, 2020 or export is otherwise blocked by law, the Dry Year obligation terminates, the banked water credit survives and can be transferred or assigned consistent with laws and regulations, with groundwater credits depreciated at 5% per year (unless otherwise negotiated)
- NSJWCD is responsible for carriage losses, assumed to be 10% of releases

1.2.2 Wet year water for NSJWCD (& SEWD)

In wet years, EBMUD will provide up to 8,000 acre-feet of Permit 10478 water (Wet Year Water) to NSJWCD or others, over and above[7] NSJWCD Permit 10477[8] rights provided:[9]

- NSJWCD has 20,000 acre-feet available under Permit 10477[10]
- EBMUD makes a determination that water is surplus to needs under Permits 10478 and 10477
- NSJWCD takes delivery by November 5th for direct or in-lieu recharge

---

[3] Total System Storage is the total storage in Pardee, Camanche, and five terminal reservoirs in the East Bay.

[4] See PDA Section 4.a.iii

[5] PDA Section 1b

[6] Water released to Lodi [see Section 4] between 11/6 and 3/30 and not part of Permit 10477 right counts against the 6,000 af limit. Part of the authorized place of use under Permit 10477 includes the City of Lodi and one of the authorized purposes of use is domestic and industrial use. Lodi has the ability to take delivery of water from the Permit 10477 water from the Woodbridge Irrigation District intake near Lodi Lake for use in the City's water treatment plant.

[7] PDA Section [2b]

[8] NSJWCD holds water right Permit 10477 to appropriate water from the Mokelumne River

[9] PDASection [2a]

[10] and the 10/11/63 Agreement as amended

50 percent of supplied Wet Year Water will be credited to the EBMUD banked water account (subject to Export Permit terms). SEWD may request Wet Year Water available to but not requested by NSJWCD subject to the same terms.

1.2.3 EBMUD extraction of banked water

EBMUD extractions of groundwater[11] are subject to obtaining an Export Permit. The Parties agree to work in good faith to facilitate obtaining the Export Permit.[12] Other provisions include:

- Existing extraction facilities will be used to the extent feasible
- Agreements to use existing facilities are subject to approval by the local agency
- EBMUD may use NSJWCD or SEWD facilities when capacity is available (subject to a use agreement)
- EBMUD will pay for necessary new facilities
- New facilities will be owned and operated by the County or local agency
- EBMUD will have first right to use new extraction facilities
- Unused extraction capacity may be used by local agencies subject to negotiated terms[13]
- EBMUD may extract at its discretion (subject to Export Permit terms)
- Banked water may be transferred to others, inside or outside San Joaquin County
- The Parties will work cooperatively to comply with Water Code Section 1220[14]

1.2.4 EBMUD and NSJWCD coordinated operations

The two districts will coordinate operations[15] to facilitate:

---

[11] PDA Section [3]
[12] subject to all applicable laws including CEQA
[13] PDA Section [3bii]
[14] Water Code Section 1220.
"(a) No groundwater shall be pumped for export from within the combined Sacramento and Delta-Central Sierra Basins, as defined in the Department of Water Resources' Bulletin 160-74, unless the pumping is in compliance with a groundwater management plan that is adopted by ordinance pursuant to subdivision (b) by the county board of supervisors, in full consultation with affected water districts, and that is subsequently approved by a vote in the counties or portions of counties that overlie the groundwater basin, except that water that has seeped into the underground from any reservoir, afterbay, or other facility of an export project may be returned to the water supply of the export project. For the purposes of this section, the county board of supervisors may designate a county water agency to act on its behalf if the directors of the county water agency are publicly elected and the county water agency encompasses the entire county. The county board of supervisors may revoke that designation by resolution at any time.
(b) Notwithstanding any other provision of law, a county board of supervisors whose county contains part of the combined Sacramento and Delta-Central Sierra Basins may adopt groundwater management plans to implement the purposes of this section.
(c) A county board of supervisors shall not exercise the powers authorized by this section within the boundaries of another local agency supplying water to that area without the prior agreement of the governing body of that other local agency.
(d) This section does not apply to groundwater pumping by the Eastern Water Alliance Joint Powers Agency for export from the Eastern San Joaquin County Basin, as described on pages 38 and 39 of the Department of Water Resources Bulletin No. 118-80, provided that the groundwater pumping is approved by San Joaquin County pursuant to its ordinances regulating the management and export of groundwater as these ordinances are in effect at the time of permit approval by San Joaquin County. Section 10753.1 applies to any groundwater regulation under this section. As used in this section, the term "groundwater" has the same definition as set forth in in subdivision (a) of Section 10752."
[15] PDA Section [4]

- NSJWCD water sale to Lodi -- If Lodi requests delivery after November 5, and water is not available under the Permit 10477 direct diversion right:
    - If water is available under Permit 10477,[10] EBMUD will carry over up to 1,000 acre-feet for release between November 5th and March 30th
    - Water released to Lodi between November 5th and March 30th and not part of Permit 10477 right counts against the 6,000 acre-foot Dry Year limit[16]
    - NSJWCD will enter into coordinated operations agreement with WID, Lodi and EBMUD
- NSJWCD Tracy Lakes Groundwater Recharge Project[17] -- NSJWCD and EBMUD will execute a coordinated operations agreement for Tracy Lakes Groundwater Recharge Project

1.2.5 Groundwater Banking Demonstration Project funding

The Parties have agreed that the Demonstration Project will be located in NSJWCD and utilize portions of the NSJWCD South System. All funding is contingent on EBMUD receiving an Export Permit for moving a portion of the recharged water.

EBMUD will pay $4.0 million if an Export Permit is issued, of which $1.75 million must be used to improve the NSJWCD South System. There is no payment obligation if Export Permit not issued by June 30, 2016 unless the agreement is modified. If there is no modification, EBMUD will pay NSJWCD $1.75 million by July 15, 2016 for South System improvements. This agreement has been extended several times; the most recent is the Sixth Amendment to the Protest Dismissal Agreement signed January 30, 2017 which extends the date for issuing the Export Permit to June 30, 2017.

The Parties are to endeavor to control costs. If projected costs are likely to exceed $4.0 million, the County and EBMUD will confer to control costs or seek alternative funding sources.

1.2.6 San Joaquin County Mokelumne River Application 29835

The Parties also agreed to work cooperatively to facilitate use of San Joaquin County's water right Application 29835 on the Mokelumne River. Subject to SWRCB issuance of a permit and development of an operating agreement:

- The County may request that EBMUD collect and store up to 48,000 acre-feet/year from December 1st to June 30th
- EBMUD will determine when storage is available and will release stored water to the County from July 1st to October 31st
- Water stored for the County is in excess of EBMUD needs and which has to be released by November 5th to meet flood control requirements
- Stored water does not impact County direct diversion rights under a permit issued under Application 29385
- Application 29385 water may be conveyed through Mokelumne Aqueduct[18]

---

[16] PDA Section [4aii]
[17] See agreement [Ex.A]
[18] PDA Section [6b]

- Unused Aqueduct capacity will be determined by EBMUD
- Wheeling agreement consistent with Water Code Section 1810[19] is needed
- Agreement needed for connection facilities
- An operating agreement protective of EBMUD operations is needed for connection facilities[20] including a $2/acre-foot charge[21] and fishery protections for Lower Mokelumne River diversions[22]
- CEQA is required for Application 29835 and an administrative draft will be provided to EBMUD[23]

1.3 Recharge methods

There are two general approaches to artificial groundwater recharge: direct recharge and indirect recharge. Direct recharge includes physically delivering water to the aquifer system, whereas indirect (or in-lieu) recharge increases groundwater storage by offsetting the use of groundwater with another water supply source (e.g., surface water).[24] There are advantages to each approach, and local conditions may suggest which method is more appropriate for a particular location.

1.3.1 Direct Recharge – Spreading Basins

The use of surface spreading basins or spreading ponds is the most common type of artificial groundwater recharge. Typically, a recharge location would consist of a series of connected surface basins that may range in size, depending on the available space and slope of the land. Recharged water moves away laterally and vertically from the recharge ponds, initially through the unsaturated zone to an unconfined aquifer system. The existence of low permeability layers in the near surface may affect the performance of the recharge ponds. If low permeability layers are encountered near the ground surface, they may be excavated and removed during pond construction, with the excavated material used to construct the dikes or berms that create the individual ponds.

The type and location of the recharge basins may dictate the level of engineering and construction needed to develop and operate recharge basins/ponds. Spreading ponds utilizing existing excavations, such as sand and gravel mines, borrow pits, or natural depressions such as low lying abandoned river channels, may require few improvements. Where these opportunities do not exist, recharge basins may require more extensive planning, engineering, and construction.

Some of the features of recharge basins/ponds include:

a. Recharge of unconfined aquifer system

---

[19] Water Code Section 1810 pertains to use of a water conveyance facility which has unused capacity

[20] PDA Section [6c]

[21] PDA Section [6d]

[22] PDA Section [6g]

[23] PDA Section [6e]

[24] Direct recharge through flooding fields during the non-irrigation season was also considered, but was set aside from consideration due to the dearth of viable examples. This option may be reconsidered as an addition recharge method for the full-scale project.

b. Relatively low cost to design and construct
c. No seasonal constraint on their use[25]
d. Regulatory constraints associated with water quality are not likely to be significant
e. Existing opportunities such as gravel pits may be utilized

Factors affecting successful implementation include:

a. Requires large areas of relatively flat land
b. Requires permeable soils with no impermeable layers near the surface
c. Requires the presence of a significant unsaturated depth below the surface of potential ponding sites
d. Requires that surficial recharge areas are hydraulically connected with aquifers that can be utilized for water supply
e. Requires routine maintenance (e.g., scraping of pond sediments) to maintain adequate recharge rates
f. Requires considerable unrestricted unsaturated permeable margin areas beyond the boundaries of the proposed pond area

1.3.2 Direct Recharge – Aquifer Storage and Recovery

Aquifer Storage and Recovery (ASR) recharge involves using wells to recharge surface water into target aquifers. Stored water can be later recovered, often through the same wells. Because the recharge well can penetrate confining layers, confined aquifers (those overlain by relatively impermeable sediments or aquitards) can be recharged. The 1999 Beckman Test Injection/Extraction Project[26] was an ASR project.

Although the basic ASR concept is simple and straightforward, proper implementation of a full-scale facility is a complex undertaking which requires careful planning and design. ASR is a multidisciplinary field that requires expertise in geology, engineering, aqueous chemistry, and instrumentation and control technology to comprehensively address the technical and environmental complexities of each project.

One of the difficulties associated with recharge wells is maintaining adequate recharge rates. Several factors that may affect the long-term viability of recharge wells include:

a. Plugging of the well filter pack and aquifer formation caused by suspended solid load in the source water
b. Chemical reactions in the aquifer
c. The formation of biosolids on well screens
d. Entraining air in the aquifer system
e. Deflocculation caused by the reaction of high-sodium water with soil particles

---

25 Though use of the ponds for recharge would not have a seasonal constraint, water availability may be seasonally limited

26 Boyle, May 14, 1999, "Project Report – Beckman Test Injection/Extraction Project" for the East San Joaquin Parties Water Authority in conjunction with the East Bay Municipal Utility District

The ASR recharge method requires the source water to be treated (filtered and disinfected), and sediment and other suspended solids must be removed using best available treatment and controls. In addition, there may be water quality complications of recharging water into the aquifer system. ASR can be a relatively expensive recharge method with high capital costs (when the construction of new recharge wells or treatment facilities are needed) and high operation and maintenance costs.

Some of the benefits of ASR recharge include:

a. Low land requirements
b. Relatively cost-effective when able to use existing local infrastructure
c. Ability to incrementally test and build the system in phases
d. Effectiveness is not dependent upon near-surface local hydrogeologic conditions – the method has the ability to deliver source water to a target aquifer in areas with impermeable layers between the surface and the aquifer
e. Local water quality improvements (since treated source water is likely to be lower in dissolved solids and nutrient concentrations)
f. Less likely to transport nutrients and contaminants than would recharge ponds

Factors affecting successful implementation include:

a. Access to reliable imported water supply of suitable quality[27]
b. The ability to utilize existing wells and infrastructure, including consideration of the capability of the distribution system to deliver recovered water

1.3.3 Indirect Recharge (In-Lieu Recharge)

Indirect recharge differs from the direct recharge methods because it does not physically place the water into the aquifer system; rather, surface water replaces the use of groundwater, thereby reducing local demand on the groundwater basin and providing the opportunity for the basin to recharge from natural sources. Indirect recharge is often called in-lieu recharge and is commonly used in areas where the historical water demand has relied on the underlying groundwater basin for supply.

In-lieu recharge has been used in both urban and agricultural areas and often utilizes the existing infrastructure to distribute water supply to individual customers. One of the requirements of an in-lieu recharge program is that the replacement supply must be of the appropriate quantity and quality to satisfy the existing supply requirements.

In-lieu recharge programs are often used to improve overall supply reliability by using the imported surface water supply in wet years or months when it is available, thereby reducing the dependence on the groundwater basin. Then in dry years, when imported supplies may be reduced or not available, groundwater is used to meet those demands not met by the imported supply. In this fashion, in-lieu recharge also takes advantage of the natural hydrogeologic setting and the existing groundwater

[27] The Central Valley Regional Water Quality Control District's General Order generally requires injected water to meet drinking water standards.

infrastructure. In order for an in-lieu recharge program to be successful, the in-lieu surface water supply to be used should reduce the demand on the local groundwater system and not be used to accommodate additional increases in demand.[28]

Some of the benefits of in-lieu recharge include:

a. Relatively cost-effective when able to use existing local infrastructure
b. Does not require construction of recharge facilities
c. Effectiveness is not dependent upon near-surface local hydrogeologic conditions

Factors affecting successful implementation include:

a. Access to reliable imported water supply of suitable quality
b. Limited by seasonality of demand
c. The ability to utilize existing infrastructure
d. The ability to incentivize groundwater users to shift to surface water

Table 1-1 - Summary of In-Lieu Recharge vs. Direct Recharge for DREAM Project

In-Lieu Recharge	Direct (Pond) Recharge
Advantages: • Certainty of benefit • Revenue to distributing agency	**Advantages:** • Substantially greater year-round recharge • Ability to take flows when available • Simple operation • Provides seasonal wetland habitat
Disadvantages: • Seasonality limits recharge • Potentially high landowner capital costs • Unreliable surface supply will require landowners to operate dual systems • More complex operation	**Disadvantages:** • Generalized benefit without revenue stream • Requires periodic scraping to remove fines • May require vector control
Other: • Distributed, possibly undetectable benefits • Possible storm drainage conflicts	**Other:** • Concentrated, measureable benefits • Possible storm drainage conflicts
Concepts can be merged to minimize costs, increase revenues, enhance habitat, and increase overall recharge	

[28] See Sacramento Groundwater Authority (SGA) accounting framework for examples

1.4 Water Recharge

Recharge water sources considered for the DREAM Project included both the Mokelumne River via the North San Joaquin Water Conservation District (NSJWCD) South System, and from Pardee Reservoir via the EBMUD Mokelumne Aqueduct. However, the PDA conditioned settlement payments from EBMUD on recharge from the South System, extraction to the Mokelumne Aqueduct, and issuance of an Export Permit.

Recharge methods considered included direct recharge via percolation ponds[24] and indirect recharge by supplying groundwater users with surface water in lieu of groundwater pumping.

Three project phases were contemplated: Test Phase, Demonstration Phase, and Full Scale implementation. These phases can be described as follows:

- Test Project – Confirm aquifer parameters through physical testing, identify recharge locations, develop plans, cost estimates, and agreements, obtain permits (including export permit) and draft landowner agreements for Demonstration Project
- Demonstration Project – Construct and operate recharge and extraction system for 3-5 years to prove banking feasibility
- Full Scale Project – Expand demonstration project to ultimate size

Water for the Test Phase will be supplied from local sources that could include municipal systems or existing wells located an appropriate distance away. The test will verify that water can be percolated from the surface. Initial sizing assumptions are shown in Table 1-2.

Table 1-2 – Initial Sizing Assumptions

Initial Sizing Assumptions

Phase	Recharge Rate cfs	Pipe Dia @7 ft/s in	Pipe Velocity ft/s	Pond Area @1 ft/d ac	Field Flooding Area @0.25 ft/d ac	In-Lieu Acres@2.5 af/ac @20% peak month ac
Test	0.5	6	2.5	1	4	62
Demonstration	5.0	12	6.4	10	40	615
Full Scale	20.0	24	6.4	40	160	2,460

1.4.1 DREAM Project Size

The initial layout of the Demonstration Project was developed to be expandable to a full-scale project using the same area and facilities used for the Demonstration Project. However, initial cost estimates indicated this would exceed the project budget, and might result in stranded, unused facilities should the project not proceed to full-scale development. In particular, the pipeline from the extraction well to the Mokelumne Aqueduct might cost $2 million and have limited utility if the project did not proceed.

Several alignments were considered: a connection of the South System to the Mokelumne Aqueduct along farm roads, a similar route in public rights-of-way along Alpine Road, and use of the NSJWCD east branch ditch and conveyance through Bear Creek.

The project partners directed the engineering team to take all possible measures to moderate project costs, including:

- Reducing the volume recharged
- Reducing the flow rate
- Considering a temporary pipeline and pumping facilities
- Consider hanging conveyance piping from existing bridges instead of tunneling under streams
- Consider County rights-of-way instead of purchasing of easements
- Do not consider a full-scale project as part of the Demonstration Project design

Ultimately, a recharge volume of 1,000 acre-feet with recovery of 500 acre-feet was determined to be adequate to demonstrate the groundwater banking concept. A 2 cfs flow was selected to allow use of a more economical 8-inch diameter pipeline,[29] use of Pixley Slough and a route along unpaved farm roads and across existing bridges was selected to simplify construction. Finally, the return pipeline was increased in size to 12 inches with provisions for future turnouts so that the pipeline could be used for local conveyance should it not be needed for banking operations.

1.4.2 Water Availability Modeling

The EBMUDSIM model was used to estimate water available under the NSJWCD Water Right Permit 10477 as modified by the November 2014 Settlement, and supplemental water that might be provided by EBMUD as part of the DREAM Project banking program. Five EBMUDSIM studies, summarized in Table 1-3, were requested to define the No Action baseline, and test availability of supplemental agricultural in-lieu supply from the Mokelumne River, and availability of direct recharge supplies from the Mokelumne Aqueduct. These action alternatives would each test availability at both demonstration and full-scale levels. Pumped groundwater would be exported via the Mokelumne Aqueducts during years when EBMUD is rationing and aqueduct capacity is available. Actual extractions would be restricted by an annual 5% decay rate (e.g. 90% of banked water available after 2 years). These studies were performed by EBMUD staff, but ultimately were not used due to the downsizing of the demonstration project and the directive not to consider full-scale projects as described above in Section 1.4.1.

[29] With a nominal velocity of 5.7 ft/s

Table 1-3 - Initial EBMUDSIM Modeling Specification

Study	NSJWCD Demands	Groundwater Recharge	Groundwater Recovery
1- No Action	Irrigation schedule per 2014 settlement	None	None
2- Enhanced Irrigation - Demo	Irrigation schedule per 2014 settlement + groundwater recharge supply	Up to 10 cfs of EBMUD entitlement delivered via Mokelumne River on an irrigation schedule	Dry year return to Mokelumne Aqueduct of up to 2 cfs of pumped groundwater, not to exceed 50% of recharge supply
3- Recharge Pond - Demo	Irrigation schedule per 2014 settlement	Up to 2 cfs of EBMUD entitlement delivered via Mokelumne Aqueduct year-round	Dry year return to Mokelumne Aqueduct of up to 2 cfs of pumped groundwater, not to exceed 50% of recharge supply
4- Enhanced Irrigation - Full Scale	Irrigation schedule per 2014 settlement + groundwater recharge supply	Up to 20 cfs of EBMUD entitlement delivered via Mokelumne River on an irrigation schedule	Dry year return to Mokelumne Aqueduct of up to 20 cfs of pumped groundwater, not to exceed 50% of recharge supply
5- Recharge Pond - Full Scale	Irrigation schedule per 2014 settlement	Up to 20 cfs of EBMUD entitlement delivered via Mokelumne Aqueduct year-round	Dry year return to Mokelumne Aqueduct of up to 20 cfs of pumped groundwater, not to exceed 50% of recharge supply

1.4.3 Seasonality of Available Water

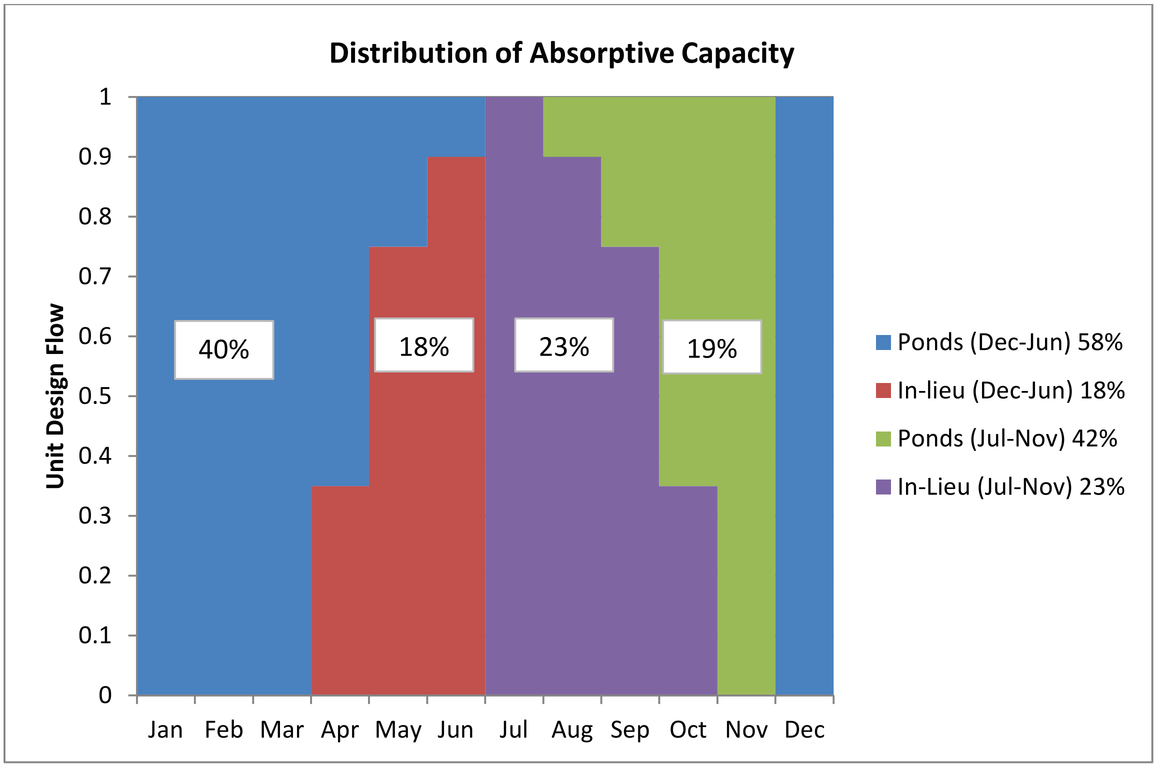
The water available will vary depending on hydrology, water right, and absorptive capacity.[30] The distribution of absorptive capacity potential is shown in Figure 1-1. In general:

- Hydrology will affect both the volume and timing of flows
- Regulation of flows in Pardee and/or Camanche reservoirs can shift the timing of flows to better match needs
- Assuming a constant annual rate of water availability, about 41% could be used for irrigation; if the irrigation period is restricted to the period of NSJWCD's water right permit (December through June) only 18% could be used for irrigation

[30] As used herein, "absorptive capacity" simply means the ability of the system to accept recharge water

- Recharge ponds can be used year-round; 100% of available supplies can be recharged
- If both in-lieu and pond recharge is used, with in-lieu given priority of use, 41% would be recharged in-lieu, and 59 percent would be recharged in ponds.

Figure 1-1 – Approximate Distribution of Absorptive Capacity



1.5 Water Extraction

Pumped groundwater would be exported via the Mokelumne Aqueducts during years when EBMUD is rationing and aqueduct capacity is available. Groundwater extractions will be governed by the terms of the Export Permit required by the County's Groundwater Export Ordinance.[31] Key provisions of the Ordinance include:

- The amount of water approved for export is limited to an amount that provides a net addition to usable groundwater underlying the project[32]
- The project shall not create conditions that are worse than those that would have existed absent the project unless mitigated or overlying users are compensated[33]

[31] Ordinance 4064, An Ordinance Amending Division 8 to Title 5 of the Ordinance Code of San Joaquin County Regarding the Extraction and Exportation of Groundwater from San Joaquin County, June 27, 2000 ("Groundwater Export Ordinance")
[32] Groundwater Export Ordinance, Section 5-8340(c)(1), p.9
[33] Groundwater Export Ordinance, Section 5-8340(f), p.10

- Migration losses will be assumed to be a minimum of 5 percent per year[34]

1.5.1 Storage Decay

The Export Ordinance restricts extractions for export by an annual 5 percent decay rate (e.g. 90% of banked water available after 2 years). This is a surrogate for migration of water away from the project site. It also ensures a net benefit to the basin, and provides a continuing incentive for the groundwater banker to supply recharge water. EBMUD water recharged as part of the Proposal Dismissal Agreement limits the banked groundwater credit to 50 percent of the quantity recharged.[35]

1.6 Monitoring Protocols

The Groundwater Export Ordinance requires establishment of a five-member Monitoring Committee.[36] For the DREAM Project, the Monitoring Committee would consist of:

- The County Director of Public Works
- The County Director of Environmental Health
- A representative for the Permittee
- A representative from NSJWCD (the local agency that provides water service in the project area)
- A representative of landowners within two miles of the Project area

Each entity is responsible for the cost of its representative. All other costs including hired groundwater specialists and the collection and evaluation of data are to be paid by the Permittee.[37]

Monitoring would include at least three monitoring wells surrounding any recharge ponds, and an additional three monitoring wells at the perimeter of the recharge area encompassing the extraction well or wells. A triangular network of monitoring wells will allow computing local and regional water table gradients.

Water quality will be sampled prior to commencement of recharge and periodically thereafter. Influent water quality will also be sampled periodically for drinking water quality parameters. Additionally, monitoring will include rates and volumes of supplied and extracted water, percolation rates, and evaporation, as appropriate.

The Monitoring Plan submitted with the Groundwater Export Application is included in Section 9.

1.7 Overlying Uses

Land use, soil type, water source, depth to groundwater, crop type, water conveyance, environmental considerations and other factors were mapped as part of the Freeport Element Project.[38] These various

[34] Groundwater Export Ordinance, Section 5-8340(g), p.10

[35] Protest Dismissal Agreement, November 26, 2014, Sections 1.b.vii, and 2.a.vi, pages 5 and 7

[36] Groundwater Export Ordinance, Section 5-8345(a), p.11

[37] Groundwater Export Ordinance, Section 5-8345(g), p.11

[38] GEI Consultants, August 2011, San Joaquin County Freeport Element of the American River Use Strategy, Phase I: Final Draft Feasibility Study

factors were weighted in a Geographic Information System (GIS) application to identify areas most suited for groundwater recharge.[39] Soil type and absence of hardpan are among the most important factors for successful pond recharge; existing use of groundwater and proximity to surface water sources are among the most important factors for in-lieu recharge. The resulting maps for Pond Recharge, In-Lieu Recharge, and Injection Recharge are shown in Figure 1-2 through Figure 1-4. The derivation of these maps is described in the Freeport Element report.[40] In these figures, cooler colors (violet, blue) designate areas that are more favorable for recharge than warm colors (orange, red).

Important constraints added by the Protest Dismissal Agreement[41] include:

- The demonstration project must be located within the NSJWCD
- Demonstration project recharge areas must be able to be served from the NSJWCD South System

In addition, EBMUD requires that the Demonstration Project must physically export a meaningful volume of banked groundwater. A detail of the in-lieu potential in the target project area is presented as Figure 1-5.

[39] GEI Consultants, August 2011, San Joaquin County Freeport Element of the American River Use Strategy, Phase I: Final Draft Feasibility Study, Table 4-4, p.4-26

[40] GEI Consultants, August 2011, San Joaquin County Freeport Element of the American River Use Strategy, Phase I: Final Draft Feasibility Study , Figures 4-10 through 4-12, pp. 4-27 through 4-29

[41] See Section 1.2

Figure 1-2- Pond Recharge Constraints Map

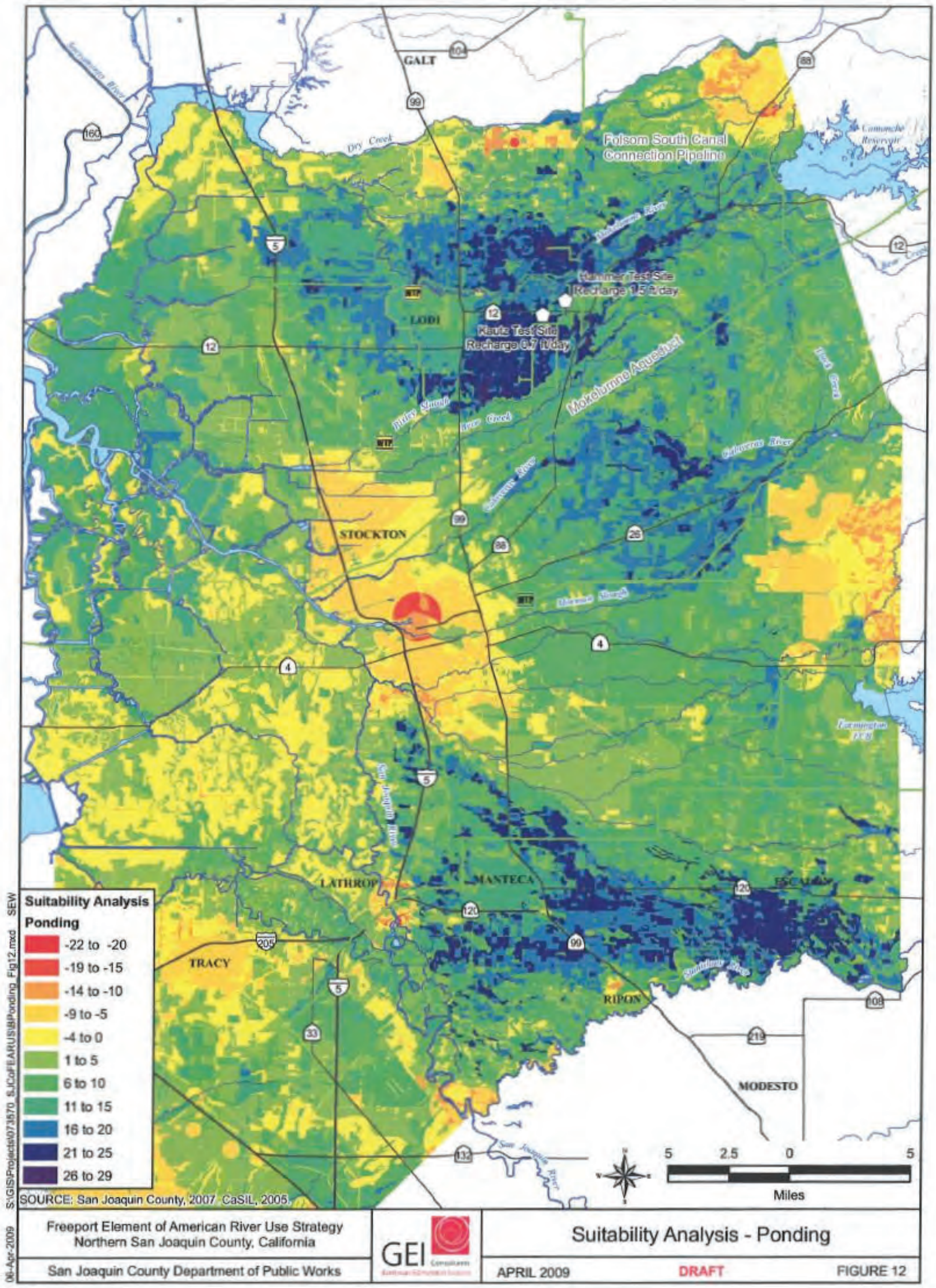


Figure 1-3 - In-Lieu Recharge Constraints Map

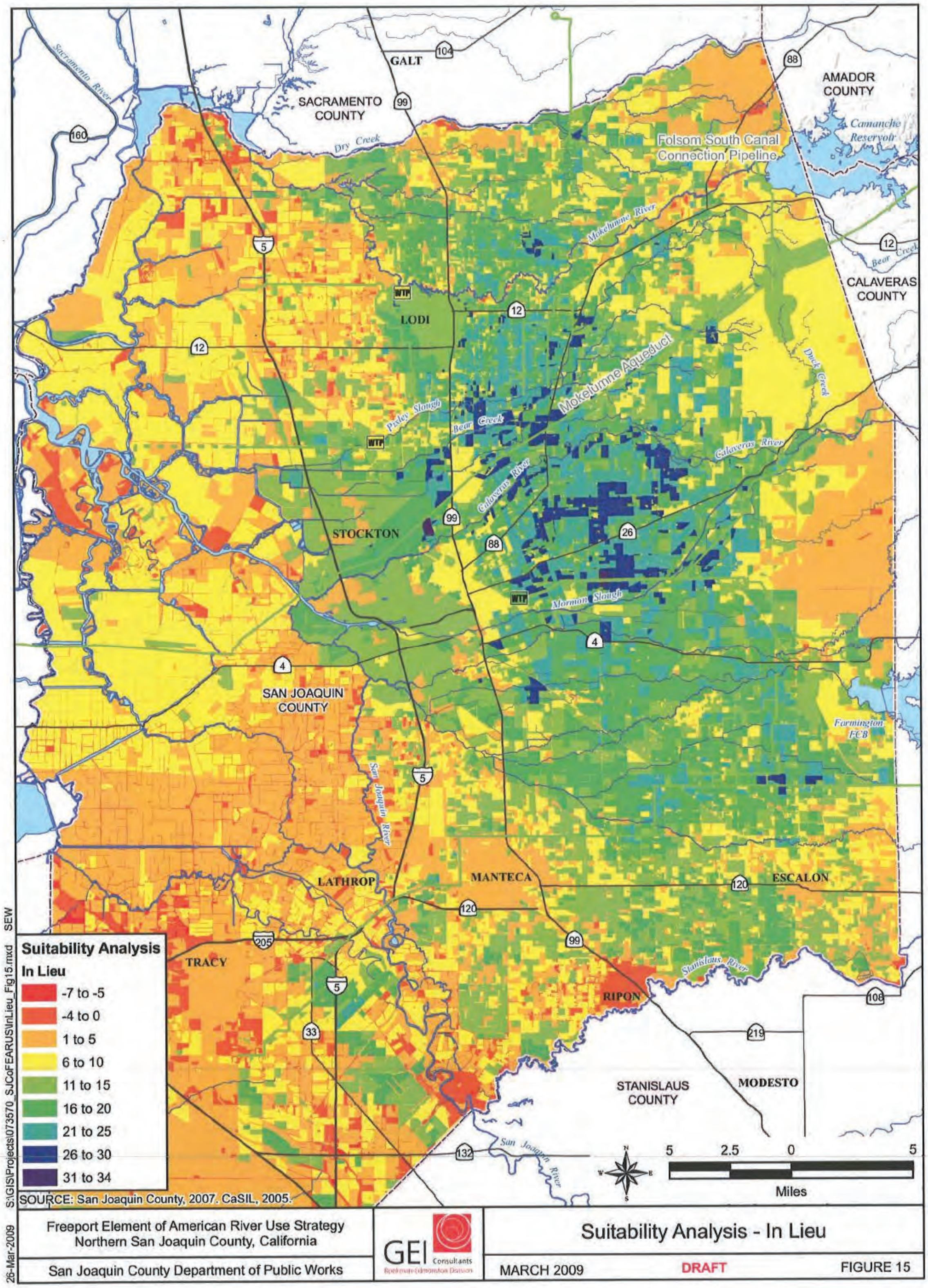


Figure 1-4 - Injection Recharge Constraints Map

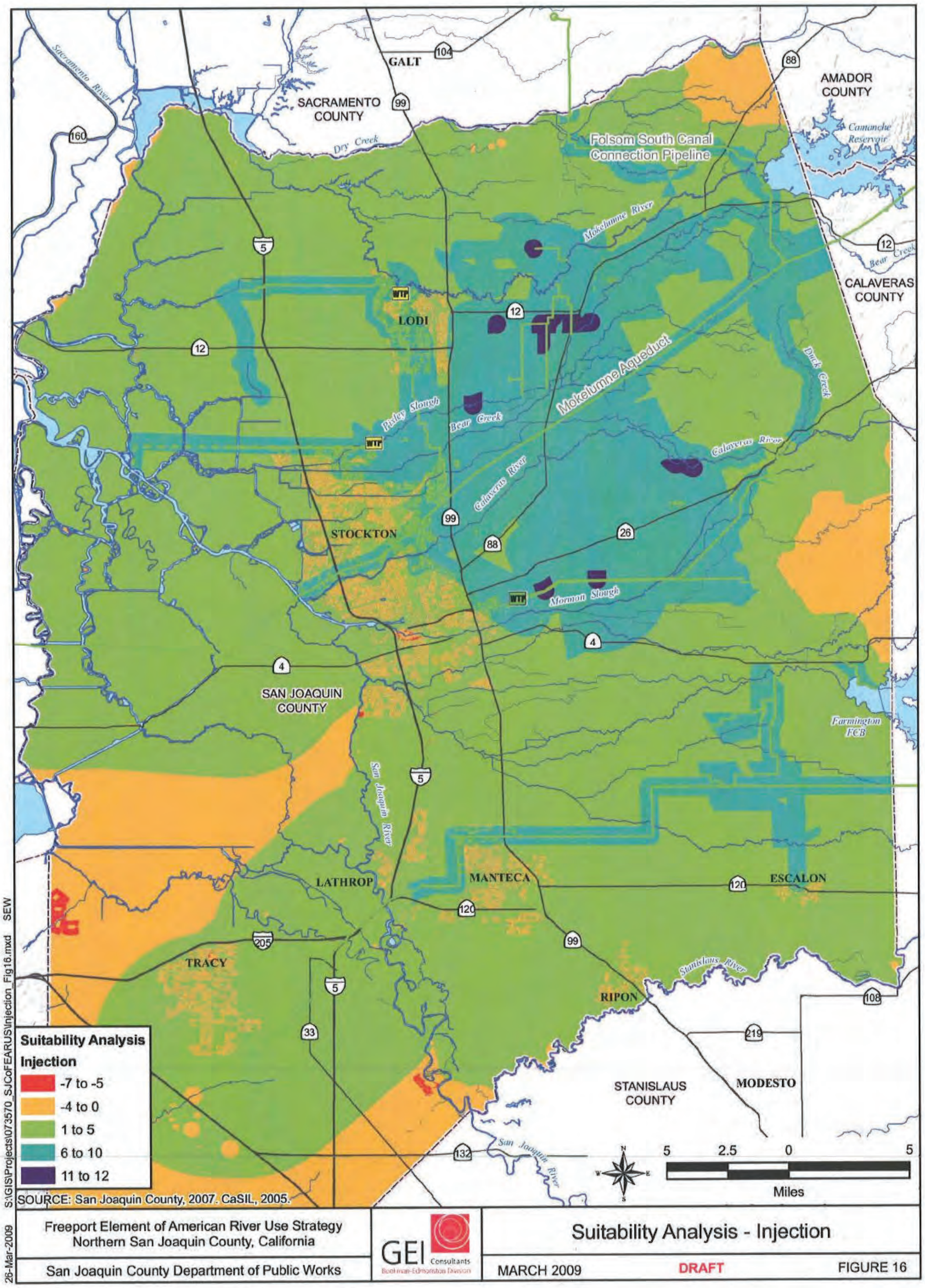
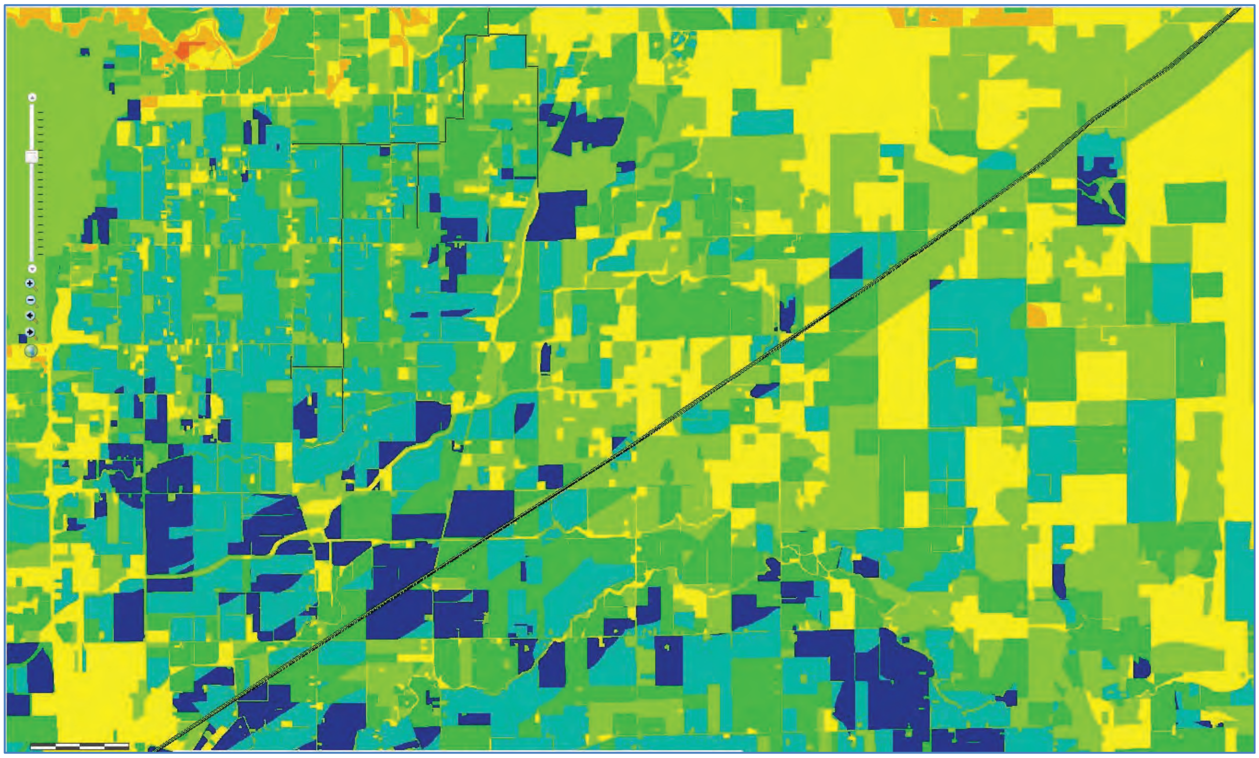


Figure 1-5 - In-Lieu Potential in Project Area



1.8 Environmental Constraints

The County of San Joaquin has prepared an Initial Study (IS) of environmental effects, and intends to adopt a Mitigated Negative Declaration (MND) for a demonstration conjunctive use groundwater replenishment project and improvements to North San Joaquin Water Conservation District's (NSJWCD) South System surface water distribution facilities. A Notice of Intent (NOI) was published and circulated on March 4, 2016 starting a public review period that was extended to July 8, 2016. On August 23, 2016 the San Joaquin County Board of Supervisors held a public hearing and adopted the Final Initial Study and Mitigated Negative Declaration and the Mitigation Monitoring and Reporting Program for the project.

The Demonstration Recharge Extraction and Aquifer Management (DREAM) Project involves the one-time application of 1,000 acre-feet (AF) of surface water supplied by the East Bay Municipal Utility District (EBMUD) to existing developed farmland in lieu of existing groundwater extraction. The NSJWCD will extract up to 500 AF of groundwater and deliver it to the existing EBMUD aqueduct via a 2.8-mile pipeline to be constructed. The purpose of the project is to document the feasibility of in-lieu recharge and partial groundwater extraction for consideration in future projects. In addition, the NSJWCD proposed improvements to its existing South System surface water delivery system, including rehabilitation of existing pipelines and channels, existing agricultural diversion facilities along Bear Creek and Pixley Slough and construction of one new diversion on Pixley Slough.

The IS/MND has analyzed the potential environmental effects of the project in the range of environmental subject areas specified in the California Environmental Quality Act (CEQA) and the CEQA Guidelines. On the basis of this analysis, the IS/MND finds that the project will not involve any significant environmental effects, provided that the mitigation measures described in the IS/MND are implemented.

1.9 Water Quality

The replenishment water will be high-quality Mokelumne River surface water, with suspended solids less than 10 mg/l[42] and conductivity averaging less than 50 µmho/cm (about 40 ppm TDS). The recharge water is neutral in pH and meets all primary drinking water standards.[43] EBMUD supplied water quality data for the water supply to hatchery below Camanche Dam for the period 2010-2014.[44]

A complete suite of water quality analyses was conducted on the proposed extraction Well K-13 in January 2016. The groundwater is of high quality with 180 mg/L Total Dissolved Solids, and meets all primary drinking water standards. The well was tested for a variety of pesticides, chlorinated acids, dibromo-chloropropane (DBCP), and uranium, none of which were detected. A summary of water quality measurements is presented as Table 1-4. The full water quality report is attached as Section 10.

Table 1-4 - Summary of Water Quality Measurements

		Well K-13	**Mokelumne Hatchery**
		Groundwater	Surface Water
Dates		1/26/2016	2010-14
Conductivity	µmhos/cm	230	49
TDS	mg/L	180	38*
Dissolved Oxygen	mg/L	--	11
Hardness as CaCO3	mg/L	77	18
Total Nitrogen	mg/L	0.54	--
Chromium VI	µg/L	2.4	--
Copper	µg/L	ND	0.6
Zinc	µg/L	ND	1.1
pH		7.64	6.9
Pesticides, Uranium, Chlorinated Acids, DBCP	--	ND	--

*computed from conductivity

42 From Beckman Test Well report
43 Data from EBMUD, 2016
44 See Table 10-2

ND = not detected

CZA0677 FINAL 02 19 16 1555.PDF

1.10 Public Outreach

A variety of public and landowner contacts were made in the course of project siting and development. Outreach included telephone and in-person meetings, presentations at the NSJWCD Board meetings, the Groundwater Basin Authority, Advisory Water Commission, and other public forums, and public meetings on the project and environmental documentation.

A Project Development Team (PDT) was organized as a forum for project sponsors (San Joaquin County and EBMUD) to meet and monitor and direct project development. The PDT met approximately monthly starting in August 2014. A Technical Advisory Committee (TAC) was formed as a parallel forum for meeting with other stakeholders including the North San Joaquin Water Conservation District, Stockton East Water District, Woodbridge Irrigation District, and the San Joaquin Farm Bureau Federation. These two groups were merged in early 2015. A project website was established but was little used due to TAC hesitancy to publish project information ahead of discussions with the various member constituencies. An outreach flyer published on the project website is presented as Figure 1-6.

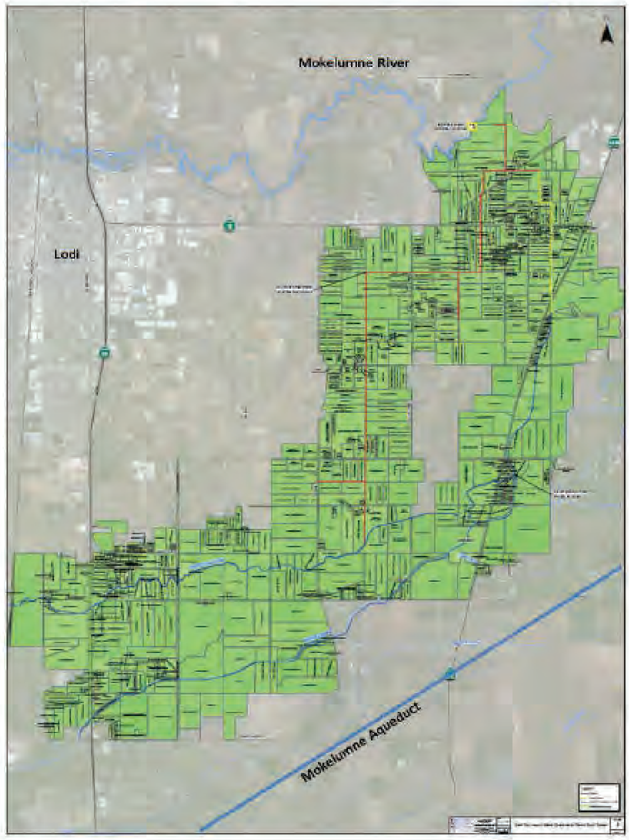
Figure 1-6 Sample Outreach Flyer

Demonstration Recharge Extraction and Aquifer Management *(DREAM)* Project

GROUNDWATER SUSTAINABILITY IN THE EASTERN SAN JOAQUIN REGION

The **Demonstration Recharge, Extraction and Aquifer Management (DREAM) Project** is a multi-agency effort that will establish the feasibility of storing available wet year water supplies in the groundwater aquifers underlying San Joaquin County, and extraction of a portion of these banked supplies for use in dry years. The project is funded by the San Joaquin County Department of Public Works and the East Bay Municipal Utility District in cooperation with the North San Joaquin Water Conservation District and the Stockton East Water District.

This demonstration project is a short-term (approximately 3 year) effort that will recharge up to 1,000 acre-feet of water from the Mokelumne River through the south distribution system of the North San Joaquin Water Conservation District. Lands within 2,000 feet of the south distribution system are shown in green on the map.



Participating landowners will use this surface water in-lieu of pumping groundwater, reducing pumping costs and groundwater overdraft. Up to 500 acre-feet will be subsequently pumped into the Mokelumne Aqueduct for delivery to EBMUD.

Landowners interested in participating in the project should be current groundwater users, within the mapped green area, and be able to make the changes needed to take surface water into their irrigation system. Improvements to the surface water distribution system will be partially funded by EBMUD.

If this short-term demonstration project is successful in recharging and extracting water, planning for a larger groundwater recharge project will begin. A larger project would enable local districts, like North San Joaquin Water Conservation District and Stockton East Water District, to bring additional surface water supplies into the area to augment and sustainably manage groundwater.

If you are interested in participating in this demonstration project, please contact:

Mark Williamson	GEI Consultants	(916) 631-4500	mwilliamson@geiconsultants.com
Brandon Nakagawa	San Joaquin County	(209) 953-7460	
Gerald Schwartz	East Bay MUD	(209) 334-3048	
Joe Valente	North San Joaquin WCD	(209) 334-4786	
Scot Moody	Stockton East Water Distric1	(209) 948-0333	

*The **Demonstration Recharge, Extraction and Aquifer Management (DREAM) Project** is a multi-agency effort that will establish the feasibility of storing available wet year water supplies in the groundwater aquifers underlying San Joaquin County, and extraction of a portion of these banked supplies for use in dry years. The project is funded by the San Joaquin County Department of Public Works and the East Bay Municipal Utility District in cooperation with the North San Joaquin Water Conservation District and the Stockton East Water District.*

1.11 Cost Allocation

As part of the Protest Dismissal Agreement,[45] EBMUD has pledged up to $4.0 million for funding the Demonstration Project. This funding is contingent on EBMUD receiving an Export Permit for exporting a portion of the recharged water.

EBMUD will pay up to $4.0 million if the Export Permit is issued, of which $1.75 million must be used to improve the NSJWCD South System. There is no payment obligation if the Export Permit is not issued by June 30, 2016 unless the agreement is modified. If there is no modification, EBMUD will pay NSJWCD $1.75 million by July 15, 2016 for South System improvements. This agreement has been extended several times; the most recent is the Sixth Amendment to the Protest Dismissal Agreement signed January 30, 2017 which extends the date for issuing the Export Permit to June 30, 2017.

The Parties are to endeavor to control costs. If projected costs are likely to exceed $4.0 million, the County and EBMUD will confer to control costs or seek alternative funding sources. Alternative funding sources might include grants, loans, local contributions, and landowner improvements for conveyance of in-lieu recharge supplies.

[45] See Section 1.2, p.1-2

2 Site Selection and Hydrogeologic Investigation

This section was published as a February 6, 2015 Draft Technical Memorandum. The primary focus of this TM was to identify the best sites for recharge ponds. Two suitable sites were identified; one each on the east and west branches of the NSJWCD South distribution system.

2.1 Introduction

San Joaquin County requested analysis of recharge potentials on agricultural or native land area for purposes of a demonstration recharge project.[46] The recharge site is to provide an understanding of the effectiveness of spreading basin recharge in the northern San Joaquin area. The purpose of this Technical Memorandum (TM) is to locate potential parcels of land, to talk with willing landowners, and to conduct a technical analysis of each parcel for its feasibility in satisfying the project objectives.

The TM focuses on the site selection processes, data and results obtained, and includes all maps, tables, cross sections, and diagrams developed in the tasks described. The initial draft TM is not intended to recommend a preferred site since completion of other critical elements of the project scope (i.e., location of source water, infrastructure, community/owner acceptance, utility conflicts, environmental concerns, permitting, etc.) must be resolved before such a recommendation can be made.

The best sites will be carried forward for further evaluation focusing on the technical (legal, engineering and operations), water availability and rights, environmental resources, cultural resources, program costs, economic benefits, and allocation of benefits and costs of project implementation.

2.2 Project Evolution

The Groundwater Recharge Demonstration Project evolved considerably over the course of the study. Originally envisioned as recharge pond project with water supplied from the Mokelumne Aqueduct, the final Demonstration Recharge, Extraction and Aquifer Management (DREAM) Project is an agricultural in-lieu recharge project supplied from the Mokelumne River.

The studies conducted are summarized below under the following headings:

- Recharge Pond Concept (Section 2.3)
- Protest Dismissal Concepts (Section 3.1)
- Separated Recharge and Extraction Concept (Section 3.2)
- Strawman Hybrid Pond/In-Lieu Concept (Section 3.3)
- In-Lieu Recharge with Residual Value Facilities (Section 4)

[46] The project as described here was the basis for the GEI Scope of Work. The project changed significantly over the course of the study.

2.3 Pond Recharge Concept

GEI's Scope of Work describes a screening process to identify the best locations and methods for the demonstration project, based primarily on recharge suitability, land use, location, concept-level cost estimates, and environmental constraints.[47]

The Scope of Work calls for selecting recharge areas within the North San Joaquin Water Conservation District south of the Mokelumne River or the northern portion of the Stockton East Water District. The Scope calls for using recharge water from the Mokelumne Aqueduct, with water returned to the Mokelumne Aqueduct or through other recovery mechanisms.[48] Initial site selection was performed based on these criteria and on the Project Principles[49] developed by the Project Development Team (PDT).

The advantages of a direct recharge project as summarized in Section 1.3 include year-round operation and concentrated recharge that would more likely show a measurable improvement in water levels. This approach was ultimately abandoned for the DREAM Project, but may be applicable for future larger-scale efforts.

2.3.1 Project Site Investigations

The steps taken for identifying suitable direct recharge sites investigation are as follows:

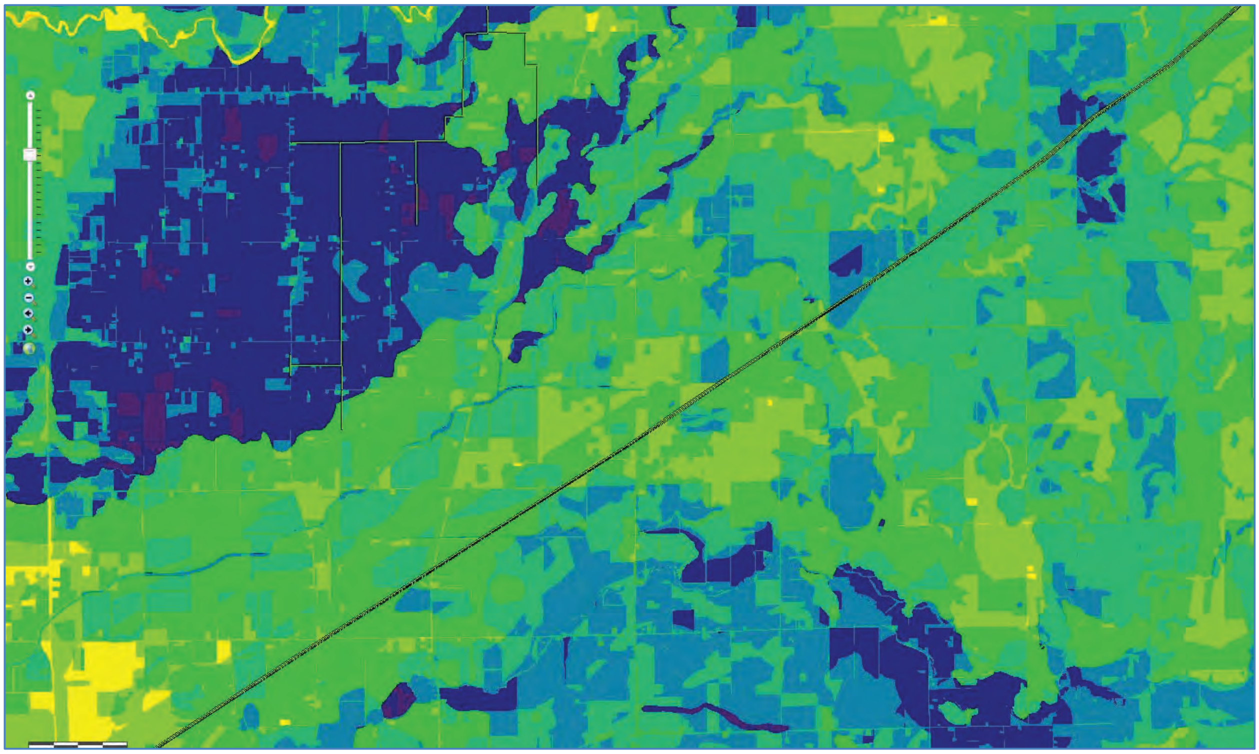
- Identify potential land areas meeting minimum requirements
- Contact landowners to ensure their willingness to fallow, or utilize, land areas for purposes of the project
- Conduct a detailed hydrogeologic analysis based on existing well data, groundwater levels and soils, groundwater, and well data in the region
- Determine the adequacy of each land area for spreading basin direct recharge

The generalized area of the Demonstration Project (Project) is identified in Figure 2-1. The Soil Survey Geographic Database, referred to as SSURGO, shows this area as generally having suitable sandy loam soil types compatible with the direct recharge project concept. Presented below are sections describing:

1. Identification of Land Areas
2. Hydrogeologic Investigation of Potential Project Sites
3. Recommendation of Suitable Project Sites

[47] Consulting Engineering Services Agreement Task 4.2
[48] Consulting Engineering Services Agreement Task 3.1c
[49] See Section 1.1, p.1-1

Figure 2-1 - Recharge Pond Potential in Project Area



2.3.2 Identification of Land Areas

Identification of suitable Project sites required meeting a set of metrics specifically created for the site selection analysis. A GIS database was developed containing the needed parametric data, including those listed in Table 2-1.

Based on the listed metrics for parcel feasibility and through use of GIS to identify the best project site locations, and based on expressed landowner willingness, two parcels were identified as being suitable for a detailed investigation. Site A and Site B attributes are indicated in Table 2-2 and Table 2-3, respectively (see location and configuration shown in Figure 2-2 and Figure 2-3). The tables indicate the parcel number, parcel address, zoning, parcel area, and additional special district information. The County Assessor's figures provide project site locations relative to major roads and waterways.

Visual drive-by identification, along with SSURGO soils maps, provided confirmation of the potential land areas as being suitable for the demonstration project. The assessment took place through the period between late December 2014 and early January 2015, following a heavy storm event. Observation of standing water in the fields and rural roadside ditches assisted in identifying lands not suitable for recharge. If lands were shown to have adequate permeability in their shallow top soil layers based on the SSURGO data, and no standing water after a storm event was visually identified, an effort was made to contact landowners and discuss their willingness to fallow all or a portion of their lands for purposes of this demonstration project.

Table 2-1 Relevant Water Banking Parameters

Existing Land Use	**Environmental Constraints**
• Estimated land value	
• Existing water use	• Existing regional and specific studies conducted on special status species, wildlife habitat and wetlands areas.
• Crop type and consumptive use	• Critical Habitats
• Parcel size and location	• General Infrastructure
Geology and Soils Properties	**General Infrastructure Information**
• SSURGO database which contains 75 tables of soil information with 874 attributes of the different soil types in the County. GEI uses the 15 most relevant attributes to develop a ranking for the selection of favorable recharge sites. The overall ranking of a particular soil type is determined by adding the 15 individual attribute values.	• Roads, Streams and Rivers
	• Geopolitical Boundaries (i.e. County Lines, Parks, City,
	• Water, Water Conservation, and Irrigation Districts etc.)
	• Roads/Railroads
	• Powerlines/Utility Lines/Transfer Stations
• Depth to groundwater and available aquifer volume	• WTP/Treatment Ponds
• Groundwater quality	• Existing and proposed pipelines, pump stations, diversion structures, and proposed reservoirs
• Groundwater contours	• Existing Detention/Recharge Basins
• Depth to groundwater and available aquifer volume	• USGS Stream Gages
	• Water Wells/Boreholes
	• Oil and Gas Wells
• Watershed boundaries	• Environmental Justice (census data)
• Groundwater basins	• Floodway/Flood Zones
	• LUST/LUFT sites

Four primary considerations are identified in the analysis of each site, as follows:

- Recharge Suitability
- Land Use
- Location/Conceptual Costs
- Environmental Constraints

A ranking system was used for each of the above factors and area maps generated showing the overall ranking for the selection of the most favorable sites for spreading basin recharge.

The initial region identified for populating a subsurface lithologic database was based on areas scoring highest in the four considerations above. Subsurface lithology is used to further focus the recharge efforts by eliminating areas that are less suitable for surface recharge.

Table 2-2 Site A – Parcel Number 063-060-11

Parcel ID	06306011
Situs Number	13050
Situs Direction	N
Situs Street	ALPINE
Situs Type	RD
Situs City	UNSJ
Parcel SqFt	892544.00
Parcel Acres	20.49
WA Contract	930003
WA Acres	20.49
WA Renewal	
WA Category	1
Districts	
PlanningArea	LOCKE-CLEM
GenPlan	A/G
Zoning	AG-40
SupervisorDist	4
HighSchoolDist	LODI UNIFIED
ElemSchoolDist	LODI UNIFIED
FireDistrict	MOKELUME
FireService	MOKELUMNE
JudicialDistrict	LODI MUNI
FireHazardArea	NODATA
SubsidiveExpansive	NONE
ServicesSewer	none
ServicesWater	none
ServicesStorm	none
IrrigationDist	NSJWCD
PhoneService	AT&T
AgriculturalPreserve	R-69-C1
TractBlkgrp	47.02 06
TrafficZone	384
SheriffBeat	2
SheriffRD	012
ZipCode	95240
PostOffice	LODI
GIS_APN	6306011

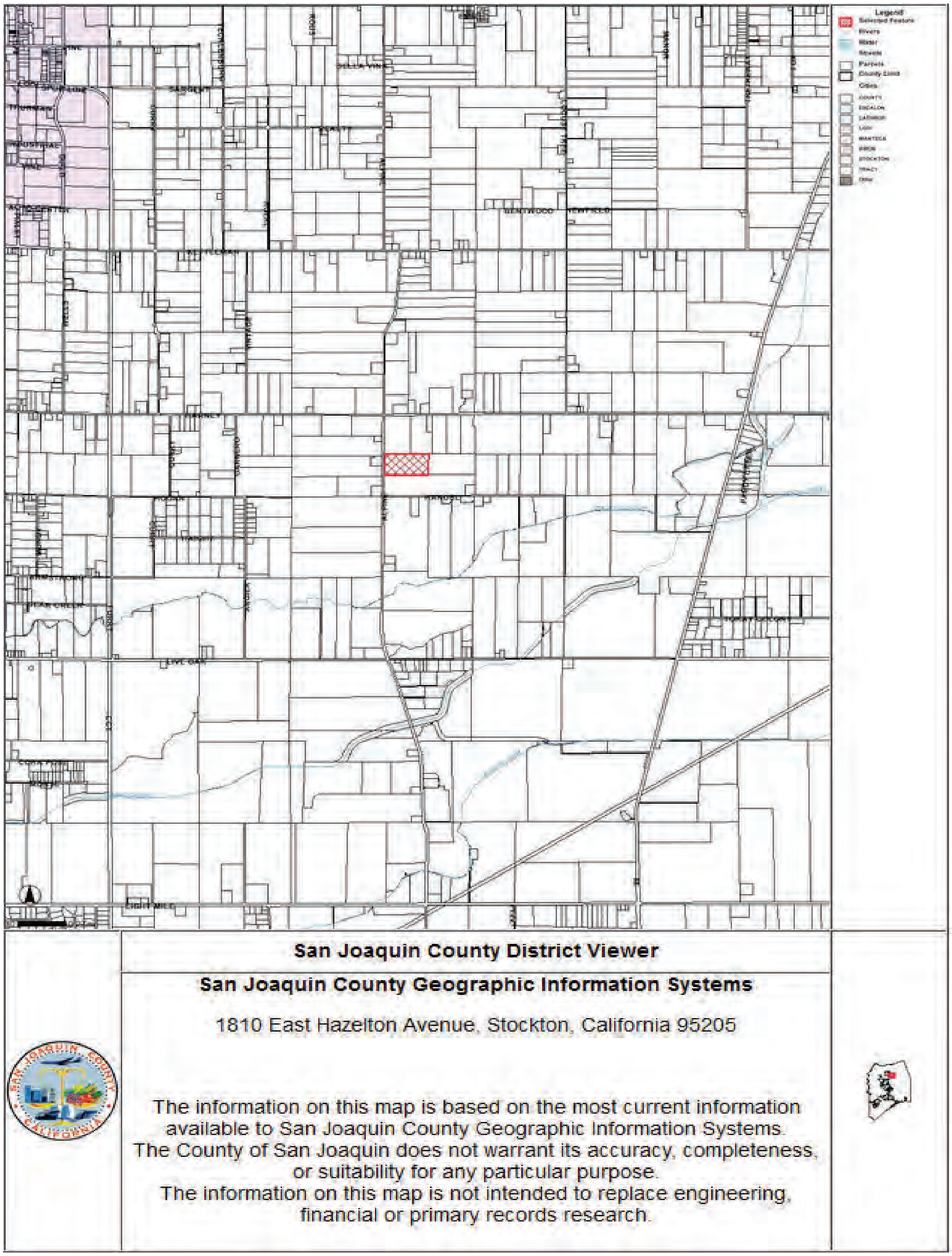
Source: http://sjmap.org/website/DistrictViewer/Viewer.asp

Table 2-3 Site B – Parcel Number 063-250-01

Parcel ID	06325001
Situs Number	12108
Situs Direction	E
Situs Street	KETTLEMAN
Situs Type	LN
Situs City	UNLO
Parcel SqFt	3305332.00
Parcel Acres	75.88
WA Contract	
WA Acres	
WA Renewal	
WA Category	
Districts	
PlanningArea	LOCKE-CLEM
GenPlan	A/G
Zoning	AG-40
SupervisorDist	4
HighSchoolDist	LODI UNIFIED
ElemSchoolDist	LODI UNIFIED
FireDistrict	MOKELUME
FireService	MOKELUMNE
JudicialDistrict	LODI MUNI
FireHazardArea	NODATA
SubsidiveExpansive	NONE
ServicesSewer	none
ServicesWater	none
ServicesStorm	none
IrrigationDist	NSJWCD
PhoneService	AT&T
AgriculturalPreserve	R-69-C1
TractBlkgrp	47.02 05
TrafficZone	389
SheriffBeat	2
SheriffRD	012
ZipCode	95240
PostOffice	LODI
GIS_APN	6325001

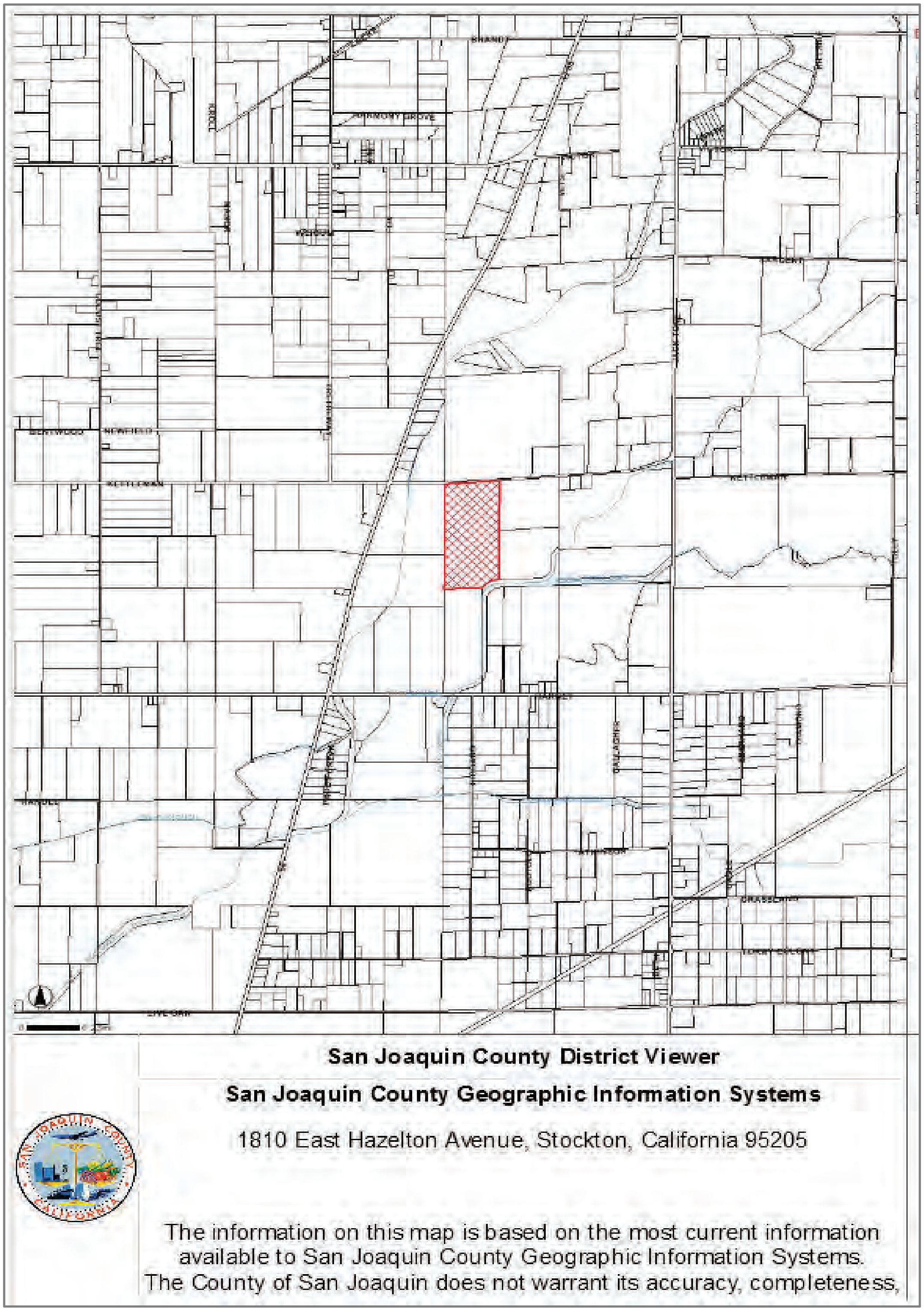
Source: http://sjmap.org/website/DistrictViewer/Viewer.asp

Figure 2-2 Site A Parcel Map



Source: http://sjmap.org/website/DistrictViewer/Viewer.asp

Figure 2-3 Site B Parcel Map



Source: http://sjmap.org/website/DistrictViewer/Viewer.asp

Drawing on work completed previously in support of the Freeport Element Project[50] and the GBA's ICU Program EIR,[51] a screening level environmental review of Project facility siting options and locations was performed prior to selecting the two sites. Environmental review focused on constraints that could impact Project feasibility and ability to complete permitting in a timely manner. Given the proposed schedule for Project implementation, the level of permitting required and time needed to acquire permits are anticipated to be a key consideration for the Project. Biological resource experts compiled and evaluated records from the California Natural Diversity Database (CNDDB), the Federal Emergency Management Agency (FEMA), applicable Habitat Conservation Plans, and documentation for prior San Joaquin County work including the Freeport Element Project, the ICU Program EIR, preliminary analyses completed by EBMUD, and others as relevant.

Environmental constraints were identified early in the process, in order to best inform facility locations and provide an early identification of possible permitting constraints. These initial analyses were utilized to inform completion of the Initial Study and Notice of Preparation, and to support development of a complete scope of work for the CEQA analysis and permitting requirements.

2.3.3 Hydrogeologic Investigation

This section considers both the surface soil conditions, and the underlying aquifer and geologic conditions of each site. This includes the following:

- Soil types
- Hydrologic conditions
- Geologic stratigraphy
- Aquifer locations and properties (i.e., transmissivity, thickness, depth, etc.)
- Groundwater conditions

Presented below is a reconnaissance level assessment of the underlying aquifer and geologic conditions, completed as a first screening process, prior to expending time and budget for additional well drilling and soils testing on for a preferred site.

2.3.3.1 Soil Types

Using an on-line UC Davis database application based on the SSURGO database, the shallow surface soil information and approximate extents are provided in the tables and figures below.

Table 2-4 provides a definition of the various predominant (greater than 85%) soil types found on each site with the relative percentage of each sub soil class included within the given project site.

The plan view of each site shown in Figure 2-4 and Figure 2-5 indicate an interlacing of soil types at the surface which is typical of alluvial deposits. This data confirms the presence of permeable soil types

[50] GEI Consultants, Inc., August 2011. San Joaquin County Freeport Element of the American River Use Strategy, Phase I: Final Draft Feasibility Study

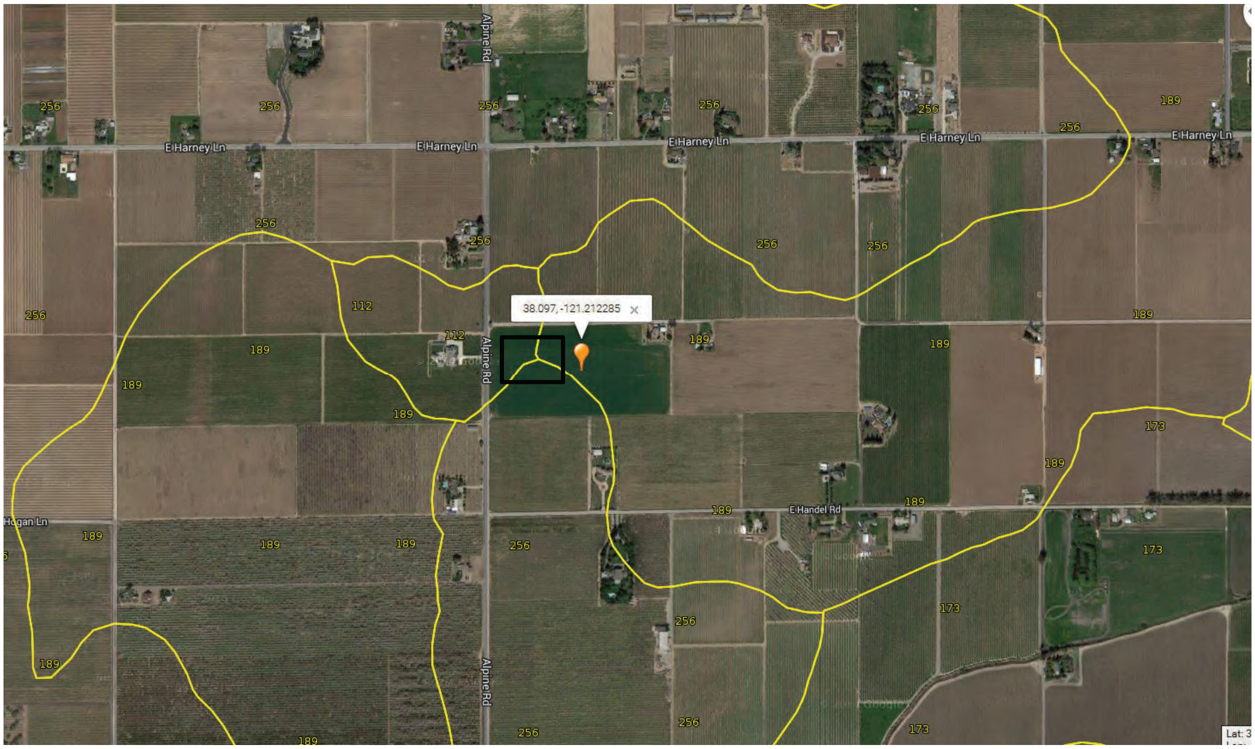
[51] Environmental Science Associates, February 2011, Northeastern San Joaquin County Groundwater Banking Authority Integrated Conjunctive Use Program Programmatic Environmental Impact Report, Final

with both sites indicating sandy loam conditions with sufficient granularity to be conducive to applied water recharge. In addition, both sites are relatively flat with a slope from 0 to 2 percent, indicating the feasibility in constructing a small berm to impound the recharge water up to two feet in height.

Table 2-4 Shallow Surface Soil Types

Soil Type	Percent of Total								Soil Description
	Site A				Site B				
Soil Group Number	189	256	112		256	240	189		
Approximate Area within Project Site									
San Joaquin	0%	0%	3%		0%	85%	0%		
Kingdon	85%	3%	0%		3%	0%	85%		The Kingdon series consists of very deep, moderately well drained soils formed in alluvium derived mainly from granitic mixed rock sources. Kingdon soils are on low fan terraces.
Devries	4%	4%	0%		4%	0%	4%		
Exeter	0%	0%	0%		0%	4%	0%		
Bruella	0%	0%	85%		0%	4%	0%		The Bruella series consists of very deep, well and moderately well drained soils formed in alluvium from granitic rock sources. Bruella soils are on low terraces and fans and have slopes of 0 to 5 percent.
Jahant	0%	0%	3%		0%	0%	0%		
Rocklin	0%	0%	3%		0%	0%	0%		
Acampo	4%	4%	0%		4%	0%	4%		
Tujunga	3%	4%	0%		4%	0%	3%		
Tokay	2%	85%	3%		85%	0%	2%		The Tokay series consists of very deep, well drained soils formed in alluvium derived mainly from granitic rock sources. Tokay soils are on low fan terraces.
Unnamed	2%	0%	3%		0%	7%	2%		
Percent Total	100%	100%	100%		100%	100%	100%		

Figure 2-4 Project Site A Location with Soils Data Overlay



Source: http://casoilresource.lawr.ucdavis.edu/gmap/

Figure 2-5 Project Site B Location with Soils Data Overlay

Source: http://casoilresource.lawr.ucdavis.edu/gmap/

2.3.3.2 Geologic Soil Profiles

Geologic data for purposes of site screening are based on past well drilling records in the region. This provides information on the sediments lying beneath the shallow soil described in SSURGO. Well drillers are required by state law to submit a Well Driller's Log upon completion of any well construction. Driller's logs (herein after referred to as logs) are now available for purposes of scientific study, though ownership information is kept private.

The quality of the logs differs based on the person describing the lithology during drilling; subsurface soils carried to the surface in drilling fluids are visually inspected and classified. Some lithologic soil descriptions are questionable and/or oversimplified, making a precise soil classification per the Unified Soil Classification System (USCS) difficult.

To ensure adequate coverage, the County made a request to the State for all logs for the project area, allowing selection of the highest quality logs in an area. A licensed geologist interpreted each log and assigned a USCS soil classification code to each lithologic layer that was entered into a data management system for profiling and visualizing the underlying geology.

Blue wells (i.e. well IDs in the 8000 series) indicated in Figure 2-6 represent wells included in the population of wells based on their interpreted logs. Each of these wells has a corresponding driller log (see example Figure 2-7) and all relevant data has have been extracted to a visual data management tool to create the full well profiles, including all attribute information (see example Figure 2-8 and Appendix C for full compilation of well logs). Unfortunately, many of these wells do not have groundwater level information, but aquifer locations can be estimated based on where the wells are screened (or perforated) over the depth of the well.

Older wells may not be screened; rather, well casings stop at a given depth leaving an open hole at the bottom (mud and sand are removed during well completion), have no screens, and rely on the hydrostatic pressure of the groundwater to fill the well column up to the given water elevation in the well.

The cross-section line A-A' shown in plan-view in Figure 2-6 and profile-view in Figure 2-9 was carefully selected to follow the general soil structure alignment. Each cross section (see Appendix A for full compilation of cross sections) depicts the history of alluvial soil deposits laid down by meandering rivers and streams generally originating in the Sierra Nevada in a northeast to southwest direction. Correlation of water bearing soil types is made by the geologist with each cross-section. Given that each well has a unique soil profile, the geologist makes a professional judgment on what occurs between each soil profile along the cross-section's length; thereby connecting sediments between wells. Each soil type can be classified based on the level of granularity (i.e., void space, porosity, etc.) to estimate its ability to transmit groundwater vertically as well as horizontally. Based on this transmissivity, a likely flow path can be estimated, acknowledging the inaccuracies of the data being used.

Unfortunately, groundwater elevation monitoring is not occurring in the cross-section wells; however, for purposes of comparison, a cross-section of the groundwater elevations based on the monitoring of nearby wells (explained further in Section 2.3.3.5) underlying cross-section A-A' is provided as Figure 2-10 to match where groundwater elevations are being measured relative to the cross-section's potential water bearing strata.

Figure 2-6 Driller's Logs and Geologic Cross Sections Used for the Project Area

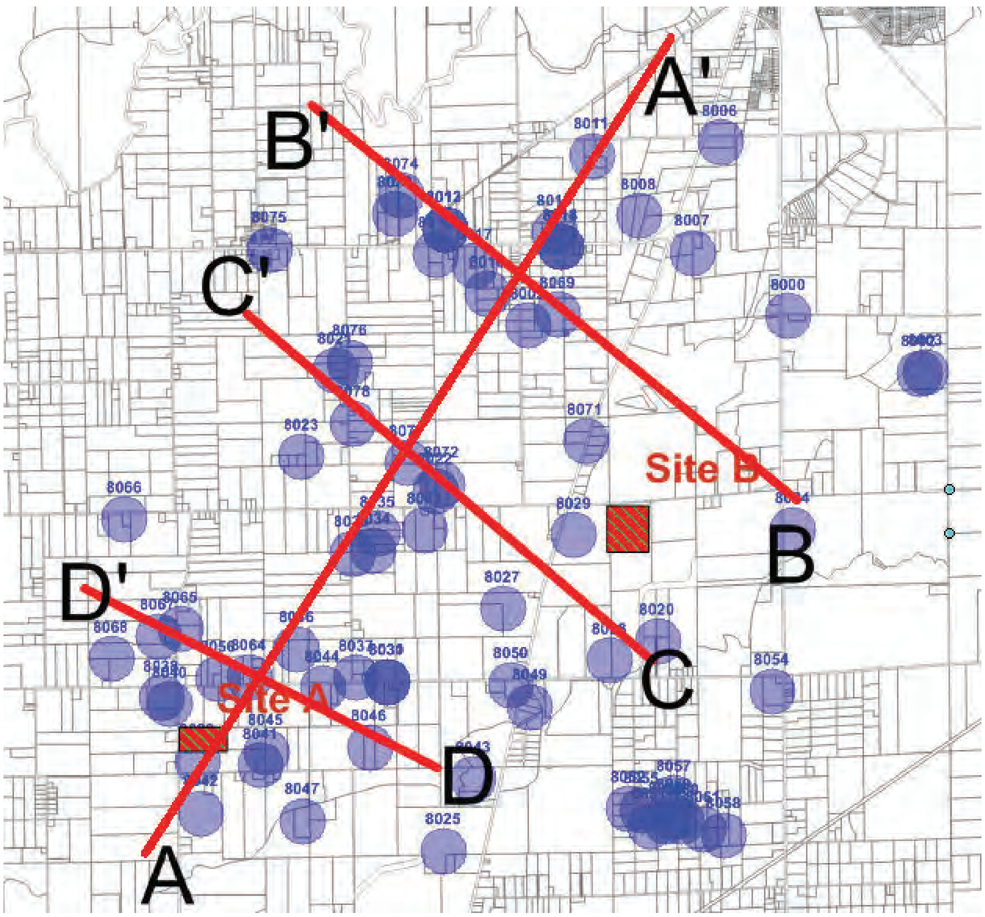
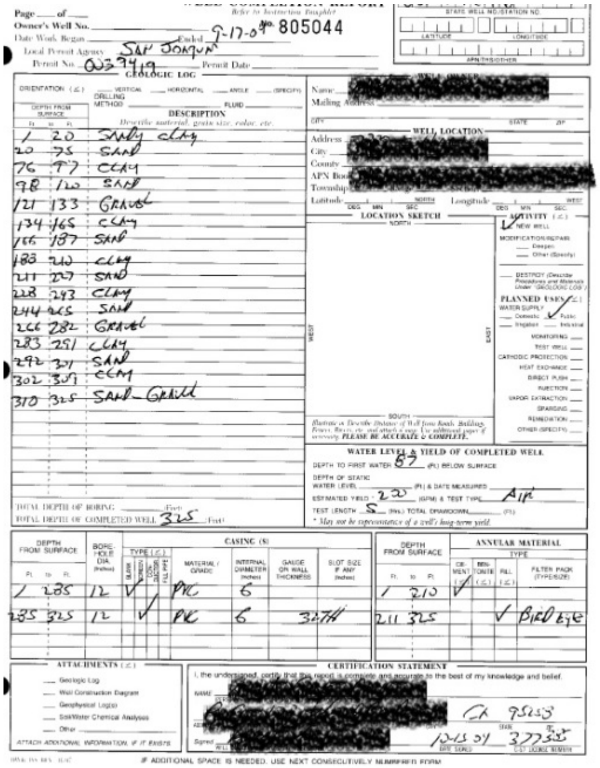


Figure 2-7 Example Driller's Log Used for Regional Geologic Understanding



WELL COMPLETION REPORT
Refer to Instruction Pamphlet

Page ___ of ___
Owner's Well No. ___
Date Work Began ___ Ended 9-17-04
No. 805044
Local Permit Agency SAN JOAQUIN
Permit No. 039419 Permit Date ___

STATE WELL NO./STATION NO.
LATITUDE LONGITUDE
APN/TRS/OTHER

GEOLOGIC LOG

ORIENTATION (✓) ___ VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)
DRILLING METHOD ___ FLUID ___

DEPTH FROM SURFACE Ft. to Ft.		DESCRIPTION Describe material, grain size, color, etc.
1	20	SANDY CLAY
20	75	SAND
76	97	CLAY
98	120	SAND
121	133	GRAVEL
134	165	CLAY
166	187	SAND
188	210	CLAY
211	227	SAND
228	243	CLAY
244	265	SAND
266	282	GRAVEL
283	291	CLAY
292	301	SAND
302	309	CLAY
310	325	SAND – GRAVEL

TOTAL DEPTH OF BORING ___ (Feet)
TOTAL DEPTH OF COMPLETED WELL 325 (Feet)

WELL OWNER
Name [redacted]
Mailing Address ___
CITY STATE ZIP

WELL LOCATION
Address [redacted]
Latitude ___ NORTH Longitude ___ WEST
DEG. MIN. SEC.

LOCATION SKETCH
NORTH / WEST / EAST / SOUTH
Illustrate or Describe Distance of Well from Roads, Buildings, Fences, Rivers, etc. and attach a map. Use additional paper if necessary. PLEASE BE ACCURATE & COMPLETE.

ACTIVITY (✓)
✓ NEW WELL
MODIFICATION/REPAIR
___ Deepen
___ Other (Specify)
___ DESTROY (Describe Procedures and Materials Under "GEOLOGIC LOG")

PLANNED USES (✓)
WATER SUPPLY
___ Domestic ✓ Public
___ Irrigation ___ Industrial
MONITORING ___
TEST WELL ___
CATHODIC PROTECTION ___
HEAT EXCHANGE ___
DIRECT PUSH ___
INJECTION ___
VAPOR EXTRACTION ___
SPARGING ___
REMEDIATION ___
OTHER (SPECIFY) ___

WATER LEVEL & YIELD OF COMPLETED WELL
DEPTH TO FIRST WATER 57 (Ft.) BELOW SURFACE
DEPTH OF STATIC WATER LEVEL ___ (Ft.) & DATE MEASURED ___
ESTIMATED YIELD * 220 (GPM) & TEST TYPE Air
TEST LENGTH 5 (Hrs.) TOTAL DRAWDOWN ___ (Ft.)
* May not be representative of a well's long-term yield.

CASING (S)

DEPTH FROM SURFACE Ft. to Ft.		BORE-HOLE DIA. (Inches)	TYPE: BLANK	SCREEN	CON-DUCTOR	FILL PIPE	MATERIAL / GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)
1	235	12	✓				PVC	6		
235	325	12		✓			PVC	6		3/4

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft. to Ft.		CE-MENT (✓)	BEN-TONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)
1	210	✓			
211	325			✓	Bird Eye

ATTACHMENTS (✓)
___ Geologic Log
___ Well Construction Diagram
___ Geophysical Log(s)
___ Soil/Water Chemical Analyses
___ Other ___
ATTACH ADDITIONAL INFORMATION, IF IT EXISTS.

CERTIFICATION STATEMENT
I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.
NAME [redacted]
[redacted]
C-57 95253
Signed [redacted] 10-15-04 377353
DATE SIGNED C-57 LICENSE NUMBER

IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

Figure 2-8 Example Well Profile Created by Data Management System

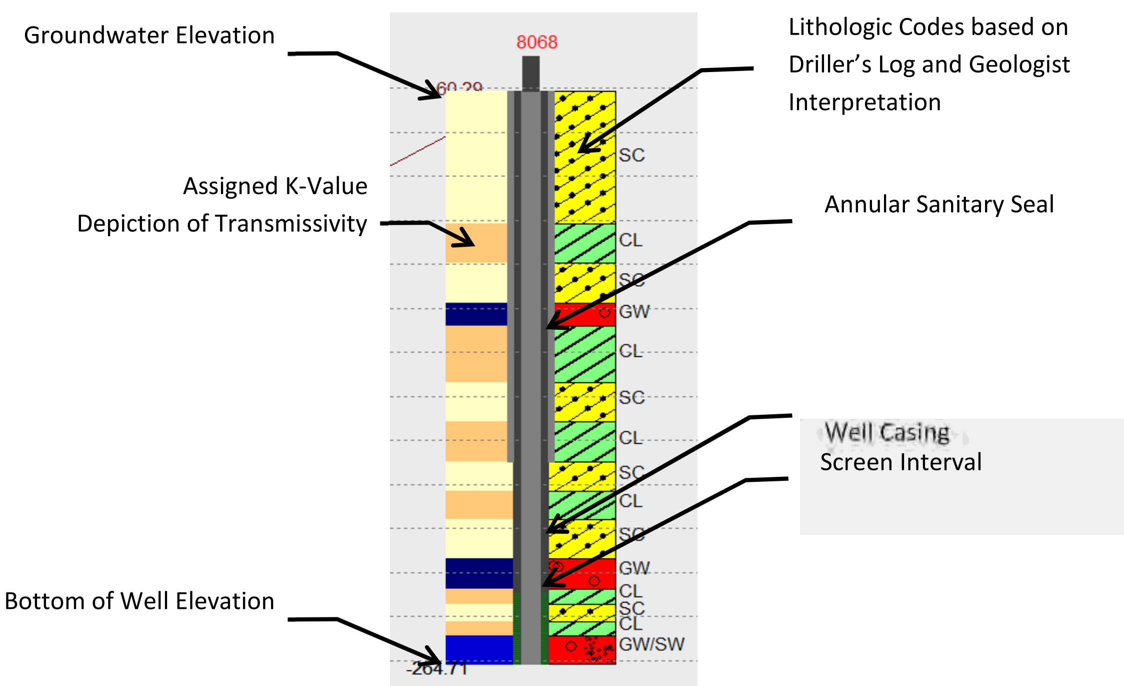


Figure 2-9 Geologic Cross Section A-A’

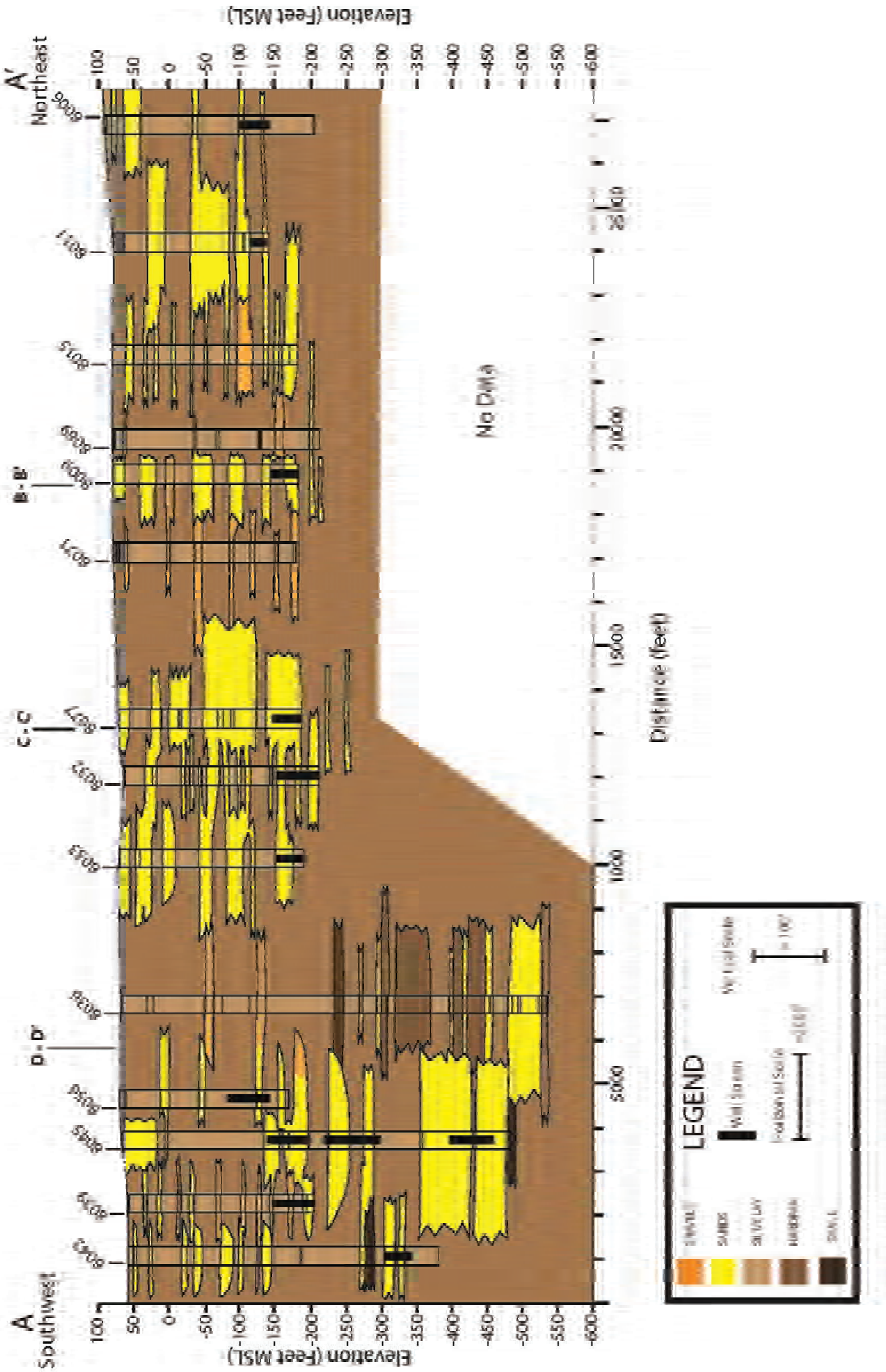
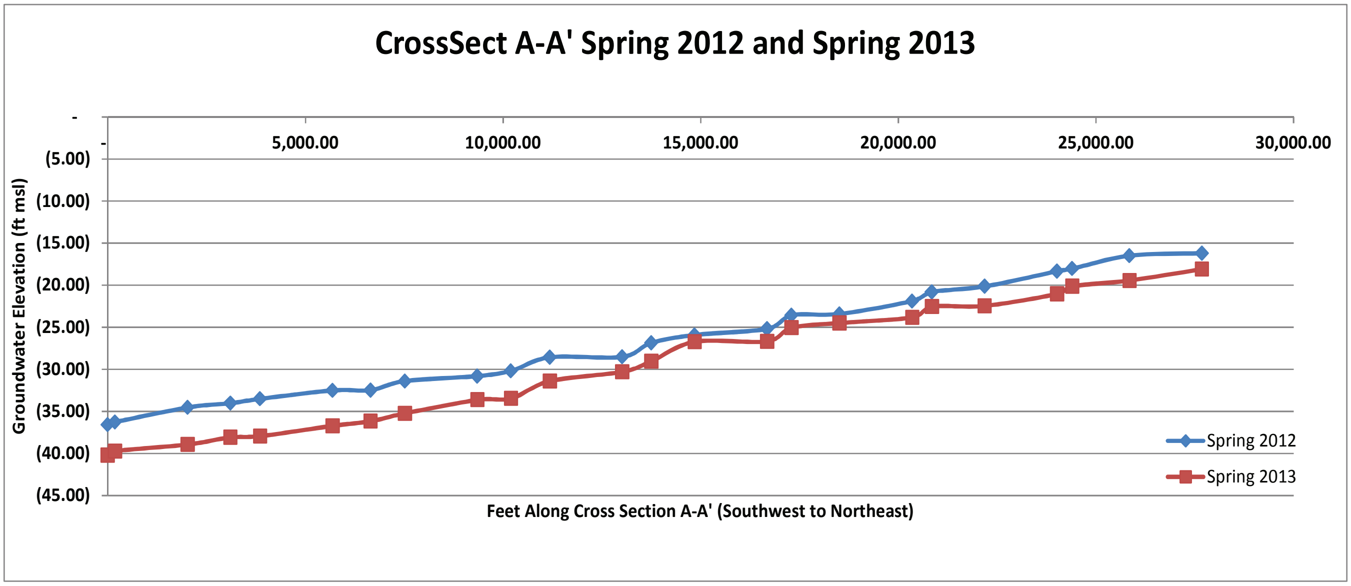


Figure 2-10 Groundwater Elevation Cross Section along Cross-Section A-A'

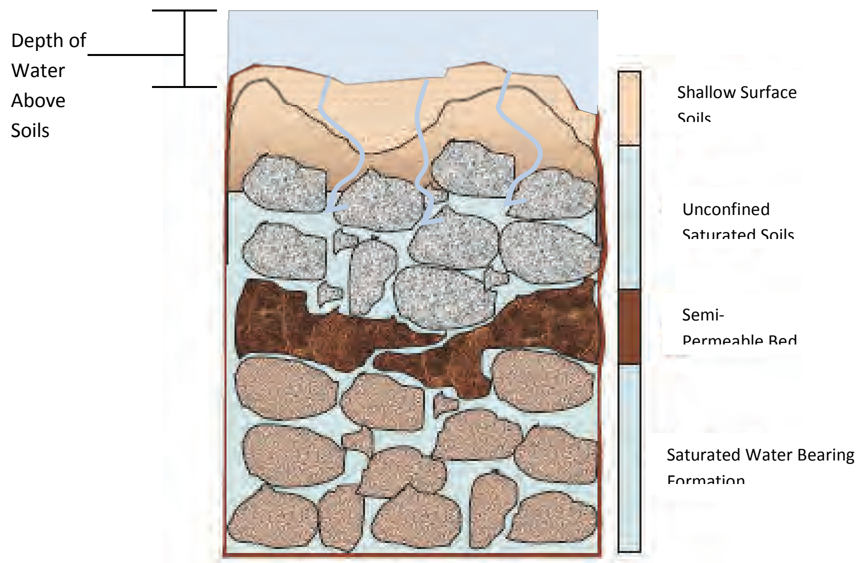


2.3.3.3 Conceptual Recharge Action

Ideally, water is applied to the project site at a fixed rate over time. In the case of a recharge spreading basin, as the depth of the water increases, the downward force on the water/soil interface increases, eventually pushing water below ground. Over time, and with sufficient rate of inflow water supply, the constant pressure induces recharge until an equilibrium condition is reached where the amount of recharge equals the amount of inflow water applied.

Once the water is beneath the soil surface and moves past the surface soils, including any plant root zone, gravity continues to apply a downward force on the water molecules into the unsaturated geologic subsurface. Once free of the root zone, water will initially fill in the available porosity (or void space, including capture by capillary action) and be held in the soil structure until saturated conditions occur, where gravity continues to force the water downward. Downward movement continues until the recharge water either reaches an aquifer or encounters an impervious clay layer where the water can become perched or forced to travel horizontally to a point where it can continue to move down vertically. This process is illustrated conceptually in Figure 2-11.

Figure 2-11 Conceptual Groundwater Recharge Action



The ability to measure change in groundwater elevations at a regional scale is difficult at the demonstration scale. The small amount of pond area and small volume of applied water may not create significant groundwater elevation changes that can be distinguished as occurring from the project, versus other from dynamic activities taking place on the groundwater system throughout the year. Especially, nearby high producing agricultural wells and lower producing private domestic wells may bias any measured change in groundwater elevations resulting from the project.

For the above reasons, the determination of feasibility of surface recharge from the project includes measurement of the quantity of applied water, and the calculation of how much of the applied water is recharged to subsurface soils and potentially to the regional water bearing aquifers. The calculation of recharge accounts for evaporation, and subtracts the minor amounts of evapotranspiration from existing trees and other naturally occurring plants within and along the perimeter of the project site.

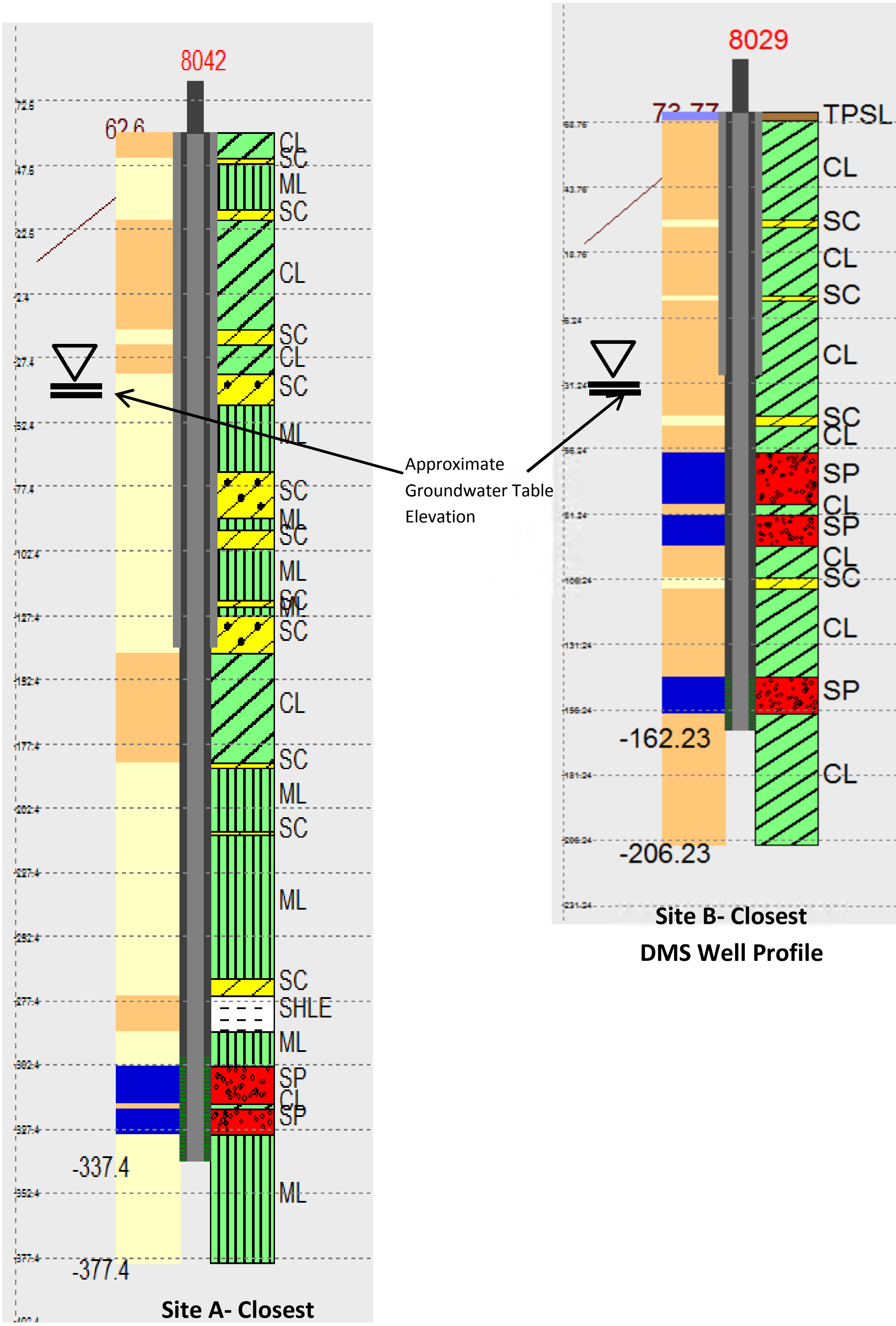
Any introduction of water to the underlying soils through surface recharge actions serves as a benefit to the groundwater basin, and given sufficient time a hydraulic flow path to the regional aquifer will be established.

2.3.3.4 Detailed Geologic Cross-sections for Project Sites

Both project sites are located near wells with driller's logs as described above. DMS Well ID 8042 and DMS Well ID 8029 are shown in Figure 2-12. The approximate Spring 2012 groundwater elevation is also indicated to provide an indication of the saturated soil layers. The numbers located on the left side of each cross-section are elevations, showing Well 8042 as a much deeper well with screens over 400 feet deep; whereas, Well 8029 screens are approximately 230 feet deep. The blue shaded area on the left side of each well is an indication of aquifer material with high transmissivity, and is typically where drillers will screen wells as construction takes place and downhole information is compiled.

As noted in the figure, spring 2012 groundwater elevations in both wells are very similar to each other and those around them. Given this similarity, one conclusion can be made that the aquifers of the two wells are likely in hydraulic communication even with predominant clay layers separating aquifer materials, as shown in Cross- Section A-A' (Figure 3-6) and Appendix A.

Figure 2-12 DMS Well Profiles for Project Sites



Site A- Closest DMS Well Profile

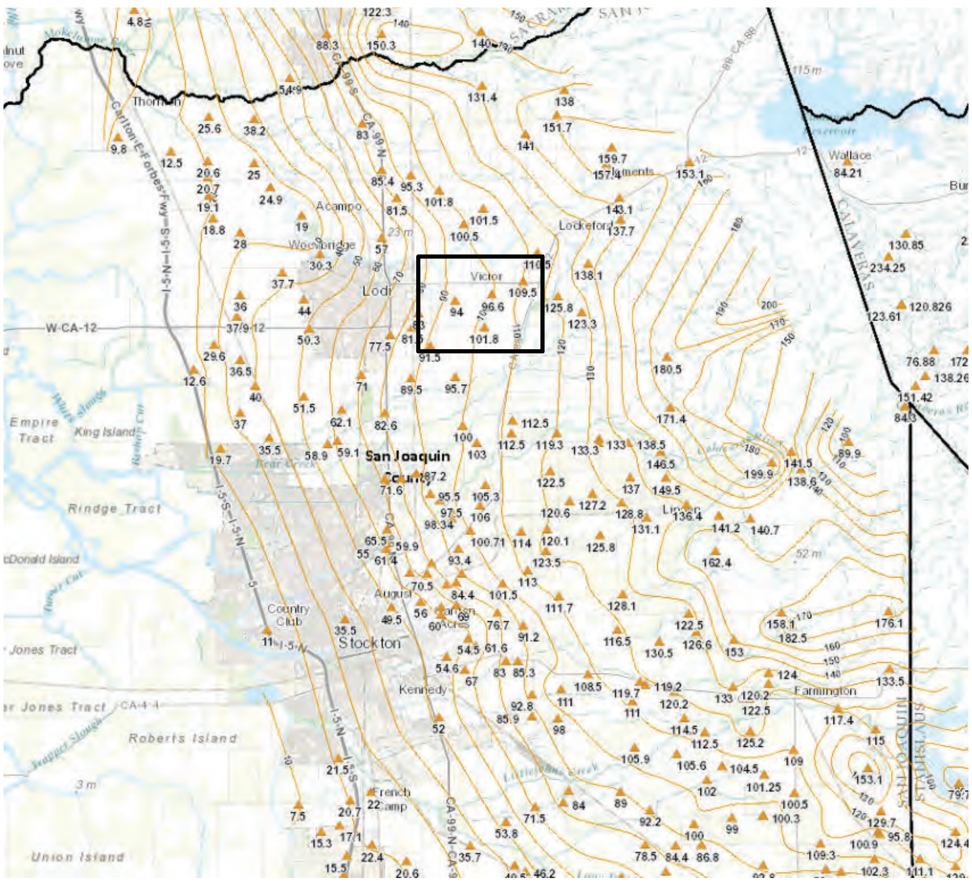
Site B- Closest DMS Well Profile

Note: Figures are closely matched to scale to show difference in well depth

2.3.3.5 Groundwater Elevations

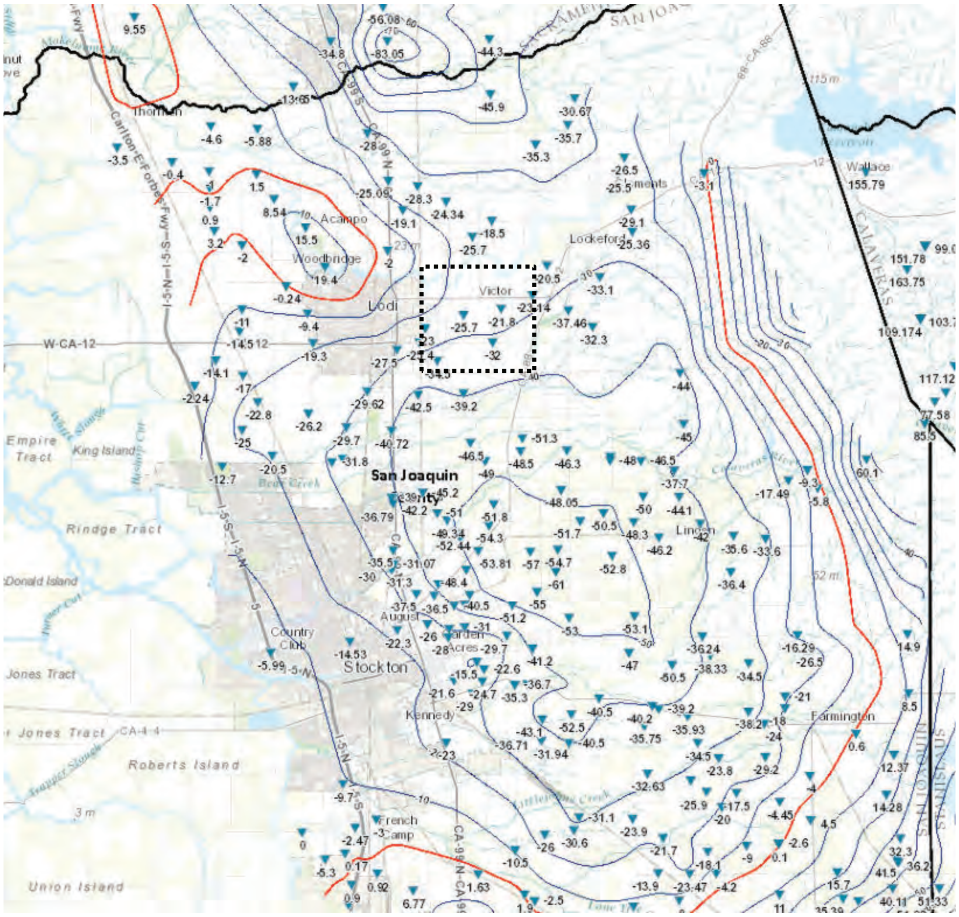
San Joaquin County and others measure regional groundwater elevations twice a year, typically in the spring and fall. Spring measurements indicate the maximum elevation (maximum storage) because of increased recharge from fall and winter rainfall events increasing natural rainfall recharge and natural recharge from rivers and streams. Spring depicts a sufficient period of time to allow groundwater levels to reach quasi-equilibrium from the previous year’s irrigation pumping and is often used as the true indicator of groundwater storage in a groundwater basin. Examples of the California Statewide Groundwater Elevation Monitoring (CASGEM) program contours for spring 2013 depth to groundwater and groundwater elevations are shown in Figure 2-13 and Figure 2-14, respectively.

Figure 2-13 Regional Depth to Groundwater Contours (Spring 2013)



Source: http://gis.water.ca.gov/app/groundwater/

Figure 2-14 State DWR Regional Groundwater Elevation Contours (Spring 2013)



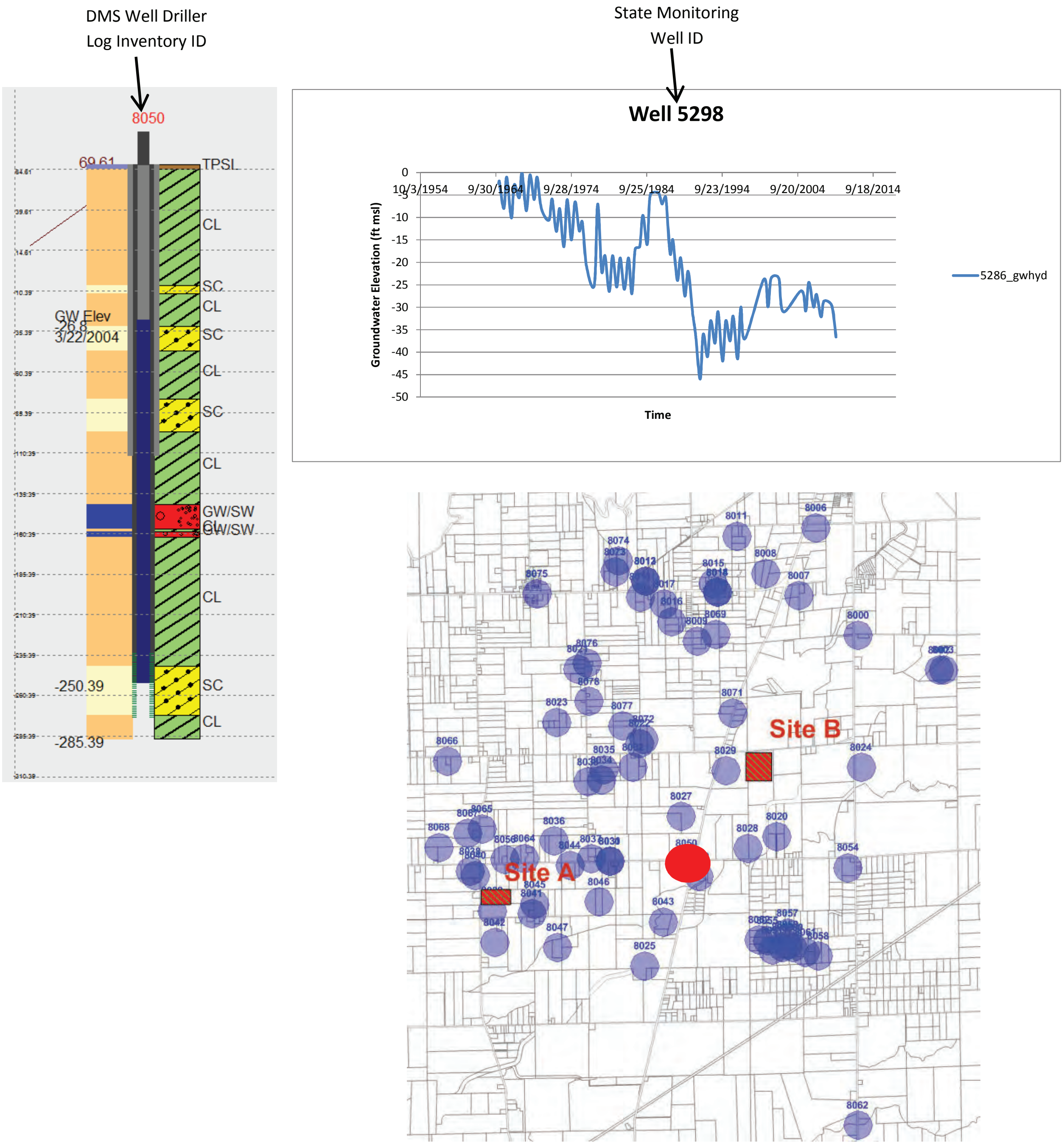
Source: http://gis.water.ca.gov/app/groundwater/

Fall measurements indicate the minimum elevation (minimum storage) after the summer months when natural recharge is at its lowest and agricultural pumping has occurred over the prior six months or so with very little time for groundwater recovery. This oscillating pattern between spring and fall is typical in areas like the project area where groundwater is the principal source of water supply. This oscillation is illustrated in Figure 2-15, using state monitoring well data near the project area.

2.3.3.6 Local Monitoring Wells

Monitoring wells used in the State's CASGEM program are often older wells where little is known about the well construction which leads to minimal understanding of exactly which aquifer is being measured. Based on the log information available, an interpretation can be made to provide a description of the underlying level of groundwater confinement leading to the presence of more than one aquifer, and the amount of communication taking place between aquifers. The location of three state monitoring wells has have been confirmed by GEI staff, and the well driller's logs are included in Appendix B.

Figure 2-15 Project Area State Monitoring Well with Driller Log Detail and Hydrograph



Given the known construction data, the screen locations are used to assess the aquifer(s) being measured. The hydrograph and well profile for DMS Well ID 8050 (or Monitoring Well ID 5298) is provided in Figure 2-15. Unfortunately, it appears that this well was taken out of the well monitoring program in 2009.

The small amount of well data creates uncertainty in the State CASGEM data until a detailed inspection of each well and geophysical data can be obtained and evaluated to discern the aquifer(s) being represented in the published data. The State well groundwater elevation contours near the two sites for spring 2012 and spring 2013 are provided in Figure 2-16 and Figure 2-17, respectively. Spring 2014 data was not fully available.

Hydrograph data for monitoring wells shown in both contour figures (5000 series well IDs) have been extracted and are shown as indicated on the figures. Additional information (e.g., State Well ID) on these wells can be found in Table 2-5 and in Appendix C. The contouring method used for both figures is based on Kriging (using the program Surfer), a popular method of contouring when data are not uniformly distributed as is the case with the Project area. Any differences in flow direction or elevation between the State's interpretation of groundwater elevations and those provided in this report are a result of the method of contouring, QA/QC of the data, and the limited number of wells used in this study, compared to using all CASGEM wells.

Table 2-5 Additional Well Details for Hydrographs Shown in Figures

DMS Well ID	Given Well Name	State Well ID	X coord	Y coord
5278	SWPSJC11	03N07E36J001M	6806074	1785850
5279	SWPSJC12	03N07E35L001M	6797839	1785675
5280	SWPSJC13	03N07E35C002M	6798070	1787996
5286	SWPSJC19/8050	03N07E23C002M	6797914	1799899
5288	SWPSJC21	03N07E21L003M	6787515	1795898
5291	SWPSJC24	03N07E19J004M	6779439	1795560
5292	SWPSJC25	03N07E18D012M	6775611	1803512
5293	SWPSJC26	03N07E17K002M	6782768	1801622
5294	SWPSJC27	03N07E17D004M	6779524	1804849
5295	SWPSJC28	03N07E15C004M	6792636	1805022
5296	SWPSJC29	03N07E12P001M	6803278	1805424
5298	SWPSJC31	03N07E08E002M	6780664	1807439
5300	SWPSJC33	03N07E03R001M	6794090	1810949
5390	SWPSJC123	02N08E05C001M	6813800	1784154

Notes: 1. Yellow highlighted Wells are CASGEM Groundwater Monitoring Wells and are included in **Section 2.3.3.7.**
2. Wells 5288 and 5296 are closest wells to project site
3. Well 5286 is also included in the Driller's Log DMS as Well ID 8050

Figure 2-16 Spring 2012 Contours and Well Hydrographs

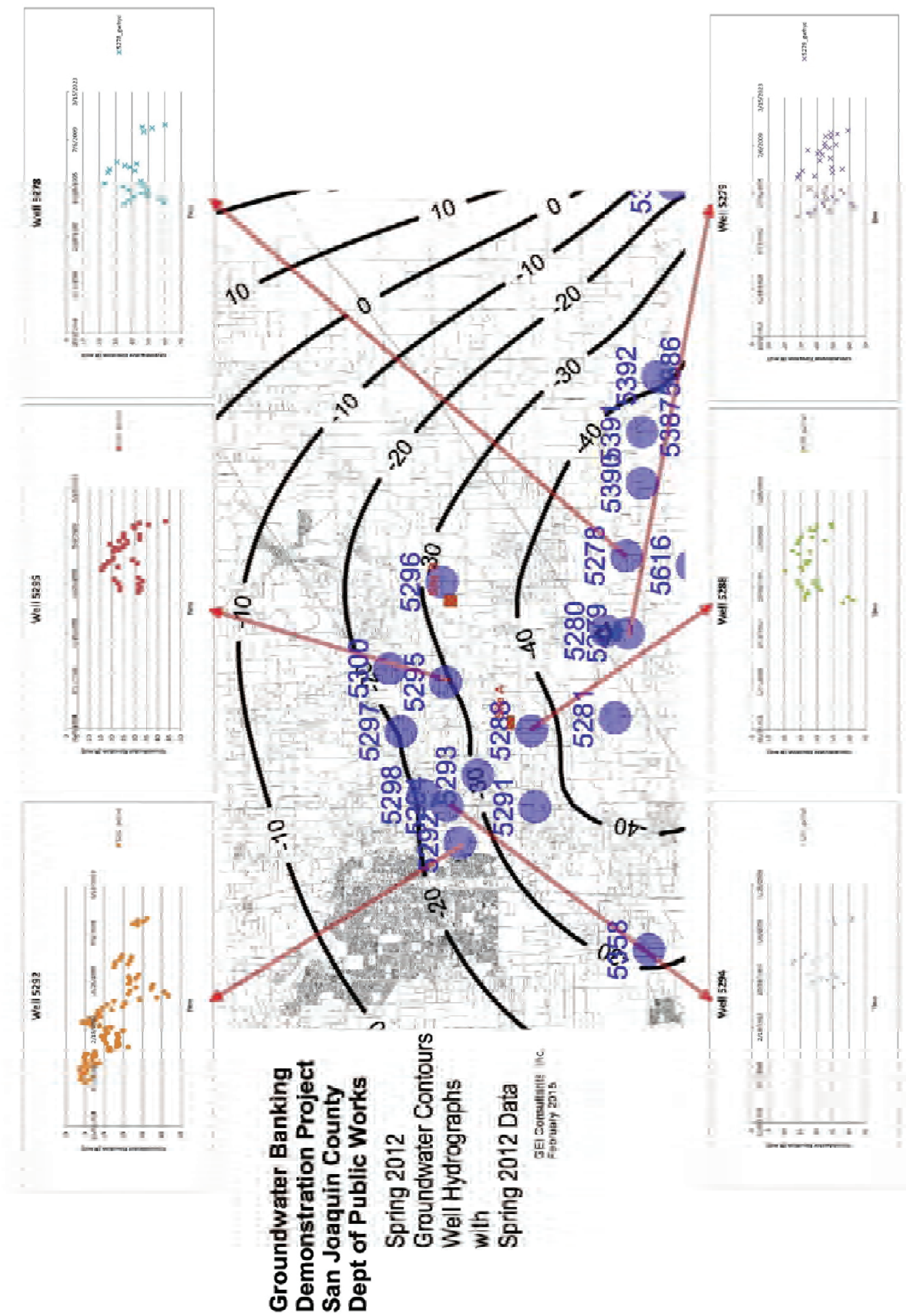
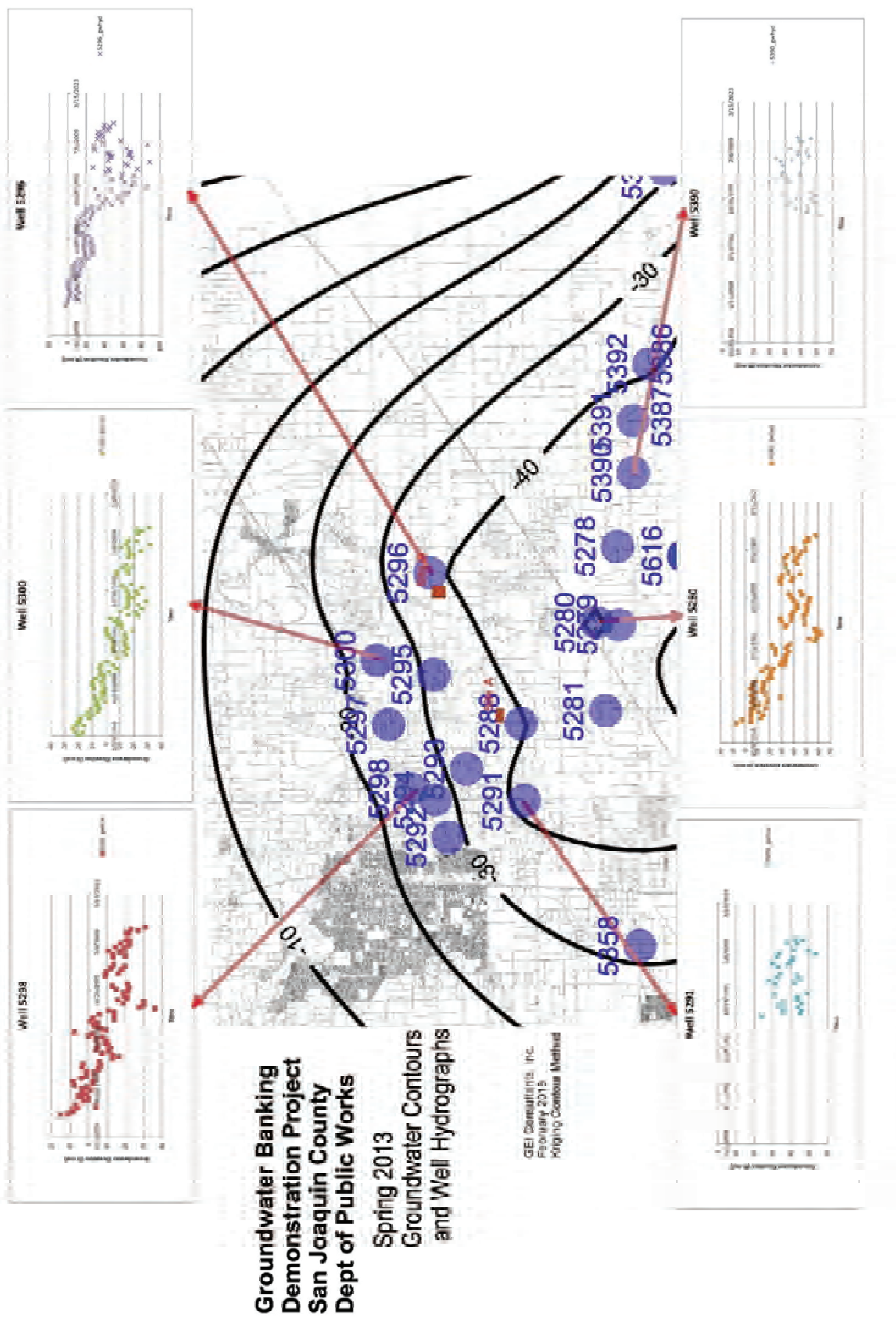


Figure 2-17 Spring 2013 Contours and Well Hydrographs



The visual difference between spring 2012 and spring 2013, both considered dry years, is not significant based on the absolute elevation contours shown in Figure 2-16 and Figure 2-17. Looking at Cross-Section A-A', elevations in Figure 2-9 (p. 2-14) also show little difference, not exceeding 5 feet over the entire record; however, there is an overall decrease in 2013, indicating increased pumping and reduced recharge from the dry year conditions.

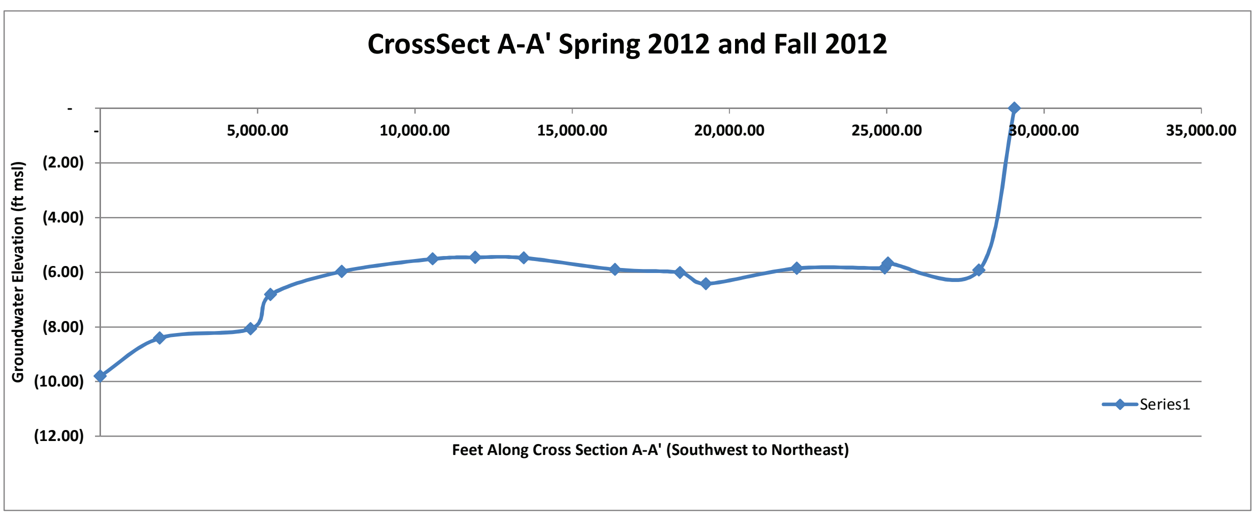
To show the difference over the entire Project area, a difference in contours is taken between the spring 2013 and spring 2012 elevation contours. Using 2-foot contour intervals, for additional exaggeration, the differences are clearly shown in Figure 2-19, and are likely the result of wells (or groups of wells) pumping more in 2013 contributing to the slightly reduced groundwater elevations shown along the cross section in Figure 2-9.

2.3.3.7 Influence of Regional and Local Groundwater Use in Project Area

Regional groundwater trends indicate overall groundwater movement toward the southeast, towards the regional cone of depression, the result of years of groundwater pumping in the region. The local influence from nearby agricultural pumping is clearly shown in Figure 2-17 by the localized cone of depression located south of the two project sites. A depression of this size is indicative of significant pumping volumes which can bias measurement data taken while implementing the project.

Up to this point groundwater elevations are characterized by their ability to recover year to year, having sustainable patterns of elevations as shown in the above hydrographs for the project area. The more dynamic changes in groundwater elevations are seen in the difference between spring and fall. The difference between spring and fall illustrates the temporary changes in groundwater elevations that can occur over a year. Cross-section A-A' (Figure 2-18) and difference contours (Figure 2-20) were used to assess this change.

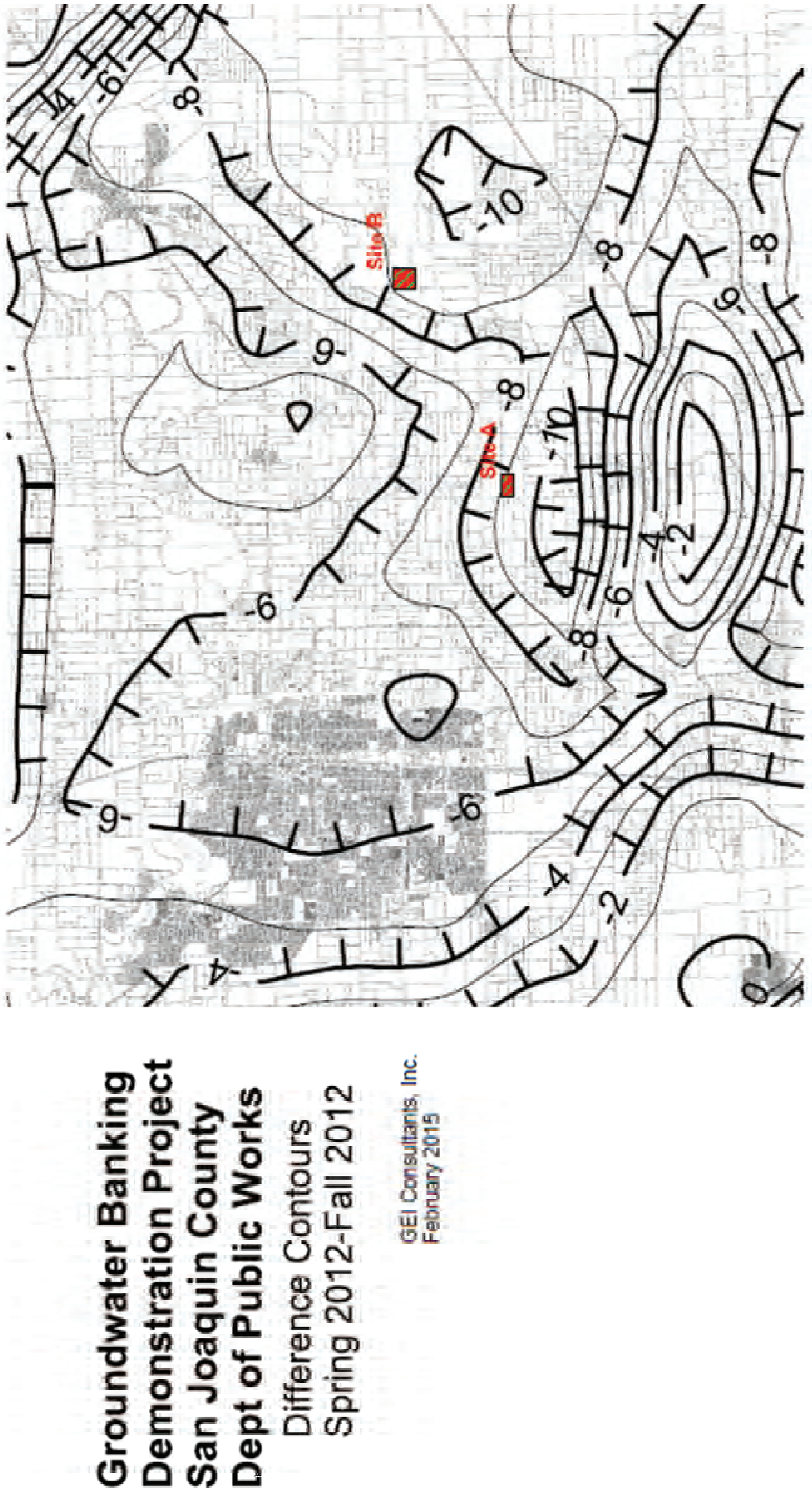
Figure 2-18 Groundwater Elevation Difference Spring – Fall 2012 along Cross-Section A-A'



Note: Site B is located south of Cross Section A-A' and between Cross Sections C-C' and B-B'

Figure 2-19 Difference Contours Spring 2013 Minus Spring 2012

Figure 2-20 Difference (Spring Minus Fall) 2012 Groundwater Contours



2.3.3.8 Groundwater Behavior Underlying Project Sites

This section associates Wells 5288 and 5296 to Site A and Site B, respectively and determines the most likely groundwater behavior for each site. Well construction details are only available for Well 5296, as indicated by the yellow highlighted wells in Table 2-5 (p. 2-22). See Appendix C for the original Well Driller's Logs for these wells.

3 Protest Dismissal Concepts

The November 2014 Protest Dismissal Agreement altered some of the site selection parameters. The dismissal calls the demonstration project to be located within the NSJWCD, and for the ability to recharge water from the Mokelumne River through the NSJWCD South System. If NSJWCD is unable to recharge the full amount available, water can be recharged within the Stockton East Water District.

In discussions with the PDT, an additional criterion required by EBMUD is that he Demonstration Project must physically export a meaningful volume of banked groundwater. A meaningful volume was informally suggested to be between 500 and 1,000 acre-feet.

Three primary configurations were considered:

1. Separated recharge and extraction sites – recharge from the NSJWCD South System with extraction near the Mokelumne Aqueduct
2. Co-located recharge and extraction using Mokelumne Aqueduct water only
3. A hybrid alternative using water from both the South System and Mokelumne Aqueduct and co-located extraction facilities

A comparison of the attributes of these primary configurations is presented in Table 3-1. In November 2014, both the PDT and the Technical Advisory Committee (TAC) endorsed the Alternative 3 hybrid alternative since it would recharge the most water and provide the most operational flexibility. As of February 2015, some stakeholders wished to reconsider the Alternative 1 separated recharge and extraction sites as the more economical alternative.

3.1 Protest Dismissal Layout

The project team identified an array of potential recharge areas and initiated landowner contact. As described in the Scope of Work,[52] landowner outreach efforts were to be led by the County[53] and EBMUD. In parallel with these activities, NSJWCD commissioned its own canvas of potential owners willing to take surface water deliveries. The NSJWCD and DREAM Project efforts were coordinated to avoid multiple landowner contacts. Owners of roughly 10 percent of the acreage in the South System area were contacted as part of these efforts. Parcels considered for direct recharge are mapped on Figure 3-1. These parcels were selected based on their soil type, proximity to the South System, and absence of permanent crops or structures.

[52] Consulting Engineering Services Agreement Task 2.5
[53] San Joaquin Flood Control and Water Conservation District

Table 3-1 - Comparison of Primary Recharge and Extraction Configurations

Alternative:	**1**	**2**	**3**
	Separated recharge and extraction sites	**Co-located recharge and extraction**	**Hybrid supply with co-located extraction**
Water Source	Mokelumne River via NSJWCD South System	Mokelumne Aqueducts	Mokelumne River via NSJWCD South System & Mokelumne Aqueducts
Schematic			
Benefits	Repairs to South System		Repairs to South System
		Co-located Recharge and Extraction	Co-located Recharge and Extraction
		Year-round operation	Year-round operation
	Low cost	Moderate cost	
		Avoids potential fishery issues	May avoid potential fishery issues
		Pressurized delivery	Partial pressurized delivery
		High recharge potential	Most recharge potential
Deficiencies	Separates area of benefit from area of impact		Most costly (but within $4M budget)
	Seasonal operational constraints		
	Least recharge potential		
Comments		Consistent with GEI Scope of Work	Consistent with Protest Dismissal Agreement

Two principal alternatives were developed – one that would utilize the west branch of the NSJWCD South System, and one which would use the east branch. Each alternative was developed with a recharge pond to capture winter flows, with substantial lands currently irrigated with groundwater that could be provided surface water during the irrigation season. Each alternative also included a pipeline to convey banked water to the Mokelumne Aqueduct. A simplified map of these alternatives and parcels that might be conveniently served surface water from the South System are shown in Figure 3-2.

Figure 3-1 - Parcels Investigated for Direct Recharge

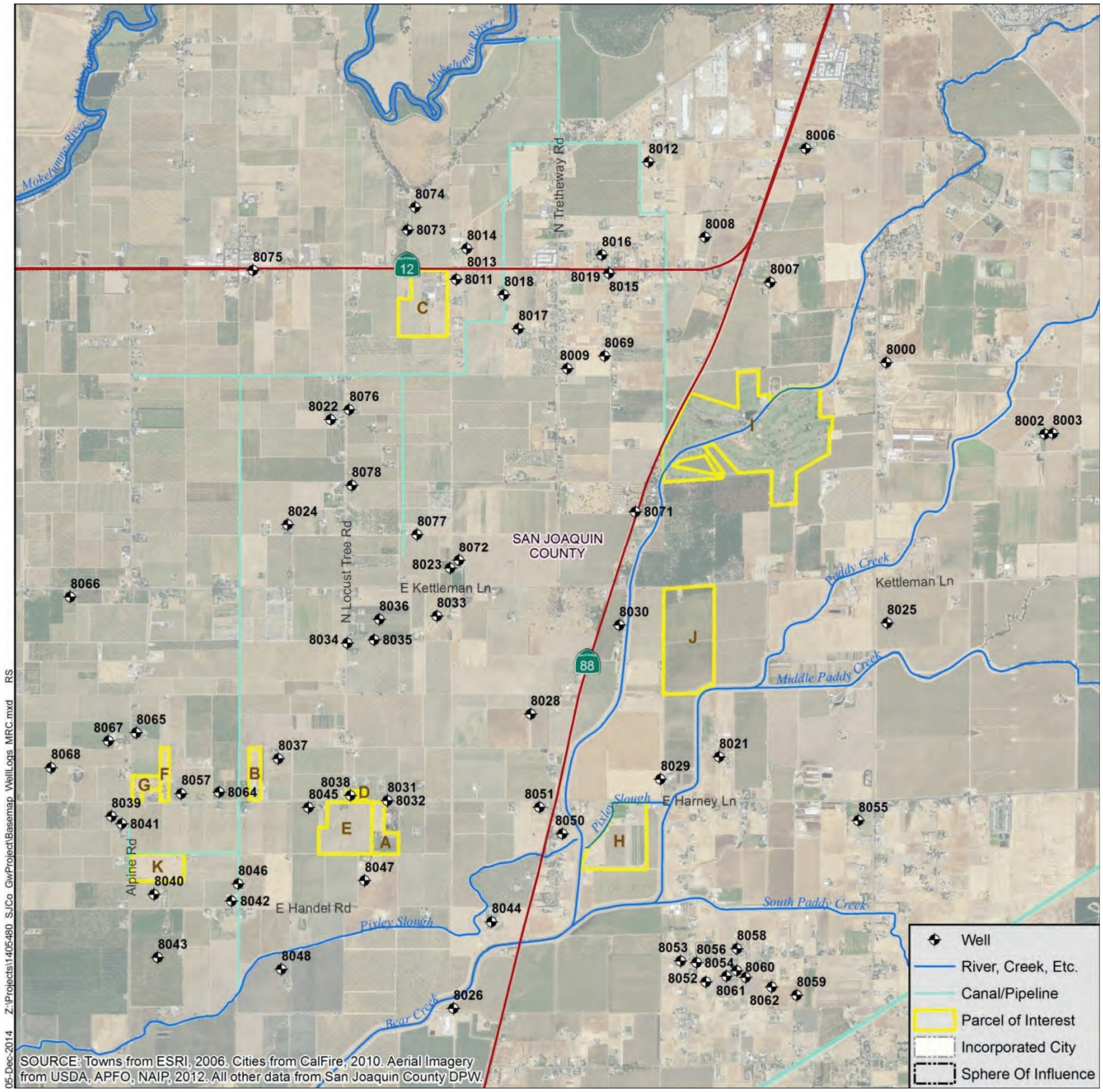
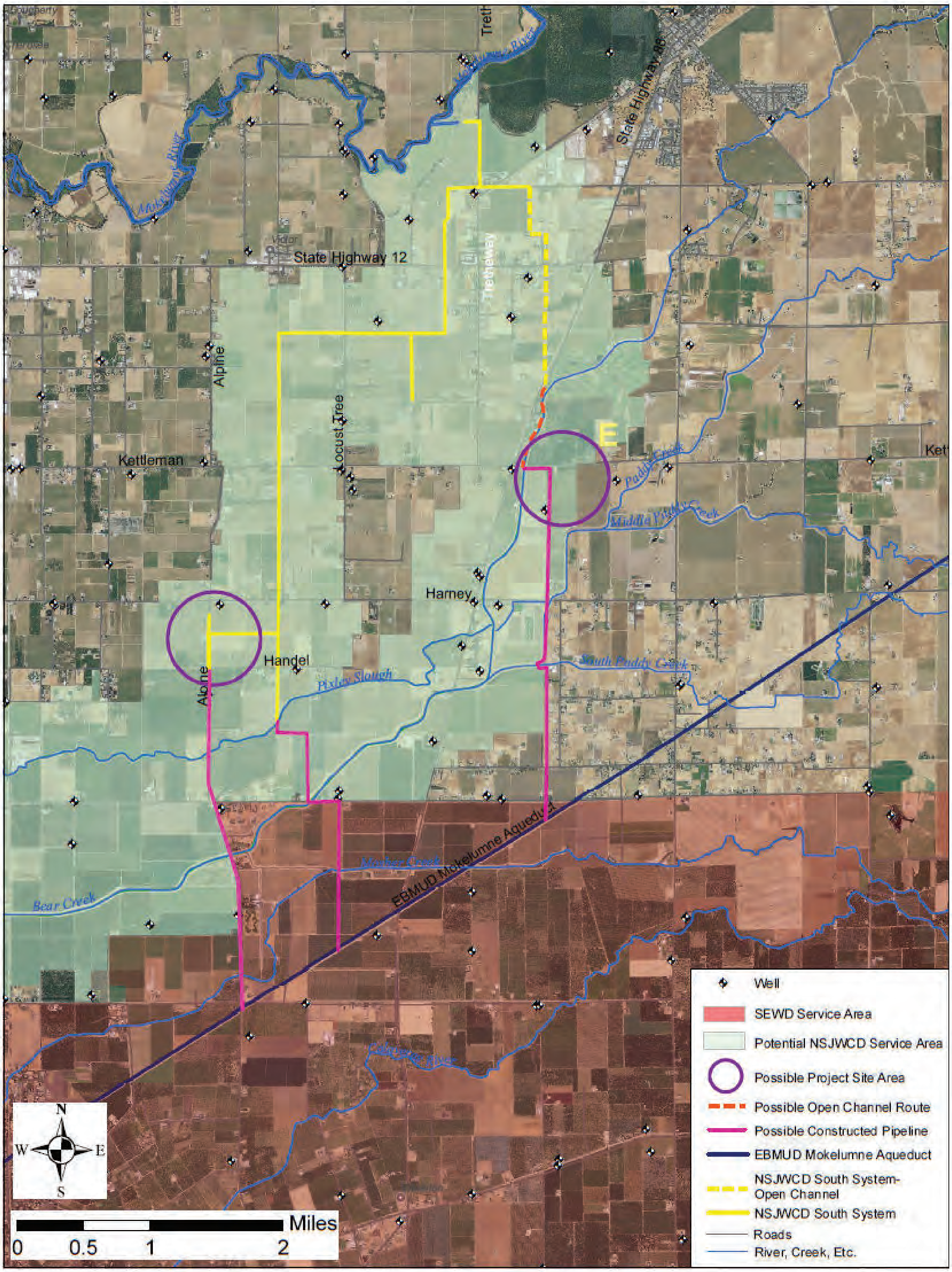


Figure 3-2 – Protest Dismissal Alternatives and Potential In-Lieu Service Area



The western alternative uses the NSJWCD pipeline distribution system. The eastern alignment relies on open channel conveyances (both constructed canals and local creeks). Another consideration is the length and thus cost of the return pipeline to the Mokelumne Aqueduct. A comparative list of parameters of the two alternatives is presented as Table 3-2.

The western alternative was preferred by members of the PDT and TAC as the more affordable, and most compatible with NSJWCD's plans for rehabilitation of the South System. Key features of the west route are the relatively short (1.8 miles) length of pipeline required, and selection of a route that could utilize existing bridges to carry the demonstration project piping. Initial estimates indicate the west site facilities could be constructed within the budget described in the Protest Dismissal.

An alternative western pipeline alignment along Alpine Road was also examined. This alignment could also make use of County road bridges, but is significantly longer (3.3 miles).

The eastern alternative uses a relatively longer pipeline route (2.7 miles). The eastern alternative has fewer stream crossings, but uses canals and stream channels which will require diversion structures and pumps.

Table 3-2 - Comparison of West and East Projects

PARAMETER	WEST PROJECT	EAST PROJECT
Route from Mokelumne River	Combine MokR pump station pumping plants to increase efficiency	
	Pump from NSJ South Pump Station through 5.5 miles of existing NSJ western pipe system	Pump from NSJ South Pump Station through 1.0 miles of existing NSJ eastern pipe system to 1.7 miles of NSJ eastern canal system, 0.7 miles through Bear Creek, redivert through 0.2 miles of new pipeline
	Pipeline is believed to be in workable condition. Winter storm drainage from Victor is being conveyed to Pixley Slough.	All facilities exist except last 0.2 miles of pipeline and the new Bear Creek diversion. The canal facilities have an unknown capacity.
Percolation Site (up to 10 acres needed)	20 acre parcel adjacent to NSJ South System, planted annually in unirrigated oats	70-acre parcel 0.2 miles from Bear Creek, planted in corn or other feed crops and irrigated from nearby well shared by one other owner.
	38° 5'50.59"N 121°12'44.70"W	38° 6'55.47"N 121°10'3.66"W
	Joseph Trifiro, 13050 N. Alpine Rd, Lodi 95240, 209/365-1073	Stanley Chaves, 12108 E. Kettleman Ln., Lodi 95240, 209/329-4243
	Relatively few nearby small domestic parcels. Substantial nearby in-lieu potential.	Relatively few nearby small domestic parcels. Some nearby in-lieu potential.
	Horizontal conductivity Kh=193 ft/day = 106 ft/yr @0.0015	Horizontal conductivity Kh=122 ft/day = 67 ft/yr @0.0015
	Vertical conductivity Kv=0.25 ft/day	Vertical conductivity Kv=0.25 ft/day
Nearby Production and Monitoring Wells	Well 8042 Depth=440', 14" bore, 8" casing. Well 3039 Depth =260', 12' bore, 6" casing.	Well 8029 Depth=355'. 12" bore. 6" casing.
Route to Mokelumne Aqueduct	Flat route @~61'	13' drop over 3 miles (87' to 74')
	1.2 miles of existing South System to Pixley Slough	
	New Pixley Slough crossing - leveed (open cut, span, or tunnel)	

<table>
<tr><th>PARAMETER</th><th>WEST PROJECT</th><th>EAST PROJECT</th></tr>
<tr><td></td><td>Small local creek (open cut)</td><td></td></tr>
<tr><td></td><td>1.8 miles of new pipeline</td><td>2.7 miles new pipeline</td></tr>
<tr><td></td><td>New crossings of Bear Creek and Mosher Creek (bridge crossings available, cut, or tunnel)</td><td>New crossing of Paddy Creek</td></tr>
<tr><td></td><td>High-head pumping plant</td><td>High-head pumping plant</td></tr>
<tr><td></td><td>Tap of Mokelumne Aqueduct</td><td>Tap of Mokelumne Aqueduct</td></tr>
<tr><td></td><td>County road crossings (Live Oak)</td><td>County road crossings (Harney, Live Oak)</td></tr>
<tr><td></td><td></td><td>Alternative to route extractions through 3.3 miles of Bear Creek, new creek diversion to 1.3 miles of new pipeline. Eliminates crossing of Paddy Creek; adds crossing of Mosher Creek. Eliminates Harney crossing. Possible compatibility issues with Mokelumne Aqueduct.</td></tr>
<tr><td></td><td>Flowing backwards either from recharge site or from Pixley Slough will require approx. 5’ (2.2 psi) surcharge to high point at existing pipe junction.</td><td></td></tr>
<tr><td></td><td>
<table>
<tr><th>Q
cfs</th><th>ID
in</th><th>V
ft/sec</th><th>h_f
ft</th><th>h_f
psi</th></tr>
<tr><td>2</td><td>8</td><td>5.7</td><td>159</td><td>69</td></tr>
<tr><td>5</td><td>8</td><td>14.3</td><td>--</td><td>--</td></tr>
<tr><td>2</td><td>12</td><td>2.5</td><td>22</td><td>10</td></tr>
<tr><td>5</td><td>12</td><td>6.4</td><td>120</td><td>52</td></tr>
</table>
At 2 cfs, would need to rebuild NSJWCD South System from recharge site to Pixley Slough, or use 12” pipe, or install low-head pumping plant at Pixley Slough.
1 cfs = 60 af/mo</td><td>
<table>
<tr><th>Q
cfs</th><th>ID
in</th><th>V
ft/sec</th><th>h_f
ft</th><th>h_f
psi</th></tr>
<tr><td>2</td><td>8</td><td>5.7</td><td>238</td><td>103</td></tr>
<tr><td>5</td><td>8</td><td>14.3</td><td>--</td><td>--</td></tr>
<tr><td>2</td><td>12</td><td>2.5</td><td>33</td><td>14</td></tr>
<tr><td>5</td><td>12</td><td>6.4</td><td>180</td><td>78</td></tr>
</table>
High pressure in 8” pipelines.
1 cfs = 60 af/mo</td></tr>
<tr><td></td><td>8” pipeline ~ $1.0M
12” pipeline ~$1.5M</td><td>8” pipeline ~ $1.5M
12” pipeline ~ $2.3M</td></tr>
<tr><td></td><td>Wetlands <0.5 ac – Nationwide Permit</td><td>Wetlands <0.3 ac – Nationwide Permit</td></tr>
</table>

3.2 Separated Recharge and Extraction Concept

Some members of the PDT and TAC noted the relatively high cost of the pipeline connection to the Mokelumne Aqueduct. This facility would be sized for the demonstration project, and would have to be paralleled or replaced for a full-scale project. The pumpback pipeline would cost from $0.9 million for the shortest route, up to $1.7 million for the longest route. If this facility could be eliminated or delayed, additional funding might be made available for improvements to the NSJWCD river intake, conveyance system, and on-farm connections.

The alternative of separating the recharge and conveyance sites was discussed with the PDT (San Joaquin County and EBMUD), and the TAC (NSJWCD and SEWD representatives and others). The boards of NSJWCD and SEWD were also briefed on the concept by their staffs and management. There was general consensus that such an approach would be acceptable if there is widespread (and perhaps unanimous) support for the concept. The proposed project, making use of the existing Beckman well used in the 1999 pilot study, was developed to a conceptual level but was ultimately rejected by the landowner and did not proceed further.

3.2.1 Issues Implicated by the Separated Concept

Elements of the Success Criteria, Project Principles, and San Joaquin County Groundwater Export Ordinance all contain elements that might require revision or adjustment if the Groundwater Banking Program utilized the separated recharge and extraction concept.

3.2.1.1 Success Criteria

The September 24, 2013 MOU between the County and EBMUD states the Demonstration Project must meet a number of criteria to be deemed a success. These criteria, together with commentary relevant to the Separated Recharge and Extraction concept are reported in Table 3-3.

Table 3-3 - 2013 Success Criteria and Commentary

MOU Success Criteria	Comments
Show net improvement in aquifer levels even when permitted withdrawals are made.	*The concept described in the Scope of Work includes both in-lieu and pond recharge. In-lieu recharge alone will spread the benefit over a wide area and may be imperceptible at the volumes we are considering.*
Demonstrate extraction for in-county and outside the county purposes.	*The Separated Concept includes many more stakeholders, each with the potential to block the project.*
Demonstrate a means by which Parties are assured the use of stored water when they need it.	*The recharge areas will be better off, but the extraction areas will be impacted by lower water levels. A strict accounting methodology (e.g. more in than out) is one possible solution. Providing some recharge in the extraction area is another possible solution, but this will be more complex and expensive. Impacts to the extraction area might be reduced by restricting extractions to non-irrigation periods, but would require pumping at twice the rate to achieve the same volume.*
Be acceptable to the local community and other stakeholders.	*Will need to make sure impacts in the extraction area were avoided or mitigated. The physical movement of recharge water is very slow, on the order of 100 feet per year.*
Have the ability to scale up and provide a sound basis for a larger banking project.	*The concept of recharging up-gradient and extracting 3-5 miles down-gradient is a long-term regional strategy that will require buy-in from a much larger stakeholder group.*

3.2.1.2 Project Principles

The DREAM Project PDT developed and reviewed draft Project Objectives, Principles and Objectives.[54] Initial discussions with the project sponsors were conducted prior to the June 18, 2014 project kick-off meeting, where Project Objectives were discussed and refined. Further refinements were made at the August 21, 2014 Project Development Team meeting.

The overall objectives are to:

- Improve supply sustainability for all parties
- Improve groundwater conditions in the basin
- Promote and enhance agricultural viability

The Demonstration Project Phase 1 objective is to:

- Develop substantial evidence that a groundwater recharge, storage and extraction project is feasible prior to investment in large-scale facilities, with feasibility established by demonstrated project consensus, technical feasibility, and a completed implementation agreement.

A set of Project Principles, Rights and Responsibilities are to serve as foundational assumptions from which the Demonstration Project and subsequent phases will be developed. These Project Principles, Rights and Responsibilities and commentary related to the separated concept are presented in Table 3-4.

Table 3-4 -Demonstration Project Principles, Rights & Responsibilities & Separated Project Comments

Project Principles	Separated Project Comments
Overlying water rights will be respected and protected	
Overlying water users affected by the Project will receive benefit	*Need to determine benefit for overlying water users in extraction area*
Water banking operations will result in a net recharge[55]	
Recognize higher value of dry-year supply and improved groundwater conditions	
Groundwater bankers will receive a right to recover banked water in dry years	
EBMUD Rights and Responsibilities	
EBMUD will supply available surface water from the Mokelumne Aqueducts	*Supply from both the Mokelumne River and Mokelumne Aqueduct is being considered. Integrating capacity to recharge NSJWCD water is now being considered.*

[54] White Paper 1, "Objectives, Principles and Methods", September 23, 2014 Draft

[55] Quantify net recharge to the operations area and the Eastern San Joaquin Groundwater Basin; Quantify fractions of recoverable and non-recoverable water

Project Principles	Separated Project Comments
EBMUD would fund the capital facilities necessary for its share of groundwater recharge obligations and groundwater extraction needs[56]	*The Protest Dismissal Agreement provides for EBMUD to fund up to $1.75M for new or upgraded capital facilities for NSJWCD.*
Water recovery would be subject to the 5% per year loss specified in the San Joaquin County Groundwater Ordinance[57]	
EBMUD would be provided a guaranteed dry year supply, subject to clearly delineated conditions related to the rate and volume that could be extracted	
San Joaquin County Rights and Responsibilities	
San Joaquin County will lead stakeholder outreach efforts	
San Joaquin County will identify willing landowners	
San Joaquin County will identify lands suitable for groundwater recharge operations	*Part of GEI Scope of Work*
San Joaquin County will procure engineering design, environmental documentation, and permitting support	*Part of GEI Scope of Work*
San Joaquin County will fund the capital facilities necessary for its share of groundwater operations[58]	*The Protest Dismissal Agreement provides for EBMUD to fund up to $1.75M for new or upgraded capital facilities for NSJWCD.*
San Joaquin County will control and operate the groundwater recharge and extraction facilities[59]	
San Joaquin County will monitor water levels and water quantities to establish baseline conditions and to determine impacts or benefits of project operations	
San Joaquin County will expeditiously publish groundwater monitoring results to a publically-accessible website	
San Joaquin County will negotiate terms and collect reasonable charges from project beneficiaries	

[56] Capital facilities may include aqueduct tap, valving and metering; transmission piping; recharge ponds; extraction wells; monitoring wells. Additional facilities may include localized on-farm distribution piping (e.g. to 160-acre units), and groundwater injection wells and associated pre-treatment works. Recovered groundwater could be, at EBMUD's option, pressurized to match the Pardee hydraulic grade line, or conveyed by gravity in one or more barrels of the Mokelumne Aqueduct for repumping at the EBMUD Bixler booster pump station.

[57] Up to 95% could be recovered one year from the time of recharge; up to 50% would be available after 10 years from the time of recharge

[58] Capital facilities may include transmission piping, valving and metering; recharge ponds; extraction wells; monitoring wells; or localized on-farm distribution piping.

[59] With appropriate cooperation with EBMUD, e.g. San Joaquin County will not operate or control the Mokelumne Aqueduct; facility ownership will depend on whether the parties form a partner or customer relationship

3.2.1.3 Groundwater Export Ordinance

The County's Groundwater Export Ordinance[60] was passed in June 2000 to establish a permit process regulating export of pumped groundwater to areas outside of the County. To date, no export permits have been granted. Key provisions of the Ordinance relevant to the separated concept include:

Table 3-5 - Groundwater Export Ordinance and Commentary

Key Export Ordinance Provisions	Separated Project Comments
The amount of water approved for export is limited to an amount that provides a net addition to usable groundwater underlying the project[61]	*The project area will need to be defined as a much larger area, with more stakeholders.*
Conditions to regulate the manner of extractions … may include the following: … (7) requiring a reasonable relationship between the points of extraction and the points of injection or recharge[62]	*Extractions will need to be from areas within NSJWCD, or the project area will need to be expanded to include areas adjacent to the Mokelumne Aqueduct, much of which are in SEWD (existing Beckman well is in SEWD). The centroid of recharge might be 3-5 miles from the centroid of extraction, with travel times on the order of decades.*
The project shall not create conditions that are worse than those that would have existed absent the project unless mitigated or overlying users are compensated[63]	*Need to carefully consider how landowners in extraction areas are protected or made whole.*

3.3 Strawman Project Description

The following is a proposed project description that was presented to project stakeholders for their review and to facilitate discussion on the configuration of both the demonstration project and the ultimate full-scale groundwater banking project.

3.3.1 Stage 1 – Base Demonstration Project

A project will be designed to convey water from the Mokelumne River to supply water along the west branch of the NSJWCD South System. Key features include:

Recharge Facilities

- Replacement of the NSJWCD intake and pumping plant to increase reliability and increase pumping efficiency, supporting NSJWCD's 40 cfs capacity goal
- Repair or replacement of key segments of the South System to allow distribution to meet the demonstration project needs

[60] San Joaquin County Ordinance No. 4064, "An Ordinance Amending Division 8 to Title 5 of the Ordinance Code of San Joaquin County Regarding the Extraction and Exportation of Groundwater from San Joaquin County", June 27, 2000

[61] Groundwater Export Ordinance, Section 5-8340(c)(1), p.9

[62] Groundwater Export Ordinance, Section 5-8340(d), p.10

[63] Groundwater Export Ordinance, Section 5-8340(f), p.10

- Reservation of capacity in the NSJWCD system adequate to convey water to meet EBMUD's demonstration level recharge and banking needs; for design purposes this is set at 5 cfs, or the otherwise unused capacity, whichever is greater
- Lands shall be identified to make use of available water supplies through a mix of in-lieu supply to agricultural groundwater users and recharge ponds; the mix of recharge methods will be determined based on which months water is expected to be available
- If capacity exists that would allow both in-lieu and pond recharge, priority shall be given to supply in-lieu agricultural uses

Extraction Facilities

- Extraction facilities will be located in the vicinity of the Mokelumne Aqueduct; new and/or existing extraction wells will be used
- EBMUD will supply temporary pumping plants to boost extracted groundwater to Mokelumne Aqueduct pressure
- Mitigation for impacts caused by groundwater extraction shall be included in the design

Design, Permitting, Construction, and Monitoring

- The local parties will be responsible for stakeholder outreach and consensus building; the standard shall be overwhelming support for pilot project implementation
- Existing wells will be used to monitor water level response to recharge and extraction to the extent feasible
- Design of the Demonstration Project shall include consideration of facilities and locations for a full-scale design
- This design configuration will be used to secure a Groundwater Export Permit
- All facilities will be designed to be constructed or upgraded for $4 million or less, unless additional local funding is provided

3.3.2 Strawman Stage 1 Parameters

Within NSJWCD

- Develop design and cost estimate to replace NSJWCD South Pump Station to single lift facility supporting NSJWCD's 40 cfs capacity goal
- Develop in-lieu surface water service agreements with owners of approximately 1,280 acres along the NSJWCD west branch pipeline
- Develop design and cost estimate to rehabilitate as necessary the NSJWCD South System west branch pipeline to serve the 1,280 acres
- Develop turnouts, farm laterals, and metering to serve the 1,280 acres
- Determine location and sizing for a recharge pond of up to 10 acres
- Perform percolation testing
- Develop capacity sharing arrangement to allow recharge of EBMUD banking water

Within SEWD

- Identify existing wells with 5 cfs (2,200 gpm) capacity proximate to the Mokelumne Aqueduct that can be used for extraction
- Develop landowner agreements for use of wells and monitoring of water levels
- Perform pumping tests and water quality analyses
- Identify additional in-lieu lands that might be served from the Mokelumne Aqueduct
- Develop design for connective piping and metering
- Identify EBMUD booster pumps that can be used to boost groundwater to Mokelumne Aqueduct pressure

Administrative

- Develop and execute operating agreement
- Develop and execute stakeholder outreach program
- Perform environmental documentation
- Obtain permits
- Apply for Groundwater Export Permit

3.3.3 Stage 2 – Operation and Full Scale Configuration

Once the Export Permit has been granted, the Demonstration Project will be constructed and operated, and planning for the full-scale phase will commence.

Construct and Operate

- If the Groundwater Export Permit is granted, this configuration will be constructed and operated for a period adequate to recharge a significant amount of water, and physically extract and export a significant amount of water subject to the terms of the Permit
- All Demonstration Project facilities will be constructed or upgraded for $4 million or less, unless additional local funding is provided
- Bid work
- Construct necessary facilities
- Operate 3-5 years or as necessary to demonstrate recharge and export operations

Full-Scale Project Initiation

- Full-scale recharge, extraction and export facilities will be designed to a level that can be readily used for a grant application, should a compatible grant program become available; facilities would include a pipeline connection to the Mokelumne Aqueduct with the capability of providing pressurized water service, recharge ponds, a high-head pump station for returning water to the Mokelumne Aqueduct, and extraction and monitoring wells; the initial assumption for conveyance capacity is 20 cfs
- Apply for grant funding for full scale facilities

4 Final Project -- In-Lieu Recharge with Residual Value Facilities

4.1 Project Layout

The final project configuration was simplified to an all in-lieu recharge project with a pipeline connection to the Mokelumne Aqueduct to return banked water to EBMUD. Two configurations were considered: a west site alignment utilizing the west branch of the NSJWCD distribution system, and an east site alignment using the east branch of the NSJWCD distribution system. Both alternatives use reaches of Pixley Slough or Bear Creek for conveyance of recharge water.

The western alternative was selected by members of the PDT and TAC as the most compatible with NSJWCD's plans for rehabilitation of the South System. Key features of the west route are 2.8-mile pipeline, routing along existing farm roads to minimize construction costs, and use of an existing bridge for the crossing of Bear Creek. The initial design sized the pipeline at 8-inches in diameter. The pipeline was subsequently upsized to a 12-inch diameter which would allow multiple greater utility for conveying water locally, whether or not a full-scale project is ultimately constructed.

For the west site alignment, water would be recharged using existing NSJWCD South System pipeline facilities to customers along Pixley Slough, including lands owned by Kautz Farms. A return pipeline would extend from the Mokelumne Aqueduct to just north of Live Oak Road along Alpine Road. The route utilizing Pixley Slough will reduce the pipeline length and number of crossings by about one-third versus a connection to the South System. The key features of the west site alignment are shown schematically in Figure 4-1 and Figure 4-2.

A listing of key design parameters is provided in Table 4-1. Among these parameters are:

- Water supply to approximately 350 acres at an estimated 2 acre-feet per acre. It will likely take two irrigation seasons to recharge the target 1,000 acre-feet
- Use of an existing farm well for extraction – this 100 horsepower well will be adequate to convey water to the Mokelumne Aqueduct
- 2.8 miles of 12-inch diameter high-density polyethylene (HDPE) pipeline
- Use of the existing Leffler farm bridge for the crossing of Bear Creek
- A rented high-head pump for pressurizing extracted water up to Mokelumne Aqueduct pressure.

Figure 4-1 West Alignment Schematic

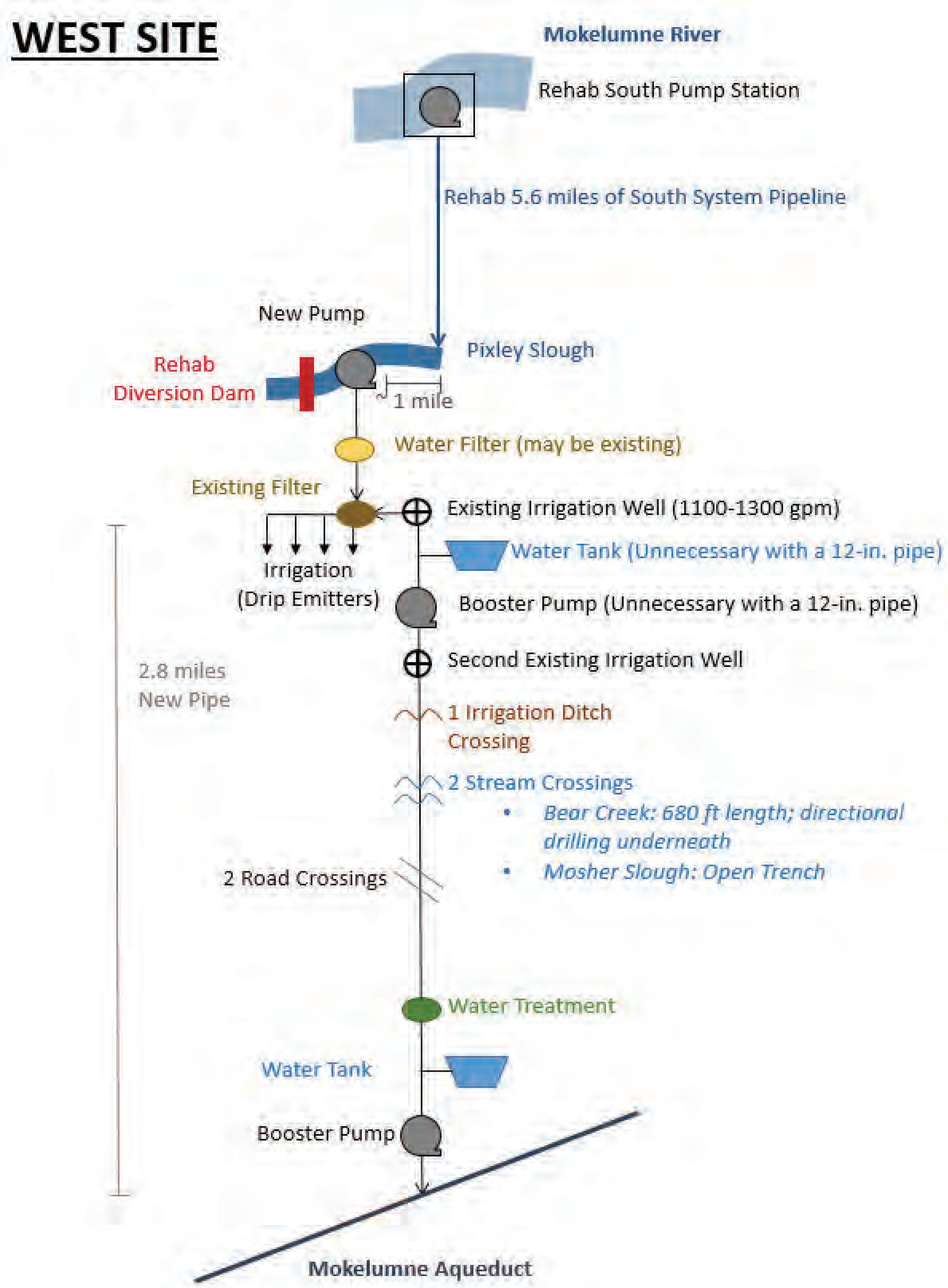


Figure 4-2 Overview of West Site Alignment

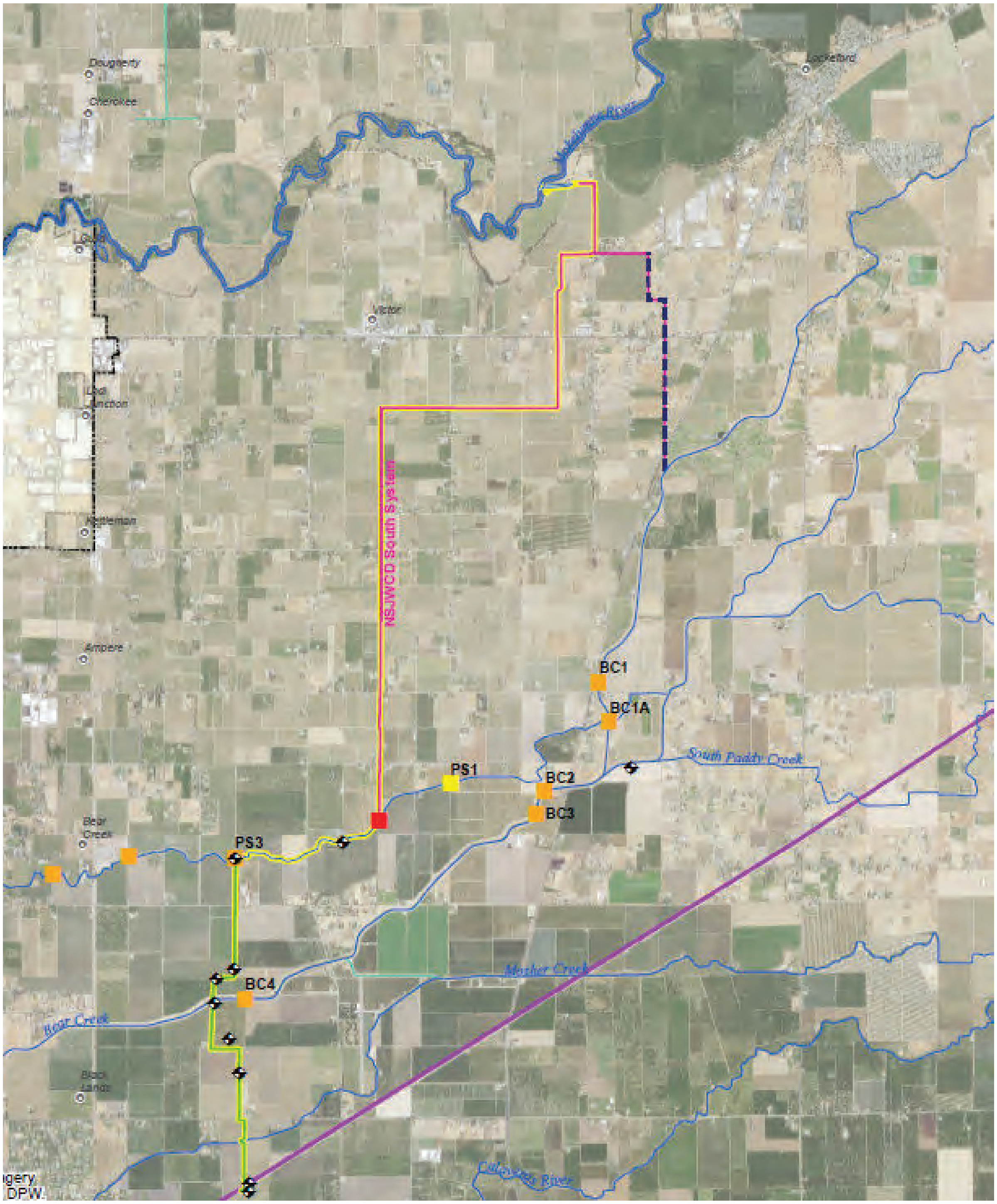


Table 4-1 West Site Alignment Design Parameters

Locality	West Side Alignment
Primary Owner	Kautz
Diversion Point	NSJWCD Mokelumne River South System -- $2.0M rehab
Conveyance to creek/slough	NSJWCD pipeline – unknown repair cost
Re-Diversion Point	Pixley Slough
Diversion Dam	Use one or two rehabilitated existing diversions. Rehabilitate existing diversion dam. Provide for quick removal. Approx. 30 ft bottom width.
Diversion Rate	5 cfs (2,200 gpm)
Diversion Pump	Require 1 new pump
Primary Crops	Wine grapes
Annual Water Requirement	2.0 AF/ac
Irrigated Acreage	~350 ac
Irrigation Supply	700 AF/yr
Irrigation Seasons for 1,000 AF	1.4
Surface Water Filtration	Filtration for algae and substances that might clog emitters - Sand Media Filter Utilize existing filtration system.
Import Pipeline	25 feet, 12" dia HDPE
Export Well	Existing 100 HP Kautz Well Production Estimated at 1100-1300 gpm = 2.45 – 2.90 cfs Est. existing system pressure 30 psi.
Tank	No Baker Tank
Booster Pump	No Booster Pump
Export Pipeline	14,700 ft (2.8 miles), 12" dia HDPE Farm Road Buried Pipe Length – 14,080 ft County Road Buried Pipe Length – 320 ft Bear Creek Crossing – Anchor to existing crossing structure. Feasibility not yet confirmed due to lack of structural information on bridge. Mosher Slough Crossing – Open Trench with concrete encasement – 60 ft
	<u>TDH:</u> Start approx. surface elev. = 56 End approx. surface elev. = 49 Friction Head Loss 12" dia @ 2 cfs = 31 ft 12" dia @ 3 cfs = 65.1 ft Sand Filtration/Water Treatment Head loss = 12' Baker Tank Height = 8' Air Gap = 2' **Pressure Head @ 2 cfs = 53' = 23 psi** Pressure Head @ 3 cfs = 87' = 37.7 psi
	Velocity 12" dia = 2.5 ft/s at Q= 2 cfs
	2 stream crossings <u>Bear Creek</u> Farm Bridge Structure – 130'. Anchor pipe to structure. Feasibility of anchorage not yet confirmed due to lack of structural information of bridge crossing structure. Must be anchored to side of structure. Cannot hang below existing chord and cannot rest on top of bridge due to damage concerns from farm equipment.

Locality	West Side Alignment
	(Secondary Option) Directional drilling approx. 680 feet 30' under levees and channel downstream of the structure using flexible fusible PVC piping. Entrance/Exit must stay minimum of 10' away from projected levee slope and 30' below levee per CVFPB Title 23. Closure elements required on either side of channel. Mosher Creek Open-trench through channel. HDPE. Closure elements required on either side of channel. Minimum 5' cover below channel invert. 2' minimum cover along slopes. Reinforced concrete encasement under channel crossing. Soil stability and channel hydraulics required. Ditch Crossing South of Live Oak Road. Open trench through crossing under farm road. Remove and replacement of 3.5' x 4' steel culvert, using same steel culvert.
	Bear Creek and Mosher Creek Crossing CVFPB Permitting/approval required for piping underneath levees and channels.
	2 road crossings (Live Oak Road & E 8 Mile Road)
	0 driveway crossings
Easements	10 property easements (including Kautz) totaling 5-6 land owners.
Export Filtration	Sand Filtration and Water Treatment as necessary Treatment for metals not required. 12 ft head loss
Tank	21,000 gal Baker Tank Height/ Top Elevation 8 ft /~57
	Air Gap = 2 x OD = 24 inches
Treatment	Water Quality to be evaluated once site selected
Drawdown over 126 days	Vicinity of Alpine Road
Mokelumne Aqueduct Connection	Unknown power availability
	Booster Pump 2 cfs @ 200 psi = 150 HP @ e=0.70
	Export 500 AF: 126 days @ 2 cfs continuous
	Unknown control & telemetry requirements

Figure 4-3 Principal Features of the West Site Alignment

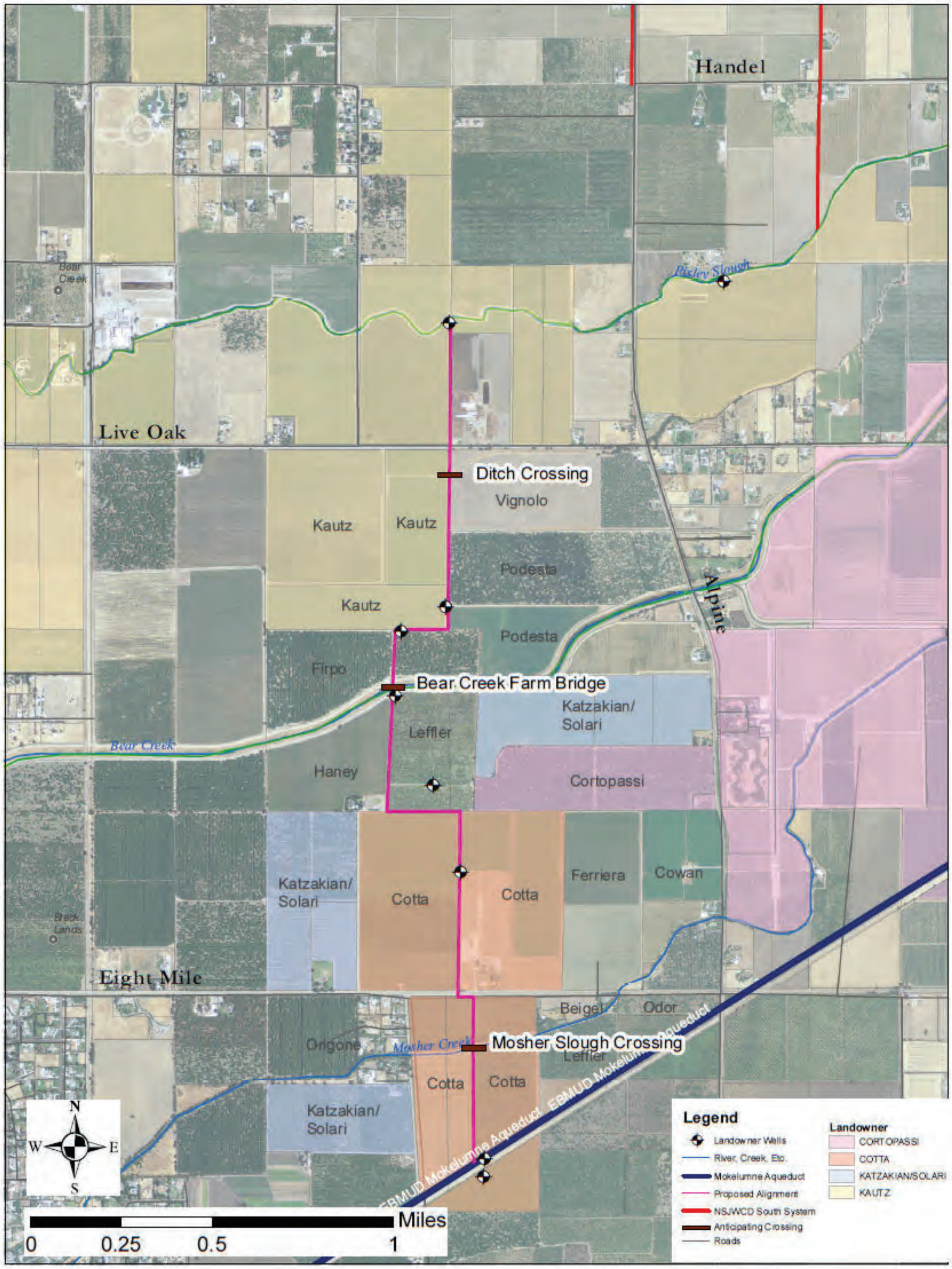


Figure 4-4 Typical Buried Pipe Section, Private Unpaved Land

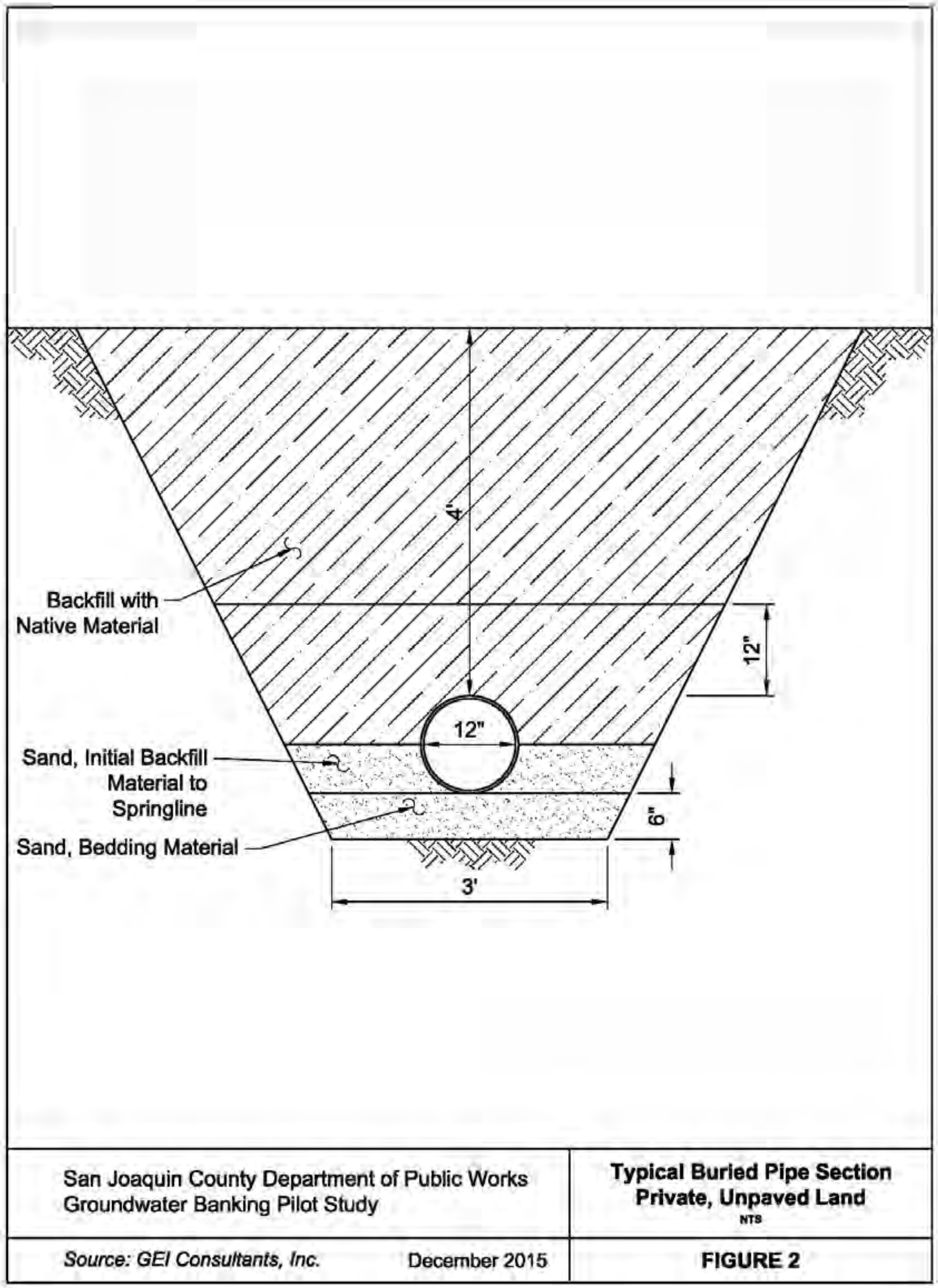
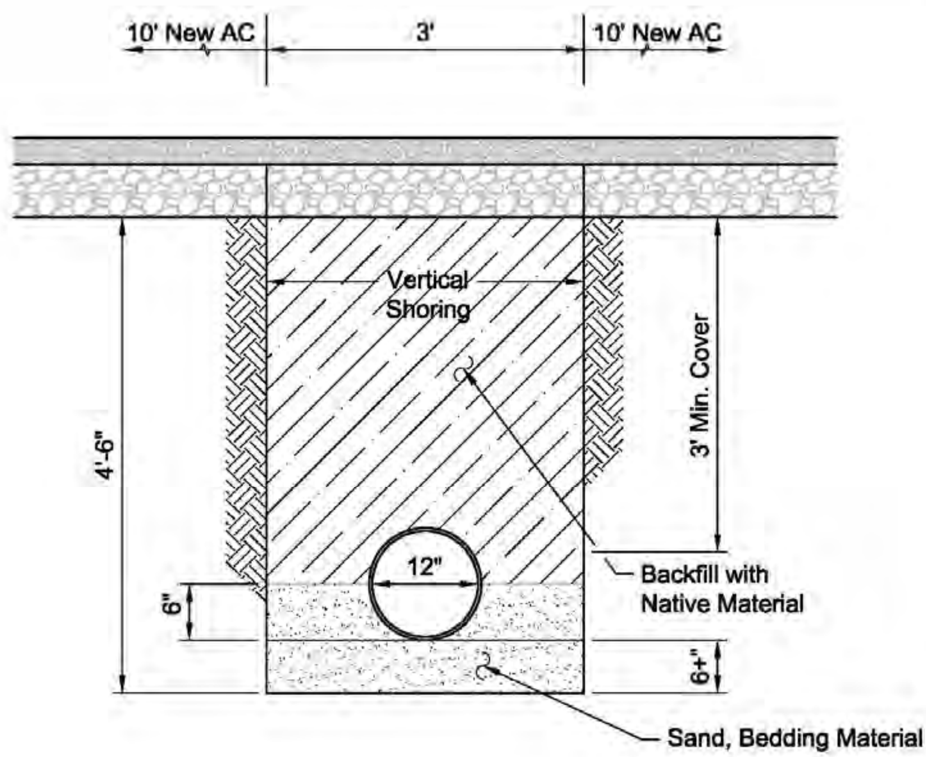


Figure 4-5 Typical Buried Pipe Section, County Road Paved Crossing

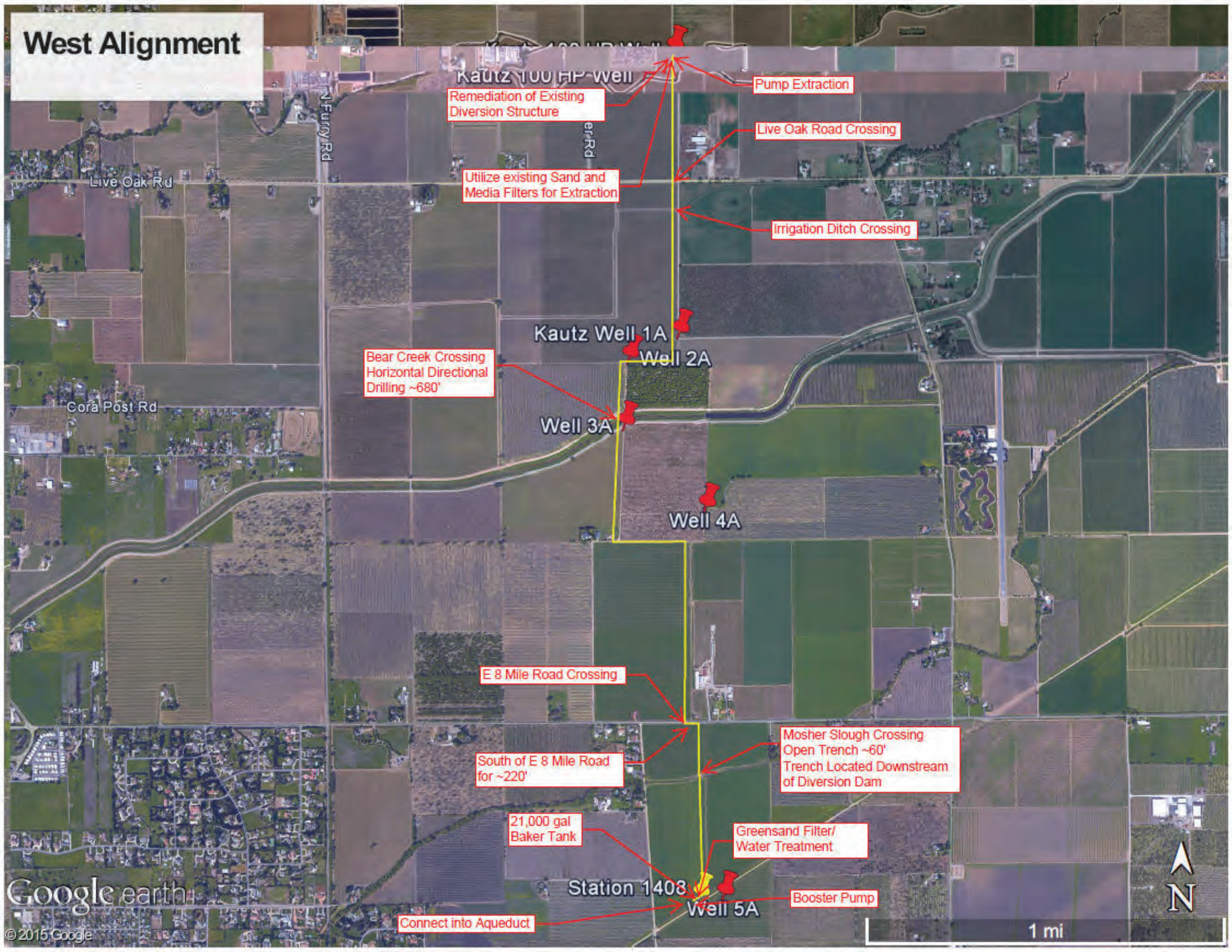


San Joaquin County Department of Public Works Groundwater Banking Pilot Study	**Typical Buried Pipe Section** **County Road, Paved Crossing** NTS
Source: GEI Consultants, Inc. December 2015	**FIGURE 3**

Table 4-2 -- Value Engineering Cost Estimate Revision

December 2015 estimate	**$2,440,000**
Potential Cost Savings	
Delete 2 permanent Pixley Slough pumps and use 1 temporary pump for up to 3 years	-$140,000
Change pipeline construction from PVC with engineered backfill to HDPE installed with trencher and engineered backfill	-$140,000
Delete directional drilling of Bear Creek crossing; confirm feasibility & hang pipe from farm bridge	-$80,000
Reduce contingency from 30% to 20%	-$190,000
Net reduction in other adders (ELA, CM, EnvDoc)	-$130,000
Total identified savings	-$590,000
Revised total project cost (plus monitoring wells, water treatment, operations & maintenance)	**$1,850,000**

Figure 4-6 Principal Features of West Alignment Pipeline



4.2 Cost Estimate

Figure 4-7 Engineer's Opinion of Probable Cost - Conceptual Design of West Alignment

San Joaquin County Department of Public Works
Groundwater Banking Pilot Study
Engineer's Opinion of Probable Construction Cost - Conceptual Design of West Site Alignment
4/12/2016 - For Discussion Purposes Only

BID ITEM	BID ITEM DESCRIPTION	Quantity	Unit	Unit Price	Cost
1	Mobilization/Demobilization (5% Construction)	1	LS	$50,144.48	$50,144.48
Surface Irrigation					
NSJ-1	Mokelumne diversion, Fish screen motor, South P/S electrical panel, Meter, Box No.1 rehab	1	LS	$50,000.00	$50,000.00
2	Diversion Structure[1]	1	LS	$50,000.00	$50,000.00
3	Pixley Slough Pump (Rental 1 Year, $2k/28-day cycle, 5 cycles, 5 cfs)	3	EA	$10,000.00	$30,000.00
4	12" Dia HDPE Pipe	25	LF	$35.10	$877.60
5	Air/Vacuum Valve	1	EA	$1,000.00	$1,000.00
6	4" Blowoff Valve	1	EA	$1,000.00	$1,000.00
7	Flow Meter	1	EA	$1,500.00	$1,500.00
8	Thrust Blocks 12" Pipe	2	EA	$187.22	$374.44
Export Well to Mokulemne Aqueduct					
9	Traffic Control (4 Days of 2 man crew @ $500/day, 2 days per road crossing)	1	LS	$2,000.00	$2,000.00
10	Baker Tank (Rental 1 Year, 21,000 gal, $31/day for 121 days)	0	EA	$3,741.00	$0.00
11	Flow Meter	2	EA	$1,500.00	$3,000.00
12	12" Dia HDPE Pipe (Material, Handling, and Installation)	14,700	LF	$40.00	$588,000.00
13	Buried Pipe Excavation and Backfill - Farm Road[2]	14,080	LF	$10.04	$141,394.83
14	Buried Pipe Excavation and Backfill - County Road[2]	320	LF	$15.53	$4,971.10
15	Road Crossing Asphalt Paving (removal and replacement, 10' beyond each side of trench)	1,702	SF	$4.45	$7,579.57
16	Bear Creek Crossing[8]	1	LS	$40,000.00	$40,000.00
17	Mosher Creek Crossing (open trench, 60')	1	LS	$16,582.02	$16,582.02
18	Booster Pump (Rental 1 Year, $9k/28-day cycle, 5 cycles, 2 cfs @ 200 psi)[9]	1	EA	$71,000.00	$71,000.00
19	Air/Vacuum Valve	3	EA	$1,000.00	$3,000.00
20	4" Blowoff Valve	13	EA	$1,000.00	$13,000.00
21	12" Blank Tees with Plugged End	5	EA	$1,095.86	$5,479.28
22	Butterfly Valve @ 0.5 miles & Creek Crossings	10	EA	$2,213.08	$22,130.79
Other Construction Costs					
	Unallocated Items in Construction Costs (5%)				$55,151.71
	Construction Subtotal				$1,158,185.83
	Recommended Construction Contingency (20%)				$231,637.17
	Construction Total				**$1,389,822.99**
	Engineering, Legal, & Administrative Costs (20%)[4]				$231,637.17
	Construction Management (10%)[4]				$115,818.58
	Environmental Documentation and Permitting				$100,000.00
	GRAND TOTAL ESTIMATED PROJECT COST TO CONSTRUCT W/O CONTINGENCY				**$1,605,641.57**
	GRAND TOTAL ESTIMATED PROJECT COST TO CONSTRUCT W/20% CONSTRUCTION CONTINGENCY				**$1,837,278.74**

Notes

[1] Cost for diversion structure rehabilitization taken from Comparison of Surface Water Supply Alternatives for Recharge of Groundwater, W.Sadler, dated November 13, 2015.

[2] Costs do not include potential conflicts with existing underground utilities including fiber optic lines, culvert crossings beneath road, etc.

[3] Bear Creek and Mosher Slough crossings must be reviewed and approved by the Central Valley Flood Protection Board prior to installation.

[4] Percentages applied to Construction Subtotal.

[5] All costs shown have been escalated to January 2015 using the 20 cities average from the ENR's Construction Cost Index.

[6] Costs presented are conceptual and intended to be Class 4 according to the Association for the Advancement of Cost Engineering International (AACEI).

[7] Costs presented assume that well water will be filtered through existing filtration system and that water will not require additional filtration prior to Mokelumne Aqueduct connection.

[8] Costs presented assume that the 12" pipe is anchored to the existing Bear Creek Crossing Bridge and penetrate through the existing levees (requires CVFPB approval). Feasibility of this design has not yet been determined due to lack of structural information of the Bear Creek crossing structure.

[9] Costs presented do not include fuel costs. Fuel costs are considered O&M.

Figure 4-8 Well K-13

Figure 4-9 Preliminary Pipe Friction Loss Calculation

GEI Consultants

QUICK CALCULATION

Project	Groundwater Banking Demonstration	By:	Kris Van Sant	Date:	11/30/2015
Client	San Joaquin County PWD	Checked:		Date:	
Subject	Kautz Align R1 Quick Pipe Friction Loss Calc	Approved:		Date:	

Note: These calculations are preliminary only and are not for use in final design.

1.0 Assumptions

1.1 Pipe is flowing full and under pressure.

2.0 Equations

2.1 $h_f = (3.022*V^{1.85}*L)/(C^{1.85}*(ID/12)^{1.165})$

2.2 V = Q/A

2.3 $A = (pi/4)*(ID/12)^2$

where

Q = Flow Rate, cfs

V = Velocity, ft/sec

A = Inside cross sectional area of pipe, ft^2

ID = Inside diameter of pipe, in

-

pi = 3.14159

L = Pipe Length, ft

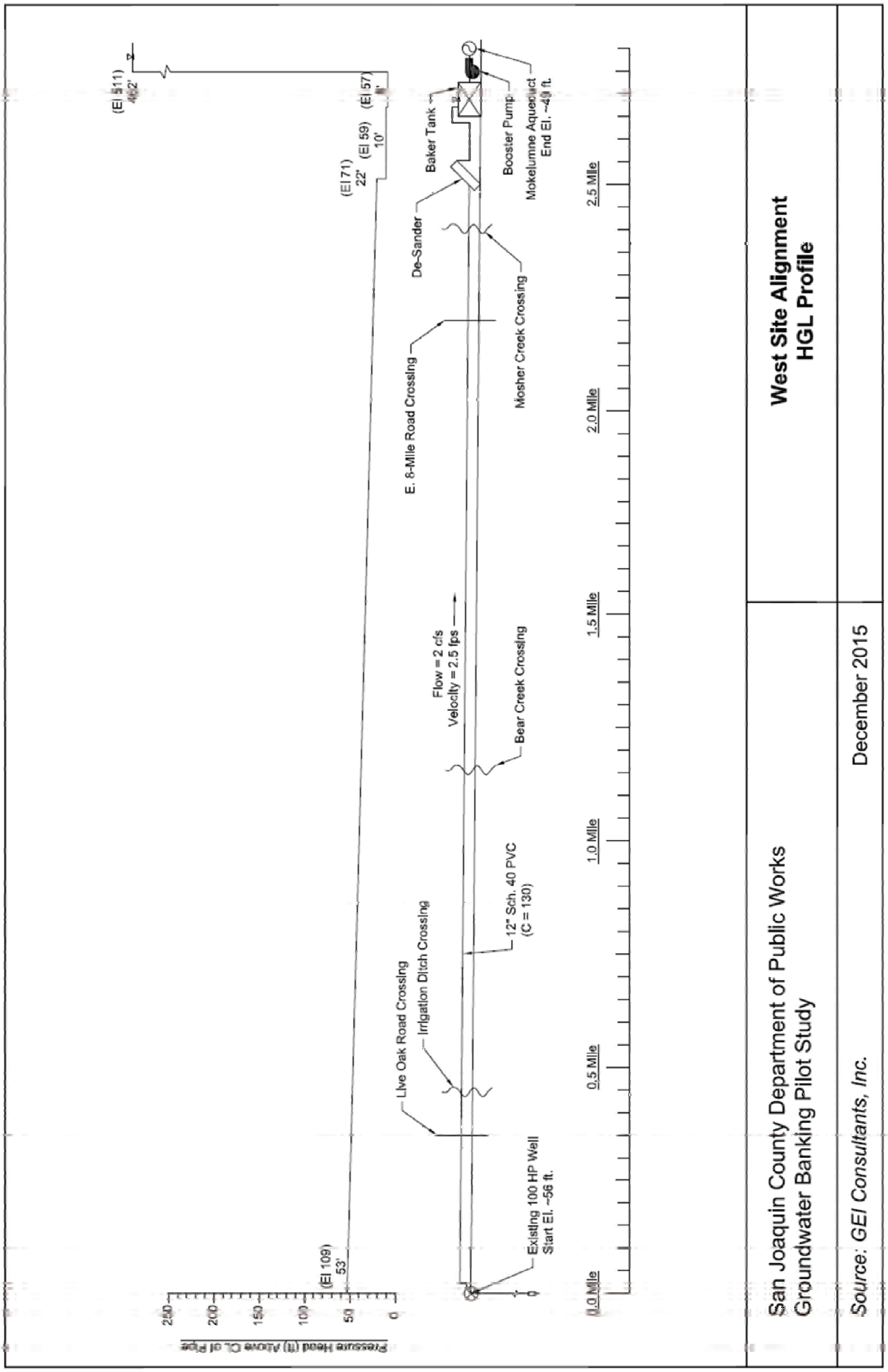
C = Hazen-Williams Friction Coefficient

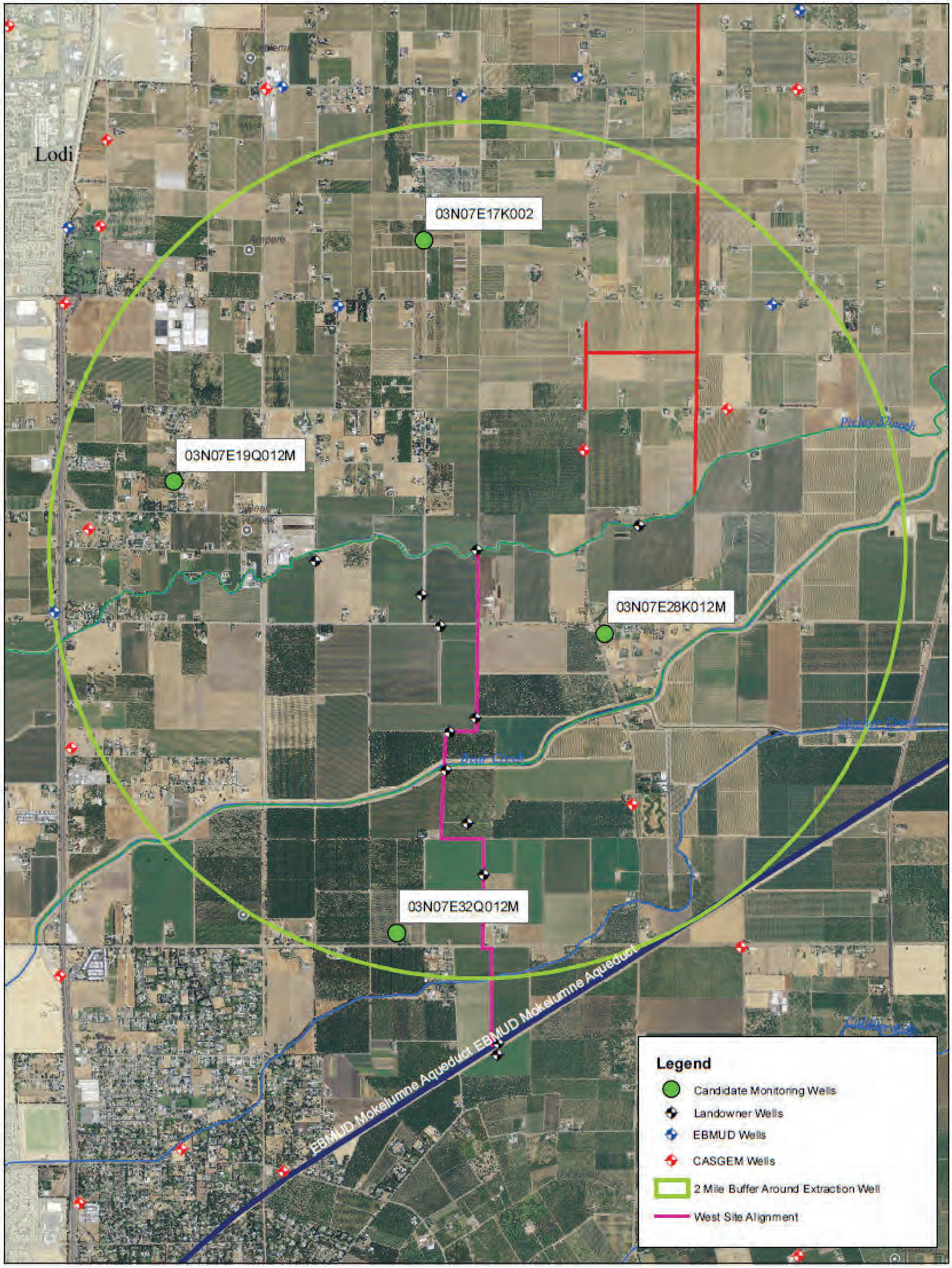
3.0 Calculations and Results

Q *cfs*	*ID* *in*	*L* *ft*	*C*	A ft^2	V ft/sec	**h_f** **ft**
2	*8*	*14,700*	*130*	0.3491	5.7	**221.05**
3	*8*	*14,700*	*130*	0.3491	8.6	**468.01**
4	*8*	*14,700*	*130*	0.3491	11.5	**796.89**
2	*10*	*14,700*	*130*	0.5454	3.7	**74.65**
3	*10*	*14,700*	*130*	0.5454	5.5	**158.05**
4	*10*	*14,700*	*130*	0.5454	7.3	**269.11**
2	*12*	*14,700*	*130*	0.7854	2.5	**30.75**
3	*12*	*14,700*	*130*	0.7854	3.8	**65.10**
4	*12*	*14,700*	*130*	0.7854	5.1	**110.84**

Legend:	
Input -	*100*
Intermediate -	100
Result -	**5.0**

Figure 4-10 West Side Alignment Hydraulic Grade Line




Lodi
03N07E17K002
03N07E19Q012M
03N07E28K012M
03N07E32Q012M
EBMUD Mokelumne Aqueduct
EBMUD Mokelumne Aqueduct
EBMUD Mokelumne Aqueduct
Legend
Candidate Monitoring Wells
Landowner Wells
EBMUD Wells
CASGEM Wells
2 Mile Buffer Around Extraction Well
West Site Alignment

4.3 Remaining Issues

4.3.1 Well Inspection

The proposed extraction well is over 40 years old and its condition and suitability for extended periods of extraction is not known. The pump should be pulled from the well, and a video inspection should be performed to determine the condition of the well, casing, and screens.

4.3.2 Bear Creek Bridge Crossing

The project cost estimate is predicated on suspending the export pipeline on the existing farm bridge spanning Bear Creek (Figure 4-11). Limited engineering has been performed on this. A similar pipe crossing was proposed for the nearby Leffler farm bridge in 1984. Partial plans (Figure 4-12) have be located.

4.3.3 Mokelumne Aqueduct Connection

Engineering for the Mokelumne Aqueduct connection, pump station and controls are to be developed by EBMUD. EBMUD provided archive drawings of the aqueduct and vicinity of the proposed Aqueduct connection, but the design has not been started. These drawing are presented as Figure 4-13 thrugh Figure 4-16.

4.4 Export Permit Application

4.4.1 Engineer' Report

An Engineer's Report has been prepared to accompany the Export Permit application.

4.4.2 Environmental Documentation

Environmental documentation for the Demonstration Project was prepared by NSJWCD and included consideration of other planned improvements to the NSJWCD conveyance systems. On August 23, 2016 the San Joaquin County Board of Supervisors held a public hearing and adopted the Final Initial Study and Mitigated Negative Declaration and the Mitigation Monitoring and Reporting Program for the project.

Figure 4-11 Bear Creek Farm Bridge

Figure 4-12 Plans for Adding Pipe to Leffler Bridge, 1984

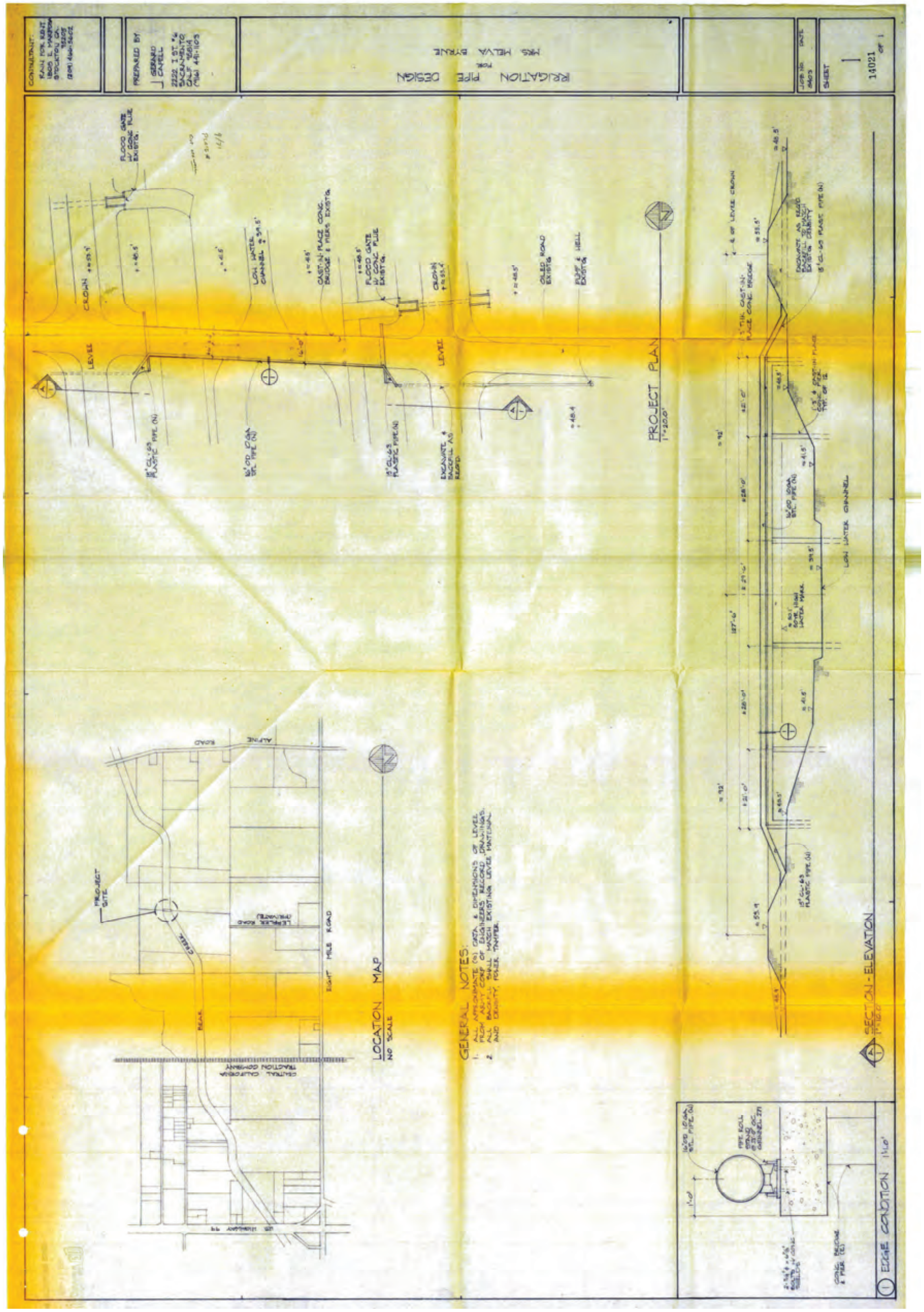


Figure 4-13 Mokelumne Aqueduct Location Map

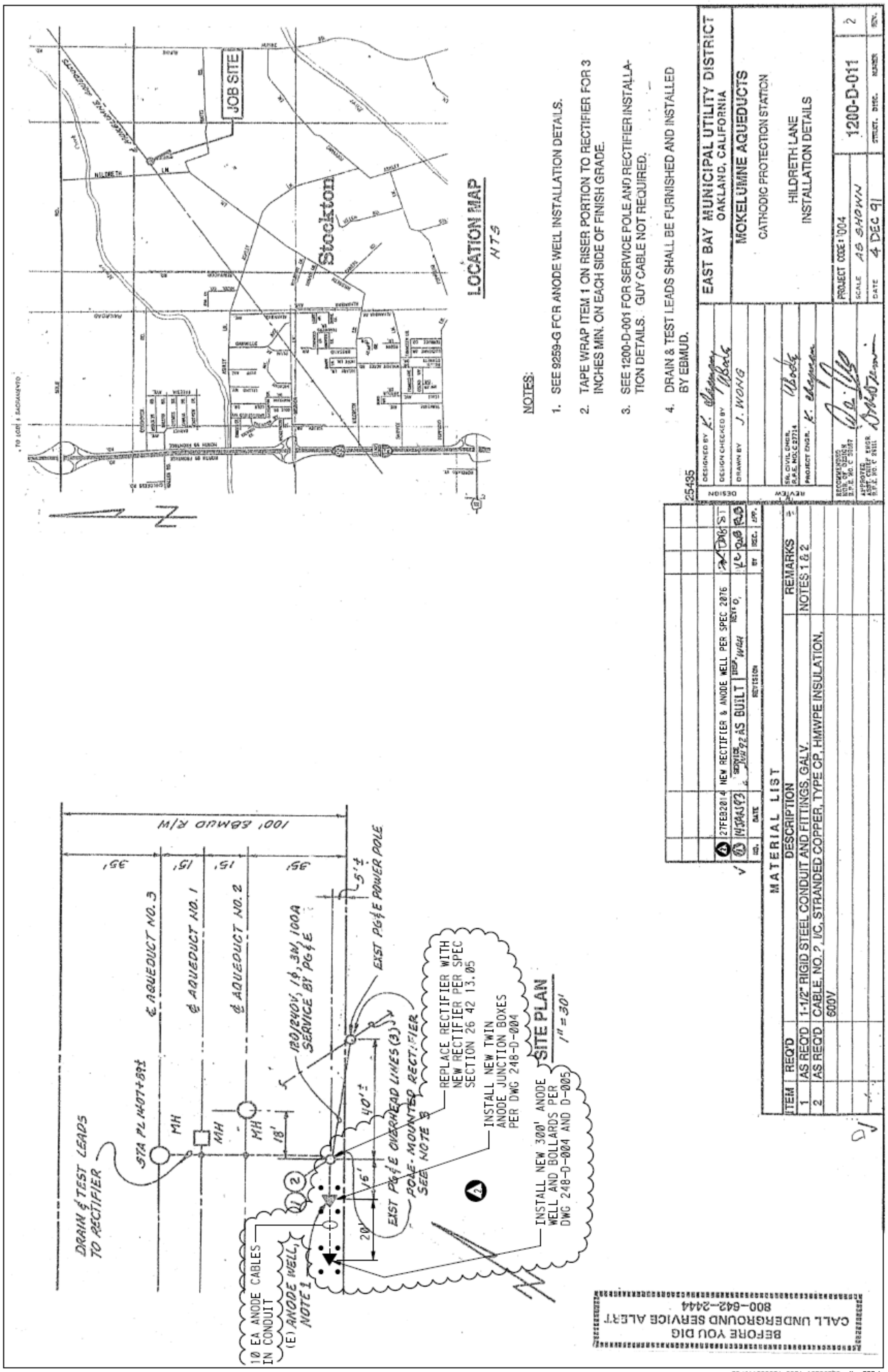


Figure 4-14 Mokelumne Aqueduct Profile and Alignment

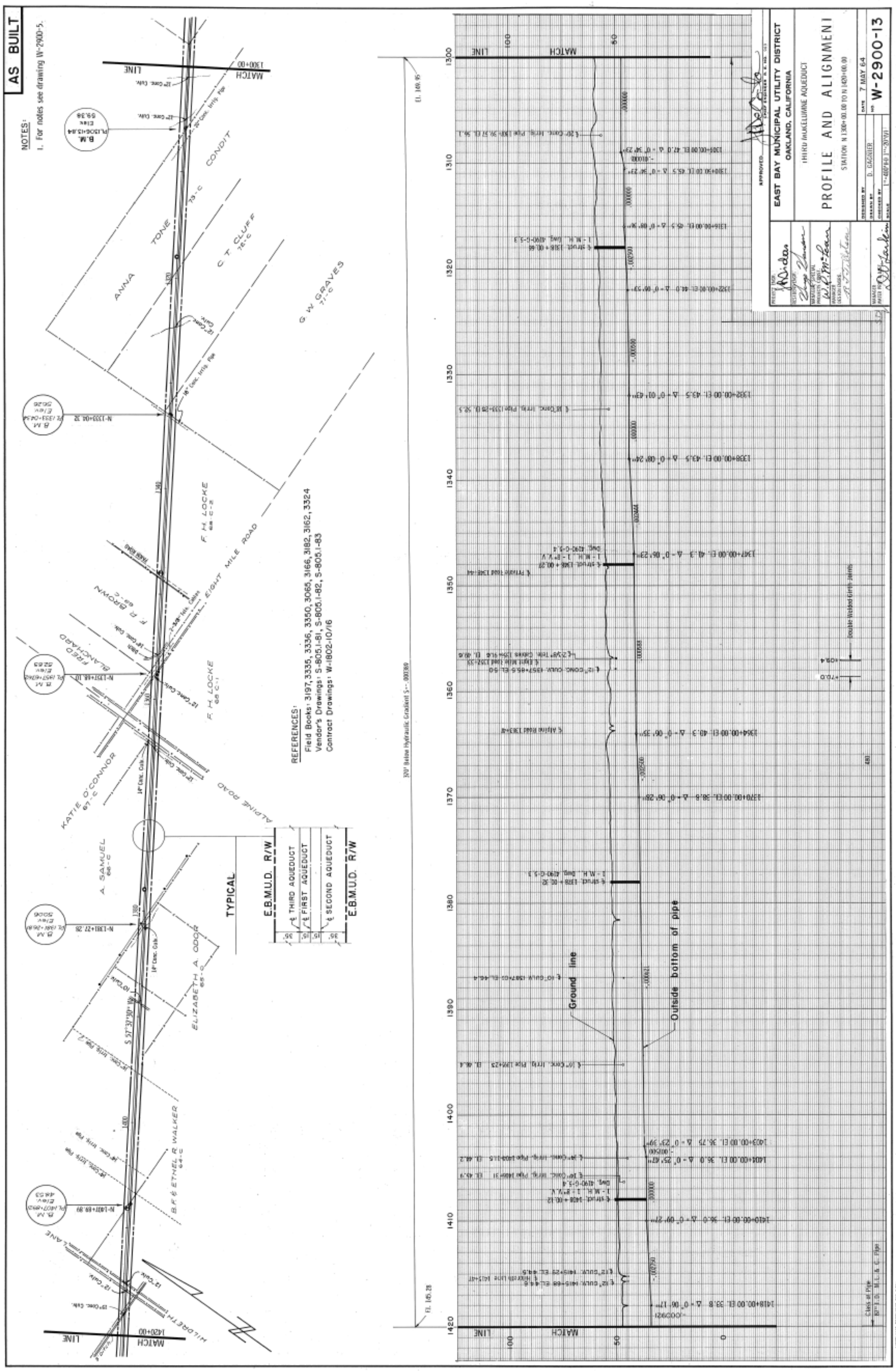


Figure 4-15 Mokelumne Aqueduct Air Value Detail Drawing

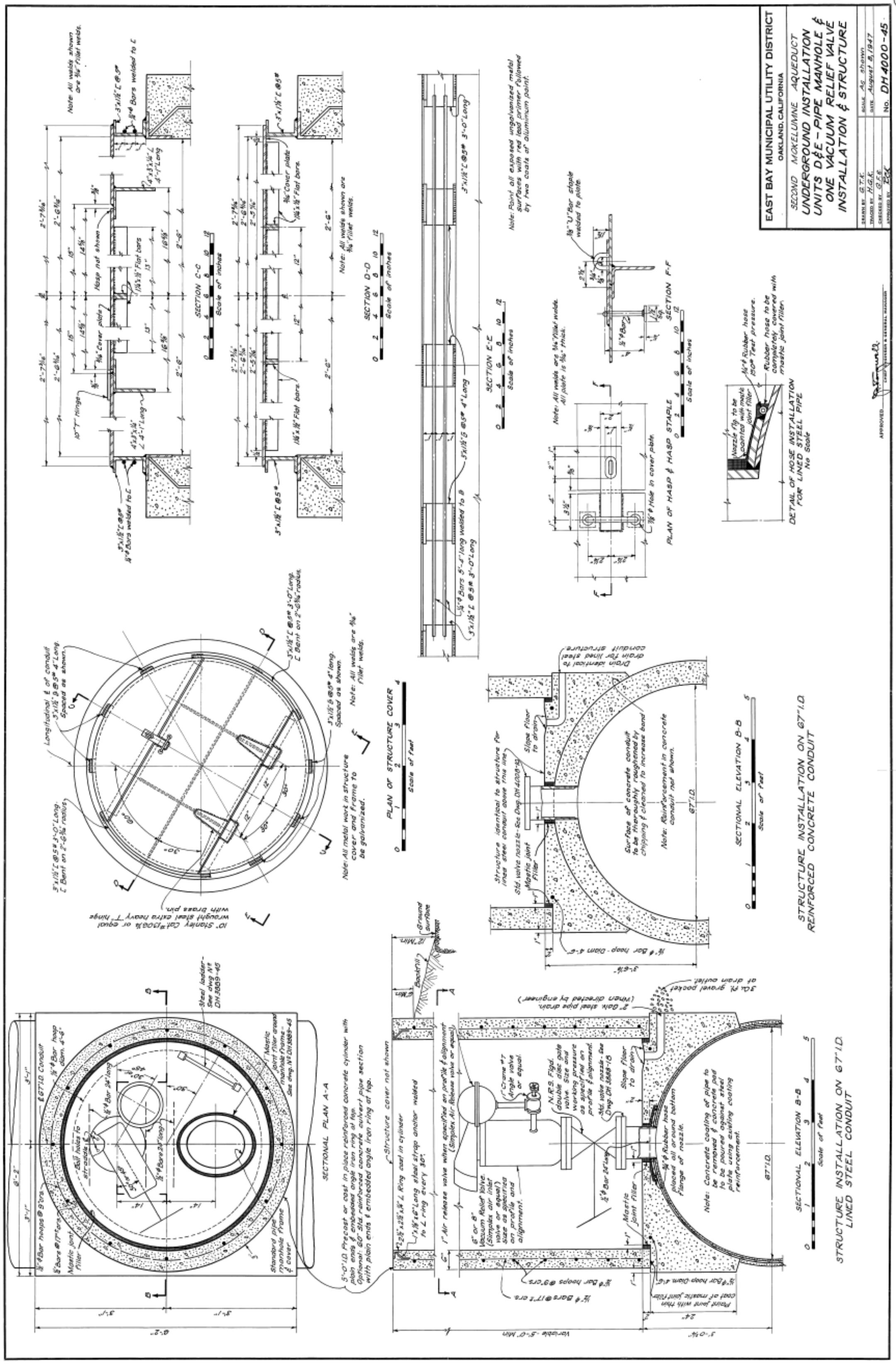
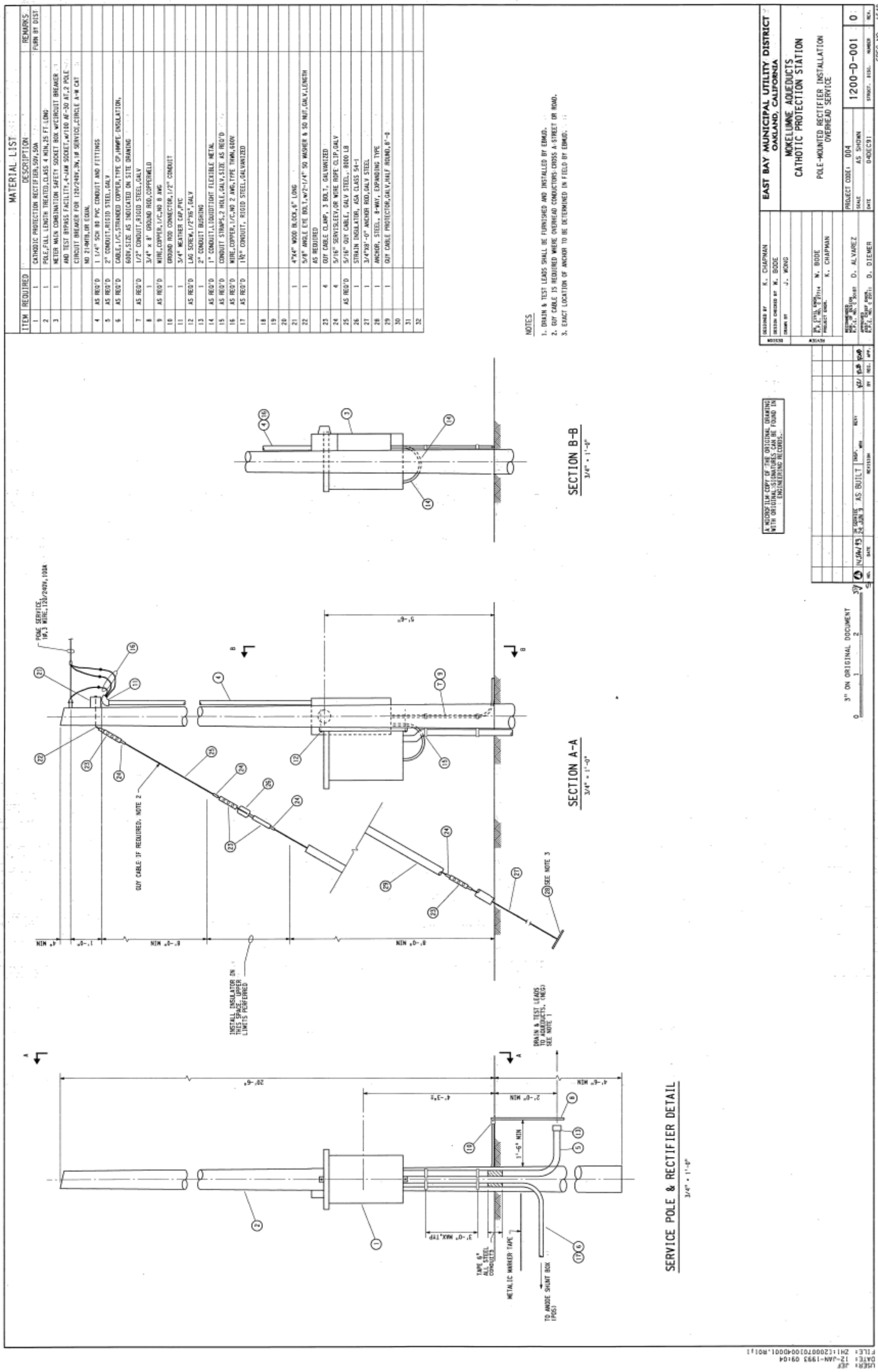


Figure 4-16 Mokelumne Aqueduct Cathodic Protection Station Drawing



5 Appendix A Geologist's Report and Cross Sections

5.1 Cross-Sections

Four geologic cross-sections were created to illustrate the geology beneath the study area. The sections were created after over 180 Well Logs from California Department of Water Resources (DWR) were reviewed. Well logs were selected that were readable, had sufficient data (depth information, location information, construction details, etc.) and were located in the study area. Some locations had a higher density of well logs due to clusters of residential areas. The logs were chosen to have a spatial distribution of at least one well log per section, which is one square mile.

A list of 22 wells was received from EPUR indicating wells that had water level data. These wells were plotted on a regional map and the ones that fell within the study area were used. There were only about four wells from the EPUR data that fell into the study area. Of these wells GEI was only able to obtain well logs for one of the wells. After all of the DWR and EPUR wells were sorted they were digitized by adding their data to a database. The database is used by a program called SHEDTOOL.

The SHEDTOOL allows different data to be queried and visualized. The lithology data were input with respect to depth to create lithologic logs for each well log. Geologic cross-sections were made by selecting multiple lithologic logs and then interpreting the geology between the wells to create a framework for estimating the aquifers that are below the study area and the potential pathways and barriers to groundwater recharge based on the potential recharge basin locations.

5.2 Geology

The lower Modesto Formation is the primary geologic formation near the project area. The formation consists of alluvial sediments ranging from clay to coarse gravel. Underlying the Modesto Formation is the Riverbank Formation that is also comprised of sediments similar to the Modesto Formation. Over time these sediments have been reworked by the fluvial (river) processes of the Bear Creek, Mokelumne River, Calaveras River, etc. These rivers and streams have created coarser channel deposits and finer levee and floodplain deposits. As these layers have been stacked over time the river channels which are coarser, are more permeable and the flood plains are comprised of finer clay and silt and are orders of magnitude less permeable than the coarse deposits. The variability of recharge rates will be site specific based on the permeability and interconnectedness of different layers beneath the site.

The geologic cross-sections show two primary horizons at which wells have been screened to produce water. These two levels are referred to as the upper and lower aquifers. The upper aquifer is present between elevations -100 to -250 feet mean sea level (msl). The lower aquifer is present, based on well construction data, around -400 to -500 feet msl. It is difficult to monitor each of the separate aquifers individually as the wells that are completed in the deeper aquifer also have screen intervals within the shallow aquifer. The water levels in these wells will be comprised of a composite water level and will not provide an accurate water level for either aquifer.

Figure 5-1 Approximate Location of Geologic Cross Sections
Approximate Location of Geologic Cross Sections

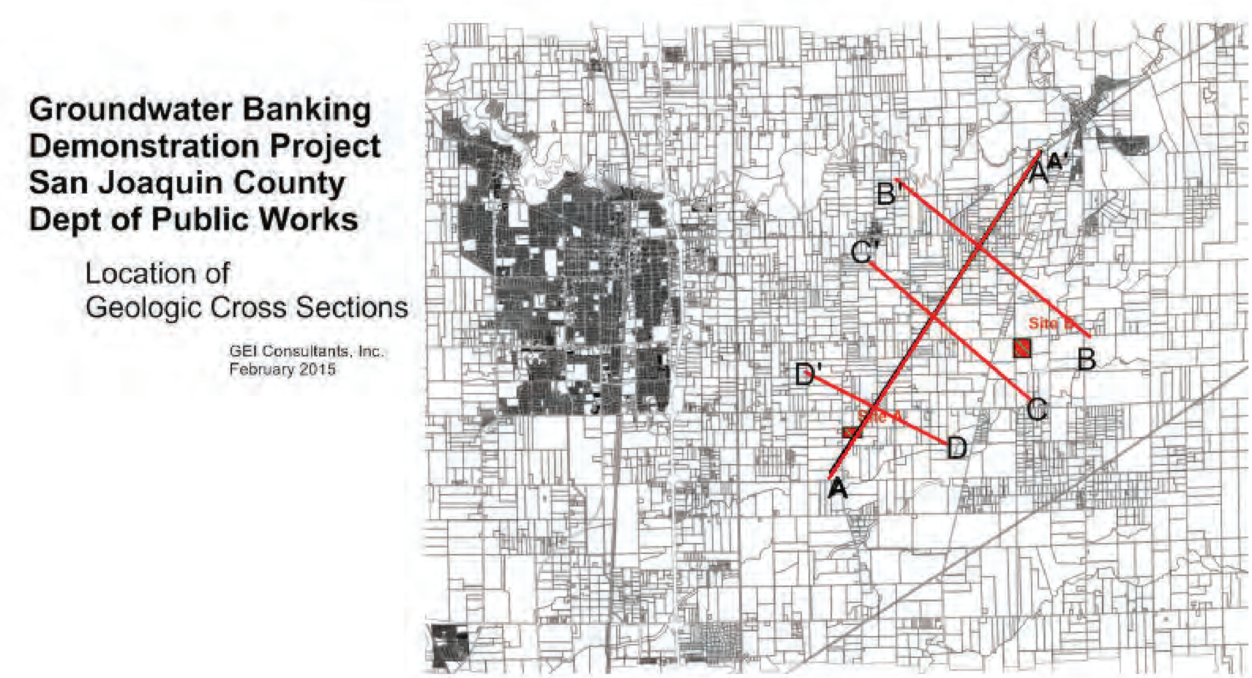


Figure 5-2 Cross Section A-A'

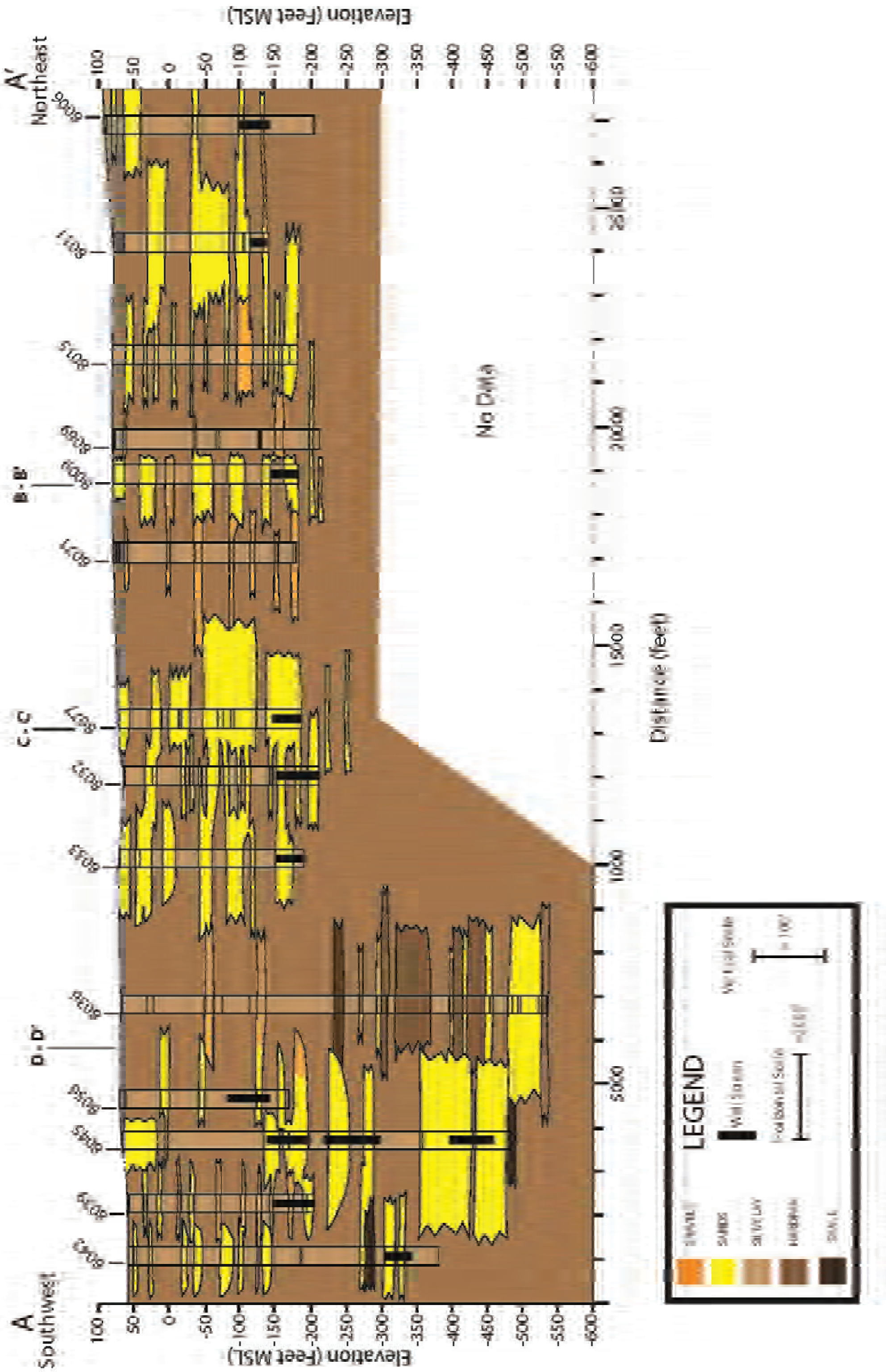


Figure 5-3 Cross Section B-B'

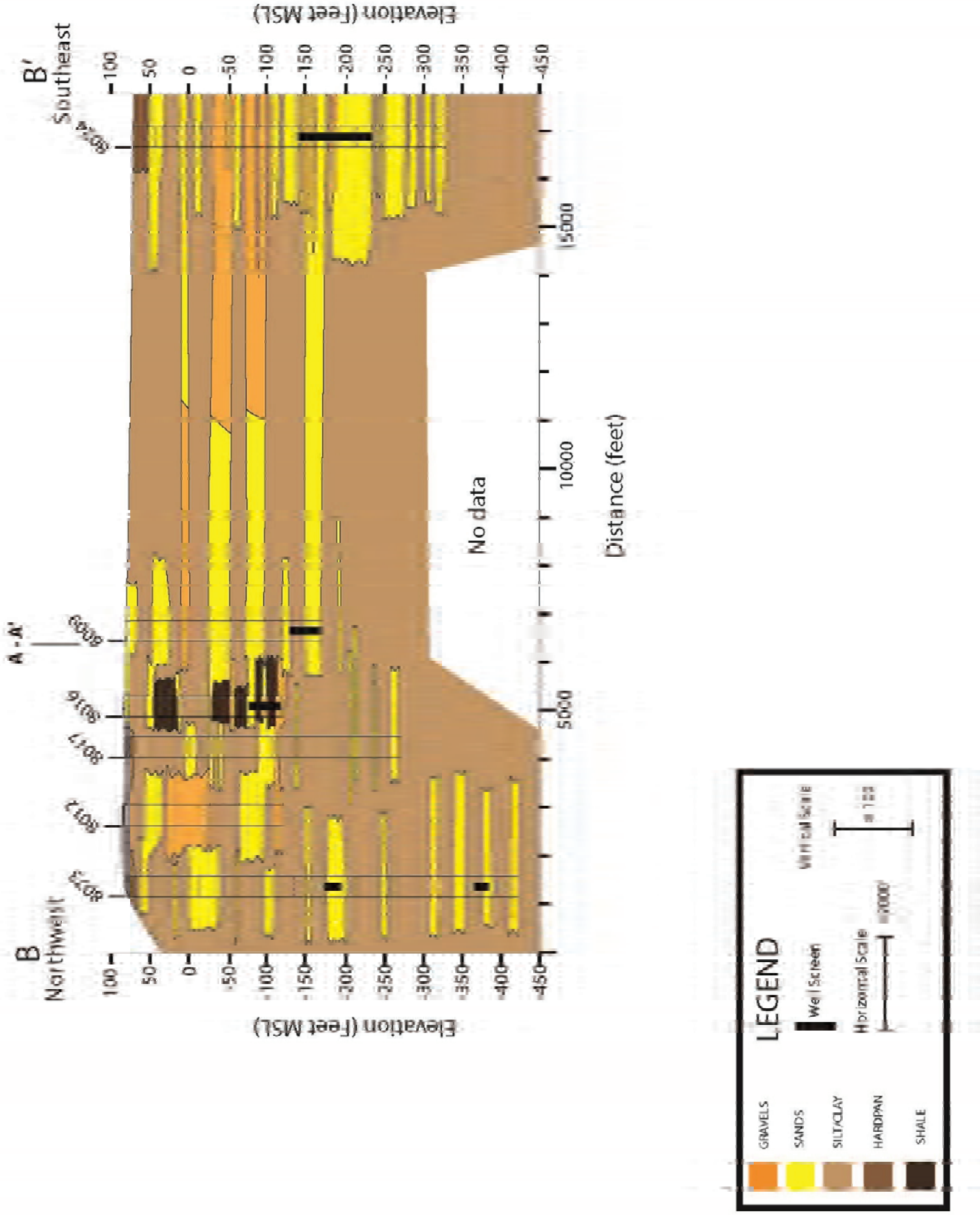


Figure 5-4 Cross Section C-C'

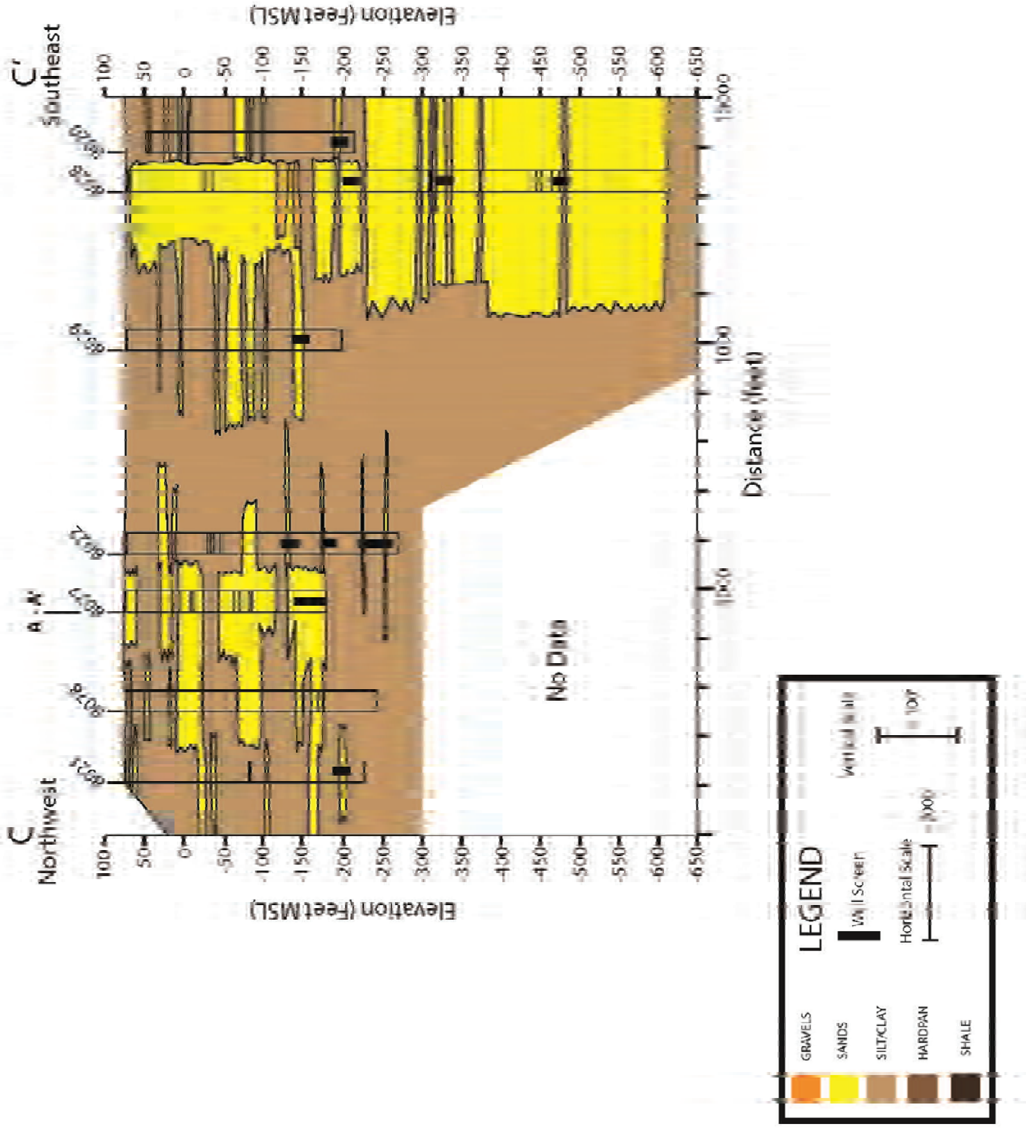
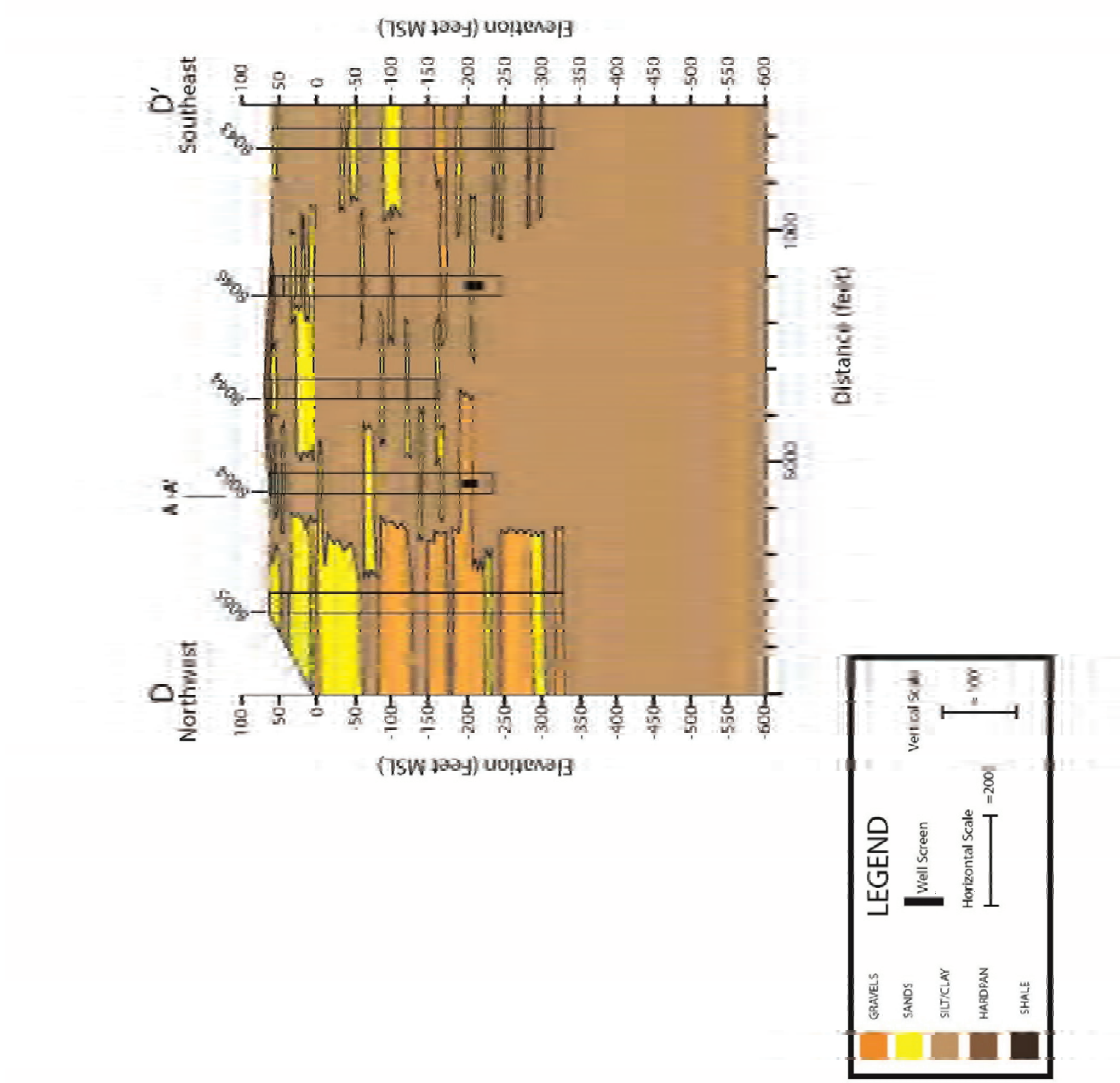


Figure 5-5 Cross Section D-D'



Appendix B Available Driller's Logs Used for Monitoring within Project Area

Figure 5-6 - State Well Driller Log 5296

REGION

COUNTY San Joaquin

NEAR Victor

STATE OF CALIFOR[NIA]
DEPARTMENT OF WATER [RESOURCES]

39-693

BASIN

DWR No. 3N/7E-3R1, MD O & M

OTHER Nos.

WELL LOG

LOCATION 0.42 mile South of Highway 12 on Locust Rd & then 0.26 mile East

OWNER Emil Handel ADDRESS Rt 4, Box 1270 (same as well)

DRILLED BY Kirschenman (deceased) ADDRESS Lockford

DRILLING METHOD ? GRAVEL PACKED ? DATE COMPLETED 1920

SIZE OF CASING DEPTH Rocked & cemented 0' to 81' 12" 81'-100' & 10" From 100'-130' STRUCK WATER AT ?

PERFORATIONS Casing tore @ 106' SIZE NO.

WATER LEVEL BEFORE PERFORATING — AFTER —

TEST DATA: DISCHARGE G.P.M. — DRAWDOWN FT. — HOURS RUN —

OTHER DATA AVAILABLE: WATER LEVEL RECORD DWR (COOP) BK 3/4 ANALYSIS —

SURFACE ELEV. 74.8 DATUM Sea level SOURCE OF INFORMATION USGS Quad

DEPTH	ELEV. OF BOTTOM OF STRATUM	MATERIAL	THICKNESS	SP. YIELD %
0-81'		well dug to this depth & cemented off from Formations		
81-100'	-25'	Cased off		
100-130	-55'	gravel — cased off but tore @ 106'	30'	
139-144	-69'	gravel	5'	
175-178	-103'	sand	3'	
188-198	-123'	sand	10'	
203-205	-130	sand	2'	
209-212	-137	sand	3'	
214-220	-145	sand	6'	
		TD = 220'		

FOR FIELD COPIES USE ALTERNATE LINES

LOG OBTAINED BY W.T.S. (DWR) From Emil Handel DATE 3/23/65 SHEET 1 OF 1

FORM 263

Figure 5-7 - State Well Driller Log 5293

STATE OF CALIFOR[NIA]
DEPARTMENT OF WATER [RESOURCES]

39-738

REGION
COUNTY San Joaquin
NEAR Lodi

BASIN
DWR NO. 3N/7E-17K2 MD D & M
OTHER NOS.

WELL LOG

LOCATION From Int of Harvey Lane & Jackson Rd -0.3 Mi North of Jackson Rd. Well is on West side of road in NE corner of Front yard

OWNER Dorothy Wright ADDRESS Same as well

DRILLED BY Ed Stelzer ADDRESS 170 So. Cornith Ave, Lodi, Calif.

DRILLING METHOD Cable tool GRAVEL PACKED ? DATE COMPLETED June 2, 1961

SIZE OF CASING DEPTH 12" 252' deep. STRUCK WATER AT 60'

PERFORATIONS none ? SIZE NO.

WATER LEVEL BEFORE PERFORATING — AFTER —

TEST DATA: DISCHARGE G. P. M. — DRAWDOWN FT. — HOURS RUN —

OTHER DATA AVAILABLE: WATER LEVEL RECORD DWR: CO-OP BK 3/4 ANALYSIS

SURFACE ELEV. 57.0 DATUM Sea Level SOURCE OF INFORMATION U.S.G.S. Quad

FOR FIELD COPIES USE ALTERNATE LINES

DEPTH	ELEV. OF BOTTOM OF STRATUM	MATERIAL	THICKNESS	SP. YIELD %
0-3'	54	Top soil	3'	
3-20'	37	clay	17'	
20-60	-3	dry sand	40'	
60-61	-4	sand	1'	
61-100	-43	clay	39'	
100'-102	-45	sand	2'	
102-140	-83	clay	38'	
140'-141	-84	sand	1'	
141-180	-123	clay	39'	
180-190	-133	sand	10'	
190-200	-143	clay	10'	
200-204	-147	sand	4'	
204-230	-173	clay	26'	
230-240	-183	sand	10'	
240-248	-191	clay	8'	
248-265	-208	sand	17'	

TD = 265'

LOG OBTAINED BY W.T.S. (DWR) from owner DATE 3/24/65 SHEET 1 OF 1

FORM 263

Figure 5-8 - State Well Driller Log 5286

ORIGINAL
File Original, Duplicate and Triplicate with the REGIONAL WATER POLLUTION CONTROL BOARD No.______ (Insert appropriate number)

WATER WELL DRILLERS REPORT

(Sections 7076, 7077, 7078, Water Code)

STATE OF CALIFORNIA 985

LOCATION NOT CHECKED
Do Not Fill In
No 39898
State Well No. 3N/7E-23 Coo
Other Well No. 3N/7E-23

(1) OWNER:
Name Harmony Grove School
Address Rt. 1 Box 219
Lodi, Calif.

(2) LOCATION OF WELL:
County San Joaquin Owner's number, if any—
R. F. D. or Street No.
Harney Lane & Highway 88

(3) TYPE OF WORK (check):
New well ☒ Deepening ☐ Reconditioning ☐ Abandon ☐
If abandonment, describe material and procedure in Item 11.

(4) PROPOSED USE (check):
Domestic ☒ Industrial ☐ Municipal ☐
Irrigation ☐ Test Well ☐ Other ☐

(5) EQUIPMENT:
Rotary ☐
Cable ☒
Dug Well ☐

(6) CASING INSTALLED:
SINGLE ☒ DOUBLE ☐

From	ft. to	ft.	Diam.	Gage or Wall
	152		10	#12

If gravel packed: Diameter of Bore / from ft. / to ft.

Type and size of shoe or well ring 1/2 x 4
Size of gravel:
Describe joint Welded

(7) PERFORATIONS:
Type of perforator used None
Size of perforations ___ in., length, by ___ in.
From ___ ft. to ___ ft. Perf. per row ___ Rows per ft.

(8) CONSTRUCTION:
Was a surface sanitary seal provided? ☒ Yes ☐ No To what depth 30 ft.
Were any strata sealed against pollution? ☐ Yes ☒ No If yes, note depth of strata
From ___ ft. to ___ ft.
Method of Sealing

(9) WATER LEVELS:
Depth at which water was first found 72 ft.
Standing level before perforating ft.
Standing level after perforating ft.

(10) WELL TESTS:
Was a pump test made? ☐ Yes ☐ No If yes, by whom?
Yield: gal./min. with ft. draw down after hrs.
Temperature of water Was a chemical analysis made? ☐ Yes ☐ No
Was electric log made of well? ☐ Yes ☐ No

(11) WELL LOG:
Total depth 248 ft. Depth of completed well 248 ft.
Formation: Describe by color, character, size of material, and structure.

From (ft.)	To (ft.)	Formation
0	3	Top soil
3	40	Yellow sandy clay
40	44	Hard pan
44	48	Sand & gravel
48	62	Sandy clay
62	64	Sand & gravel
64	76	Sandy clay
76	84	Red clay
84	88	Sand & gravel
88	110	Red sandy clay
110	112	~~kkk~~ Hard pan
112	114	Sand & gravel
114	120	Hard shale
120	125	Coarse sand & gravel
125	127	Yellow clay
127	146	Sand & gravel
146	156	Clay
156	198	Red shale
198	200	Sand & gravel (hard)
200	212	Sandy clay
212	248	Hard shale
248		Big gravel

CONFIDENTIAL
Section 7076.1, Water Code

FOR OFFICIAL USE ONLY

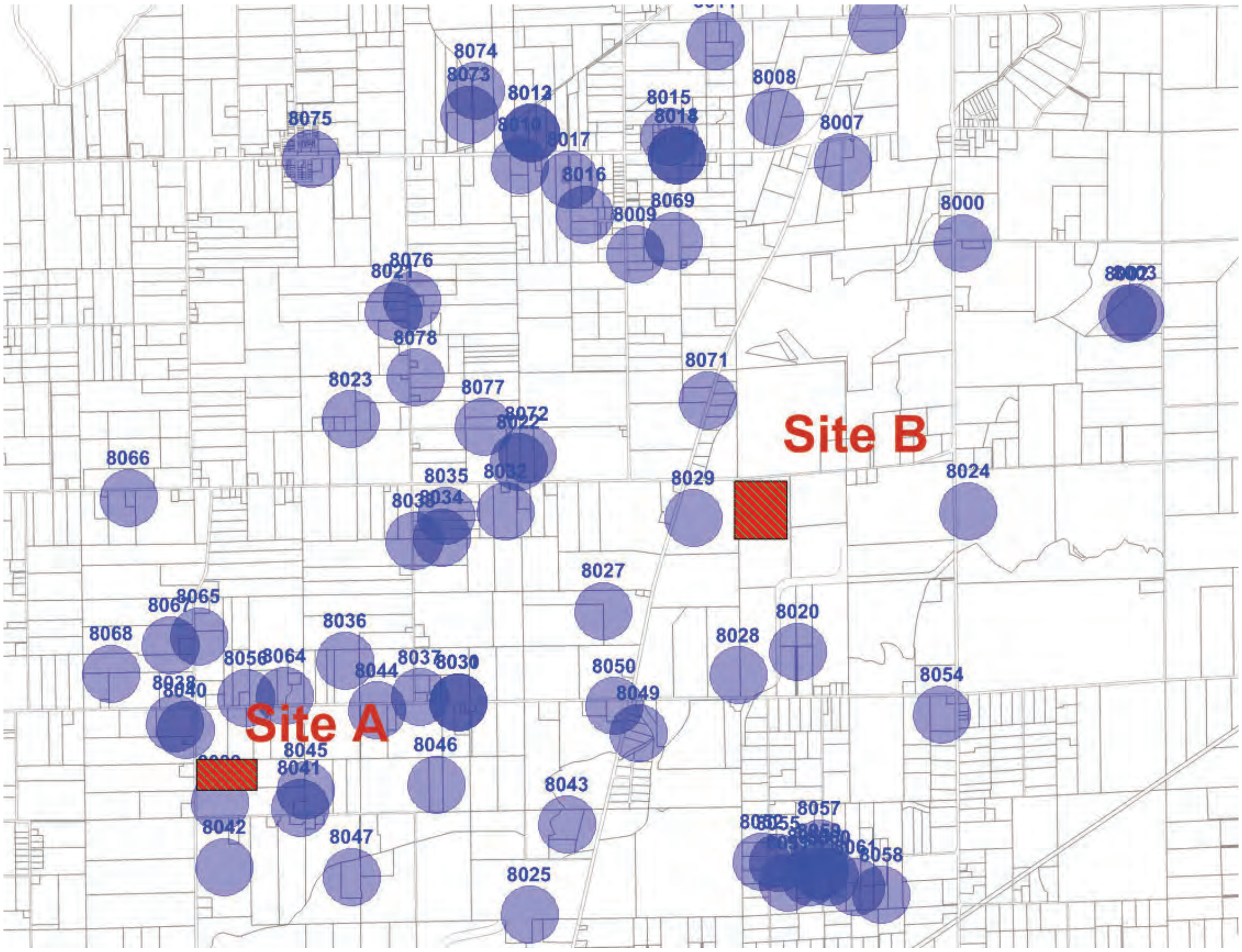
Work started 6/19/58 19 , Completed 6/26/58 19

WELL DRILLER'S STATEMENT:
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.
NAME Clark Well Drilling Co.
(Person, firm, or corporation) (Typed or printed)
Address 2024 E. Charter Way
Stockton 6, Calif.
[SIGNED] Robert L. Clark
Well Driller
License No. 76602 Dated 7/7/58, 19

95689 3-54 50M QUIN SPO
DWR FORM NO. 246 (REV. 3-54)

6 Appendix C Compilation of All Data Management System Well Logs

Figure 6-1 Location Map for DMS Well Logs



7 Modeling Appendix

7.1 Introduction

This Technical Memorandum (TM) was prepared to document review of existing regional numerical groundwater models with model domains that include the portion of San Joaquin County along the Mokelumne Aqueduct immediately northeast of Stockton and east of Lodi (study area) (Figure 1). This task is part of a Groundwater Banking Demonstration Study being conducted by a consultant team led by GEI Consultants. This TM was prepared by Peter Leffler and Paul Sorensen of Fugro Consultants, Inc., and transmitted on January 7, 2015.

7.1.1 Purpose of Study

This task is being conducted to provide information on hydraulic conductivities of shallow (e.g., upper 200 feet) sediments to aid in assessment of recharge pond potential in the study area, and for potential use of regional scale models to provide aquifer parameters and boundary conditions for a local-scale model that may be developed in a later phase of the Groundwater Banking Demonstration study. The overall study is designed to evaluate the feasibility of a groundwater banking project. The general concept of the banking project is to recharge water when it is available in average to wet rainfall years from the Mokelumne Aqueduct, store the recharged water in the vacated storage space in the aquifer, and recover a portion of the stored water during droughts.

7.1.2 Background

The project study area is located in an approximately 140 square mile area in northeastern San Joaquin County along the Mokelumne Aqueduct east of Lodi (Figure 1). This area has had historic groundwater level declines of up to approximately 80 feet, which has created vacated aquifer storage space that could potentially be utilized in a groundwater banking project. The groundwater banking project being considered in this study involves banking of East Bay Municipal Utility District (EBMUD) water from the Mokelumne Aqueduct.

The benefits of the potential project for EBMUD include a supplemental drought year water supply, and the benefits for San Joaquin County from supplemental groundwater recharge result from the fact that only a portion of the recharged water would ultimately be extracted by EBMUD.

7.2 Previous Groundwater Modeling Studies

7.2.1 Introduction

There are three primary existing numerical models that incorporate northeastern San Joaquin County. The United States Geological Survey (USGS) Central Valley Hydrologic Model (CVHM) covers the entire central valley of California, and was constructed using the MODFLOW finite difference code. The CDM Dyn-Flow model covers San Joaquin County and portions of the surrounding three counties, and was constructed using a proprietary finite element code. The C2VSim model covers the entire Central Valley and is based on a refined and updated version of the IGSM model code. Details of each model are presented in the following sections of this TM. More detail is provided for the CVHM model due to its possible future use in providing boundary conditions for the project-specific groundwater model.

7.2.2 USGS Central Valley Hydrologic Model

The USGS developed the Central Valley Hydrologic Model and published documentation as Professional Paper 1766 (Faunt, et.al., 2009). The CVHM is a revision and update of an earlier model – the Central Valley Regional Aquifer System and Analysis (CV-RASA) model. The model domain covers the entire Central Valley of California, and was calibrated for a time period from 1961 to 2003 using monthly stress periods. The model domain is comprised of uniform one-mile square grid cells. The model domain grid cells that occur within the project study are shown in Figure 1.

The CVHM model includes 10 model layers that extend to a maximum depth of 1,800 feet below ground surface, or 1,500 feet below the Corcoran Clay (where it is present). In general, the first model layer is 50 feet thick with underlying layers increasing in thickness with depth. The depth interval for each model layer in the study area is presented in Table 7-1.

Table 1. Summary of CVWM Model Layers

Table 7-1 Summary of CVWM Model Layers

Model Layer	Depth Interval (feet bgs)	Comments
1	0 to 50, or 0 to 147	Layer is 0 to 50 feet west of Highway 99, and 0 to 147 feet east of Highway
2	50 to 150, or 147 to 150	Layer is 50 to 150 feet west of Highway 99, and 147 to 150 feet east of Highway 99. See Note below.
3	150 to 300	
4	300 to 301	Represents Corcoran clay where present. In study area it is a "phantom" layer used only to keep tract of layer numbering.
5	301 to 302	Represents Corcoran clay where present. In study area it is a "phantom" layer used only to keep tract of layer numbering.
6	302 to 500	
7	500 to 750	
8	750 to 1,050	
9	1,050 to 1,400	
10	1,400 to 1,800	

Note: Where the water table is between 50 and 150 feet below ground surface (east of Highway 99), model layer 1 was made to 147 feet instead of 0 to 50 feet) and model layer 2 was converted to a "dummy" layer that was three feet thick from 147

As described in Table 7-1, changes to model layer thicknesses in model layers 1 and 2 were made in areas where the water table is deeper than 50 feet below ground surface. In addition, model layers 4 and 5 represent the Corcoran Clay where it is present. Where the Corcoran Clay is not present (as is the case within the present study area), model layers 4 and 5 were converted to one-foot-thick "phantom" layers.

For the overall model domain, most of the lateral boundaries were simulated as no-flow, but the Delta area included general head boundary cells. The study area is generally located in the middle portion of the overall model domain, and there are no hydraulic boundaries along edges of the study area. Sources of recharge to the model include stream infiltration, precipitation, and excess applied irrigation water. Sources of discharge include wells, evapotranspiration, and gaining streams. The Delta general head boundary cells also serve as sources of both recharge and discharge.

The USGS obtained approximately 150,000 drillers' logs for the texture analysis of the Central Valley. These logs were reviewed to select only the highest quality logs of sufficient depth and density for use in the study. The resulting well log database used for the study consisted of about 8,500 drillers' logs over a total study area of about 20,000 square miles. A previous study in the 900 square mile Modesto area (Burow, et. al., 2004) utilized 3,500 drillers' logs and was not resampled for the CVHM study. In accordance with previous designations developed by Page (1986), drillers' logs sediment descriptions were classified as either coarse-grained (e.g., gravel, sand, clayey or silty gravel, clayey or silty sand) or fine-grained (e.g., clay, silt, sandy clay, sandy silt). The percent of coarse-grained materials was calculated based on 50-foot depth intervals from ground surface to the total depth of the log. The mean percentage of coarse-grained materials for the entire Central Valley is 36 percent.

The study area is located in the northern portion of the USGS-designated spatial province named Northern San Joaquin – Corcoran Clay Absent. The mean percent of coarse-grained materials within this province is 34 percent. The northern portion of this province along the Mokelumne and Calaveras rivers, where the study area is located, is generally comprised of finer grained sediments compared to the southern portion of the province along the Stanislaus, Tuolumne, and Merced rivers. This difference in sediment texture is a function of whether or not the drainage areas for each river are connected to former glaciated portions of the Sierra Nevada, and deposition of coarser grained sediments along the up-gradient portions of the San Joaquin River. Although not explicitly stated in the USGS report, it can be concluded that the study area mean percent of coarse-grained materials is less than the province-wide average of 34 percent.

Based on review of model report documentation, it appears that there is less than one drillers' log per square mile on average throughout the Central Valley. In addition, it should be noted that the median well log depth is 321 feet, and only 129 of the 8,500 well logs extend below a depth of 1,000 feet. Thus, the number of texture values (i.e., percent coarse-grained) is greatest at shallower depths, and decreases with increasing depths below ground surface.

Geostatistical methods (e.g., kriging) were applied to the data set to estimate the percent of coarse-grained material between drillers' logs. The model grid was then overlaid on the geostatistical results to obtain the percent coarse-grained for each one-mile square model grid cell.

The percent of coarse-grained sediments in each model layer is provided in Figures 2 through 11. The percent coarse-grained sediments in model layer 1 are below 50 percent through the study area. The highest values, between 40 and 43 percent, are located in the eastern portion of the study area and in an area immediately south of the Mokelumne River and east of Highway 99. The highest values in model layer 3 are in the easternmost portion of the study area, with some values exceeding 50 percent. Model layers 6 and 7 also show a general pattern of higher percent coarse-grained materials in the eastern portion of the study area.

Model layer 7 has the broadest area with percent coarse-grained greater than 50 percent. Model layers 8 through 10 have the lowest percent coarse-grained materials. Hydraulic conductivity (K) values were initially based upon a texture model and lithologic end-member K values. Equivalent horizontal conductivity (Kh) and vertical conductivity (Kv) were assumed to be correlated to sediment texture. A power mean formula was applied – inputs included the fraction of coarse grain material, K value of coarse grain material, fraction of fine grain material, and K value of fine grain material. Initial input K values were then adjusted during the calibration process. The final calibrated horizontal and vertical K values for each model layer are displayed in Figures 12 to 31.

In general, horizontal K values range from 100 to 200 feet/day in model layer 1 over most of the study area. There is an area of K values in the 200 to 300 feet/day range in the northwestern portion of the study area in model layer 1, and an area of K values from 200 to 250 feet/day in the southeast. Comparison of Figures 2 and 12 indicates a general correlation of model grid squares with horizontal K over 200 feet/day corresponding to model grid squares with the highest percent coarse-grained.

Model layer 3 horizontal K values are somewhat higher and in the range of 150 to 300 over most of the study area. In general, K values are less than 200 feet/day in the western portion of the model domain and greater than 200 feet/day in the eastern portion of the model domain. Comparison of Figures 4 and 14 shows a general correlation with areas of higher percent coarse grained sediments having higher horizontal K values.

Model layers 6 through 10 show a general pattern of higher horizontal K values in the eastern third of the model domain, with the contrast in K values (between the western portion and eastern third of the study area) becoming greater with depth. For model layers 6 through 8, there is a general correlation between percent coarse-grained and horizontal K values.

However, model layers 9 and 10 have large differences in K values between the eastern and western portions of the study area that are not correlated to percent coarse-grained materials. The abrupt change in horizontal K values in model layers 9 and 10 are likely a result of model calibration.

In general, vertical K values range from 0.02 to 0.27 feet/day in model layers 1 and 3 across the study area. The lowest values of 0.02 to 0.03 feet/day occur in the eastern quarter of the study area in both model layers 1 and 3. The highest values of 0.24 to 0.27 feet/day occur in the western three-quarters of the study area. There is an abrupt transition from the low values (0.02 to 0.03 feet/day) to the high values (0.24 to 0.27 feet/day). The abrupt transition from lower to higher vertical K values does not appear to correlate with percent coarse-grained materials based on comparison of Figures 2 through 11 to Figures 22 through 31. It is likely that the abrupt transition in vertical K values is a result of model calibration.

The model storage properties are represented by the specific storage parameter with units of feet-1 (Figures 32 to 41). The specific storage value must be multiplied by the saturated thickness to obtain the storage coefficient (for model layers 2 through 10) or specific yield (for model layer 1 only). It should be noted that the model layer 1 specific storage value assumes a constant saturated thickness equal to the model layer thickness (either 50 or 147 feet), in order to simplify model computations. Based on review of literature and previous studies, specific yield values specified by USGS for the model were assumed to range from 0.09 (no coarse-grained deposits) to 0.40 (100 percent coarse-grained deposits). Approximately 50 percent of specific yield values in the model domain are between 0.20 and 0.30, with about 15 percent of values greater than 0.30. Based upon review of model layer 1 within the study area, specific yield values generally range from 0.25 to 0.35. Calculation of initial specific storage values were based upon porosity (0.25 for coarse-grained and 0.50 for fine-grained sediments), fractional aggregate thickness of coarse- and fine-grained sediments, and compressibility of water (1.4 x 10-6). Final calibrated specific storage values are provided in Figures 32 to 41.

The temporal discretization involves use of monthly stress periods of two time steps each. The simulation period extends over 42.5 years from April 1961 to September 2003 (Faunt, et.al., 2009). It is our understanding that a model update is in progress to extend the simulation period through 2013.

7.2.3 CDM Dyn-Flow Model

CDM developed the Dyn-Flow Model and published documentation in the San Joaquin County Water Management Plan – Volume 2 (CDM, 2001) and in Integrated Regional Water Management Plan (IRWMP) documentation (CDM, 2008). A previously existing IGSM Model for the region was used as a basis for development of the Dyn-Flow Model (California Water and Environmental Modeling Forum, 2008). The model domain covers portions of San Joaquin, Sacramento, Calaveras, and Stanislaus counties, and was initially calibrated for a time period from 1970 to 1993 using monthly stress periods. The model simulation period was extended through 2006 as part of the IRWMP modeling effort (CDM, 2008). The updated modeling effort conducted for the IRWMP did not result in any changes to model layering or hydraulic properties. It is not known if additional updates and/or modifications to the Dyn-Flow model have been completed since the efforts documented in the CDM 2008 report.

The model domain is comprised of 1,892 triangular elements. There are 3 active model layers that extend to a maximum depth of about 2,500 feet below ground surface. In the vicinity of the Mokelumne River, the model extends vertically to a depth ranging from about 1,000 feet MSL on the east to 2,500 feet MSL on the west (Appendix A). The uppermost model layer is 15 to 190 feet thick with underlying layers generally being of considerably greater thickness. Along the Mokelumne River, the upper layer appears to range from 50 to 150 feet and the intermediate layer appears to range in thickness from about 650 to 1,300 feet based upon model cross-sections (Appendix A). The uppermost layer is intended to represent shallow alluvial and Victor Formation deposits, the intermediate layer represents the Laguna and Mehrten formations, and the lowest layer represents the Valley Springs Formation.

The horizontal K values of the upper layer in the Dyn-Flow Model are generally 200 feet/day along the Mokelumne River, 100 feet per day in the western and middle portions of the Study Area, and 10 feet/day in the easternmost extent of the Study Area (Appendix A). The vertical K values were 0.1 to 1.5 feet/day, with higher vertical K values associated with areas of higher horizontal K values. Within the Study Area, intermediate layer horizontal and vertical K values are generally similar to upper layer K values (Figure 3-8, CDM, 2001). The lowest active model layer has horizontal K values of 5 to 40 feet/day (Figure 3-9, CDM, 2001) and vertical K values of 0.1 to 0.4 feet/day (CDM, 2001).

The Dyn-Flow Model boundary conditions include general heads along the south, west, and northwest, constant heads along the north, and no-flow along the eastern edge of the model domain. River/variable heads were also used in the model to represent Dry Creek and the San Joaquin, Tuolumne, Stanislaus, Calaveras, Mokelumne, Consumes rivers. The river properties included in the river/variable head boundary conditions are river width, river bed thickness, and vertical K.

Overall, the Dyn-Flow model is relatively coarse in terms of the model grid and especially model layers compared to what is needed for a future demonstration project model. The aquifer parameter zones are also quite large with K and S values held constant over large areas. The Dyn-Flow model does not have the characteristics needed for application to the demonstration project.

7.2.4 C2VSim Model

The California Department of Water Resources (DWR) developed the California Central Valley Groundwater-Surface Water Simulation Model (C2VSim) for use as a water management planning tool. It simulates the occurrence and movement of surface water and groundwater throughout the 20,000 square mile Central Valley alluvial area. The model incorporates monthly data for precipitation, land use, crops, and surface water from 1921 to 2009, and is used to calculate historical water use, groundwater pumping, and groundwater storage change. Among other uses, the model is considered to be a useful tool in evaluating impacts from large-scale conjunctive use and water transfer programs (DWR, June 2013).

The current version of the model was developed using DWR's Integrated Water Flow Model (IWFM) application. IWFM integrates a three-dimensional finite element groundwater flow model with one-dimensional land surface, river, lake, vadose zone, and small stream processes. The model can calculate groundwater crop water demands, soil moisture, effective precipitation, applied surface water, and calculate estimated groundwater pumping demands to meet the residual crop water demands (DWR, June 2013).

The C2VSim model utilizes 21 hydrologic subregions, and the project study area straddles the Eastside streams and Delta subregions in C2VSim. The Eastside Streams subregion encompasses 1,400 square miles that are divided into 88 model elements. The Delta subregion encompasses 1,130 square miles that are divided into 78 model elements. Thus, each model element in the project area encompasses about 15 square miles.

The C2VSim model is based on the model framework and data sets previously developed for the Central Valley Groundwater-Surface Water Model (CVGSM), which was based on previous models. Overall, the model consists of 1,392 elements (i.e., model cells) and three model layers over the approximately 20,000 square miles of the Central Valley (about 14.4 square miles per element). Rivers are simulated with river segments where vertical flow from/to the river is a function of groundwater level, river stage, and streambed conductance.

In general, model layering is constructed so that layer 1 represents the unconfined portion of the aquifer above the Corcoran Clay (where present), layer 2 represents the confined portion of the aquifer that has groundwater pumping and is below the Corcoran Clay (where present), and layer 3 is the confined portion of the aquifer where no groundwater pumping occurs. The base of layer 3 is either bedrock or the base of fresh water. In areas where the saturated thickness of model layer 1 was less than 100 feet, the base of model layer 1 was lowered to always maintain a minimum 100-foot thickness. The saturated thickness of model layer 1 ranges from 100 to 500 feet in most areas, but can be as much as 700 feet thick where the Corcoran Clay is deep below ground surface. Based on available information in the C2VSim report, the thickness of Model layer 1 in the study area appears to be 200 to 300 feet, and model layer 2 appears to be about 200 feet thick (Appendix B).

The aquifer parameters used in the C2VSim model are summarized in Table 7-2. Model layers 1 and 2 are of primary interest to the San Joaquin banking study and have horizontal K values ranging from 6 to 100 feet/day, with an average of about 50 feet/day. Vertical K values range from 0.02 to 0.3 feet/day with an average of 0.1 feet/day. Specific yield values for Model layer 1 average about 0.2, and specific storage for Model layer 2 was an average of 2 x 10-5 ft-1.

Table 7-2 Summary of C2VSim Aquifer Parameters

Aquifer Parameter	Model Layer	Minimum	Average	Maximum
Horizontal K (ft/day)	1	6	46	100
	2	7	50	100
	3	2	5	17
Vertical K (ft/day)	1	0.02	0.1	0.3
	2	0.02	0.09	0.3
	3	0.005	0.06	0.3
Specific Yield	1	0.06	0.2	0.4
Specific Storage	2	5 x 10-6	2 x 10-5	7 x 10-5
Specific Storage	3	2 x 10-6	2 x 10-5	6 x 10-5

More specific to the San Joaquin County groundwater banking study area, horizontal K in Model layer 1 appears to range from about 30 to 60 feet/day and horizontal K in Model layer 2 from about 40 to 60 feet/day based on color coded figures provided in the C2VSim model documentation. Vertical K in the study area for Model layers 1 and 2 appears to be about 0.15 feet/day. Specific yield appears to range from 0.12 to 0.25 in Model layer 1, and specific storage appears to range from about 2 to 5 x 10-5 feet-1 in Model layer 2 in the study area (DWR, 2013).

The C2VSim model covers the entire Central Valley and is very coarse in terms of model grid and layering. The CVHM provides more detail relative to aquifer parameters, more model layers, a finer grid, and is in a preferred model code (MODFLOW). Thus, the CVHM is a better choice than C2VSim for use as a regional model to provide boundary conditions for a project specific model planned for future development to evaluate the demonstration project.

7.3 Project-Specific Groundwater Modeling Recommendations

7.3.1 Introduction

As described in the Introduction and Purpose section of this TM, the three regional groundwater models discussed above were primarily reviewed for extraction of aquifer parameter values in the study area and possible use in providing boundary conditions for a local scale model. Due to the need for a model specifically designed to evaluate the proposed project, it is recommended that a new project-specific groundwater model be developed in a later phase of the San Joaquin County Groundwater Banking Study. A groundwater model will be necessary in later phases of the study to evaluate various scenarios for recharge and extraction of water in the groundwater bank – particularly with respect to potential impacts related to groundwater level changes and water quality. Preliminary recommendations for this modeling effort are provided in subsequent paragraphs.

7.3.2 Model Code

The potential model codes that could be used include MODFLOW, IWFM (IGSM), or various other finite element codes (e.g., Dyn-Flow, FEFLOW). Given the desire for a publically available, widely utilized, and widely accepted model code to be used for this project, it is recommended that MODFLOW be used to develop the local groundwater flow model.

MODFLOW was developed by the USGS and continues to undergo improvement and refinement by the USGS. The code allows for various packages to be incorporated into the model, including new packages that may be developed in the future. It is in the public domain, and several commercial graphical user interfaces (GUI) are available to facilitate development/calibration of models and post-processing of model results.

7.3.3 Model Domain and Grid

The selected model domain will need to be large enough to minimize boundary effects on model scenario simulations, but not too large to be cumbersome and unnecessarily increase model run times. The project study area encompasses about 15.5 by 9 miles in San Joaquin County, primarily to the north and east of Stockton. The bedrock of the Sierra Nevada is located at a distance of about 10 miles to the east of the study area, and the delta is about 5 miles to the west of the study area. It is anticipated that a model domain that extends 2 to 5 miles beyond current study area boundaries would be adequate to minimize the influence of boundary conditions on model results. Appropriate grid spacing may be on the order of 200 feet by 200 feet; however, this determination should be made as part of the model construction and development process.

7.3.4 Model Layers

The selection of model layering should be based on development and review of site specific hydrogeologic cross-sections. The model base would not need to be as deep as the 1,800 feet encompassed by the regional CVHM model. If the primary groundwater production zones only extend up to about 700 feet in the study area, then a model base of 1,000 feet should be adequate. It is anticipated that perhaps five to seven model layers would be sufficient; however, this decision should be made as part of the model construction/development process and in conjunction with review of hydrogeologic cross-sections.

7.3.5 Model Boundary Conditions

Boundaries on the north, south, east, and west edges of the model domain should be represented as general head boundary conditions (as long as the model domain boundaries are not extended too far east or west, as described above), because groundwater flow can occur across these boundaries in either direction. If feasible, input on the fluctuation of heads associated with these general head boundaries should be derived from the CVHM model. To the extent that rivers occur along the model boundaries, the rivers should be represented with the appropriate MODFLOW package(s).

7.3.6 Model Inputs - Aquifer Parameters

The important aquifer parameters that need to be input for each model grid square and layer include: horizontal hydraulic conductivity, vertical hydraulic conductivity, specific yield, and specific storage. Existing regional model data provides some guidance on the range of aquifer parameters that may be suitable for the site-specific model. However, aquifer test and specific capacity data from wells within the project study area should be reviewed in detail to provide additional input with regard to aquifer parameter values for the local model. This work is planned to be conducted by other team members as part of the current scope of work and/or future phases of work for the demonstration project.

7.3.7 Model Inputs - Water Balance

The water balance inputs include the various components of recharge and discharge. Recharge in the study area may include infiltration of precipitation, streamflow infiltration, artificial recharge, irrigation and domestic return flows, and subsurface inflow from model boundaries. Discharge in the study area occurs primarily through municipal/industrial, agricultural, and domestic groundwater pumping, and subsurface outflow across model boundaries. Other sources of discharge may include evapotranspiration and discharge to streams. A detailed water balance study would be a key component of future studies to provide important input data for a project-specific model.

7.3.8 Adequacy of Study Area Data

Tasks conducted by other team members for this study include an initial assessment of the groundwater monitoring well network (EPur, 2014). The EPur study included review of available wells with water level data and associated well logs in the study area. The available data were compiled in tables and maps of well locations. The wells were organized by depth to screen mid-point (with the major categories being less than 200 feet, 200 to 300 feet, and greater than 300 feet), and length of water level monitoring record (with categories of less than 20 years and greater than 20 years). The overall assessment showed that while there is good data coverage for the overall study area, additional nested monitoring wells are recommended at locations to be determined based on the planned (yet to be determined) location of the demonstration project.

Other tasks that are ongoing in this current phase of the overall scope of work or planned for future phases of work include:

- Review of Well Completion Reports;
- Literature review to extract and compile aquifer and well test data;
- Preliminary WinFlow modeling of mounding, migration, and drawdown;
- Definition of Management Area parameters; and
- Description of monitoring requirements.

The results of the above listed tasks will provide some of the input needed to more fully describe the adequacy of existing data in the study area for development of a local groundwater model as part of a future phase of work. However, the work conducted to date indicates that adequate data for model construction likely exist, and data gaps can be addressed with targeted field efforts that include additional well installation and testing at key locations.

7.4 Summary and Conclusions

This TM is intended to briefly summarize general characteristics of the existing regional groundwater models that include the study area. The focus of the review was on the model extent/domain, boundary conditions, model layering, and aquifer parameters. The aquifer parameters in the uppermost model layer were emphasized due to their importance as input in assessment of recharge pond potential.

In comparing the upper layer of the three models, horizontal K values ranged from about 100 to 200 feet/day in the CVHM model compared to 10 to 200 feet/day in the Dyn-Flow model and 30 to 60 feet/day in the C2VSim model. In terms of vertical hydraulic conductivity, the upper layer of the CVHM ranged from 0.02 to 0.27 feet/day, the upper layer of Dyn-Flow ranged from 0.1 to 1.5 feet/day, and about 0.15 feet/day in the C2VSim model. In very general terms, horizontal hydraulic conductivities are higher in the CVHM model, whereas vertical hydraulic conductivities are higher in the Dyn-Flow model within the upper model layer in the study area.

The three regional groundwater models were also reviewed with a view towards future development of a local groundwater model of appropriate detail to simulate potential groundwater banking scenarios. It is recommended that this local groundwater model be developed using the MODFLOW code, and consider use of the CVHM model to provide boundary conditions for the local model. This TM also provides some preliminary recommendations regarding the details for development of the local groundwater model.

7.5 References

Burow, K.R., Shelton, J.L., Hevesi, J.A., and Weissmann, G.S. (2004), Hydrogeologic Characterization of the Modesto Area, San Joaquin Valley, California, U.S. Geologic Survey Scientific-Investigations Report 2004-5232.

California Department of Water Resources (DWR) (2013), Development and Calibration of the California Central Valley Groundwater-Surface Water Simulation Model (C2VSim), Version 3.02-CG, DWR Technical Memorandum, June.

CDM (2001), San Joaquin County Water Management Plan Groundwater Modeling Information, Consultant's report prepared for San Joaquin County Flood Control and Water Conservation District.

CDM (2008), Northeastern San Joaquin County Groundwater Banking Authority, Integrated Conjunctive Use Project, Groundwater Model Documentation for IRWMP Simulations, Consultants technical memorandum for model simulations conducted for the Eastern San Joaquin Integrated Regional Water Management Plan.

EPur (2014), Initial Assessment of Groundwater Monitoring Well Network to Support San Joaquin County - EBMUD Groundwater Banking Demonstration Project, Draft Technical Memorandum prepared for GEI Consultants, September 25, 2014.

Faunt, C.C., Hanson, R.T., and K. Belitz (2009), Groundwater Availability of the Central Valley Aquifer, California; Chapter A – Introduction, Overview of Hydrogeology, and Textural Model of California's Central Valley, USGS Professional Paper 1766.

Faunt, C.C., Hanson, R.T., Belitz, K, Schmid, W., Predmore, S.P., Rewis, D.L., and K. McPherson (2009), Groundwater Availability of the Central Valley Aquifer, California; Chapter C – Numerical Model of the Hydrologic Landscape and Groundwater Flow in California's Central Valley, USGS Professional Paper 1766.

Page, R.W. (1986), Geology of the Fresh Ground-water Basin of the Central Valley, California, with texture maps and sections: U.S. Geological Survey Water-Resources Investigations Report 73-6.

7.6 Appendices

7.6.1 Appendix A Dyn-Flow Model Aquifer Parameters

7.6.2 Appendix B C2VSim Model Aquifer Parameters

LIST OF TABLES

Table

LIST OF FIGURES

Figure

APPENDICES

TABLES

Table 1. Summary of CVWM Model Layers

Model Layer	Depth Interval (feet bgs)	Comments
1	0 to 50, or 0 to 147	Layer is 0 to 50 feet west of Highway 99, and 0 to 147 feet east of Highway 99. See Note below.
2	50 to 150, or 147 to 150	Layer is 50 to 150 feet west of Highway 99, and 147 to 150 feet east of Highway 99. See Note below.
3	150 to 300	
4	300 to 301	Represents Corcoran clay where present. In study area it is a “phantom” layer used only to keep tract of layer numbering.
5	301 to 302	Represents Corcoran clay where present. In study area it is a “phantom” layer used only to keep tract of layer numbering.
6	302 to 500	
7	500 to 750	
8	750 to 1,050	
9	1,050 to 1,400	
10	1,400 to 1,800	

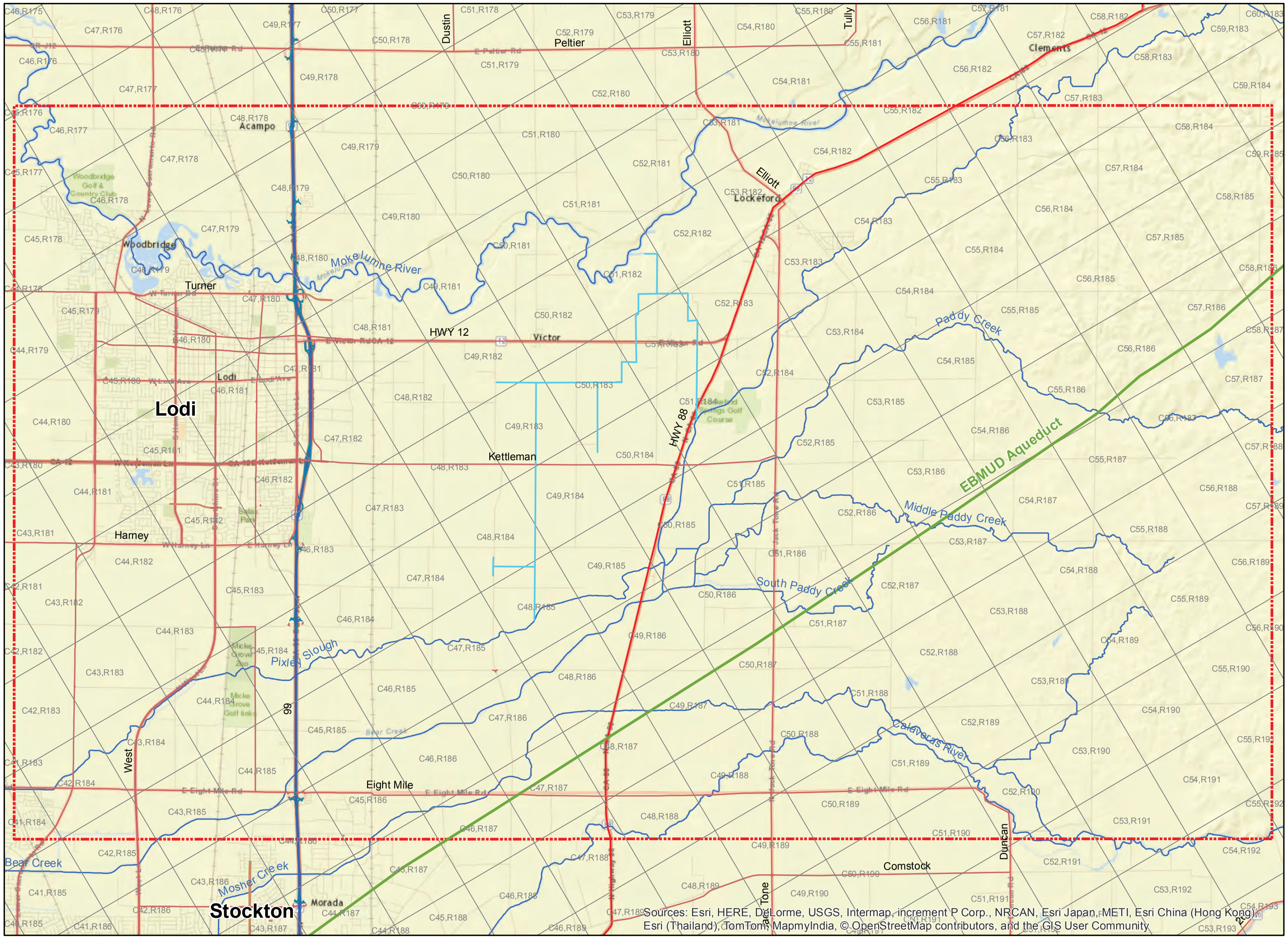
Note: Where the water table is between 50 and 150 feet below ground surface (east of Highway 99), model layer 1 was made thicker (0 to 147 feet instead of 0 to 50 feet) and model layer 2 was converted to a “dummy” layer that was three feet thick from 147 to 150 feet.

Table 2. Summary of C2VSim Aquifer Parameters (K values in feet/day).

Aquifer Parameter	Model Layer	Minimum	Average	Maximum
Horizontal K	1	6	46	100
	2	7	50	100
	3	2	5	17
Vertical K	1	0.02	0.1	0.3
	2	0.02	0.09	0.3
	3	0.005	0.06	0.3
Specific Yield	1	0.06	0.2	0.4
Specific Storage	2	5×10^{-6}	2×10^{-5}	7×10^{-5}
Specific Storage	3	2×10^{-6}	2×10^{-5}	6×10^{-5}

FIGURES

GEI Consultants
Project No. 04.62140068



LEGEND

- Ground Water Recharge Pilot Project Area
- NSJWCD South System

N

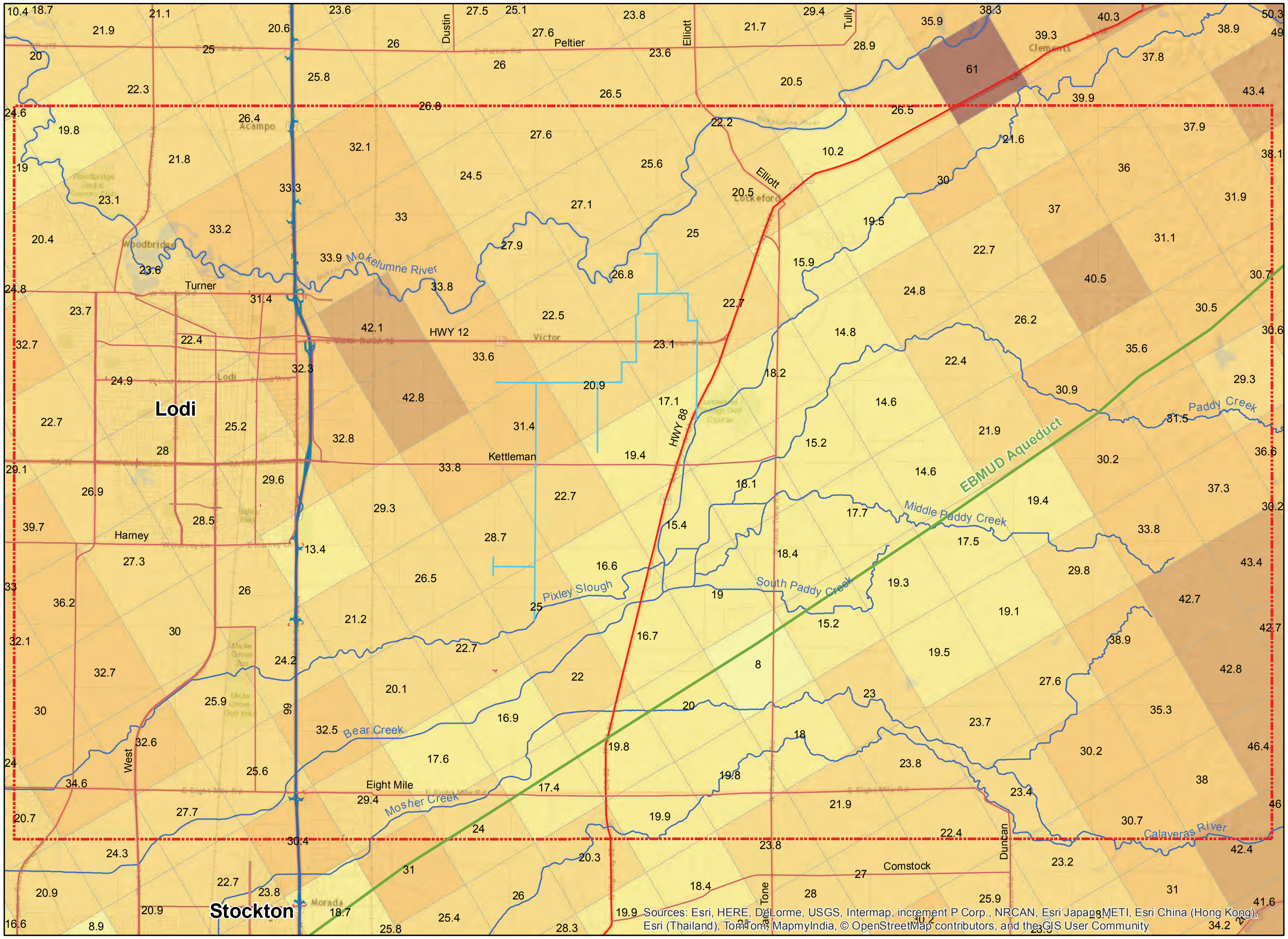
1:80,000

0 | 4,000 | 8,000 | 16,000 Feet

STUDY AREA LOCATION MAP AND USGS CVHM MODEL GRID
Groundwater Banking Project
San Joaquin County , California

Figure 1

N:\Projects\04_2014\04_6214_0068_SanJoaquinGWBanking\Outputs\Working\mxd\USGS_Model.mxd, 12/26/2014, dmiao



LEGEND

- Ground Water Recharge Pilot Project Area
- NSJWCD South System

Percent (%) Coarse-Grained

- 8.0 - 10.0
- 10.1 - 20.0
- 20.1 - 30.0
- 30.1 - 40.0
- 40.1 - 50.0
- 50.1 - 60.0
- 60.1 - 70.0

N

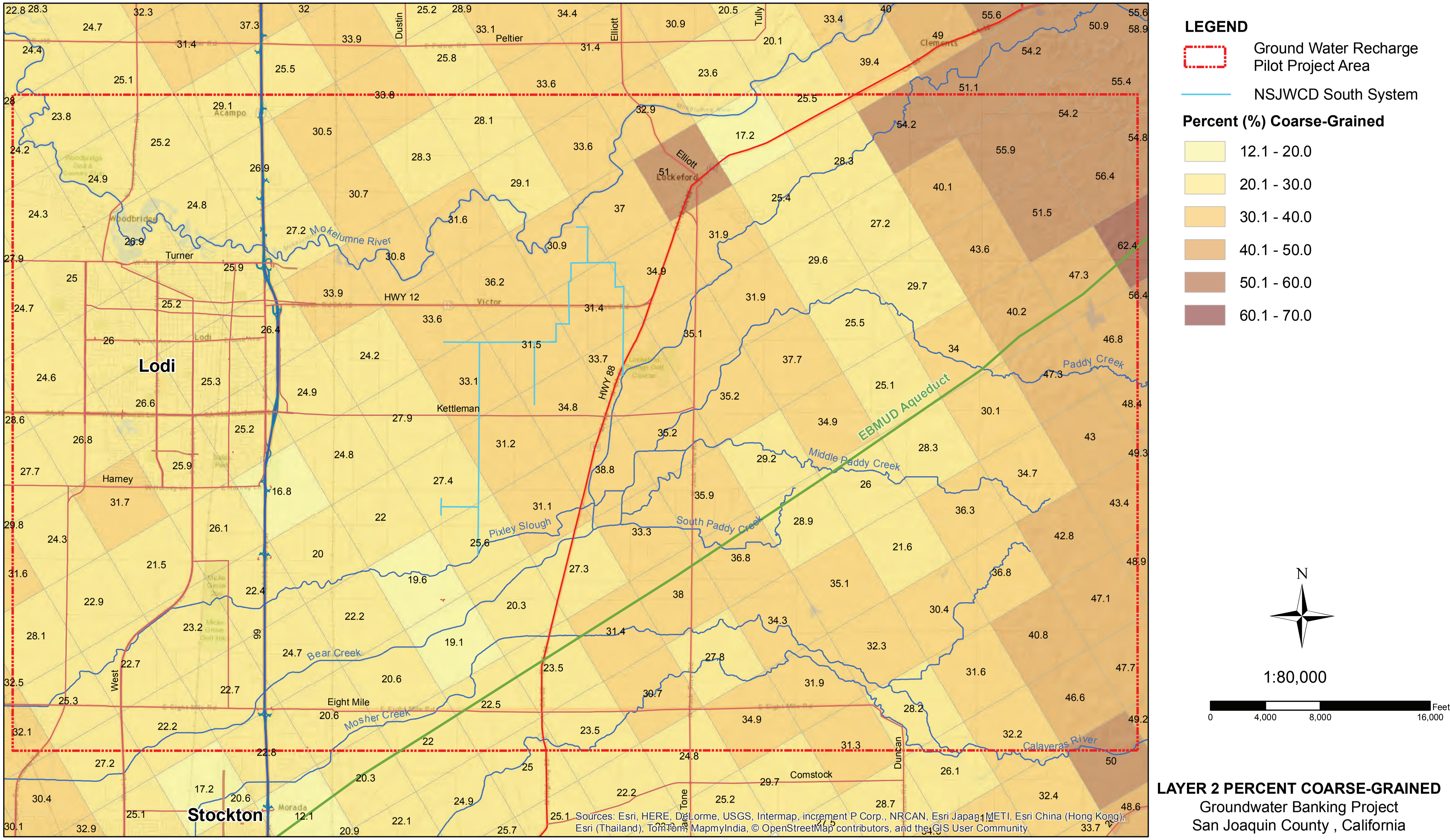
1:80,000

0 4,000 8,000 16,000 Feet

LAYER 1 PERCENT COARSE-GRAINED
Groundwater Banking Project
San Joaquin County , California

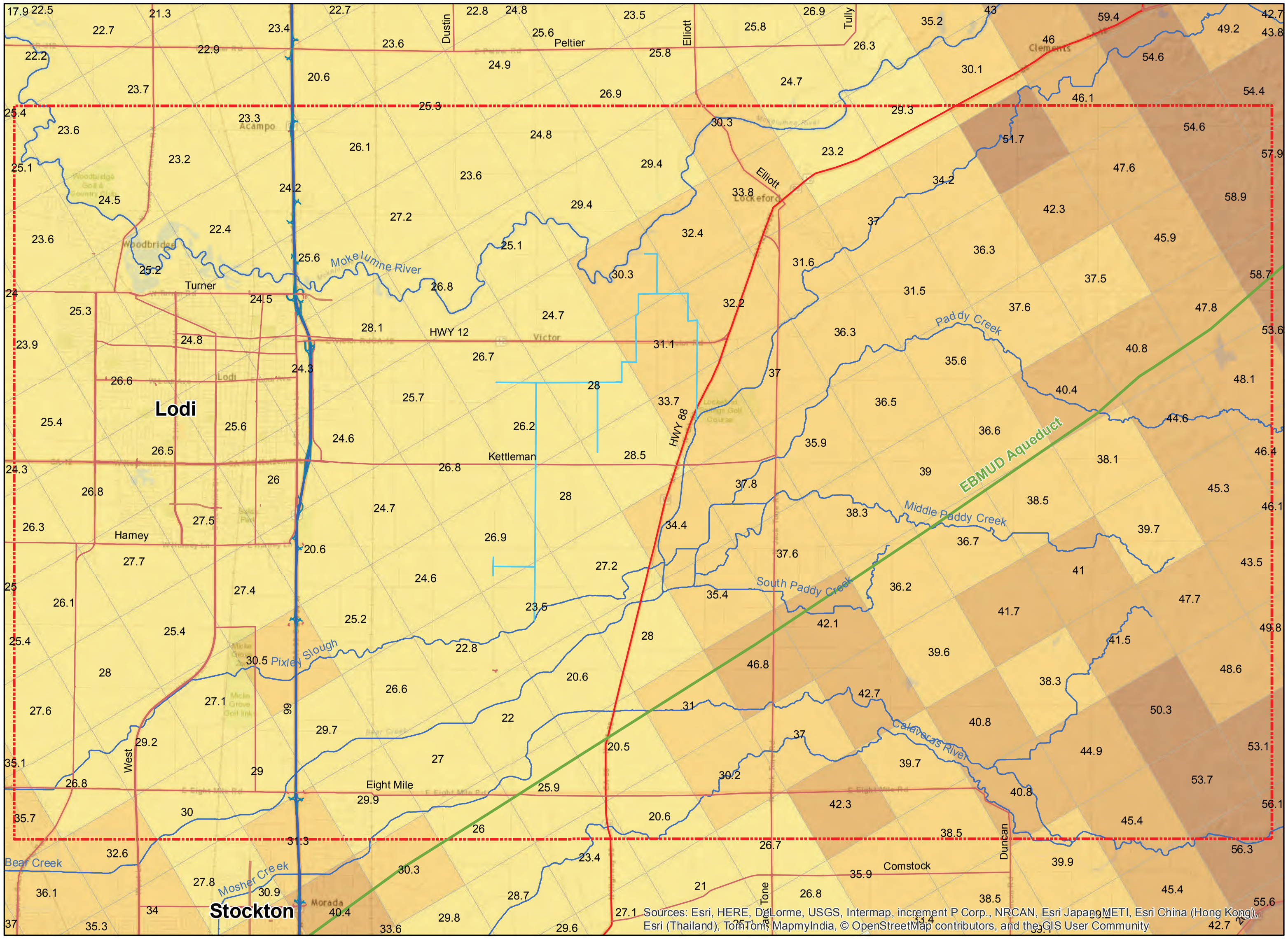
Figure 2

N:\Projects\04_2014\04_6214_0068_SanJoaquinGWBanking\Outputs\Working\mxd\L1_Zoneepc.mxd, 12/26/2014, dmiao



LAYER 2 PERCENT COARSE-GRAINED
Groundwater Banking Project
San Joaquin County , California

Figure 3



LEGEND

- Ground Water Recharge Pilot Project Area
- NSJWCD South System

Percent (%) Coarse-Grained

- 17.7 - 20.0
- 20.1 - 30.0
- 30.1 - 40.0
- 40.1 - 50.0
- 50.1 - 60.0
- 60.1 - 70.0

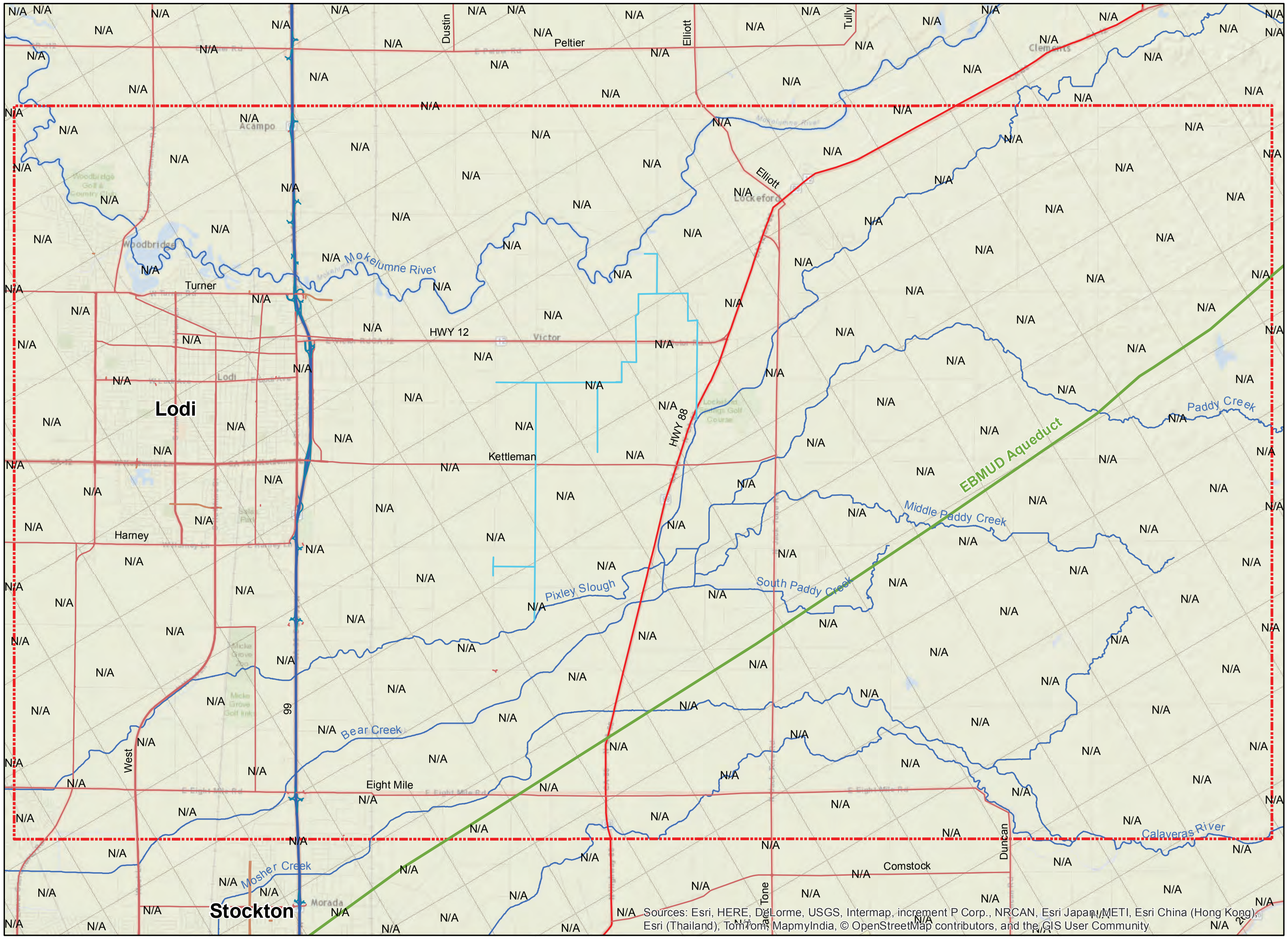
N

1:80,000

0 4,000 8,000 16,000 Feet

LAYER 3 PERCENT COARSE-GRAINED
Groundwater Banking Project
San Joaquin County , California

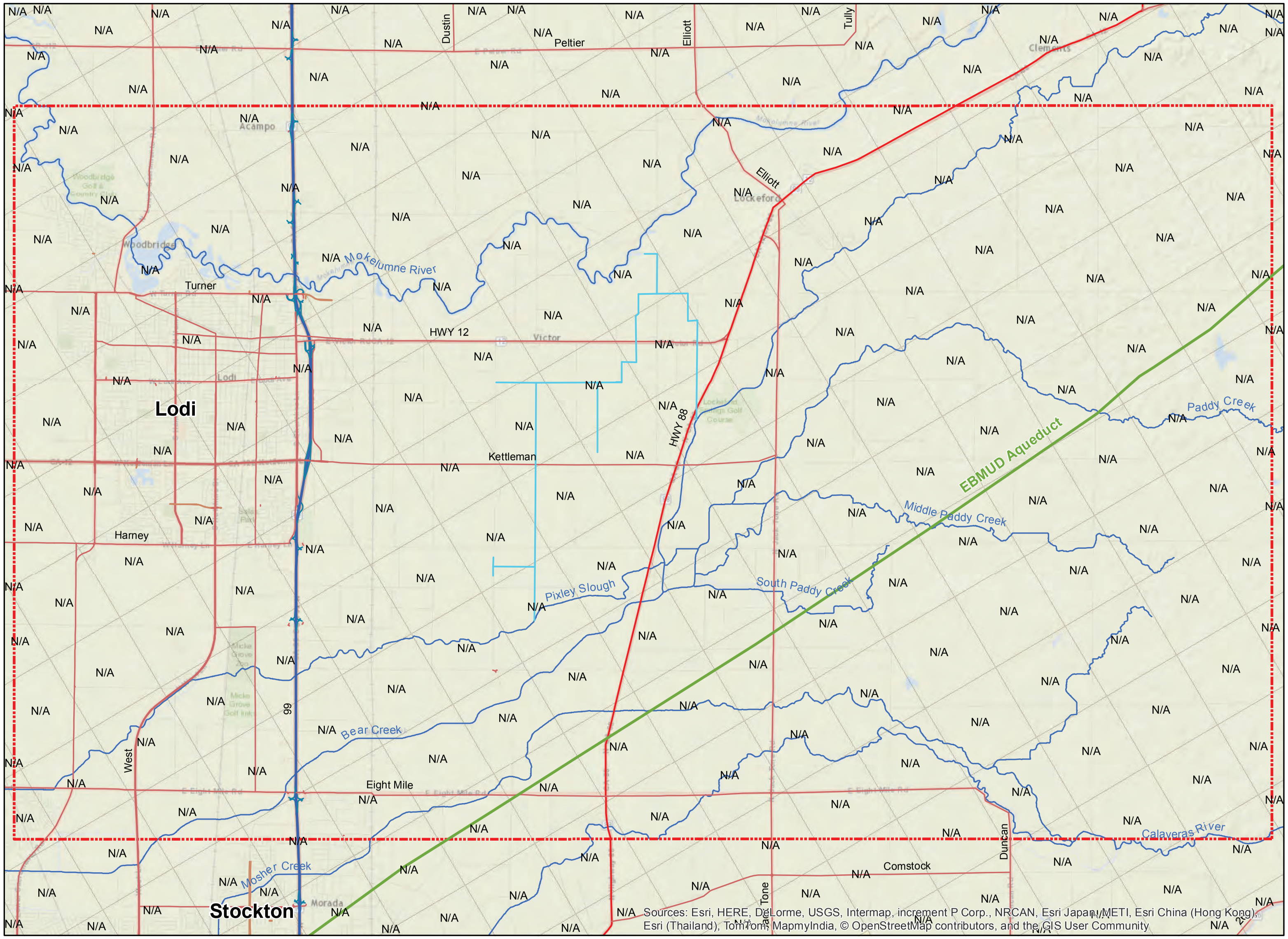
Figure 4



LAYER 4 PERCENT COARSE-GRAINED
Groundwater Banking Project
San Joaquin County , California

Figure 5

N:\Projects\04_2014\04_6214_0068_SanJoaquinGWBanking\Outputs\Working\mxd\L4_Zoneegpc.mxd, 12/26/2014, dmiao



LEGEND

Ground Water Recharge Pilot Project Area

NSJWCD South System

Percent (%) Coarse-Grained

No Data Available

N

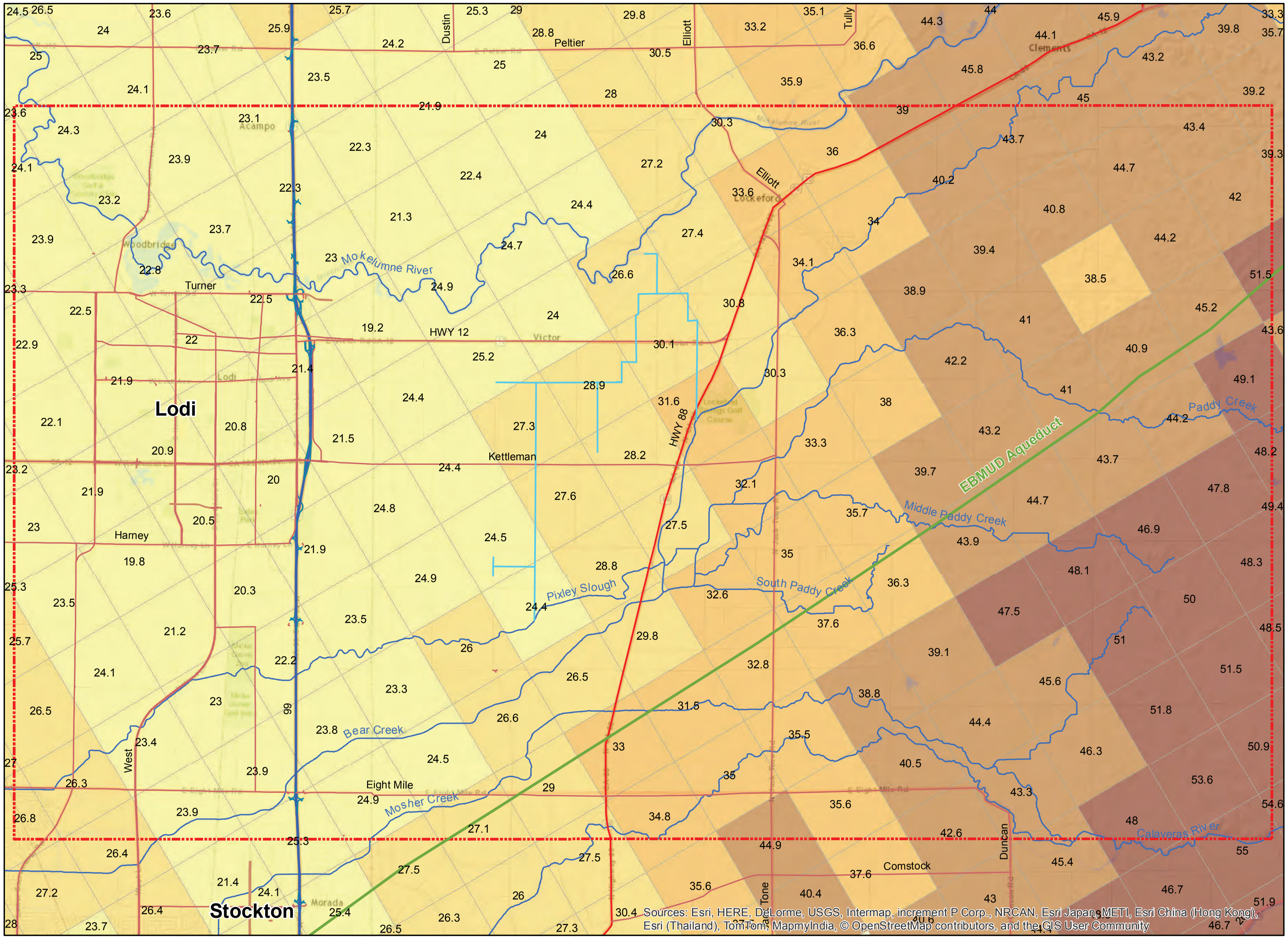
1:80,000

0 4,000 8,000 16,000 Feet

LAYER 5 PERCENT COARSE-GRAINED
Groundwater Banking Project
San Joaquin County , California

Figure 6

N:\Projects\04_2014\04_6214_0068_SanJoaquinGWBanking\Outputs\Working\mxd\L5_Zoneepc.mxd, 12/26/2014, dmiao



LEGEND

- Ground Water Recharge Pilot Project Area
- NSJWCD South System

Percent (%) Coarse-Grained

- 8.0 - 10.0
- 10.1 - 20.0
- 20.1 - 30.0
- 30.1 - 40.0
- 40.1 - 50.0
- 50.1 - 60.0
- 60.1 - 70.0

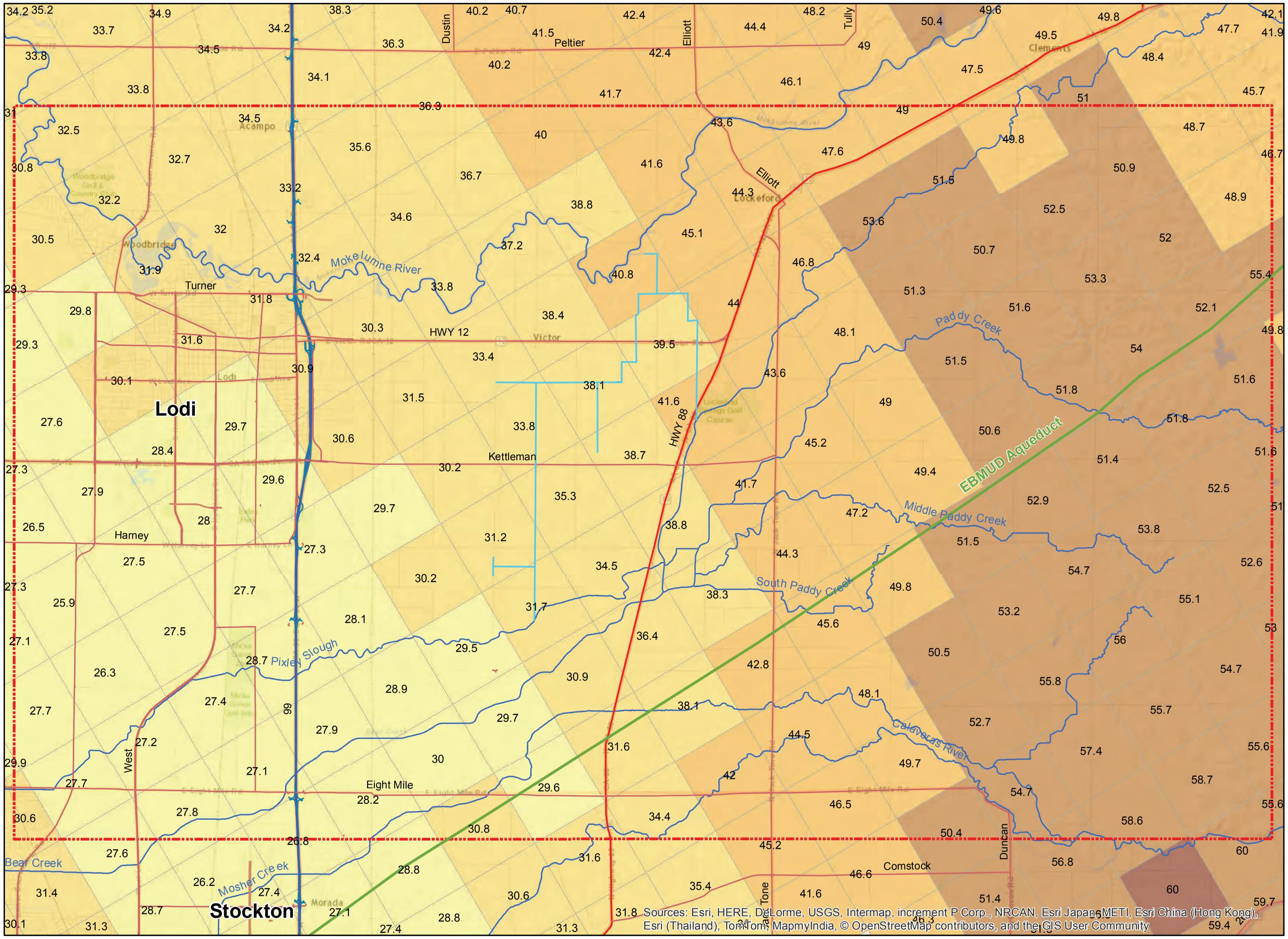
N

1:80,000

0 4,000 8,000 16,000 Feet

LAYER 6 PERCENT COARSE-GRAINED
Groundwater Banking Project
San Joaquin County , California

Figure 7



LEGEND

- Ground Water Recharge Pilot Project Area
- NSJWCD South System

Percent (%) Coarse-Grained

- 25.9 - 30.0
- 30.1 - 40.0
- 40.1 - 50.0
- 50.1 - 60.0
- 60.1 - 70.0

N

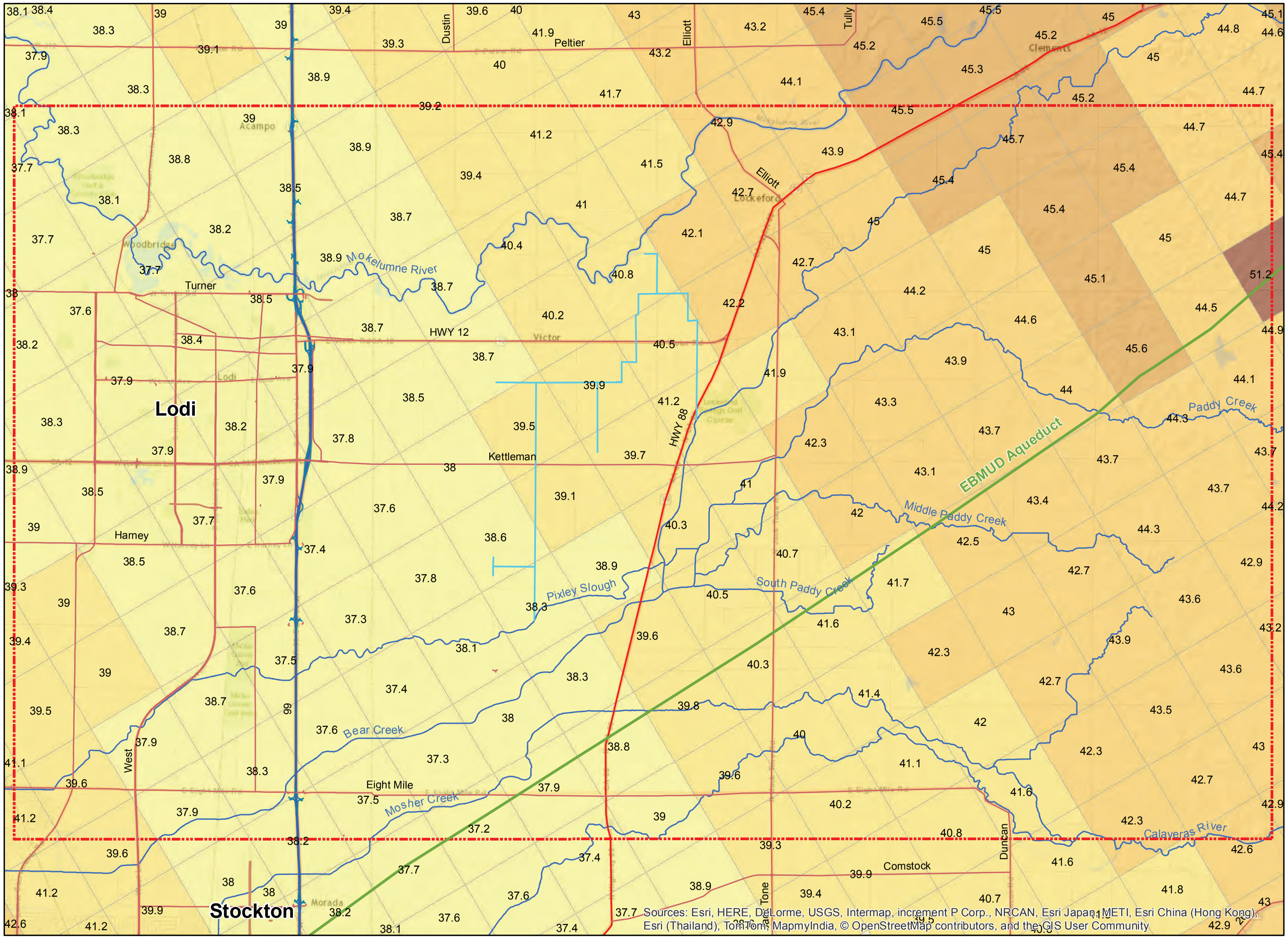
1:80,000

0 4,000 8,000 16,000 Feet

LAYER 7 PERCENT COARSE-GRAINED
Groundwater Banking Project
San Joaquin County , California

Figure 8

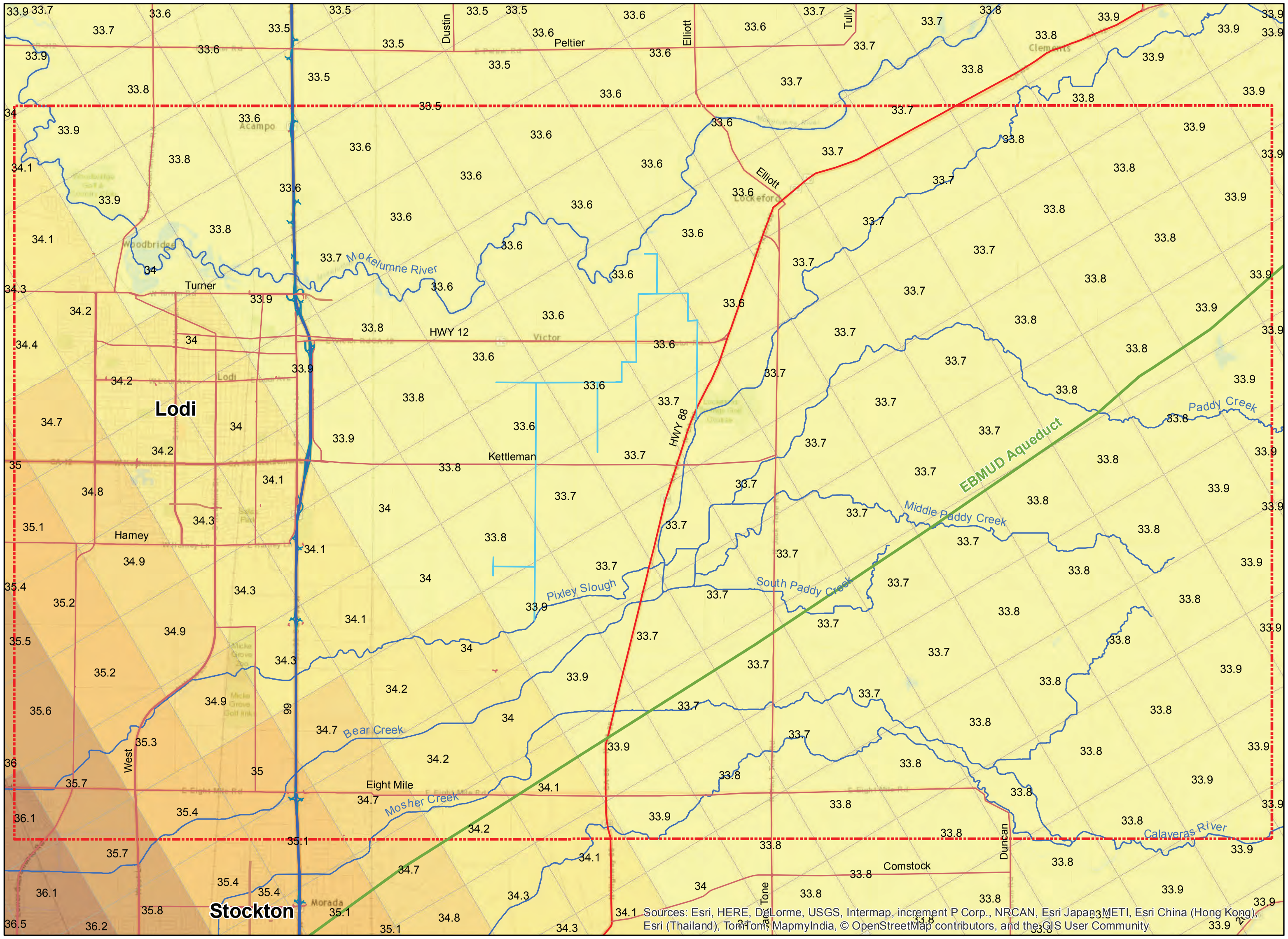
GEI Consultants
Project No. 04.62140068



LAYER 8 PERCENT COARSE-GRAINED
Groundwater Banking Project
San Joaquin County , California

Figure 9

N:\Projects\04_2014\04_6214_0068_SanJoaquinGWBanking\Outputs\Working\mxd\L8_Zoneepc.mxd, 12/26/2014, dmiao



LEGEND

Ground Water Recharge Pilot Project Area

NSJWCD South System

Percent (%) Coarse-Grained

- 33.5 - 34.0
- 34.1 - 34.5
- 34.6 - 35.0
- 35.1 - 35.5
- 35.6 - 36.0
- 36.1 - 36.5
- 36.6 - 37.0

N

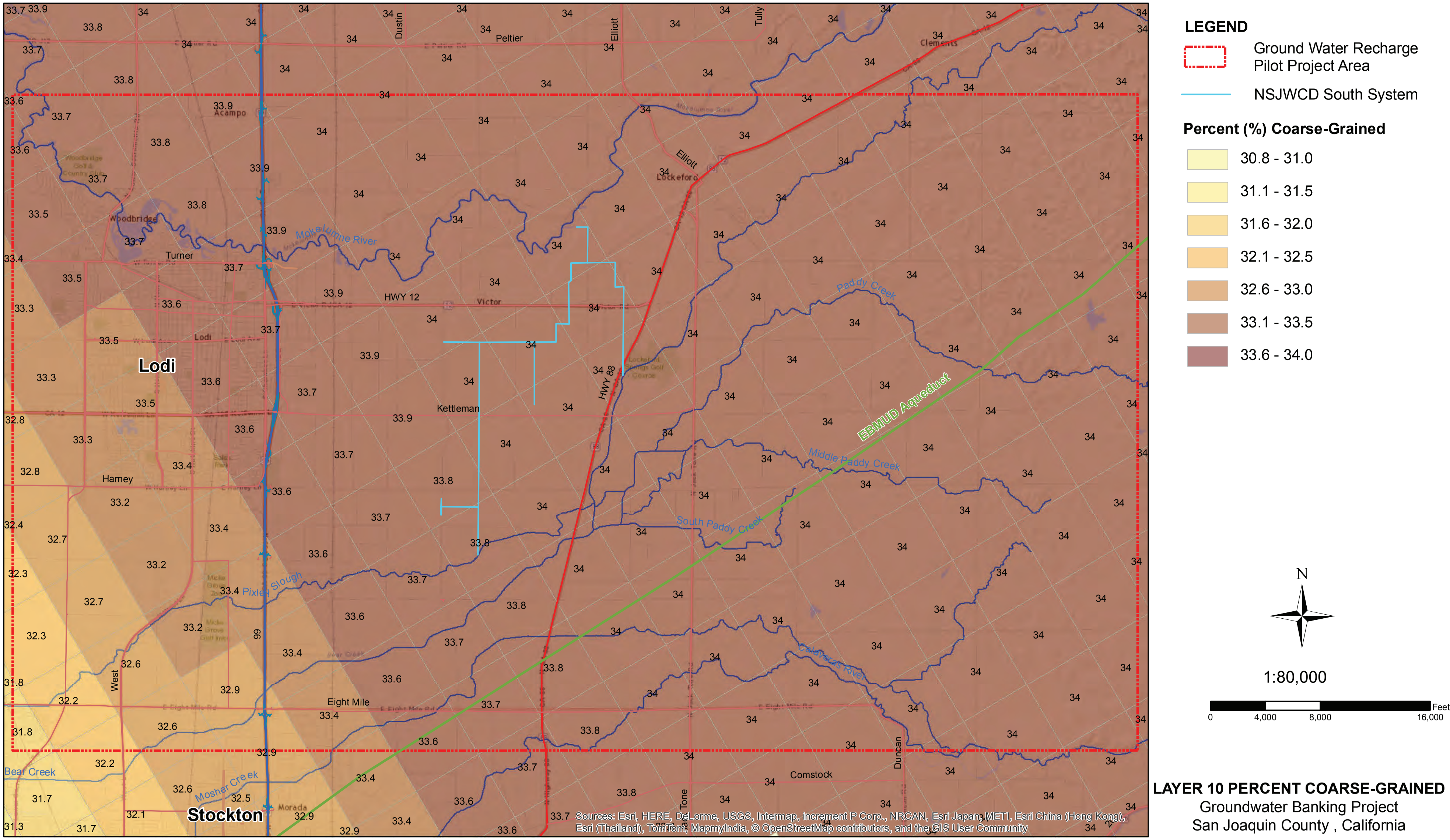
1:80,000

0 4,000 8,000 16,000 Feet

LAYER 9 PERCENT COARSE-GRAINED
Groundwater Banking Project
San Joaquin County , California

Figure 10

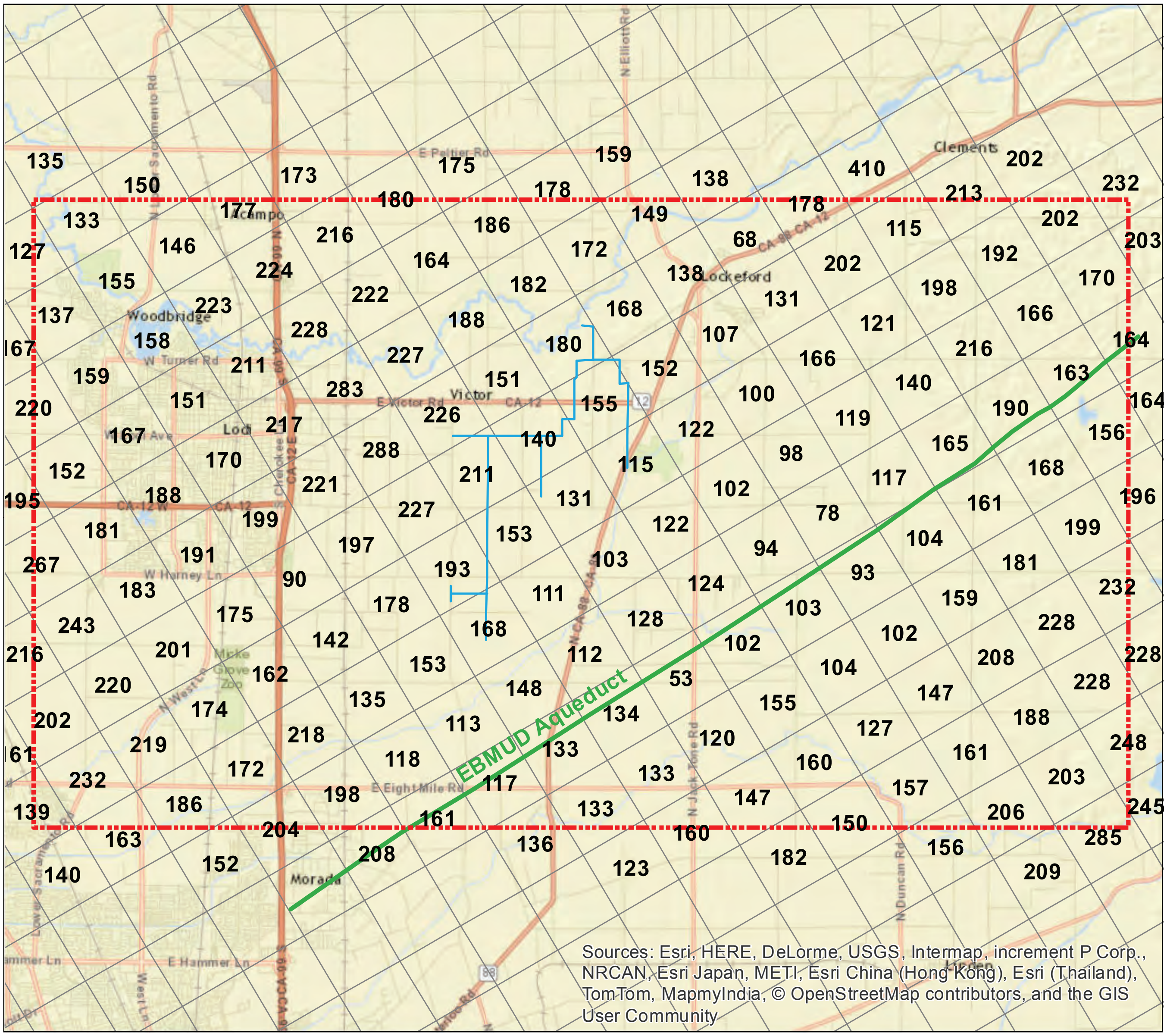
N:\Projects\04_2014\04_6214_0068_SanJoaquinGWBanking\Outputs\Working\mxd\L9_Zoneegpc.mxd, 12/26/2014, dmiao



LAYER 10 PERCENT COARSE-GRAINED
Groundwater Banking Project
San Joaquin County, California

Figure 11

N:\Projects\04_2014\04_6214_0068_SanJoaquinGWBanking\Outputs\Working\mxd\L10_Zoneepc.mxd, 12/26/2014, dmiao



Explanation

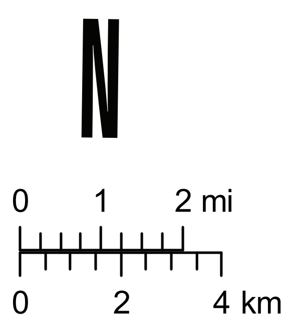
131 — K_{horiz} ft/day

Groundwater recharge pilot project area

NSJWCD South System

EBMUD aqueduct

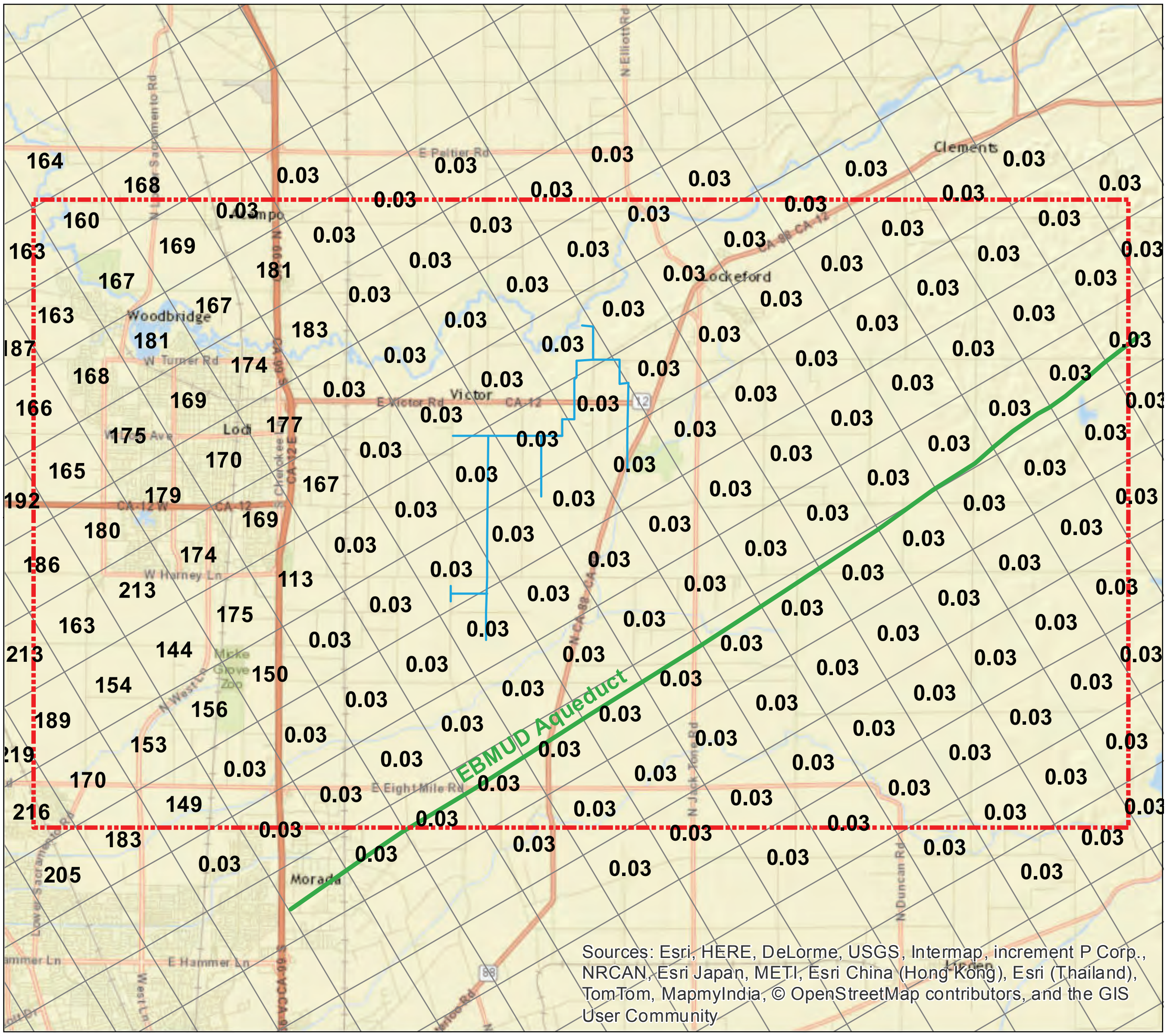
Model grid cells



Document Path: C:\Users\slayter\Documents\My Projects\62_140068_San_Joaquin_Valley\K_horiz_1.mxd

Horizontal Hydraulic Conductivity - Model Layer 1
(0-50 feet BGS west of Highway 99 and 0-147 feet BGS east of Highway 99)

FIGURE 12



Explanation

131 K_{horiz} ft/day

Groundwater recharge pilot project area

NSJWCD South System

EBMUD aqueduct

Model grid cells

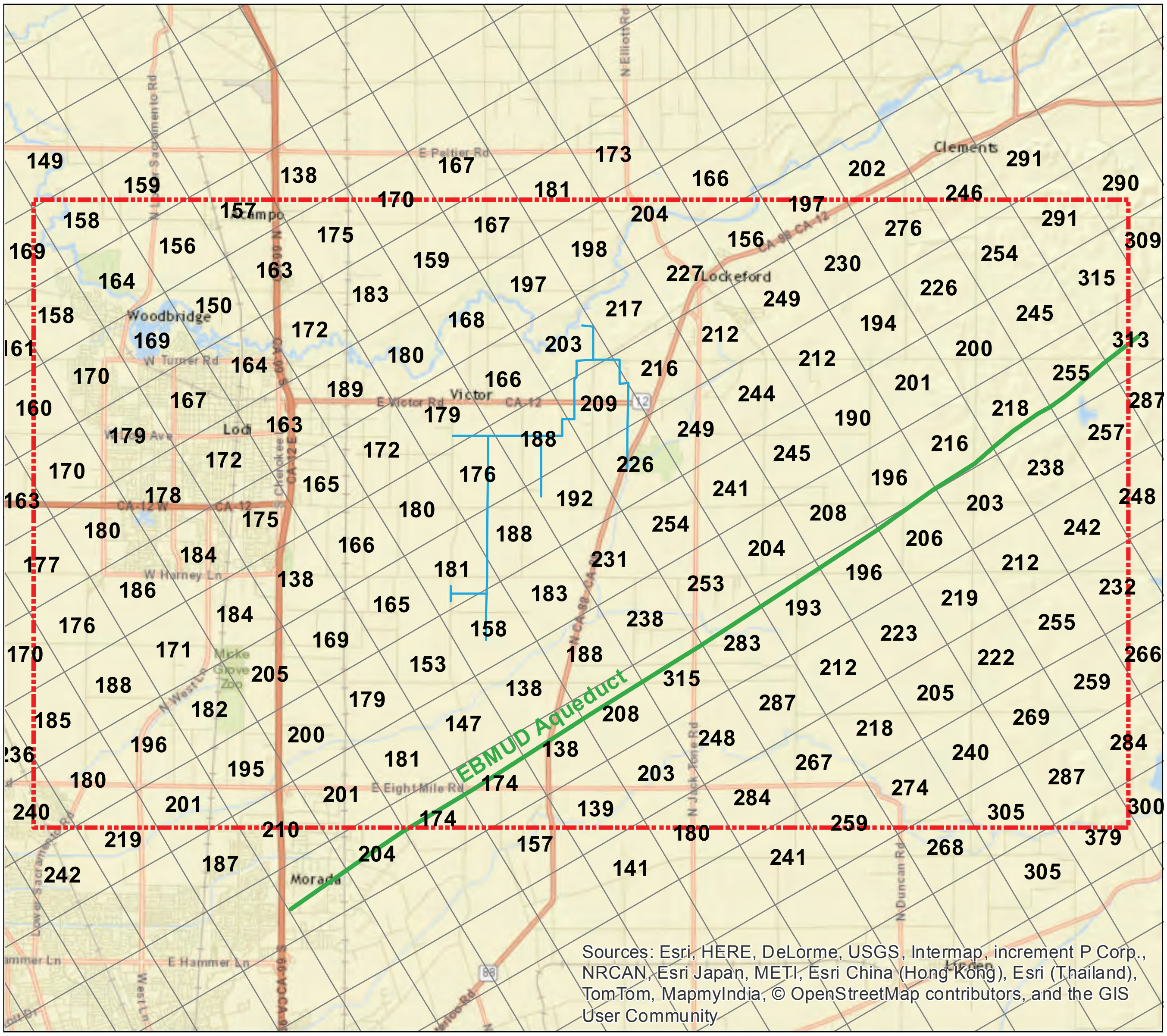
N

0 1 mi

0 2 km

Document Path: C:\Users\slayter\Documents\My Projects\62_140068_San_Joaquin_Valley\K_horiz_2.mxd

Horizontal Conductivity - Layer 2
(50-150 feet BGS west of Highway 99 and 147-150 feet BGS east of Highway 99) FIGURE 13



Explanation

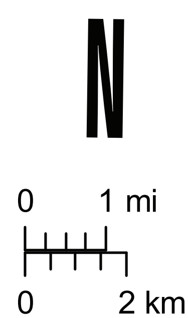
131 K_{horiz} ft/day

Groundwater recharge pilot project area

NSJWCD South System

EBMUD aqueduct

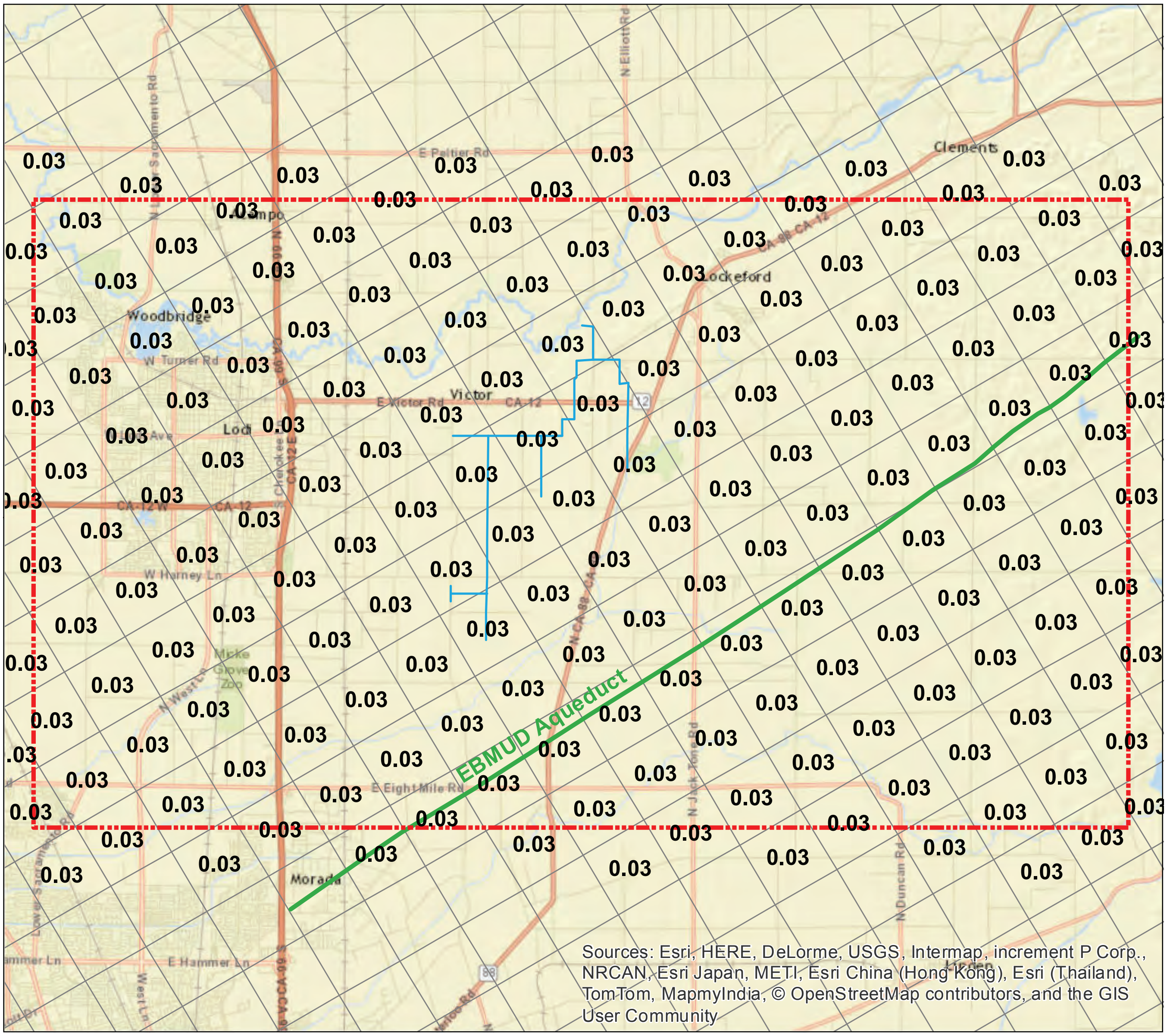
Model grid cells



Document Path: C:\Users\slayter\Documents\My Projects\62_140068_San_Joaquin_Valley\K_horiz_3.mxd

Horizontal Conductivity - Layer 3
(150-300 feet BGS)

FIGURE 14



Explanation

131 K_{horiz} ft/day

Groundwater recharge pilot project area

NSJWCD South System

EBMUD aqueduct

Model grid cells

N

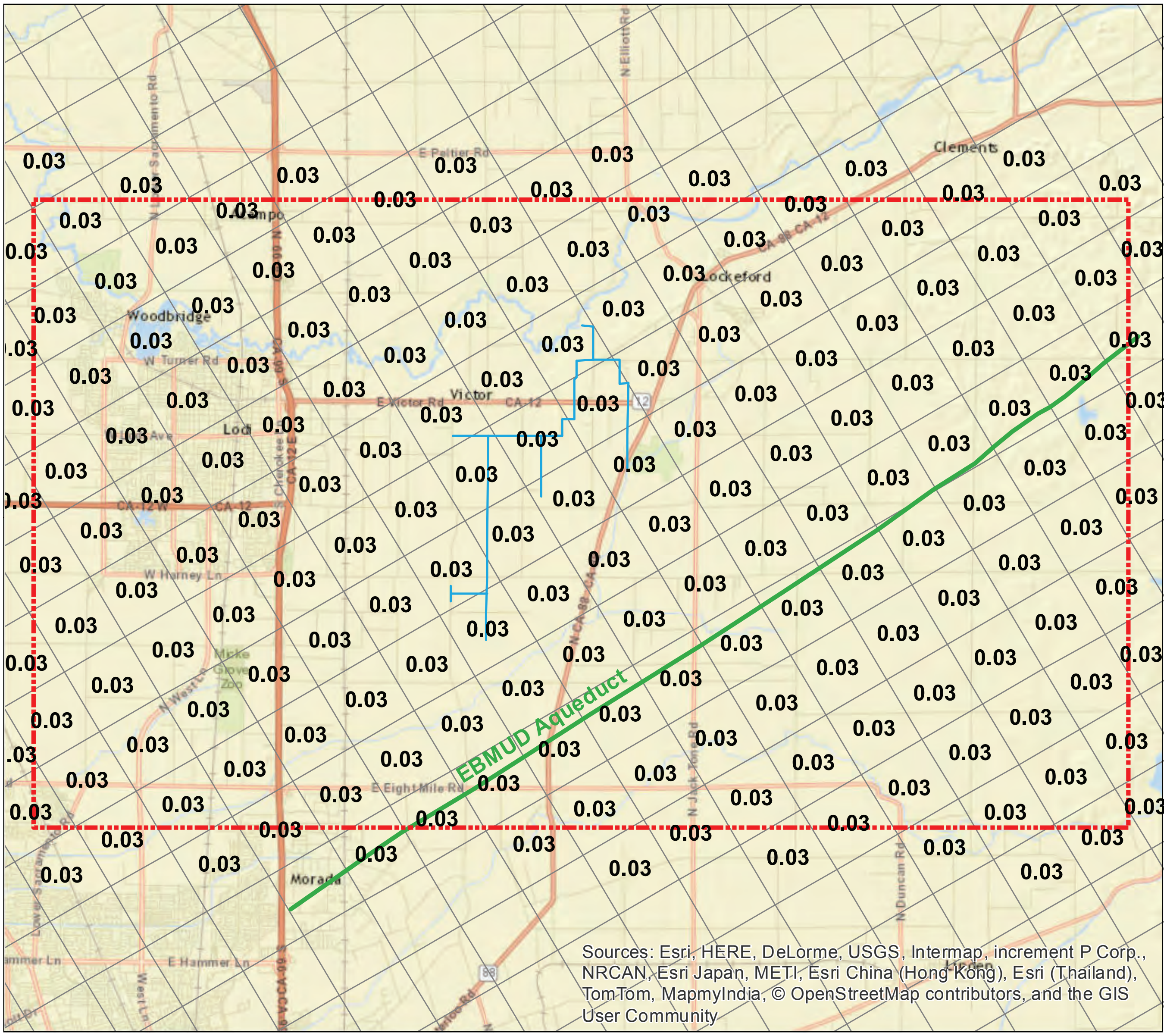
0 1 mi

0 2 km

Document Path: C:\Users\slayter\Documents\My Projects\62_140068_San_Joaquin_Valley\K_horiz_4.mxd

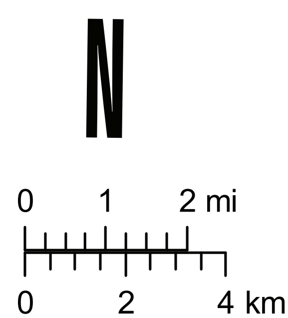
Horizontal Conductivity - Layer 4
(300-301 feet BGS. Represents Corcoran clay where present.)

FIGURE 15



Explanation

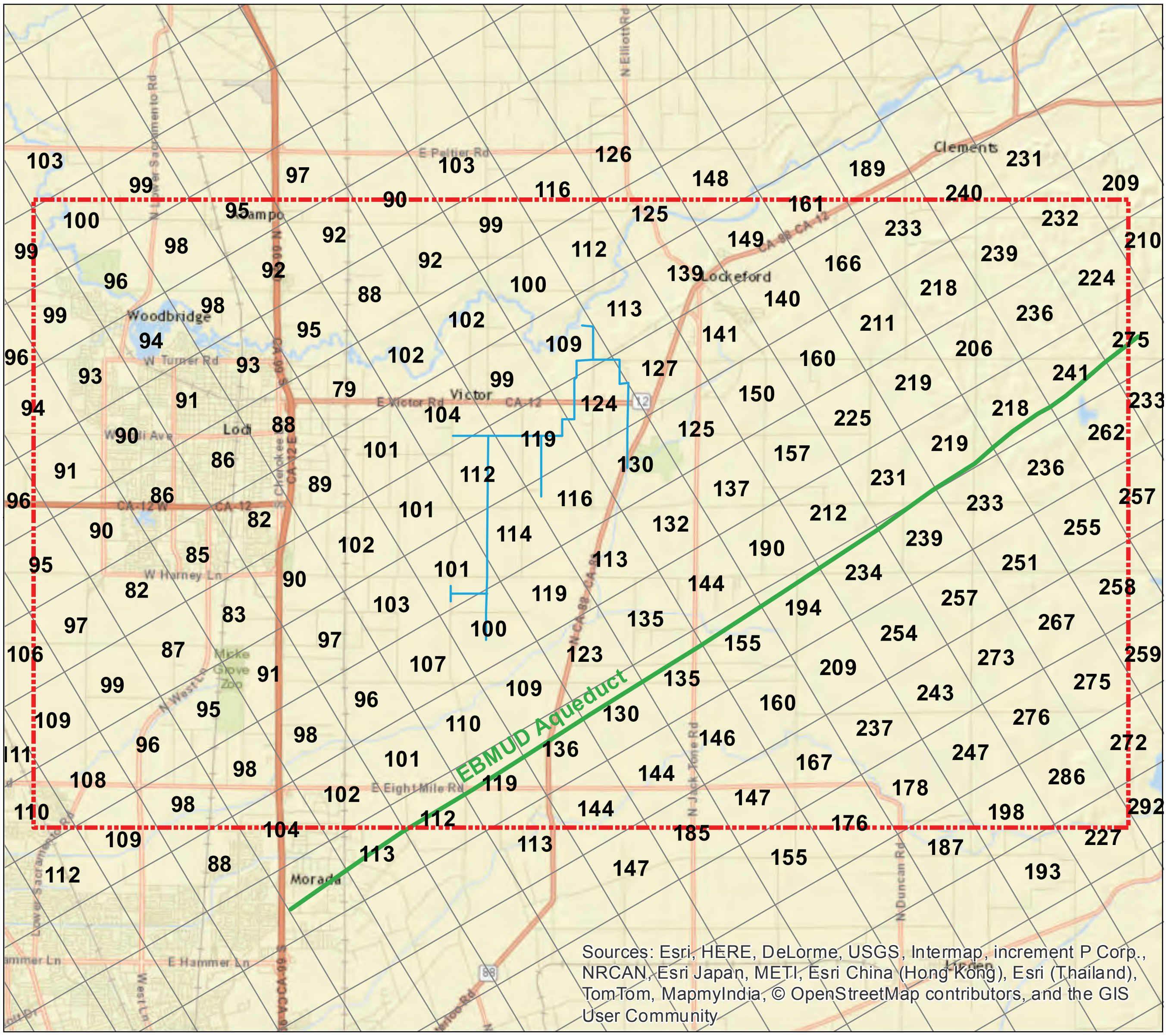
131 K_{horiz} ft/day
Groundwater recharge pilot project area
NSJWCD South System
EBMUD aqueduct
Model grid cells



Document Path: C:\Users\slayter\Documents\My Projects\62_140068_San_Joaquin_Valley\K_horiz_5.mxd

Horizontal Conductivity - Layer 5
(301-302 feet BGS. Represents Corcoran clay where present.)

FIGURE 16



Explanation

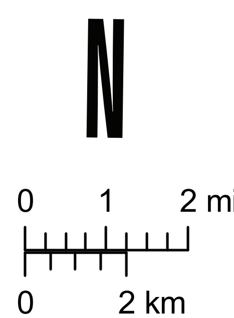
131 K_{horiz} ft/day

Groundwater recharge pilot project area

NSJWCD South System

EBMUD aqueduct

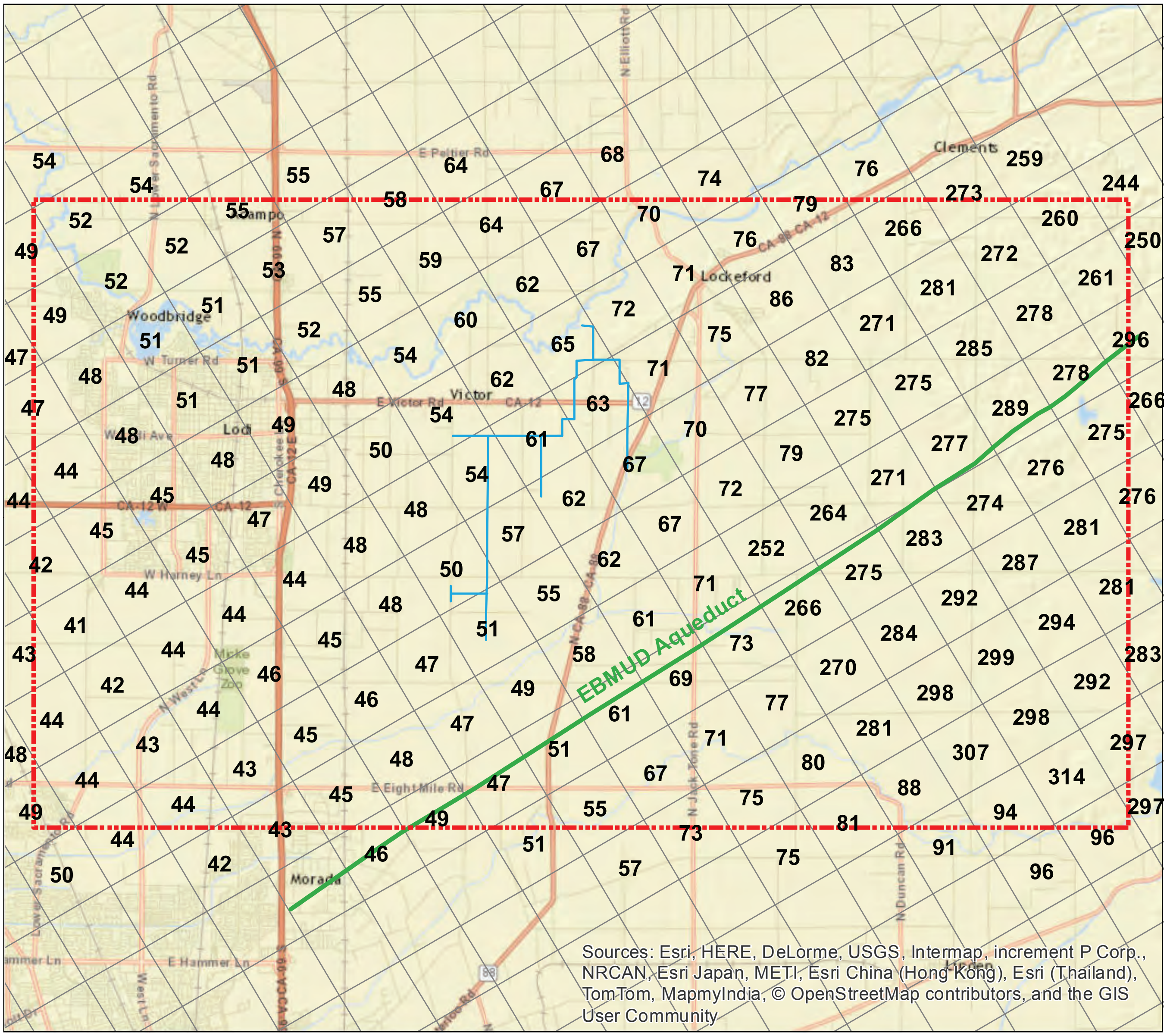
Model grid cells



Document Path: C:\Users\slayter\Documents\My Projects\62_140068_San_Joaquin_Valley\K_horiz_6.mxd

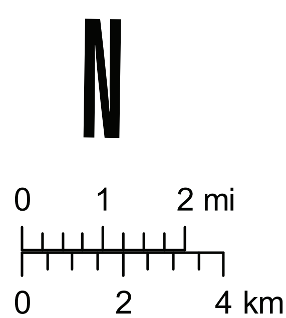
Horizontal Conductivity - Layer 6
(302-500 feet BGS)

FIGURE 17



Explanation

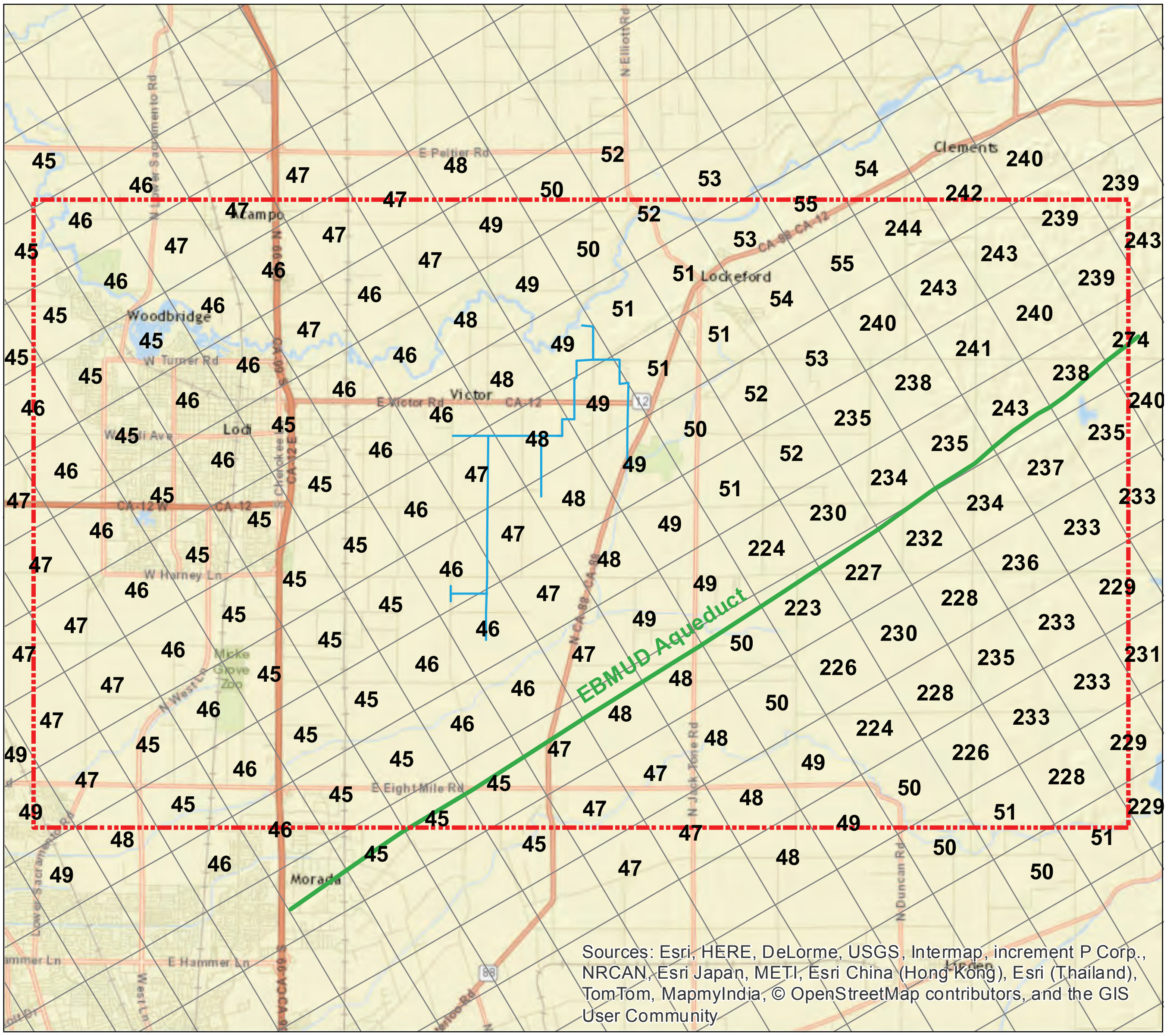
- 131 — K_{horiz} ft/day
- Groundwater recharge pilot project area
- NSJWCD South System
- EBMUD aqueduct
- Model grid cells



Document Path: C:\Users\slayter\Documents\My Projects\62_140068_San_Joaquin_Valley\K_horiz_7.mxd

Horizontal Conductivity - Layer 7
(500-750 feet BGS)

FIGURE 18



Explanation

131 K_{horiz} ft/day

Groundwater recharge pilot project area

NSJWCD South System

EBMUD aqueduct

Model grid cells

N

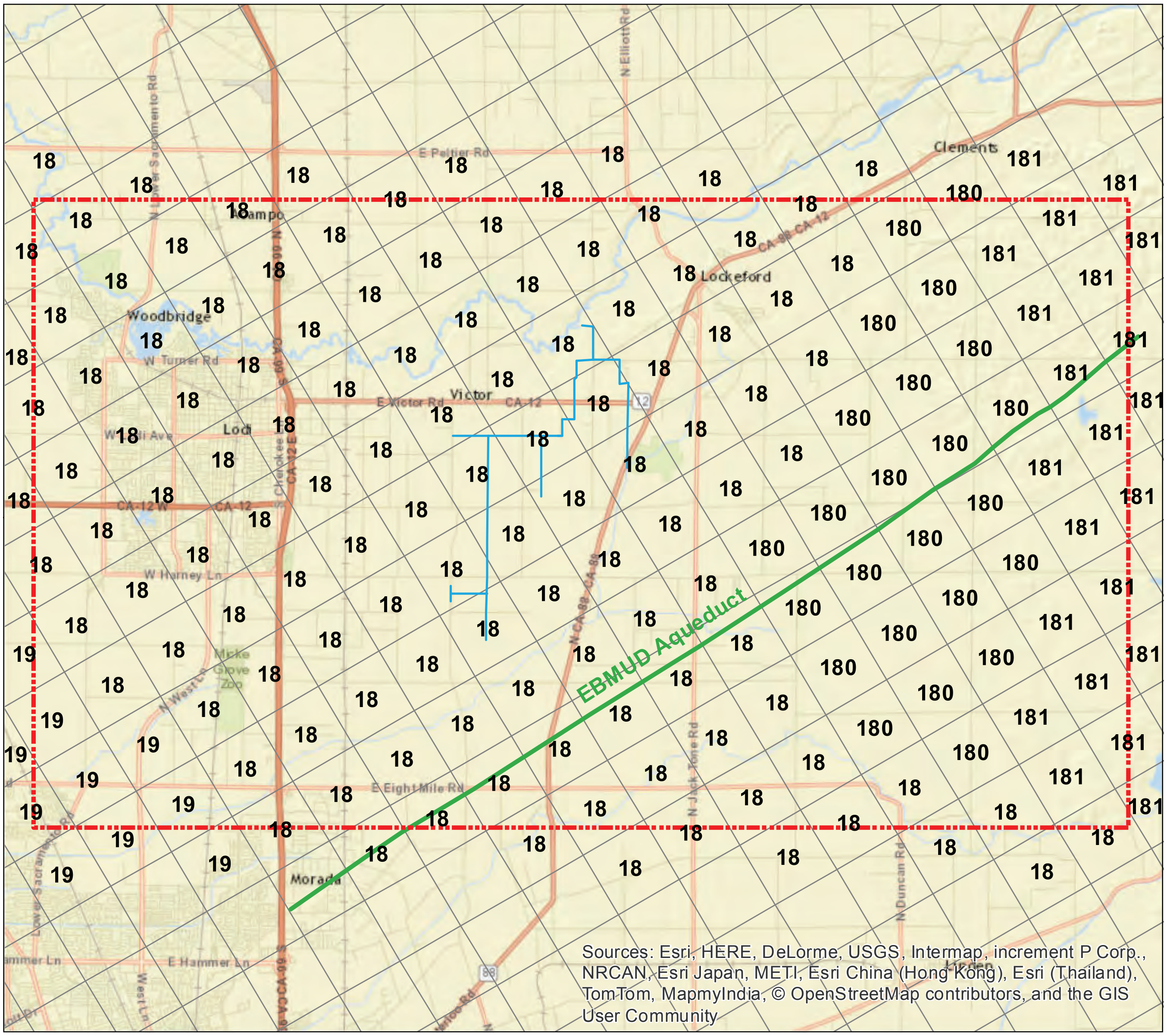
0 1 2 3 mi

0 2 4 km

Document Path: C:\Users\slayter\Documents\My Projects\62_140068_San_Joaquin_Valley\K_horiz_8.mxd

Horizontal Conductivity - Layer 8
(750-1,050 feet BGS)

FIGURE 19



Explanation

131 K_{horiz} ft/day

Groundwater recharge pilot project area

NSJWCD South System

EBMUD aqueduct

Model grid cells

N

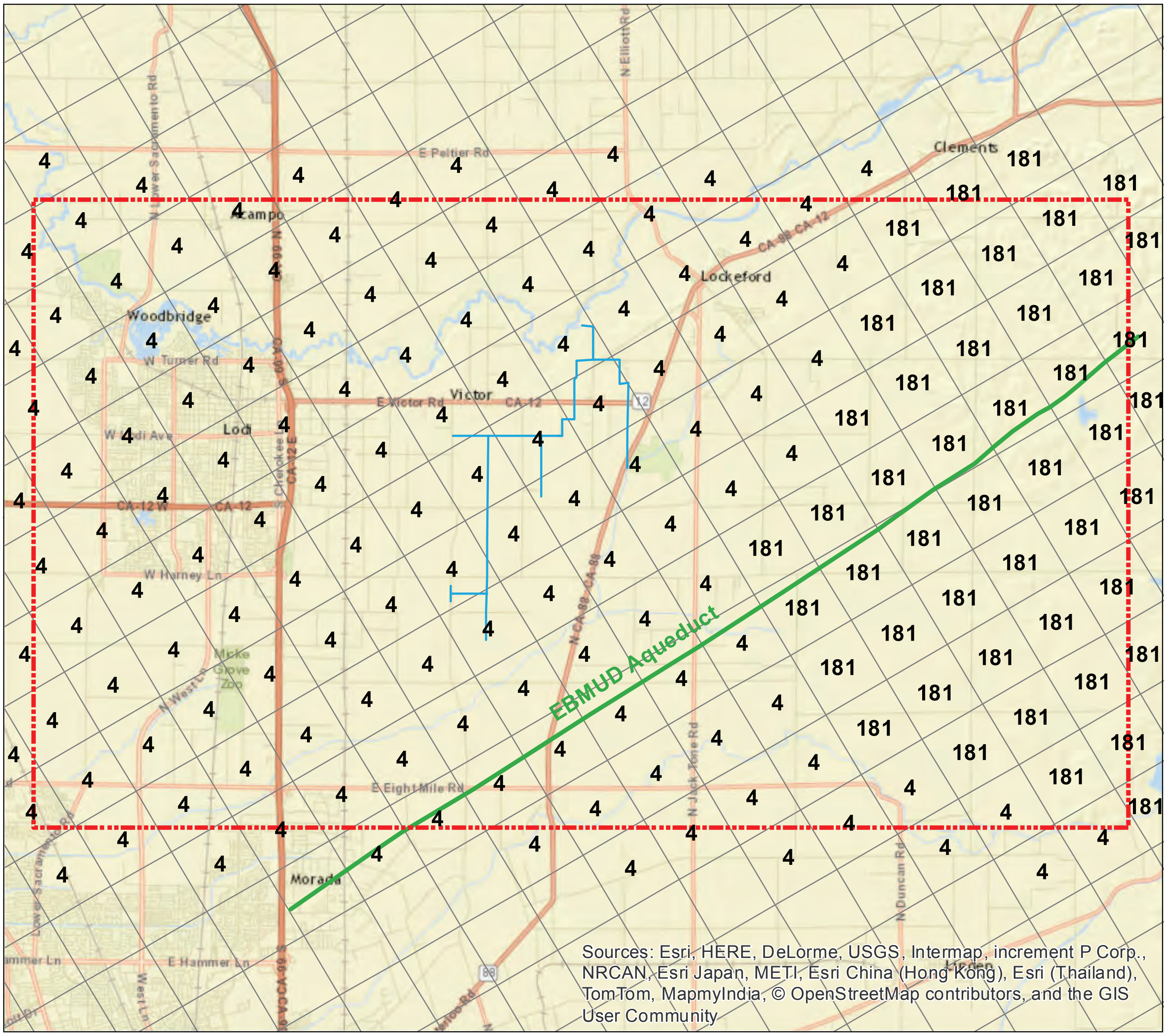
0 1 2 3 mi

0 2 4 km

Document Path: C:\Users\slayter\Documents\My Projects\62_140068_San_Joaquin_Valley\K_horiz_9.mxd

Horizontal Conductivity - Layer 9
(1,050-1,400 feet BGS)

FIGURE 20



Explanation

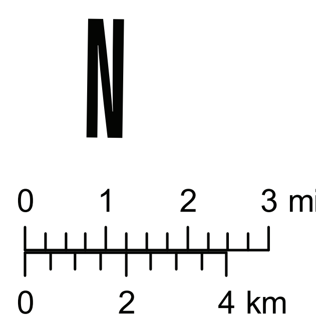
131 K_{horiz} ft/day

Groundwater recharge pilot project area

NSJWCD South System

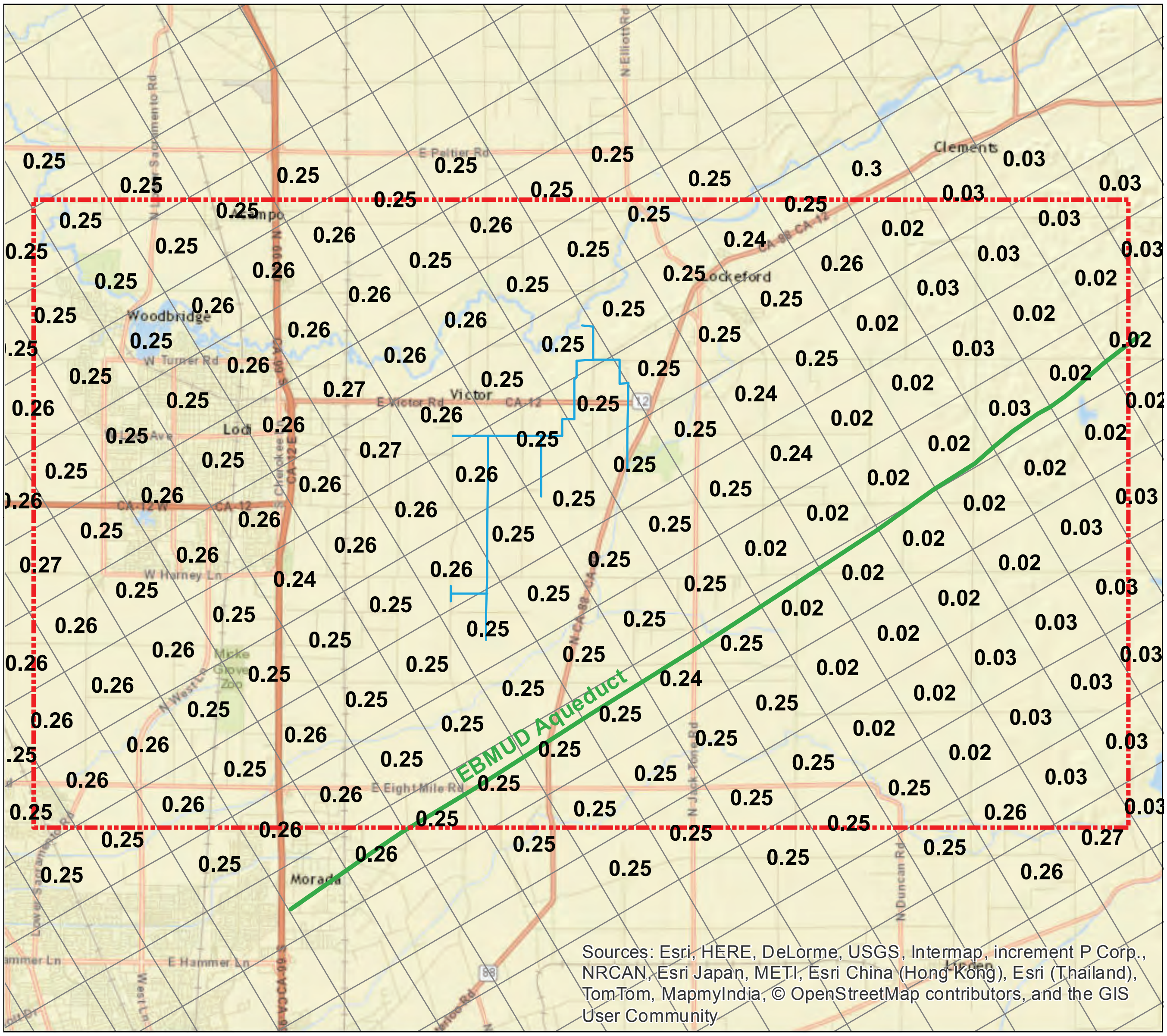
EBMUD aqueduct

Model grid cells



Document Path: C:\Users\slayter\Documents\My Projects\62_140068_San_Joaquin_Valley\K_horiz_10.mxd

Horizontal Conductivity - Layer 10
(1,400-1,800 feet BGS)



Explanation

- 0.25 — K_{vert} ft/day
- Groundwater recharge pilot project area
- NSJWCD South System
- EBMUD aqueduct
- Model grid cells

N

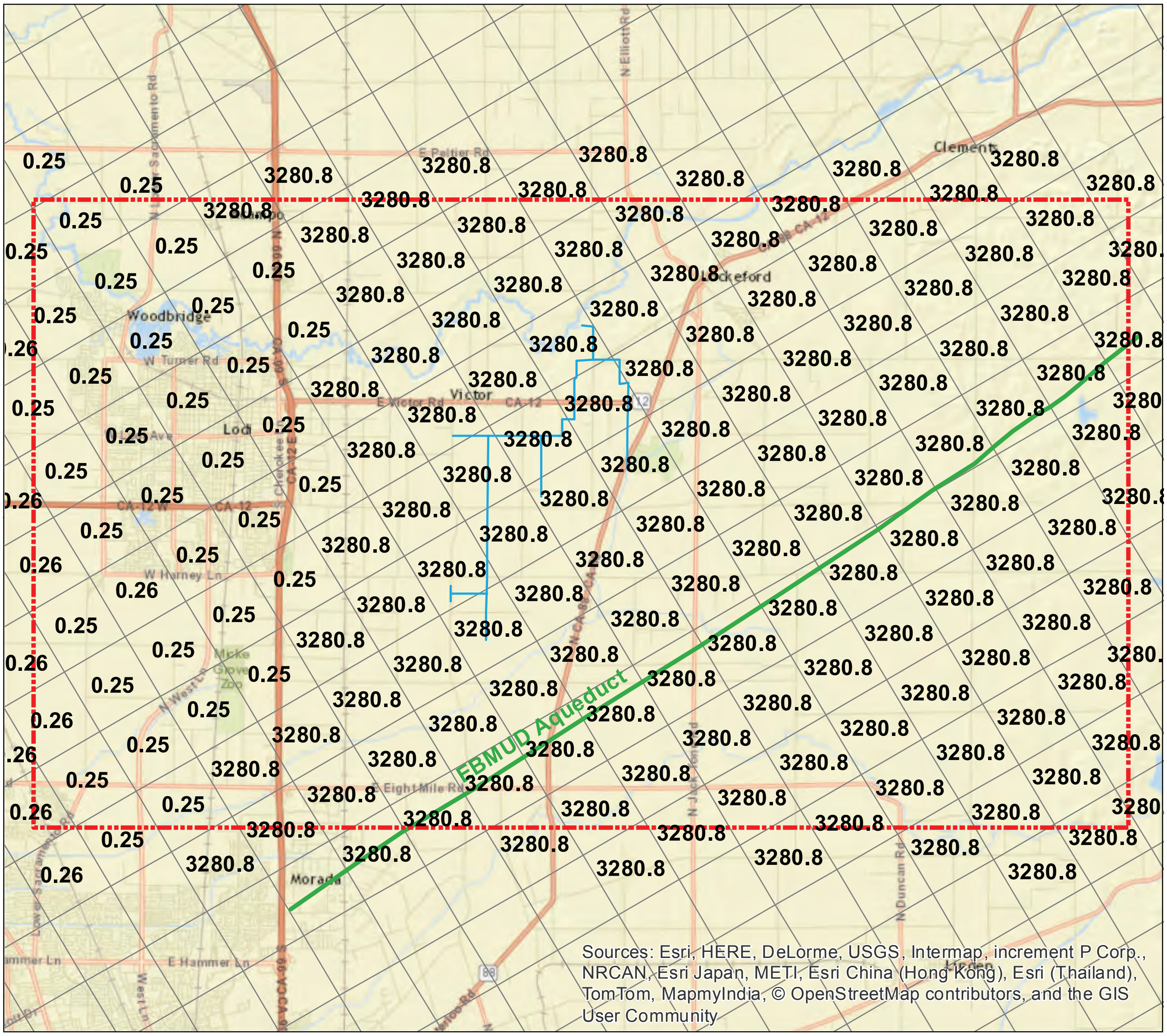
0 1 2 mi

0 2 4 km

Document Path: C:\Users\slayter\Documents\My Projects\62_140068_San_Joaquin_Valley\K_vert_1.mxd

Vertical Conductivity - Layer 1
(0-50 feet BGS west of Highway 99 and 0-147 feet BGS east of Highway 99)

FIGURE 22



Explanation

0.25 — K_{vert} ft/day

Groundwater recharge pilot project area

NSJWCD South System

EBMUD aqueduct

Model grid cells

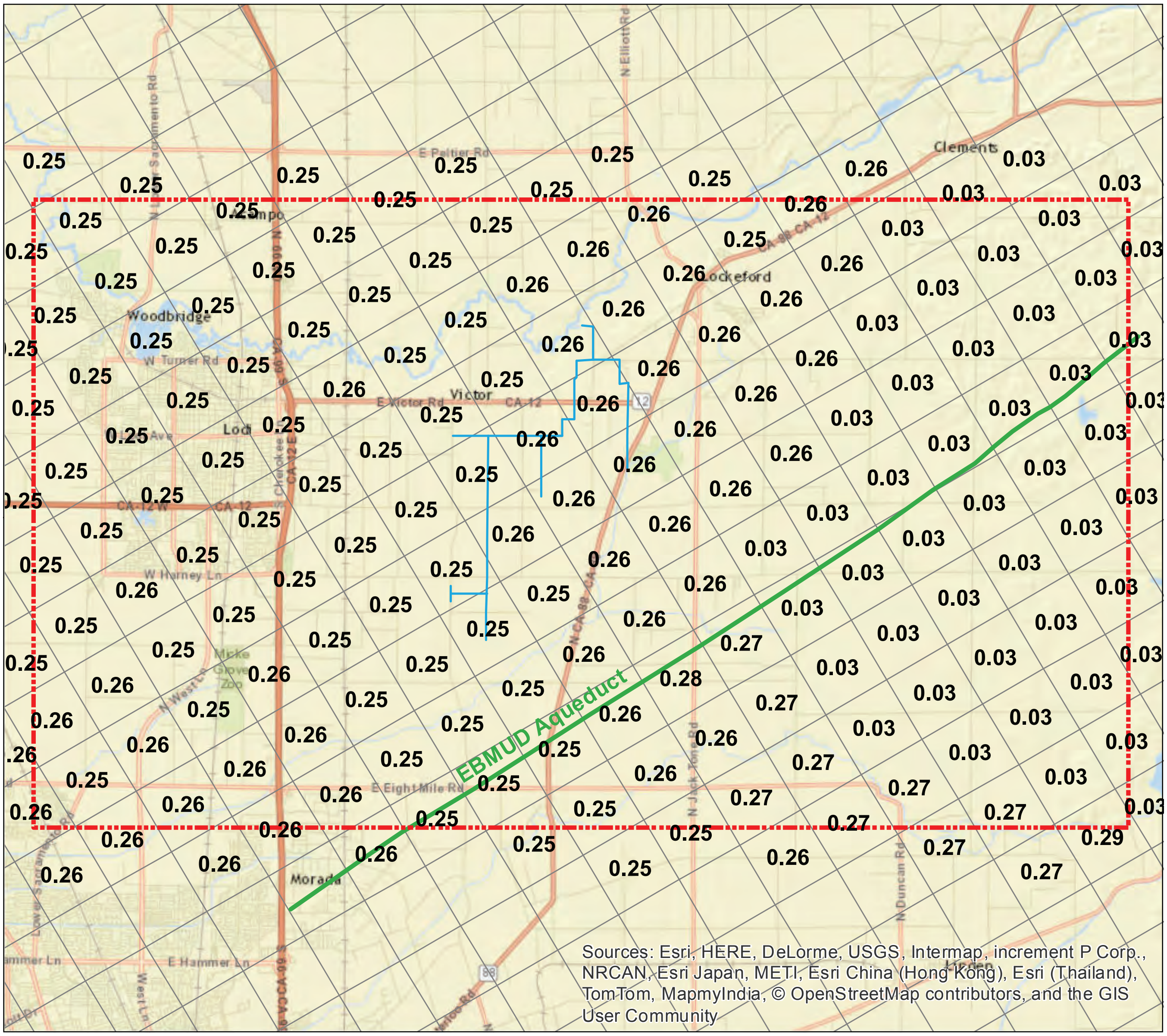
N

0 — 1 mi

0 — 2 — 4 km

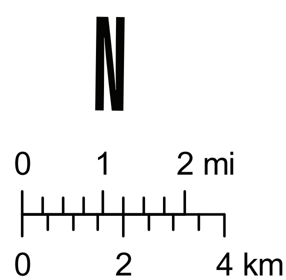
Document Path: C:\Users\slayter\Documents\My Projects\62_140068_San_Joaquin_Valley\K_vert_2.mxd

Vertical Conductivity - Layer 2
(50-150 feet BGS west of Highway 99 and 147-150 feet BGS east of Highway 99) FIGURE 23



Explanation

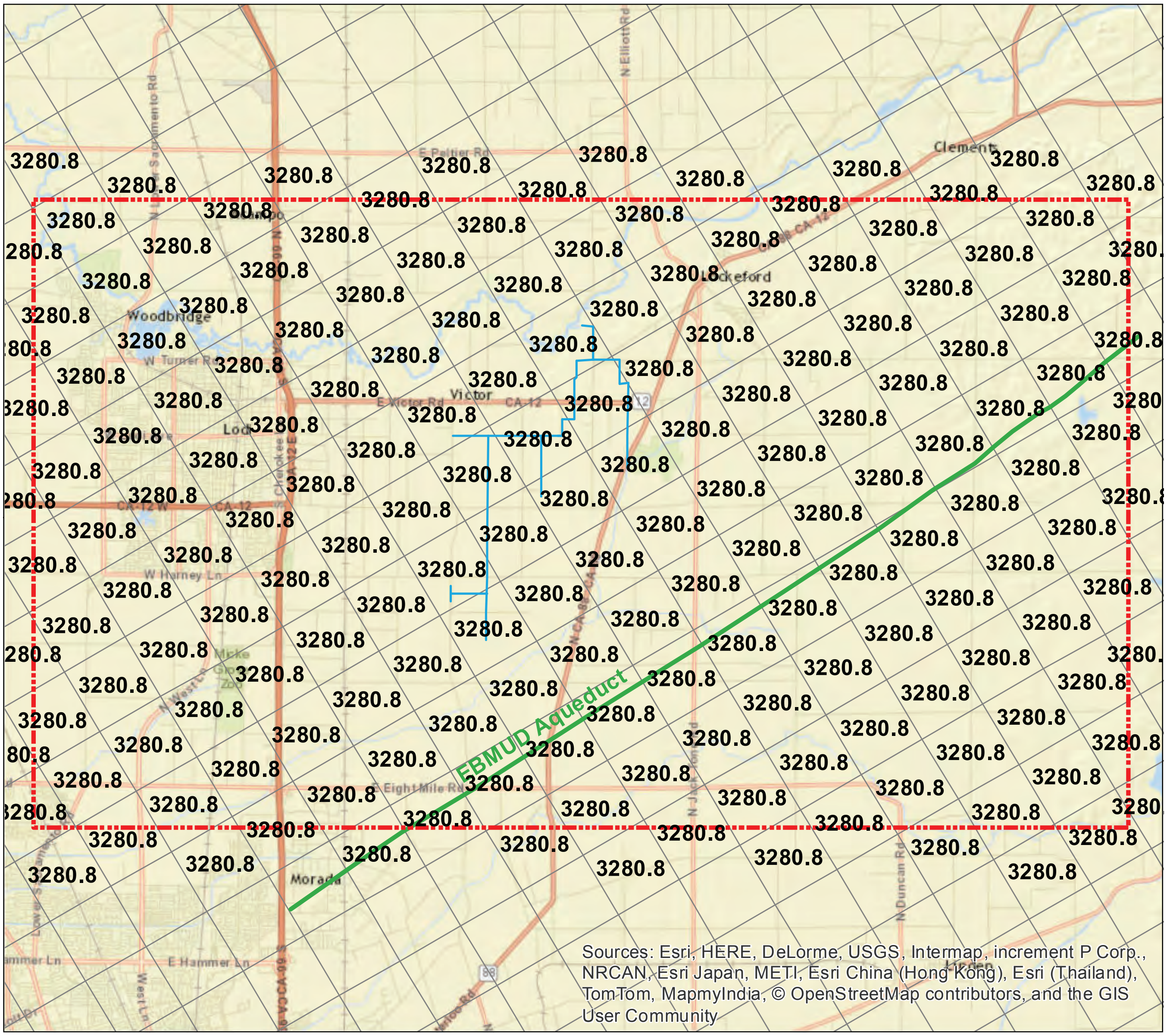
0.25 K_{vert} ft/day
Groundwater recharge pilot project area
NSJWCD South System
EBMUD aqueduct
Model grid cells



Document Path: C:\Users\slayter\Documents\My Projects\62_140068_San_Joaquin_Valley\K_vert_3.mxd

Vertical Conductivity - Layer 3
(150-300 feet BGS)

FIGURE 24



Explanation

0.25 K_{vert} ft/day

Groundwater recharge pilot project area

NSJWCD South System

EBMUD aqueduct

Model grid cells

N

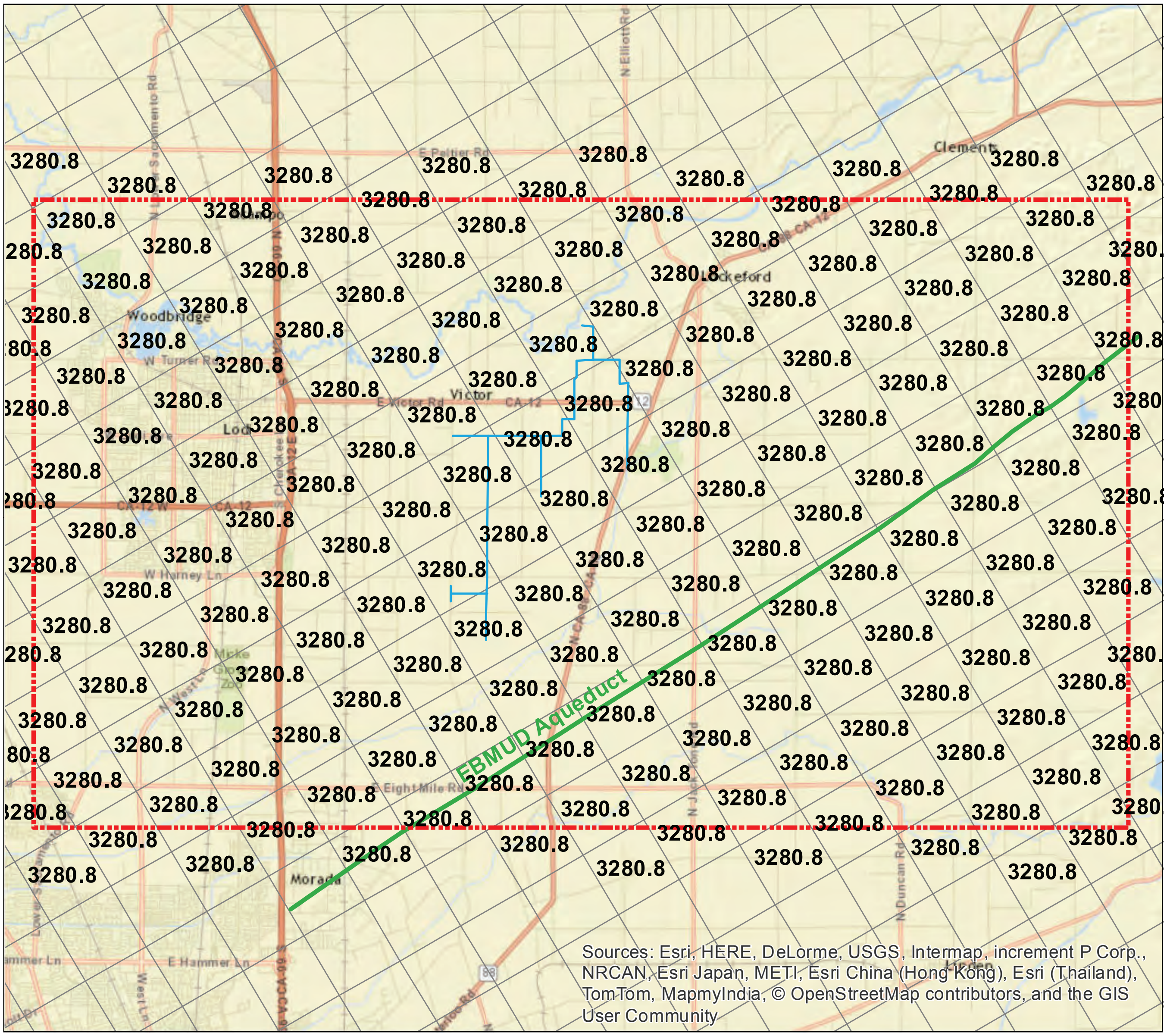
0 1 2 mi

0 2 4 km

Document Path: C:\Users\slayter\Documents\My Projects\62_140068_San_Joaquin_Valley\K_vert_4.mxd

Vertical Conductivity - Layer 4
(300-301 feet BGS. Represents Corcoran clay where present.)

FIGURE 25



Explanation

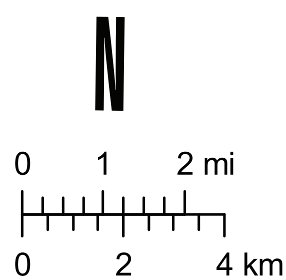
3280 K_{vert} ft/day

Groundwater recharge pilot project area

NSJWCD South System

EBMUD aqueduct

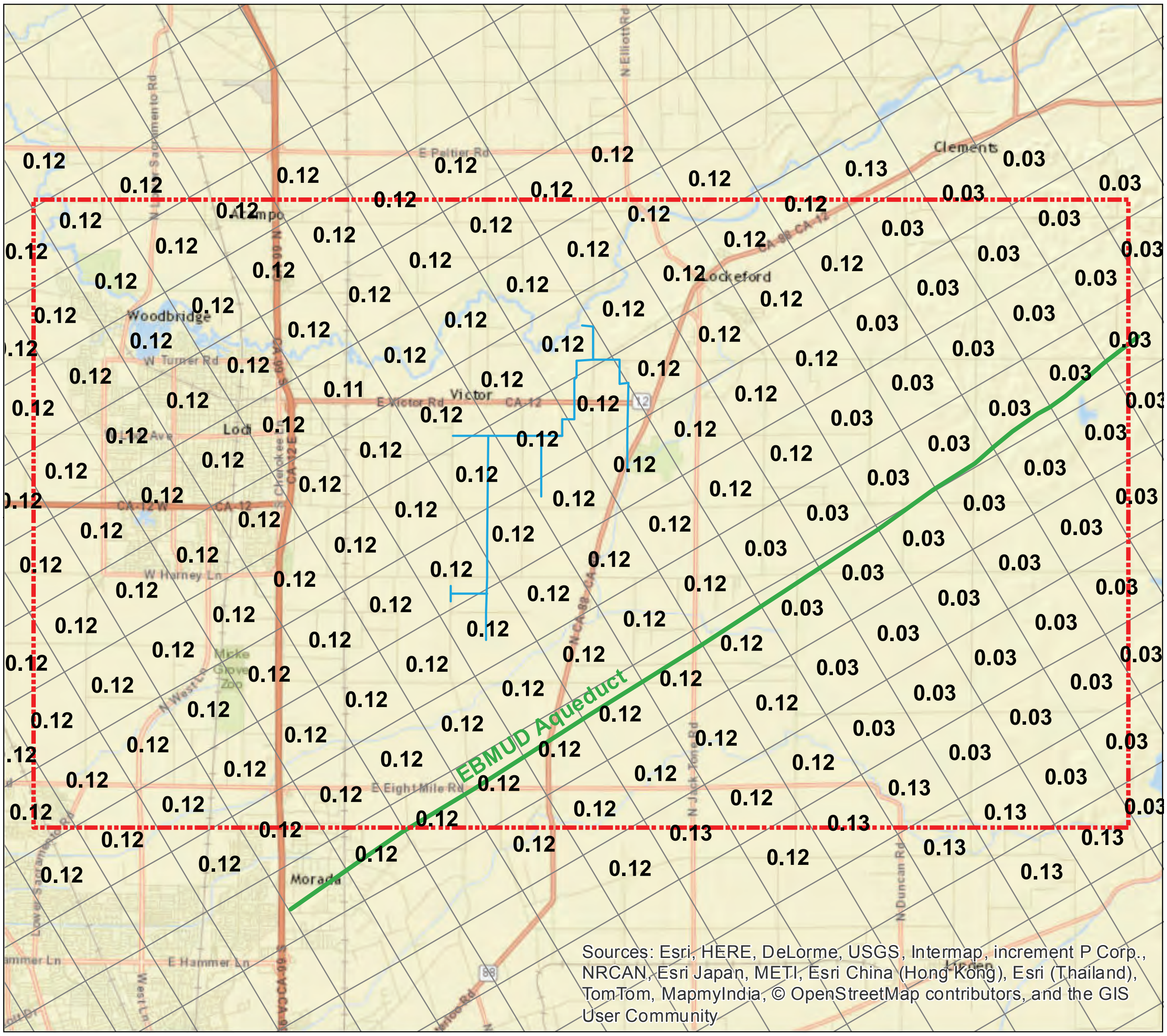
Model grid cells



Document Path: C:\Users\slayter\Documents\My Projects\62_140068_San_Joaquin_Valley\K_vert_5.mxd

Vertical Conductivity - Layer 5
(301-302 feet BGS. Represents Corcoran clay where present.)

FIGURE 26



Explanation

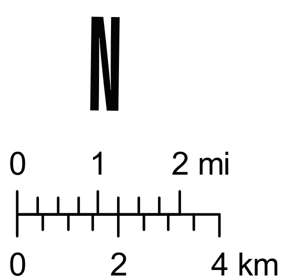
0.01 K_{vert} ft/day

Groundwater recharge pilot project area

NSJWCD South System

EBMUD aqueduct

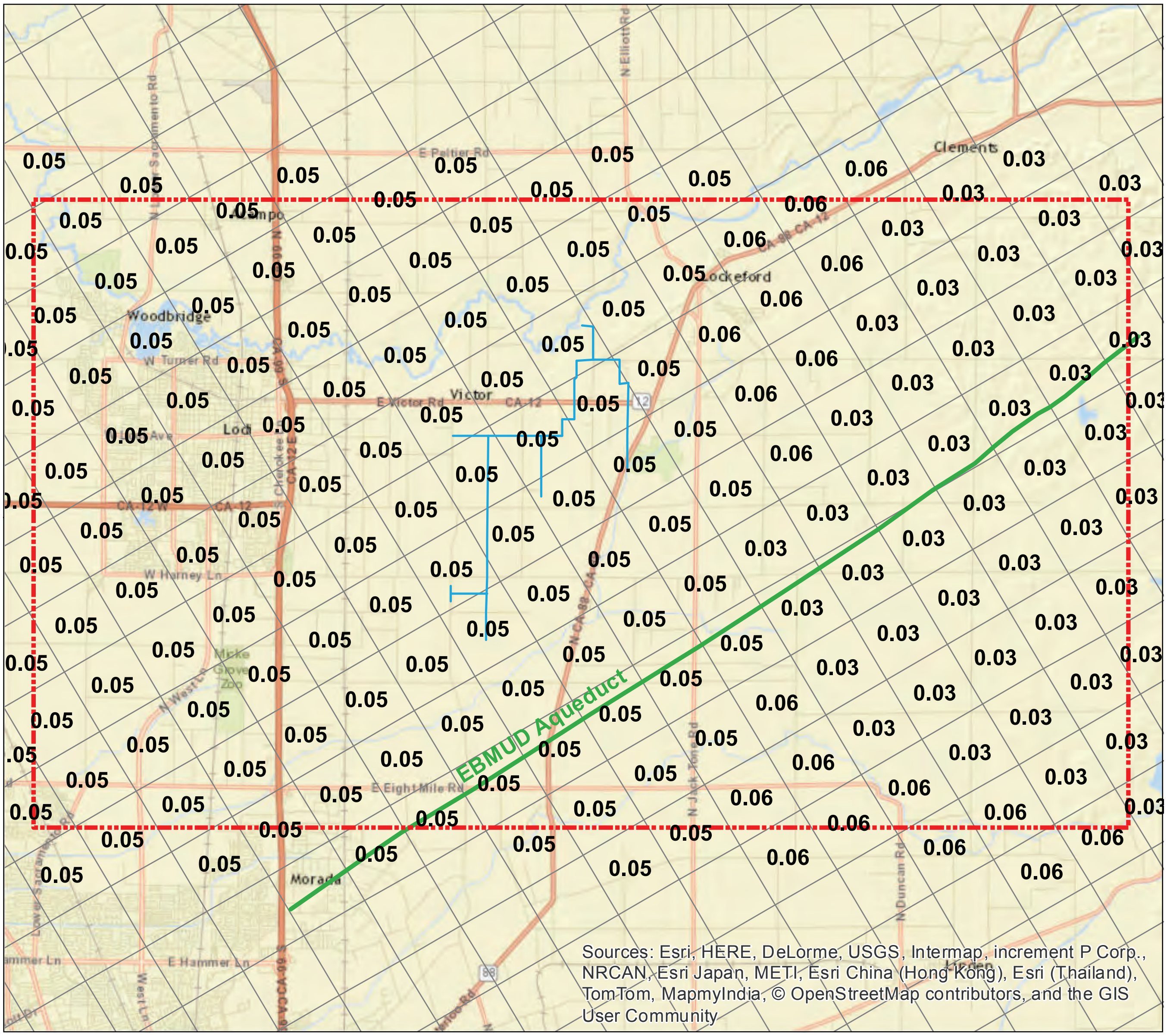
Model grid cells



Document Path: C:\Users\slayter\Documents\My Projects\62_140068_San_Joaquin_Valley\K_vert_6.mxd

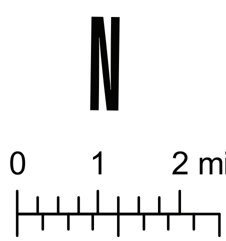
Vertical Conductivity - Layer 6
(302-500 feet BGS)

FIGURE 27



Explanation

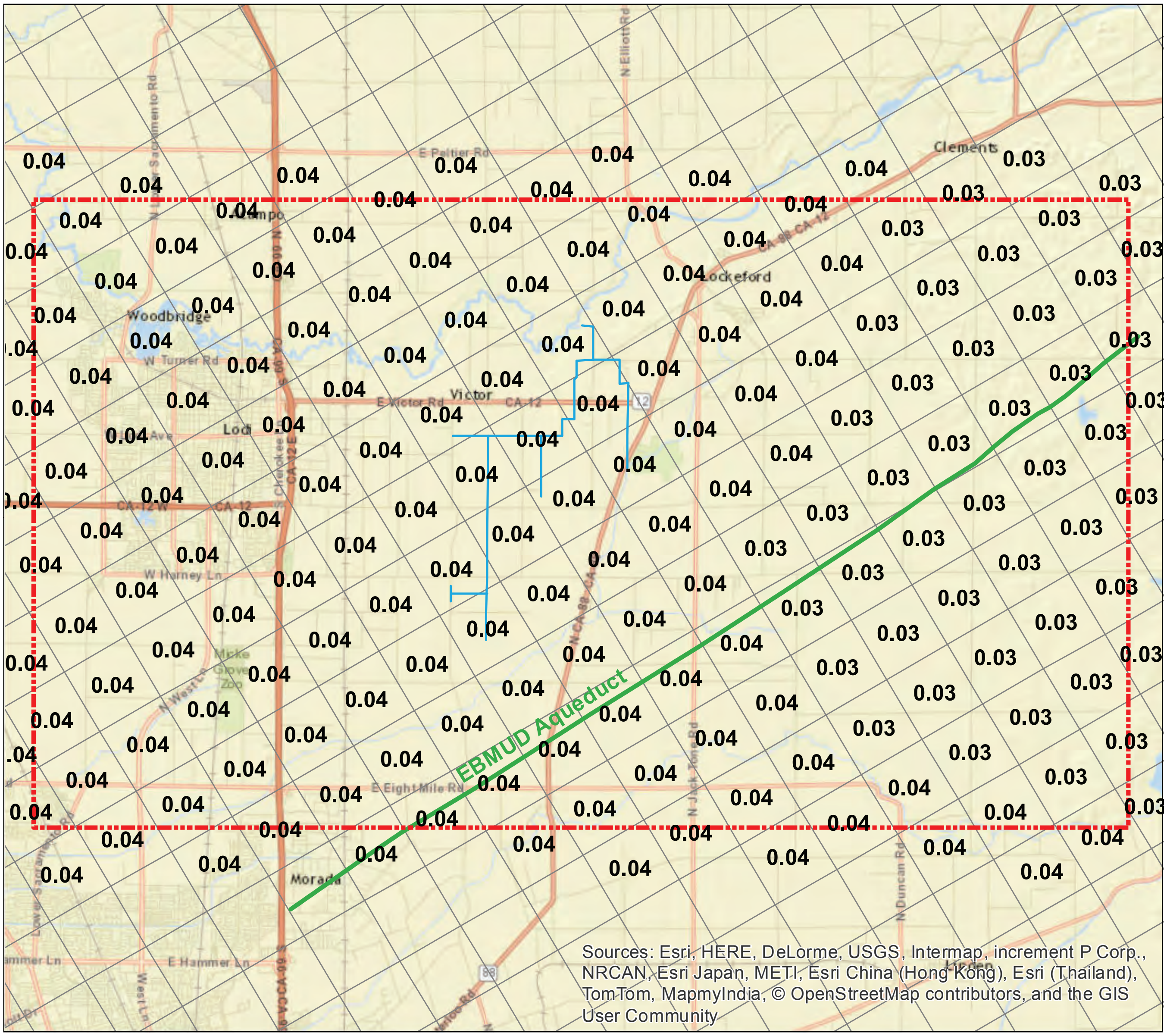
- 0.05 — K_{vert} ft/day
- Groundwater recharge pilot project area
- NSJWCD South System
- EBMUD aqueduct
- Model grid cells



Document Path: C:\Users\slayter\Documents\My Projects\62_140068_San_Joaquin_Valley\K_vert_7.mxd

Vertical Conductivity - Layer 7
(500-750 feet BGS)

FIGURE 28



Explanation

- 0.05 — K_{vert} ft/day
- Groundwater recharge pilot project area
- NSJWCD South System
- EBMUD aqueduct
- Model grid cells

N

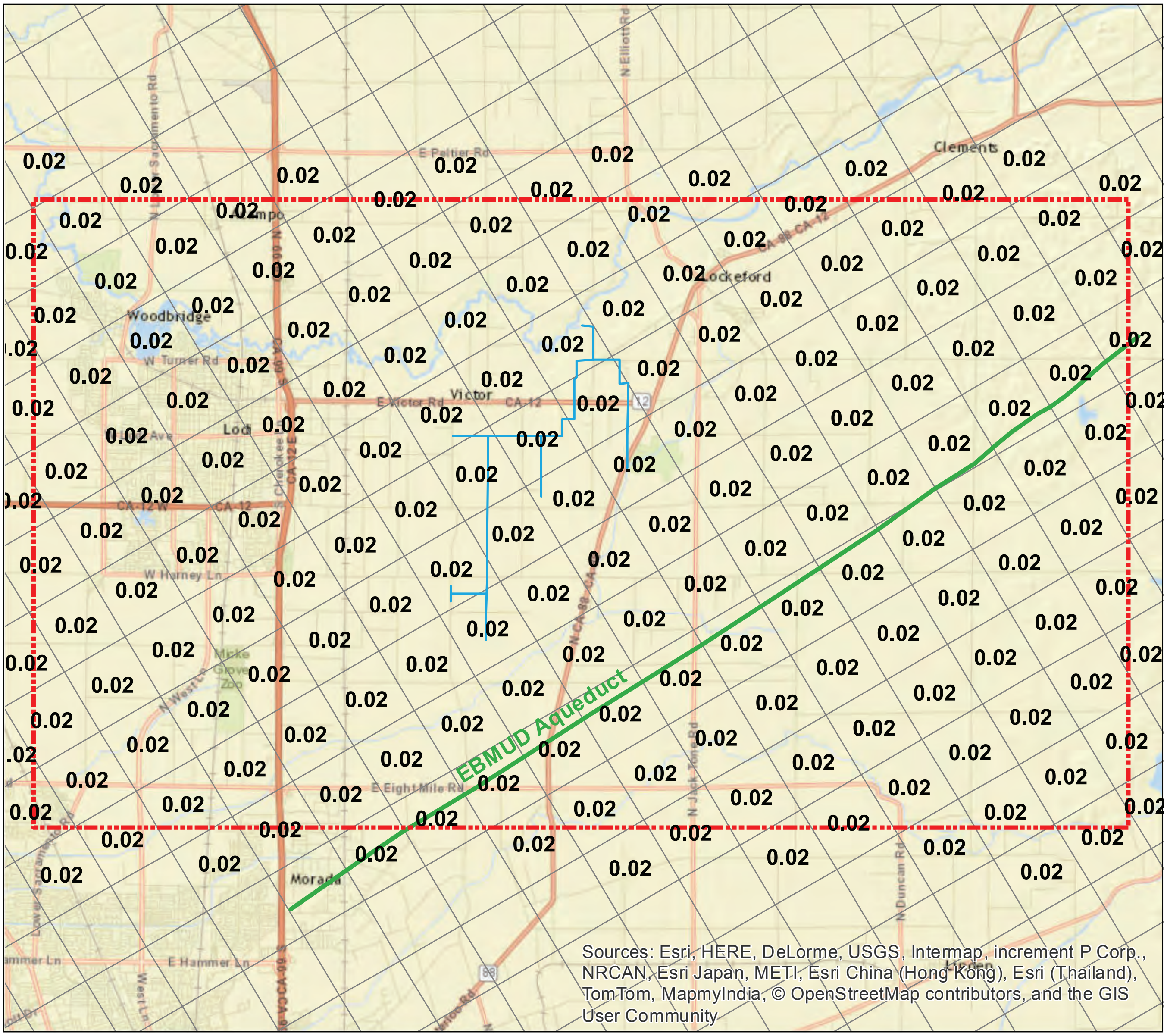
0 1 2 mi

0 2 4 km

Document Path: C:\Users\slayter\Documents\My Projects\62_140068_San_Joaquin_Valley\K_vert_8.mxd

Vertical Conductivity - Layer 8
(750-1,050 feet BGS)

FIGURE 29



Explanation

0.05 K_{vert} ft/day
Groundwater recharge pilot project area
NSJWCD South System
EBMUD aqueduct
Model grid cells

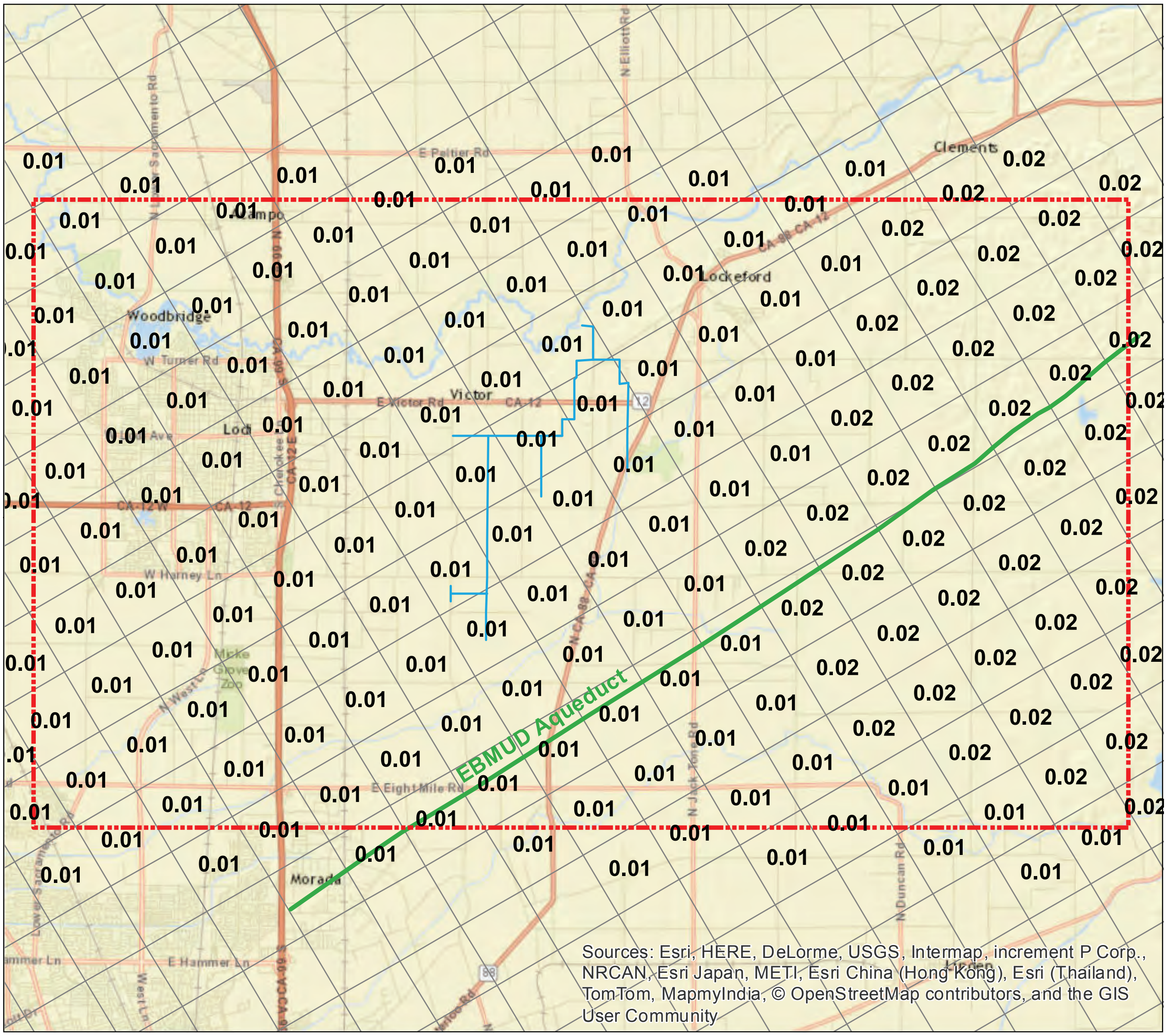
N

0 1 2 mi
0 2 4 km

Document Path: C:\Users\slayter\Documents\My Projects\62_140068_San_Joaquin_Valley\K_vert_9.mxd

Vertical Conductivity - Layer 9
(1,050-1,400 feet BGS)

FIGURE 30



Explanation

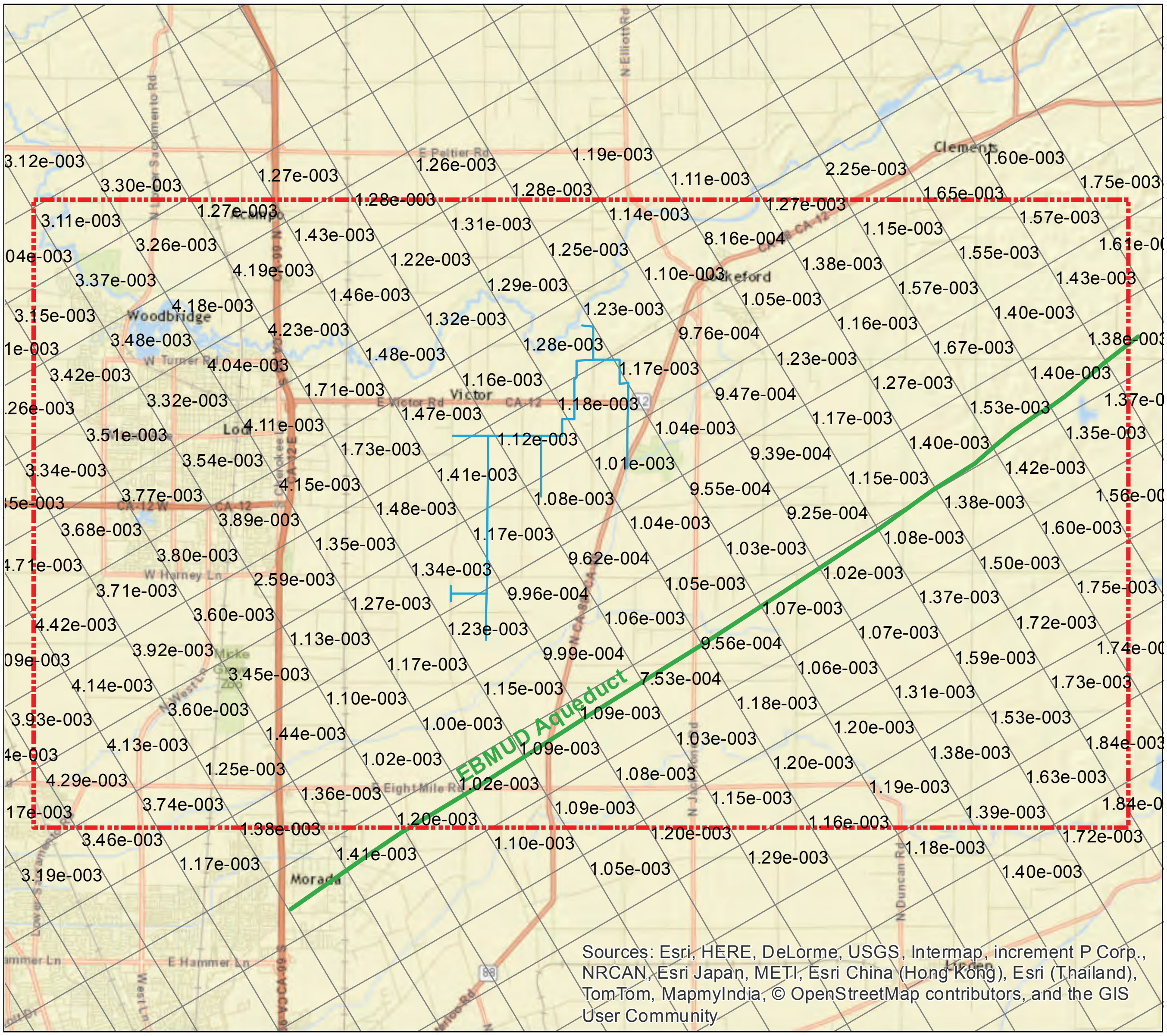
- 0.05 K_{vert} ft/day
- Groundwater recharge pilot project area
- NSJWCD South System
- EBMUD aqueduct
- Model grid cells

N

0 1 2 mi
0 2 4 km

Document Path: C:\Users\slayter\Documents\My Projects\62_140068_San_Joaquin_Valley\K_vert_10.mxd

Vertical Conductivity - Layer 10
(1,400-1,800 feet BGS)



Explanation

3.55e-002 S_s ft^{-1}

Groundwater recharge pilot project area

NSJWCD South System

EBMUD aqueduct

Model grid cells

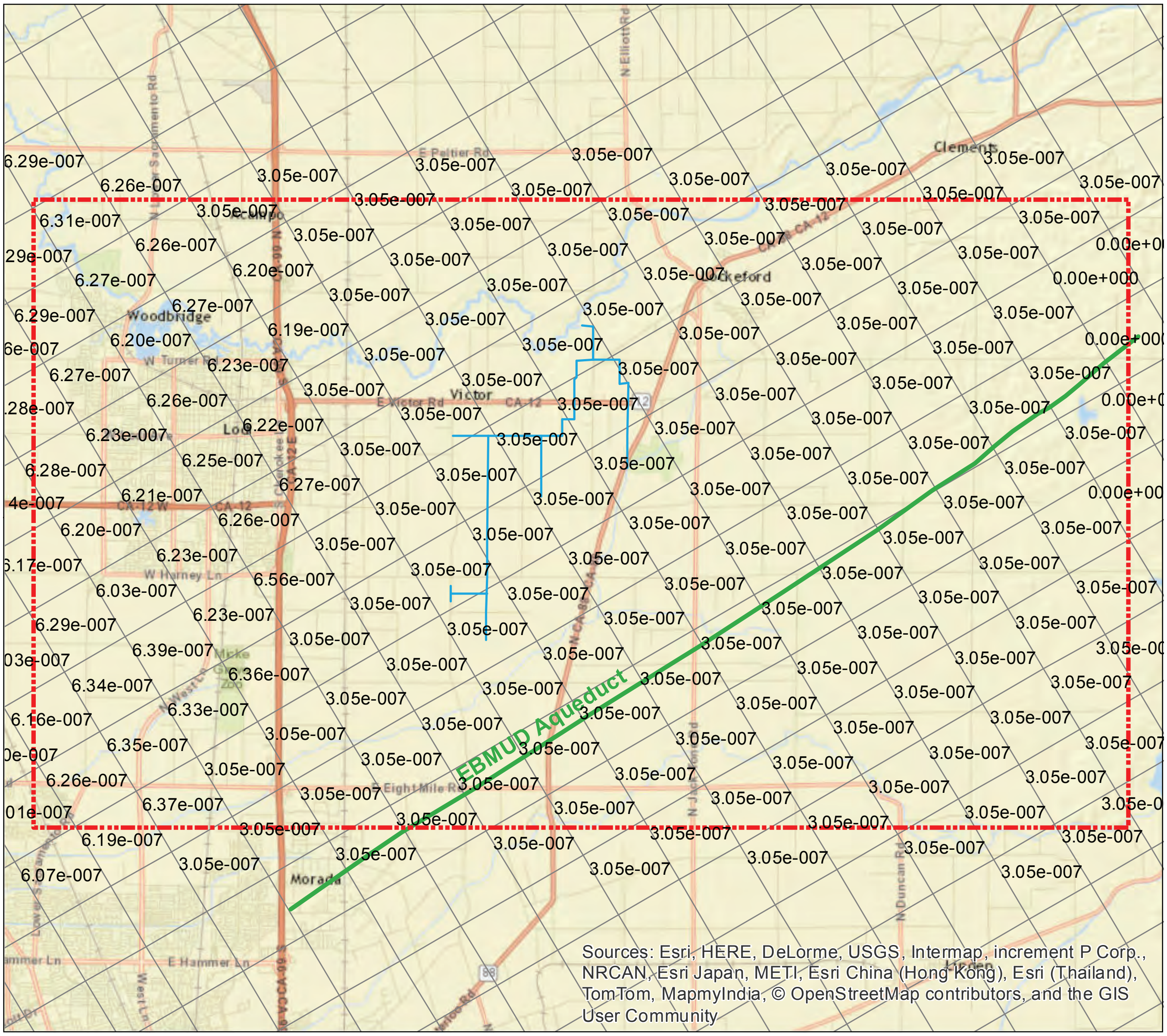
N

0 1 2 mi

0 2 4 km

Document Path: C:\Users\slayter\Documents\My Projects\62_140068_San_Joaquin_Valley\Ss_1.mxd

Specific Storage - Layer 1
(0-50 feet BGS west of Highway 99 and 0-147 feet BGS east of Highway 99) FIGURE 32



Explanation

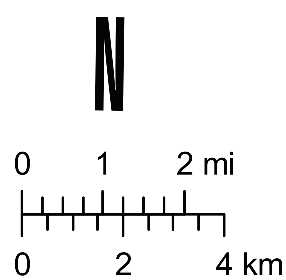
3.55e-002 S_s ft^{-1}

Groundwater recharge pilot project area

NSJWCD South System

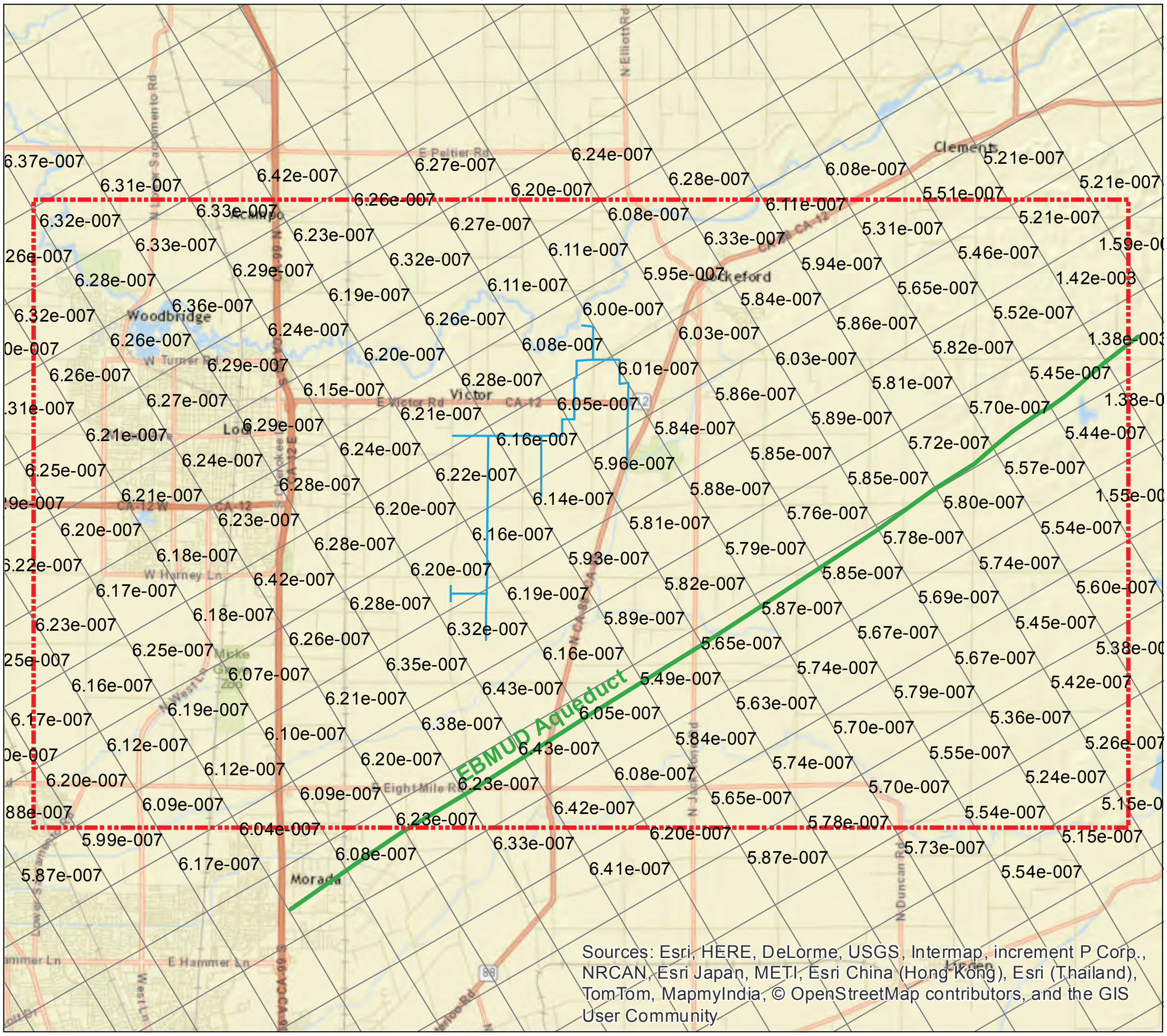
EBMUD aqueduct

Model grid cells



Document Path: C:\Users\slayter\Documents\My Projects\62_140068_San_Joaquin_Valley\Ss_2.mxd

Specific Storage - Layer 2
(50-150 feet BGS west of Highway 99 and 147-150 feet BGS east of Highway 99) FIGURE 33



Explanation

3.55e-002 S_s ft^{-1}

Groundwater recharge pilot project area

NSJWCD South System

EBMUD aqueduct

Model grid cells

N

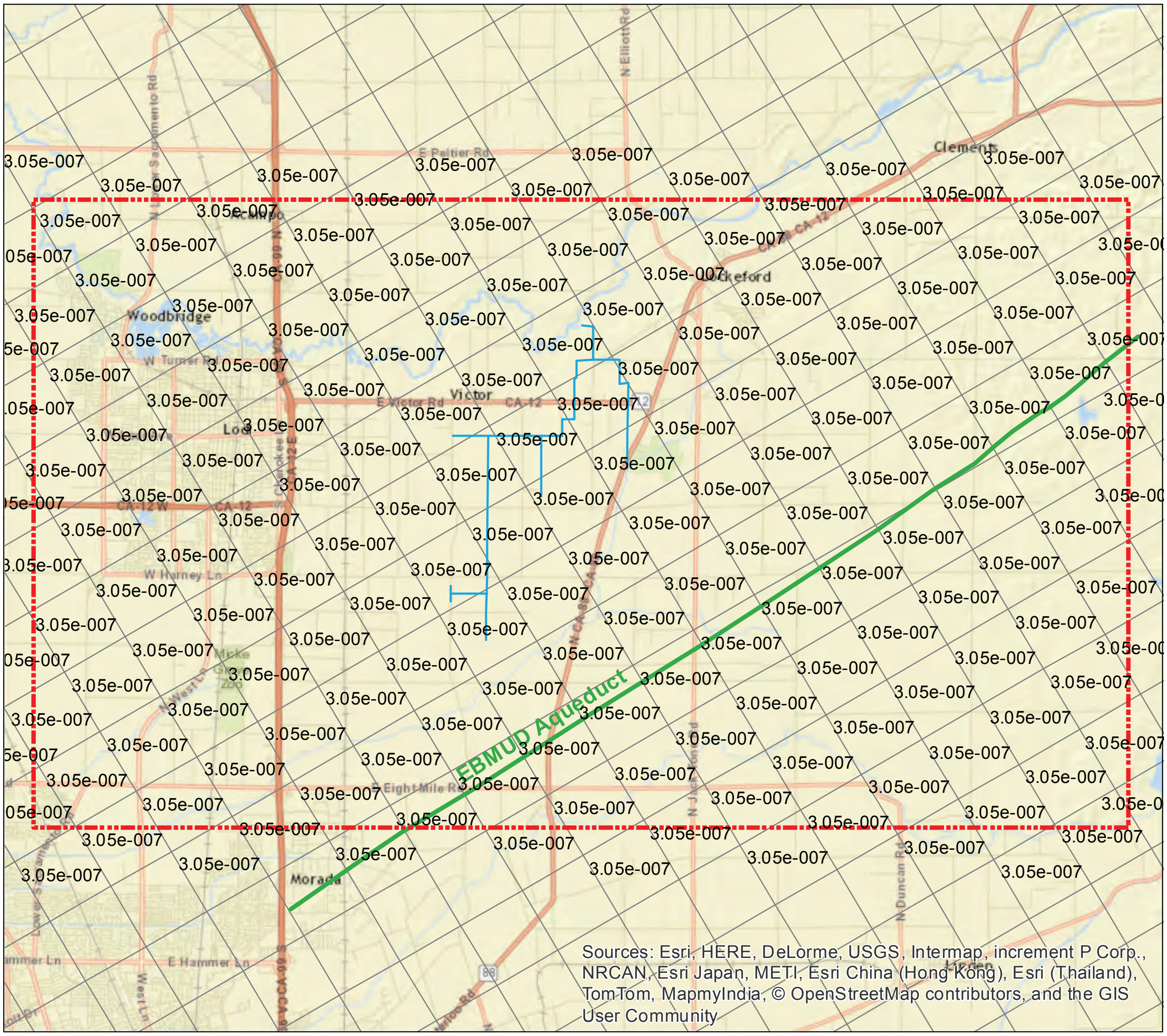
0 1 2 mi

0 2 4 km

Document Path: C:\Users\slayter\Documents\My Projects\62_140068_San_Joaquin_Valley\Ss_3.mxd

Specific Storage - Layer 3
(150-300 feet BGS)

FIGURE 34



Explanation

3.55e-002 S_s ft^{-1}

Groundwater recharge pilot project area

NSJWCD South System

EBMUD aqueduct

Model grid cells

N

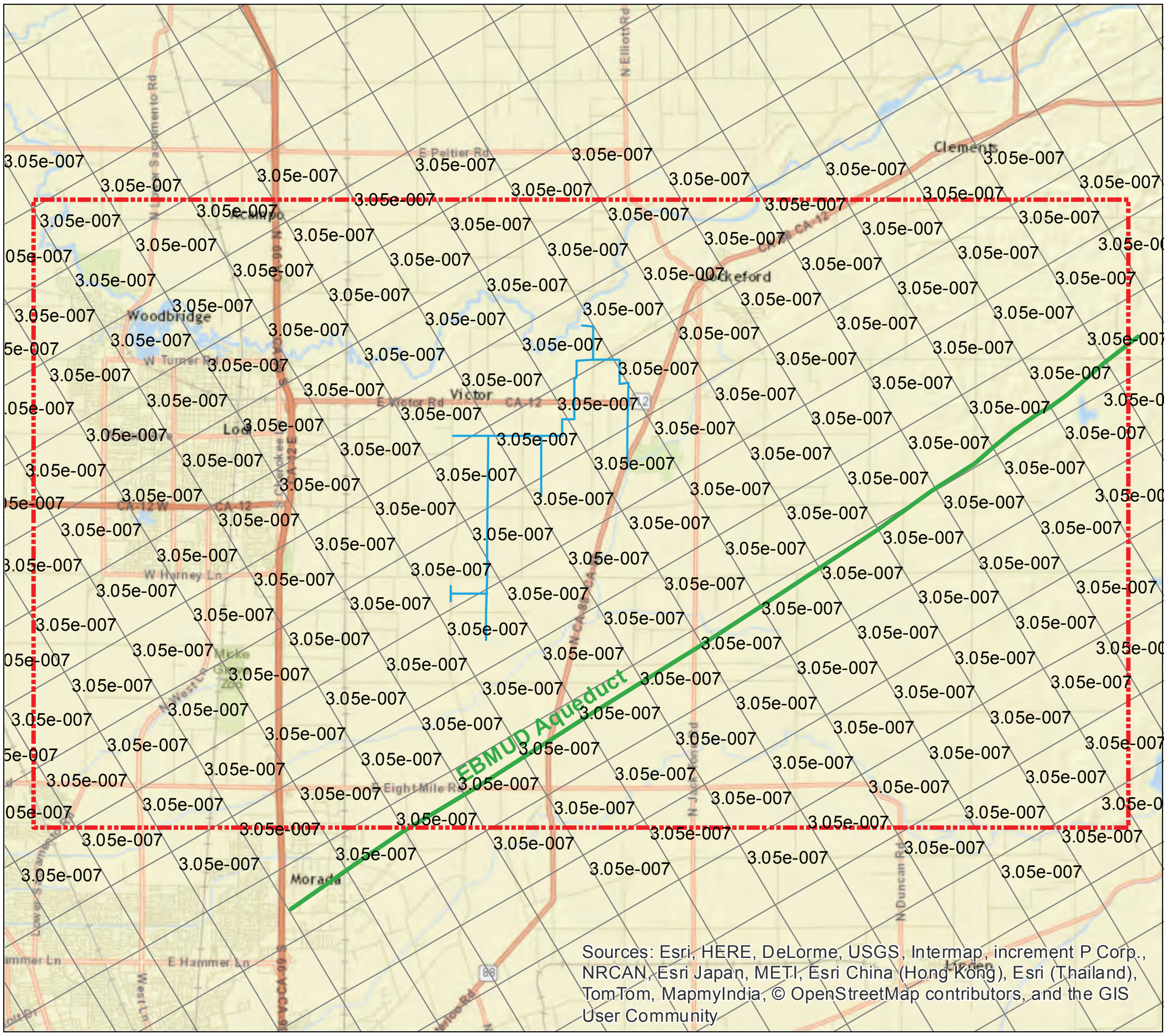
0 1 2 mi

0 2 4 km

Document Path: C:\Users\slayter\Documents\My Projects\62_140068_San_Joaquin_Valley\Ss_4.mxd

Specific Storage - Layer 4
(300-301 feet BGS. Represents Corcoran clay where present.)

FIGURE 35



Explanation

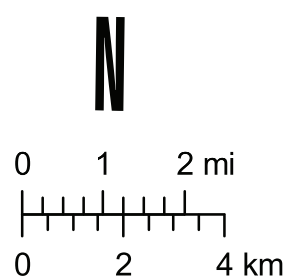
3.55e-002 S_s ft^{-1}

Groundwater recharge pilot project area

NSJWCD South System

EBMUD aqueduct

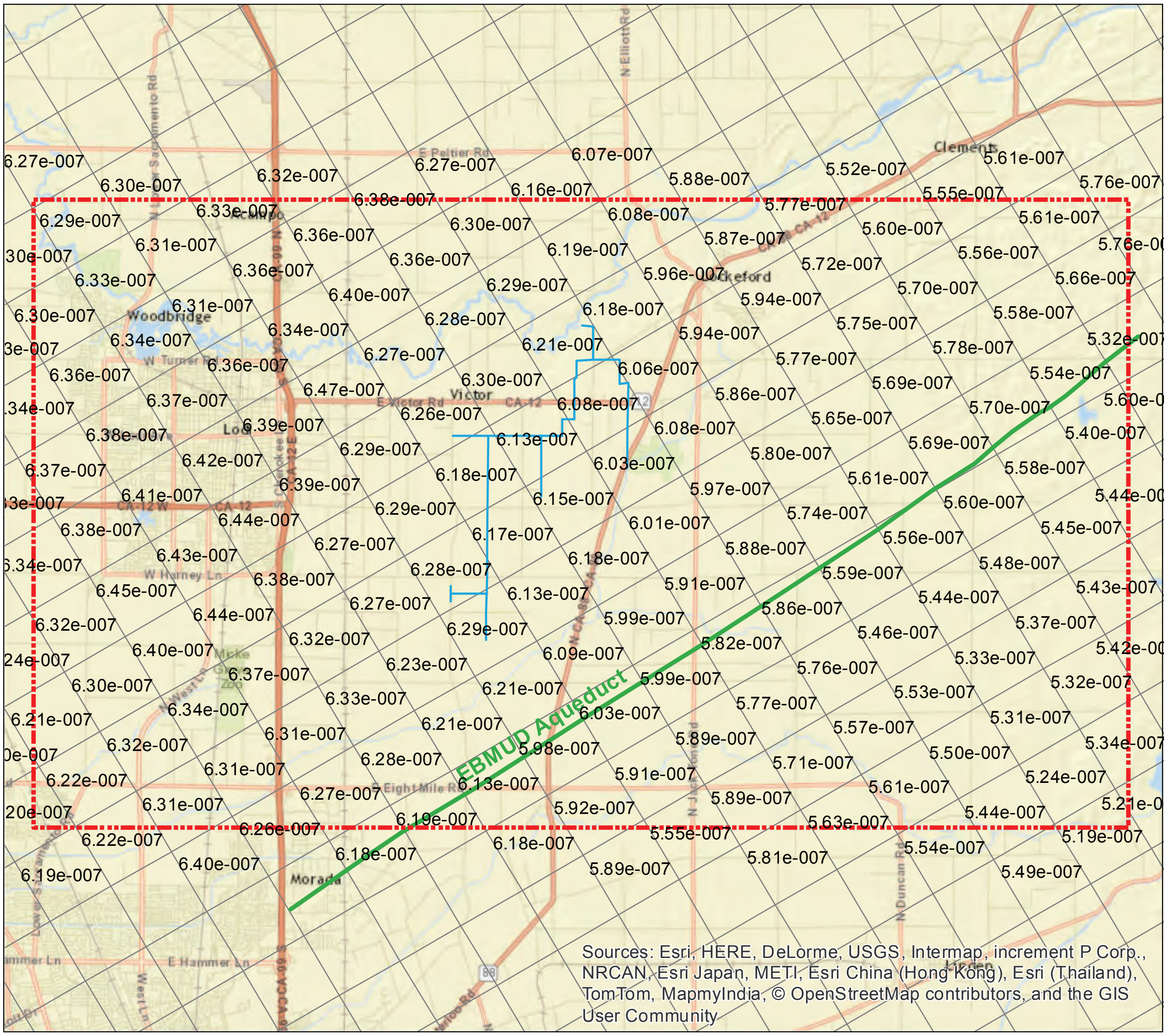
Model grid cells



Document Path: C:\Users\slayter\Documents\My Projects\62_140068_San_Joaquin_Valley\Ss_5.mxd

Specific Storage - Layer 5
(301-302 feet BGS. Represents Corcoran clay where present.)

FIGURE 36



Explanation

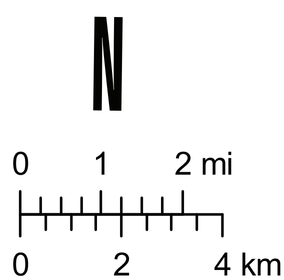
3.55e-002 S_s ft^{-1}

Groundwater recharge pilot project area

NSJWCD South System

EBMUD aqueduct

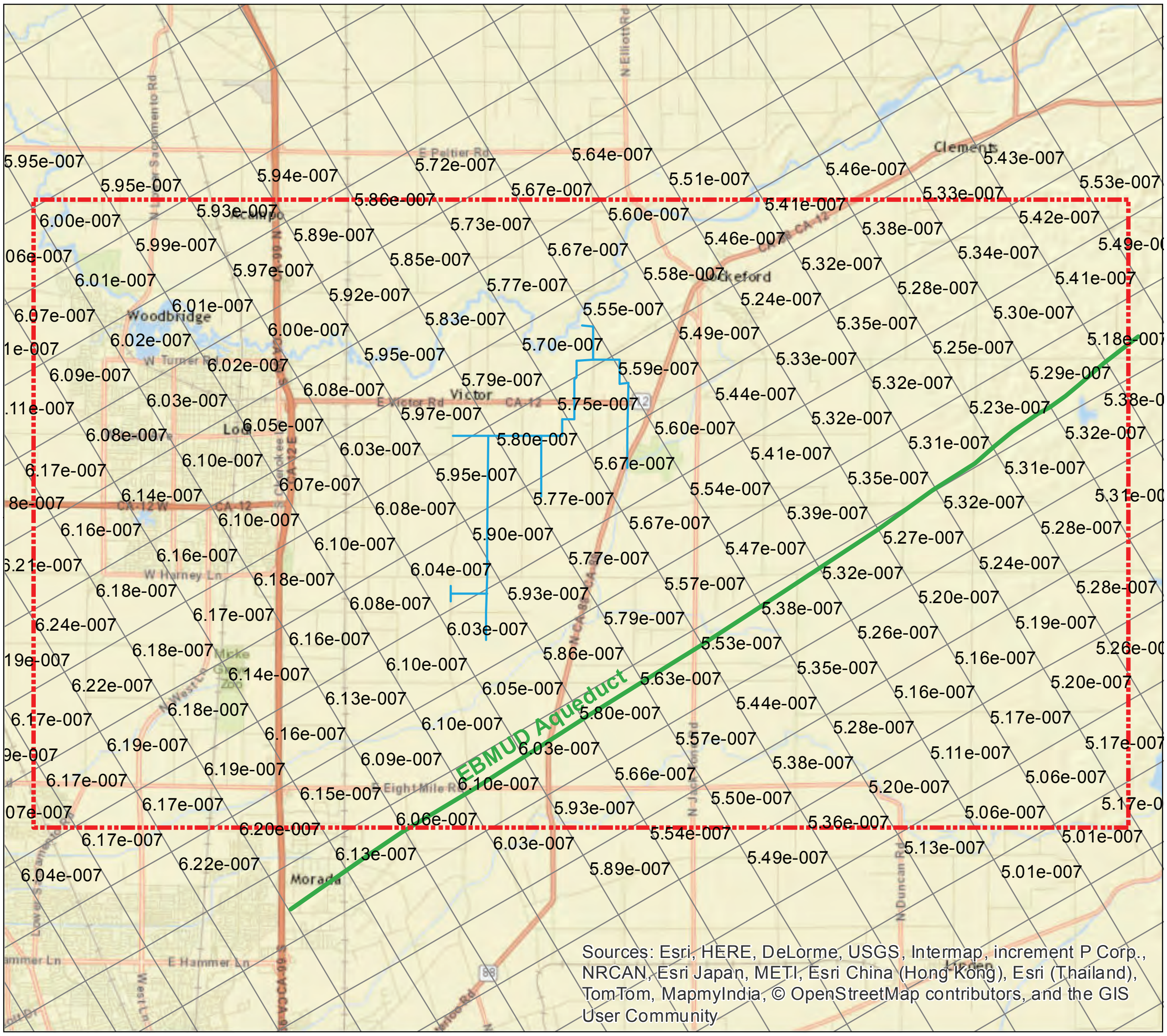
Model grid cells



Document Path: C:\Users\slayter\Documents\My Projects\62_140068_San_Joaquin_Valley\Ss_6.mxd

Specific Storage - Layer 6
(302-500 feet BGS)

FIGURE 37



Explanation

3.55e-002 S_s ft^{-1}

Groundwater recharge pilot project area

NSJWCD South System

EBMUD aqueduct

Model grid cells

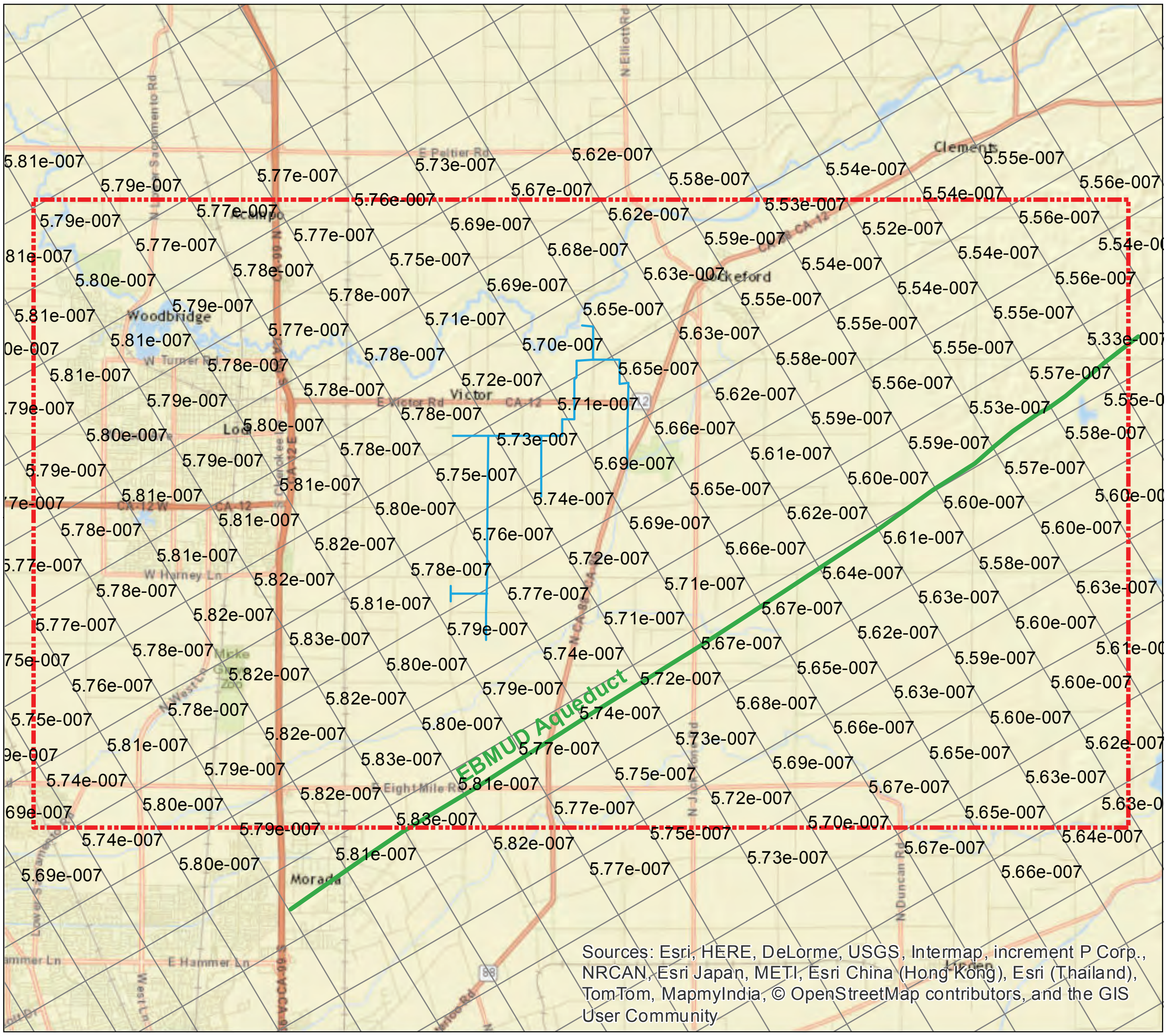
N

0 1 2 mi

0 2 4 km

Document Path: C:\Users\slayter\Documents\My Projects\62_140068_San_Joaquin_Valley\Ss_7.mxd

Specific Storage - Layer 7
(500-750 feet BGS)



Explanation

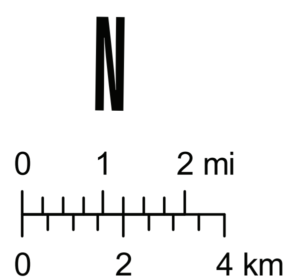
3.55e-002 S_s ft^{-1}

Groundwater recharge pilot project area

NSJWCD South System

EBMUD aqueduct

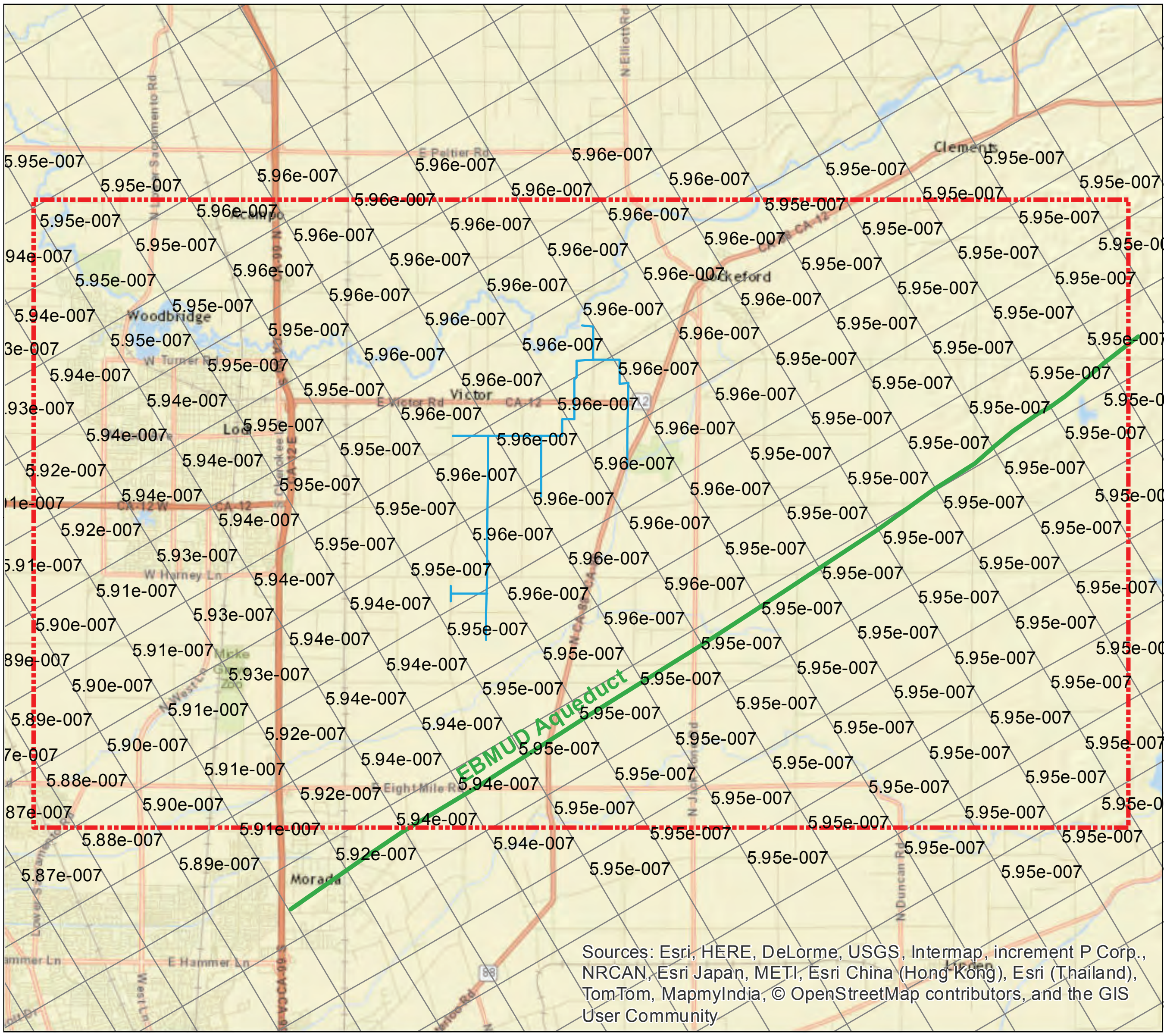
Model grid cells



Document Path: C:\Users\slayter\Documents\My Projects\62_140068_San_Joaquin_Valley\Ss_8.mxd

Specific Storage - Layer 8
(750-1,050 feet BGS)

FIGURE 39



Explanation

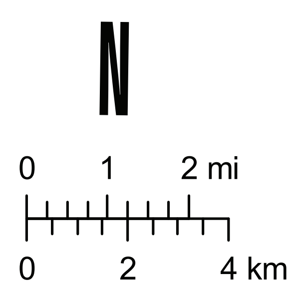
3.55e-002 S_s ft^{-1}

Groundwater recharge pilot project area

NSJWCD South System

EBMUD aqueduct

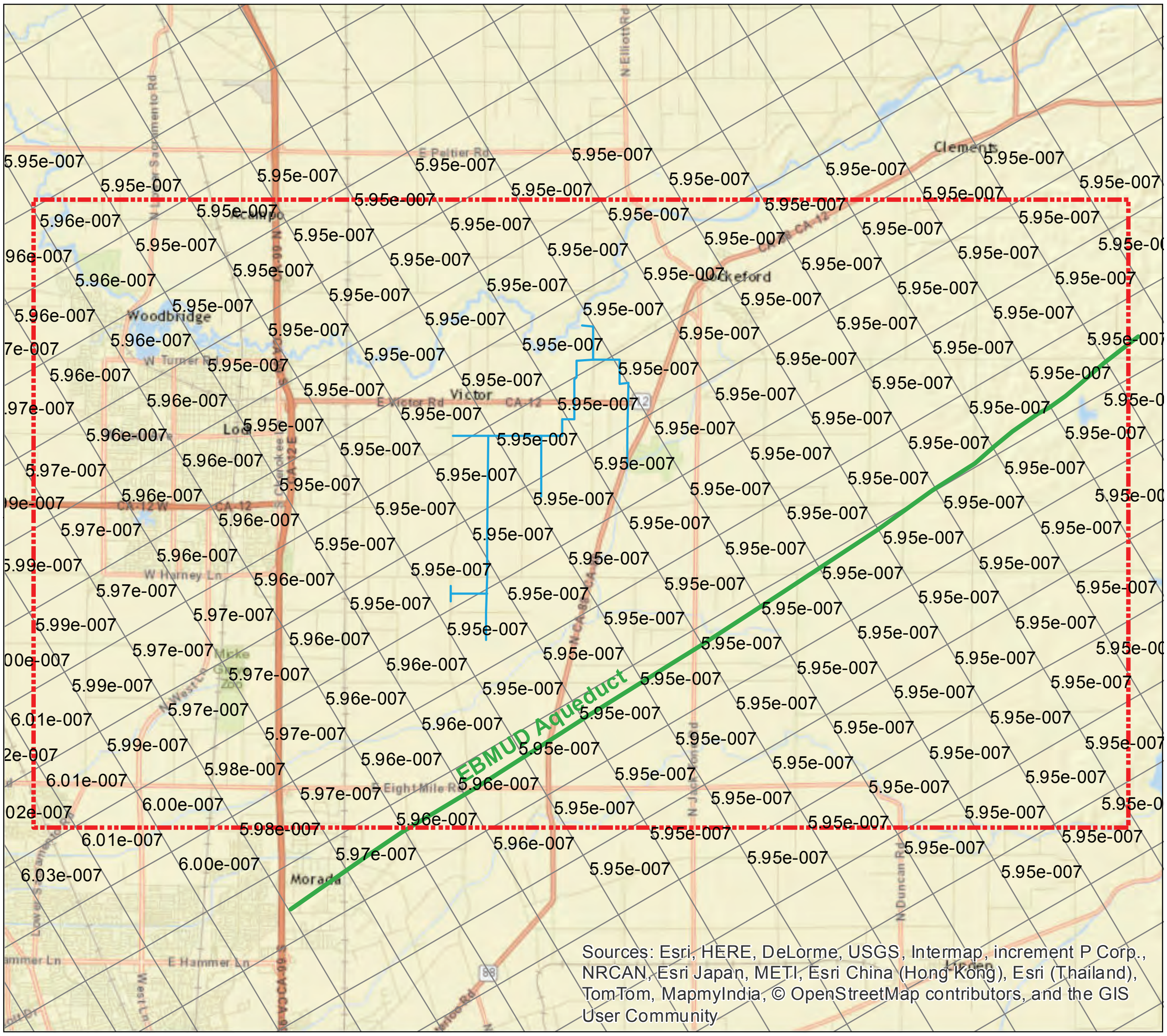
Model grid cells



Document Path: C:\Users\slayter\Documents\My Projects\62_140068_San_Joaquin_Valley\Ss_9.mxd

Specific Storage - Layer 9
(1,050-1,400 feet BGS)

FIGURE 40



Explanation

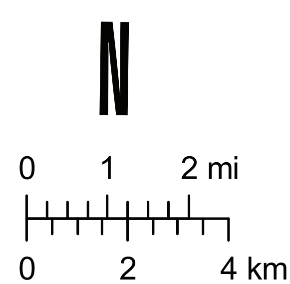
3.55e-002 S_s ft^{-1}

Groundwater recharge pilot project area

NSJWCD South System

EBMUD aqueduct

Model grid cells



Document Path: C:\Users\slayter\Documents\My Projects\62_140068_San_Joaquin_Valley\Ss_10.mxd

Specific Storage - Layer 10
(1,400-1,800 feet BGS)

FIGURE 41

APPENDICES

APPENDIX A

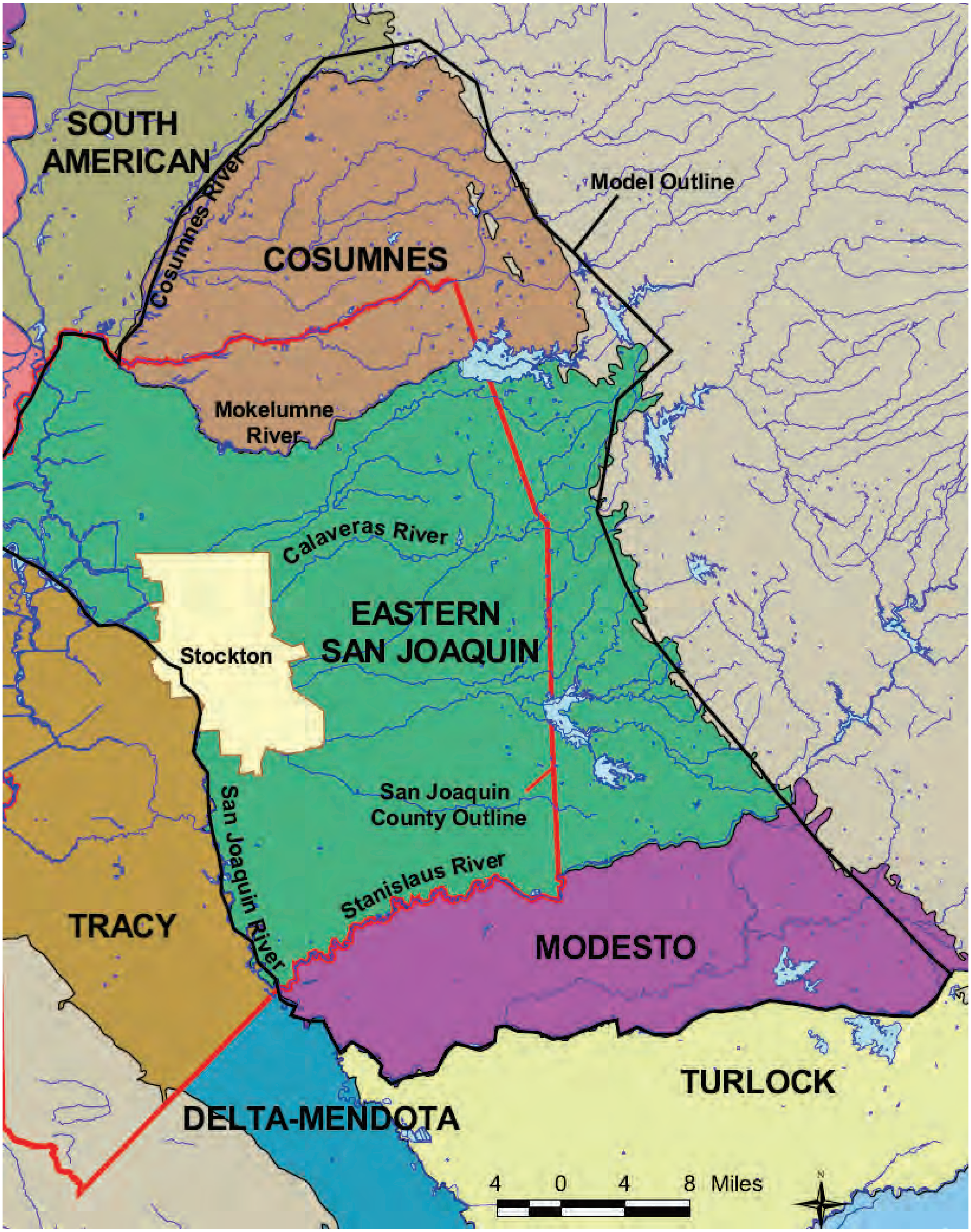


Figure 2-1
Location Map Showing Groundwater Basins Underlying San Joaquin County

CDM

Integrated Conjunctive Use Program
Northeastern San Joaquin County GBA Integrated Groundwater / Surface Water Model

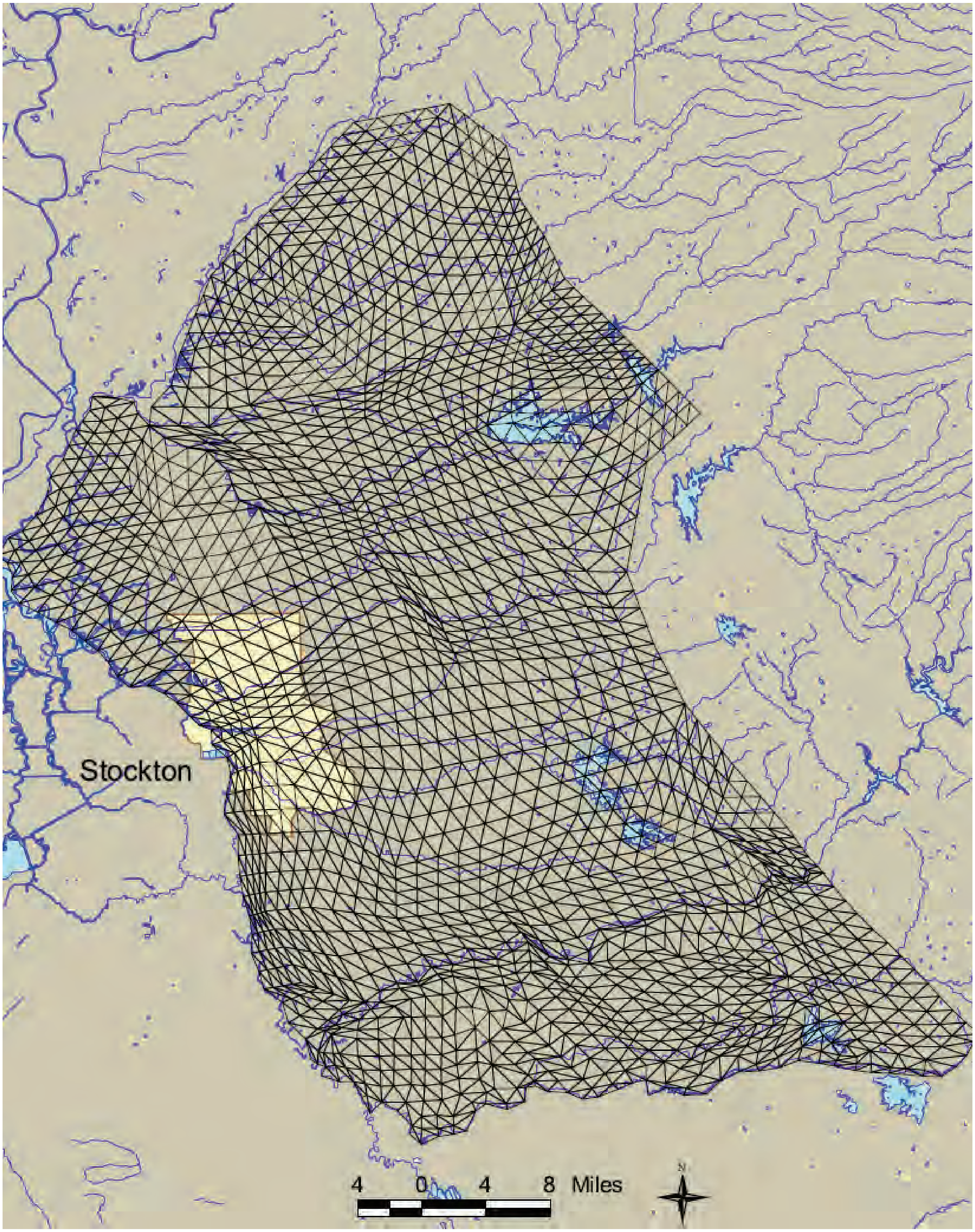


Figure 2-2
Finite Element Grid

CDM

Integrated Conjunctive Use Program
Northeastern San Joaquin County GBA Integrated Groundwater / Surface Water Model

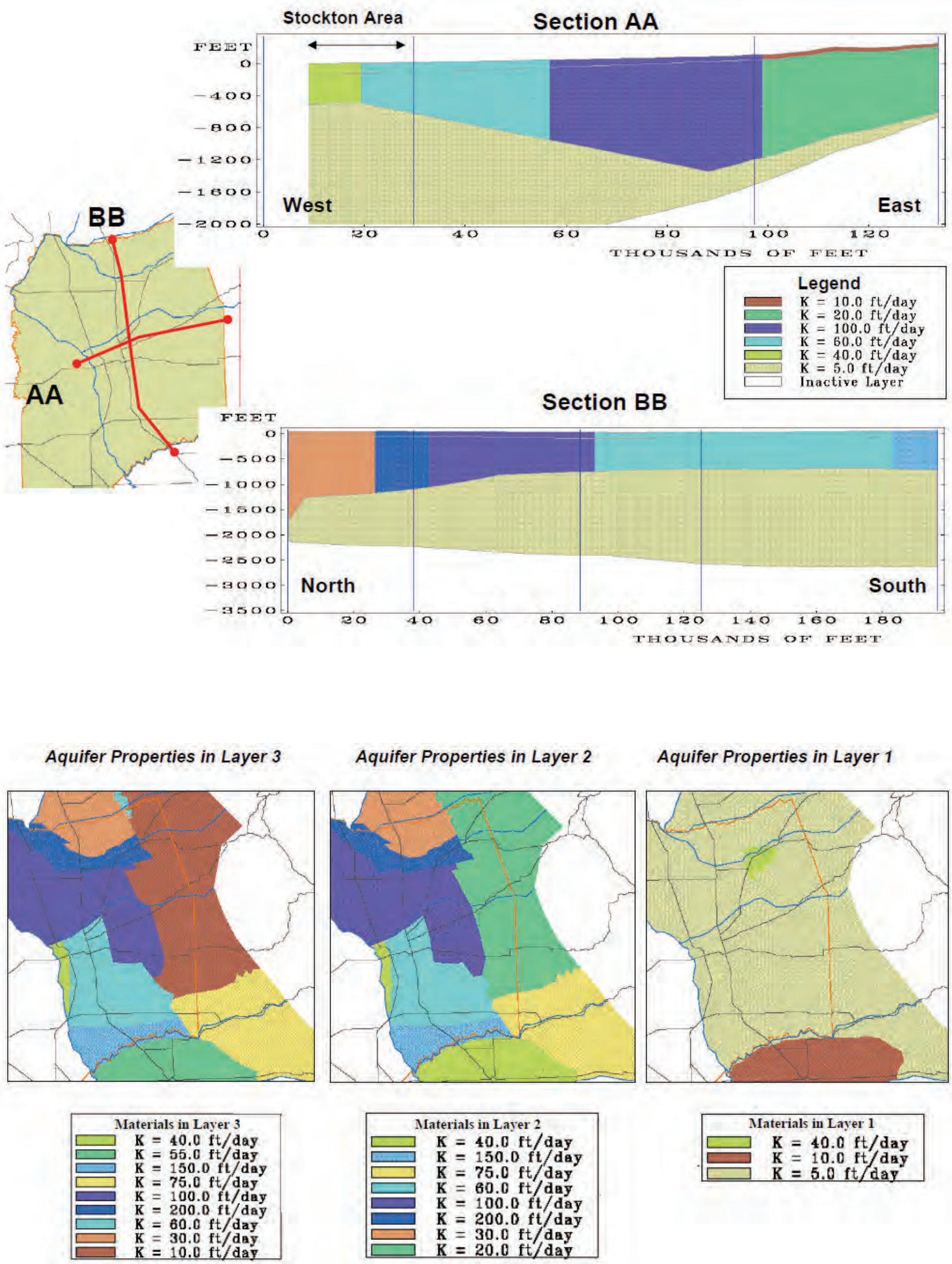


Figure 2-3
Model Aquifer Layering and Hydraulic Property Assignments

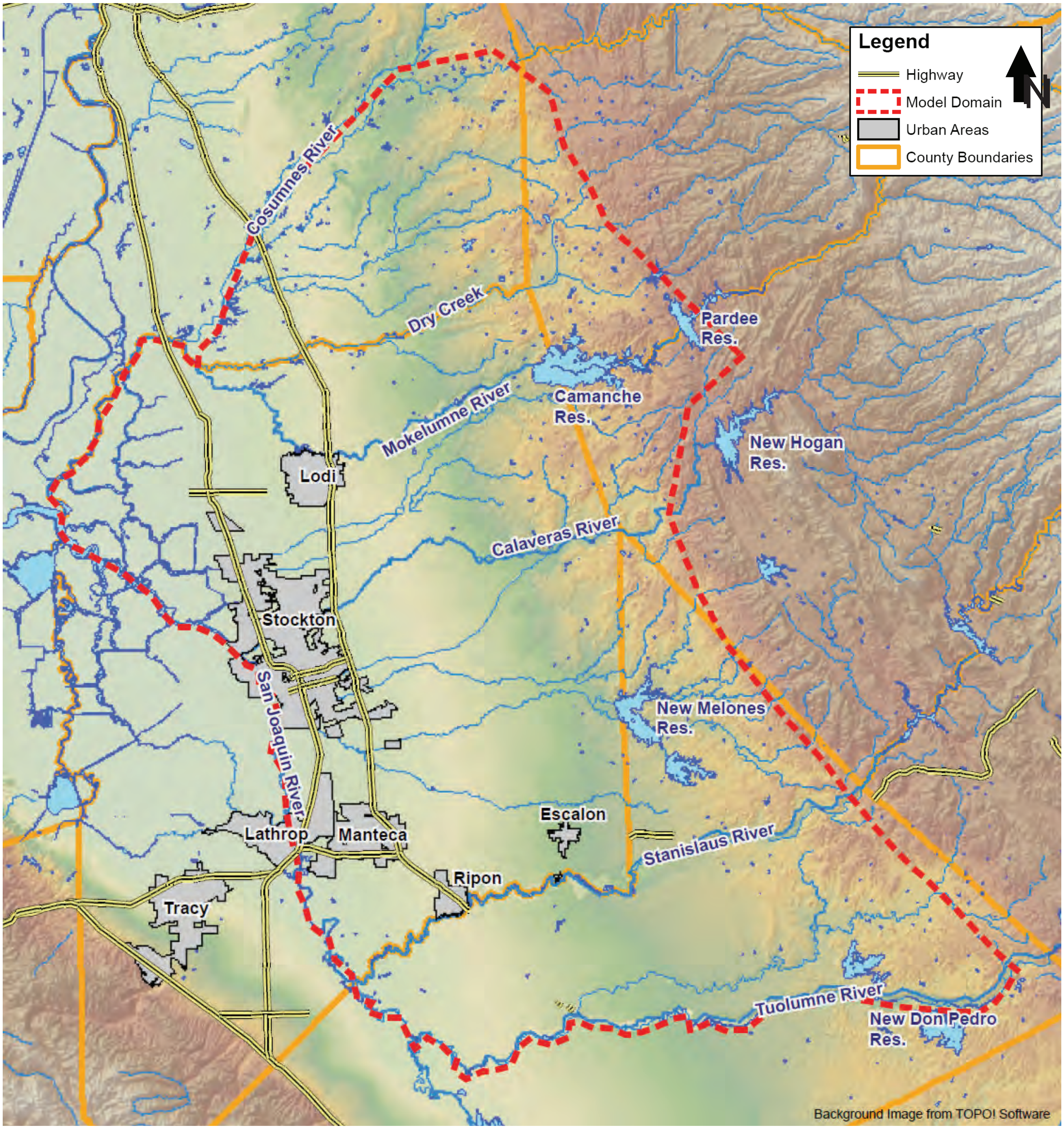


Figure 1-1
General Location Map

CDM

Integrated Conjunctive Use Program
Northeastern San Joaquin County GBA Integrated Groundwater / Surface Water Model

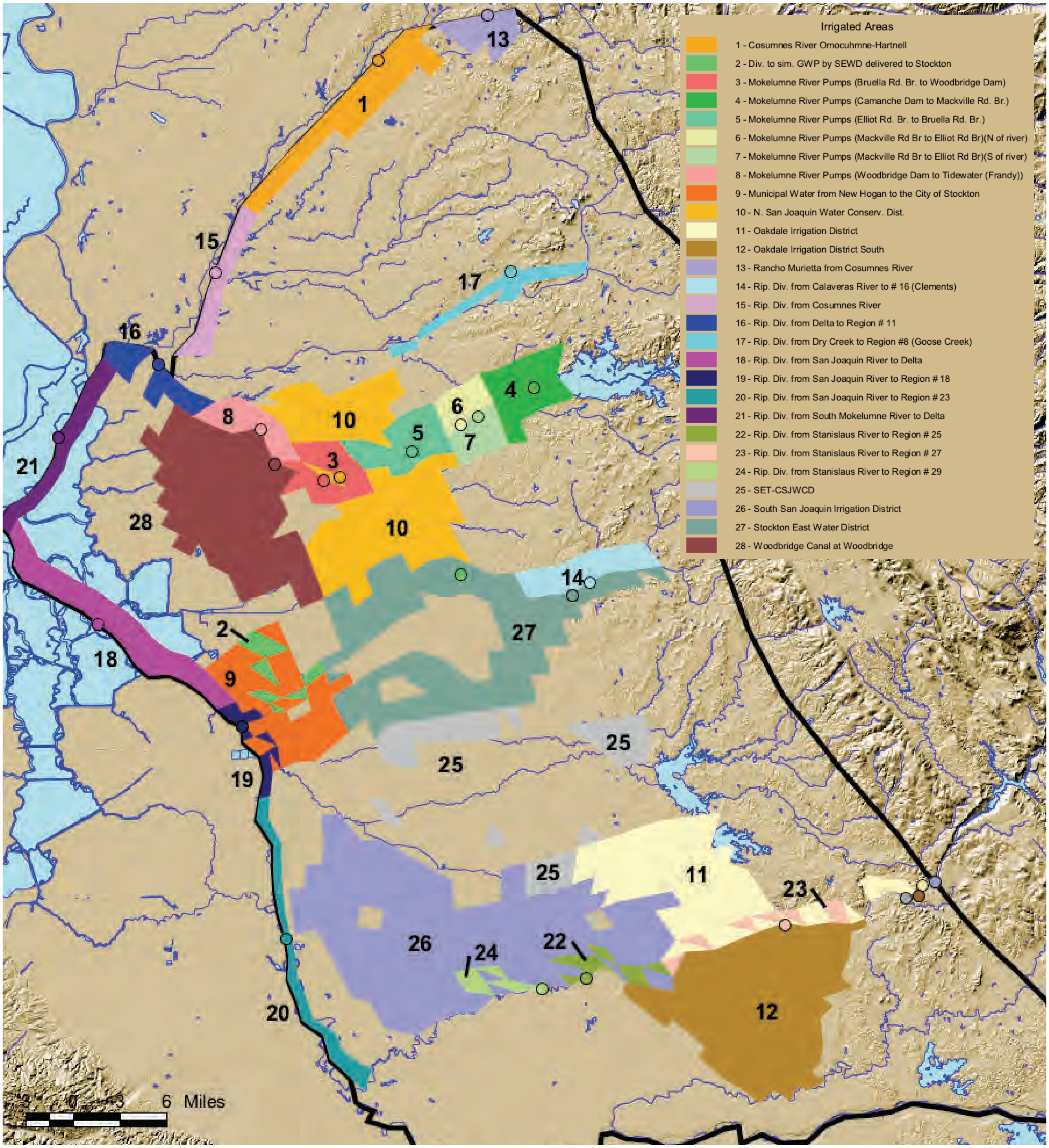


Figure 2-4
Location of Major Diversion Points and Associated Irrigated Areas

APPENDIX B

Figure 4. California Geology

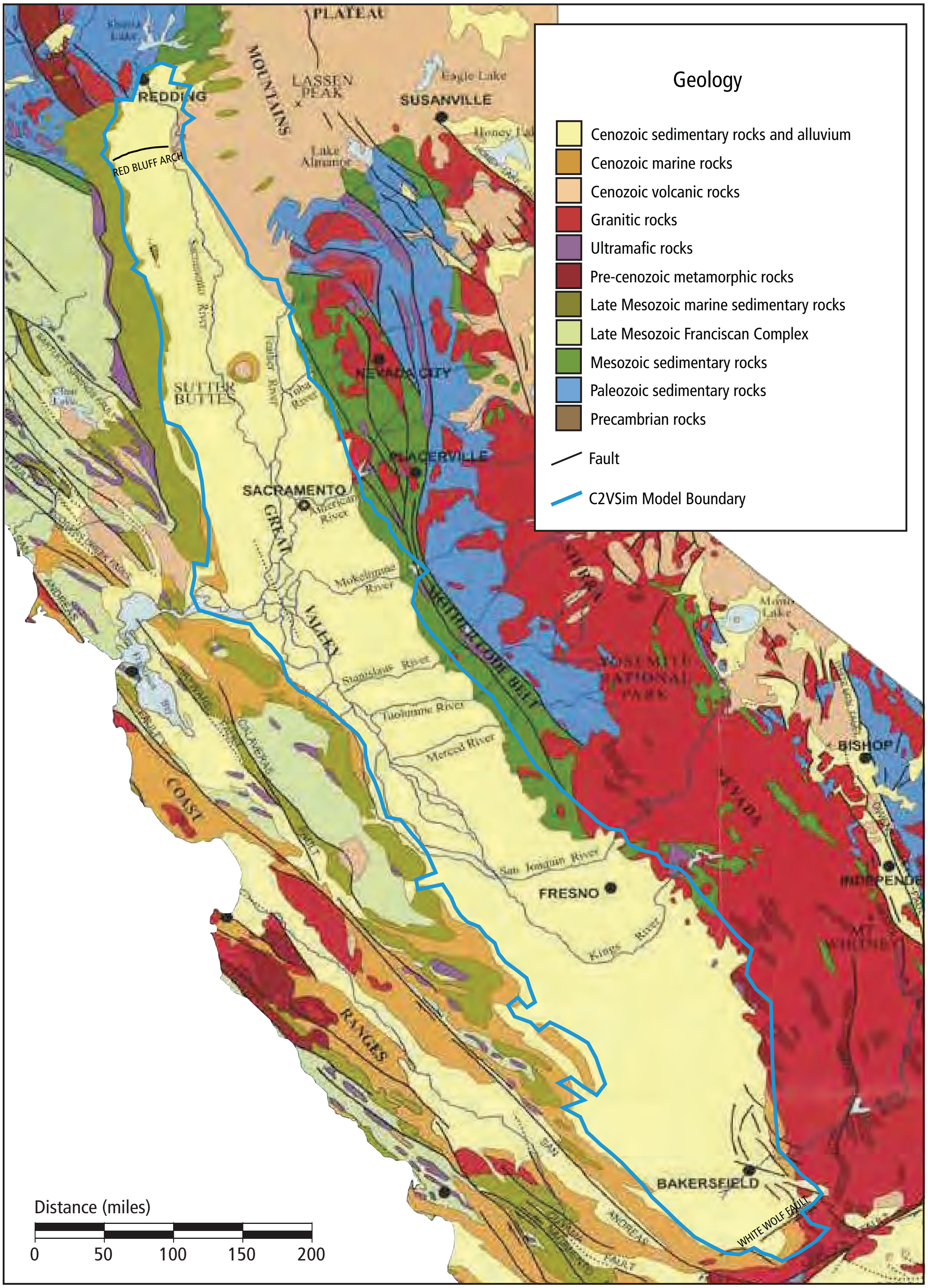


Figure 12. C2VSim coarse-grid model framework.

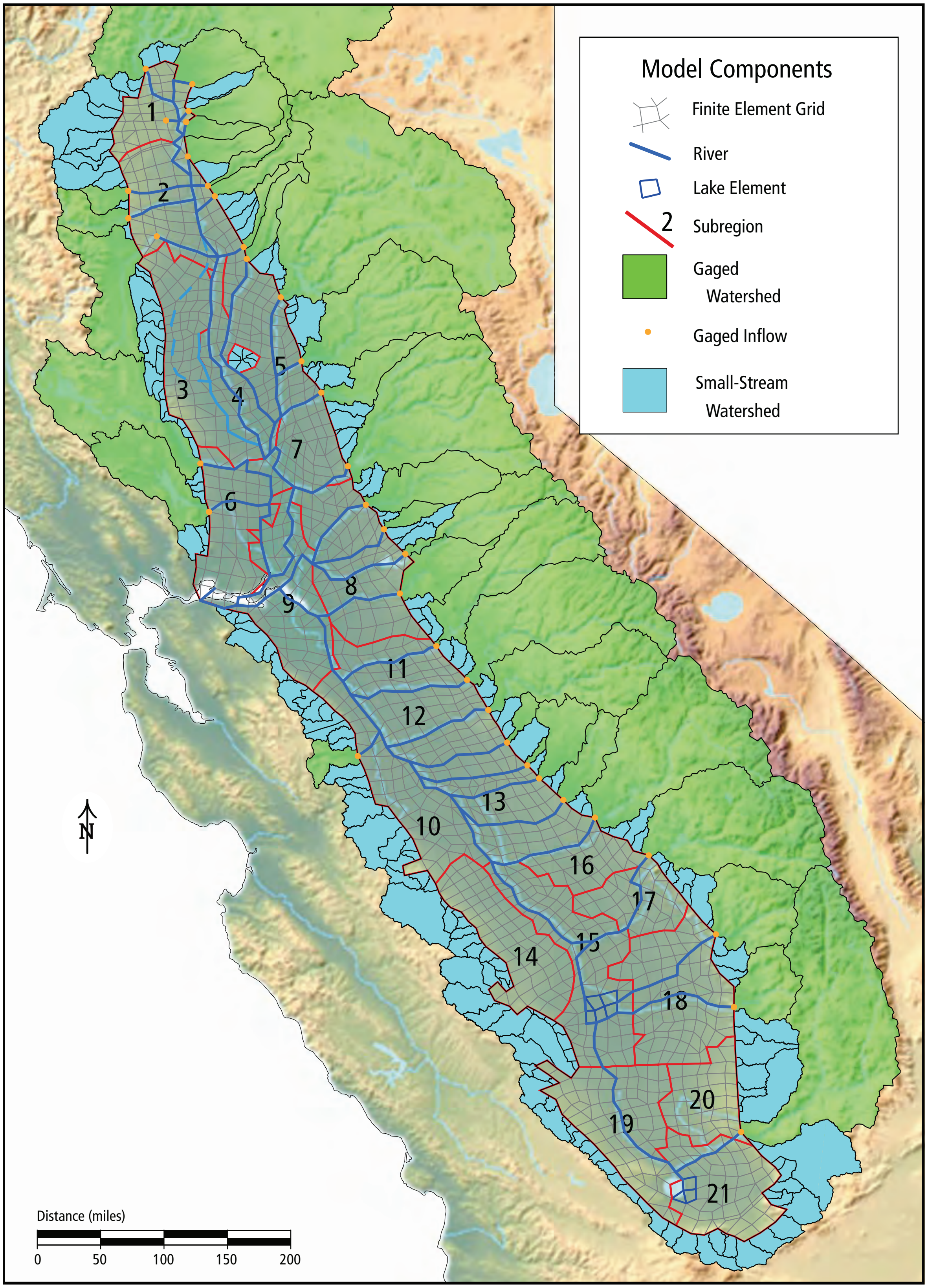


Figure 13A. Thickness of the top model layer.

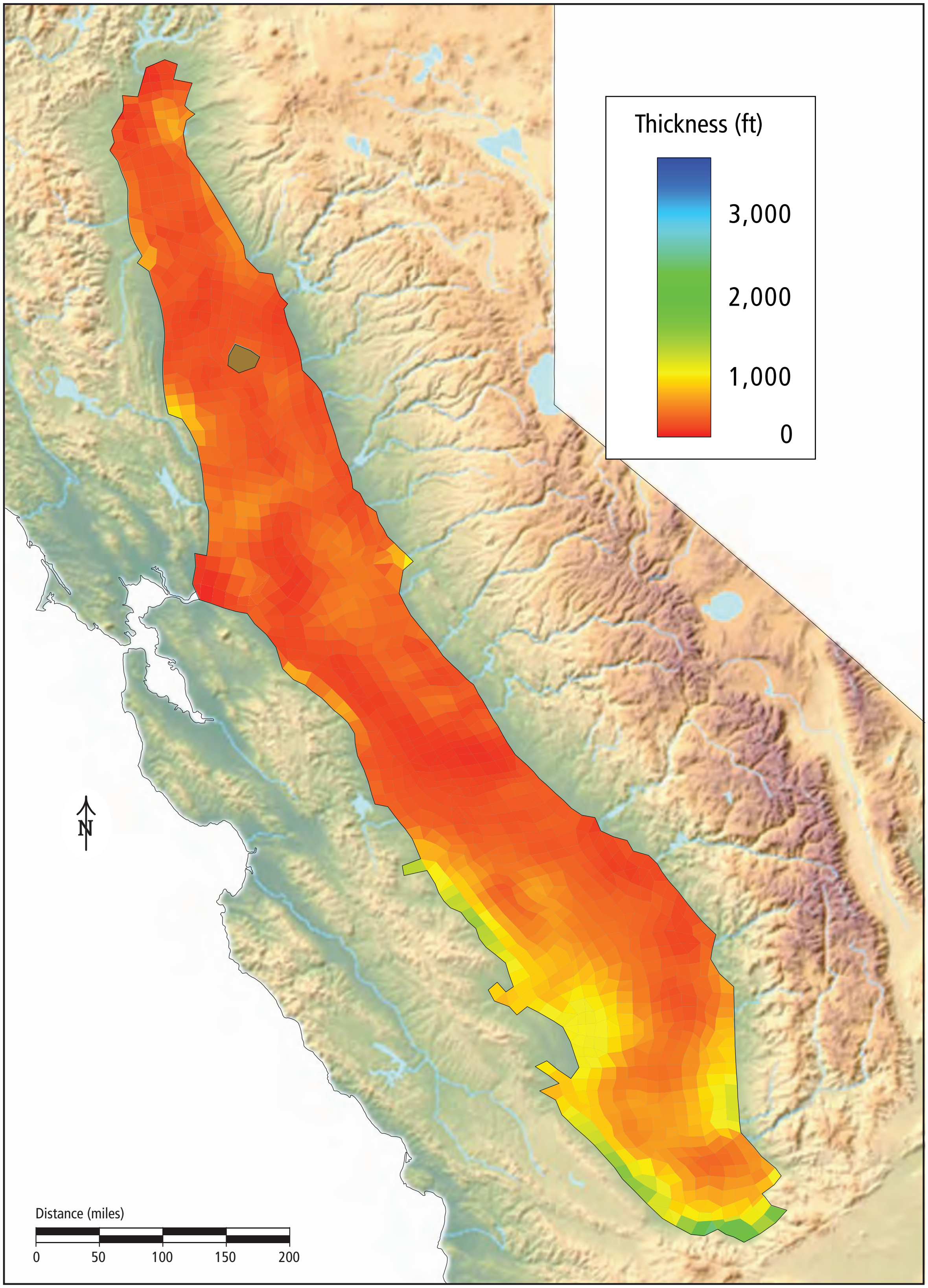


Figure 13B. Thickness of the Corcoran Clay.

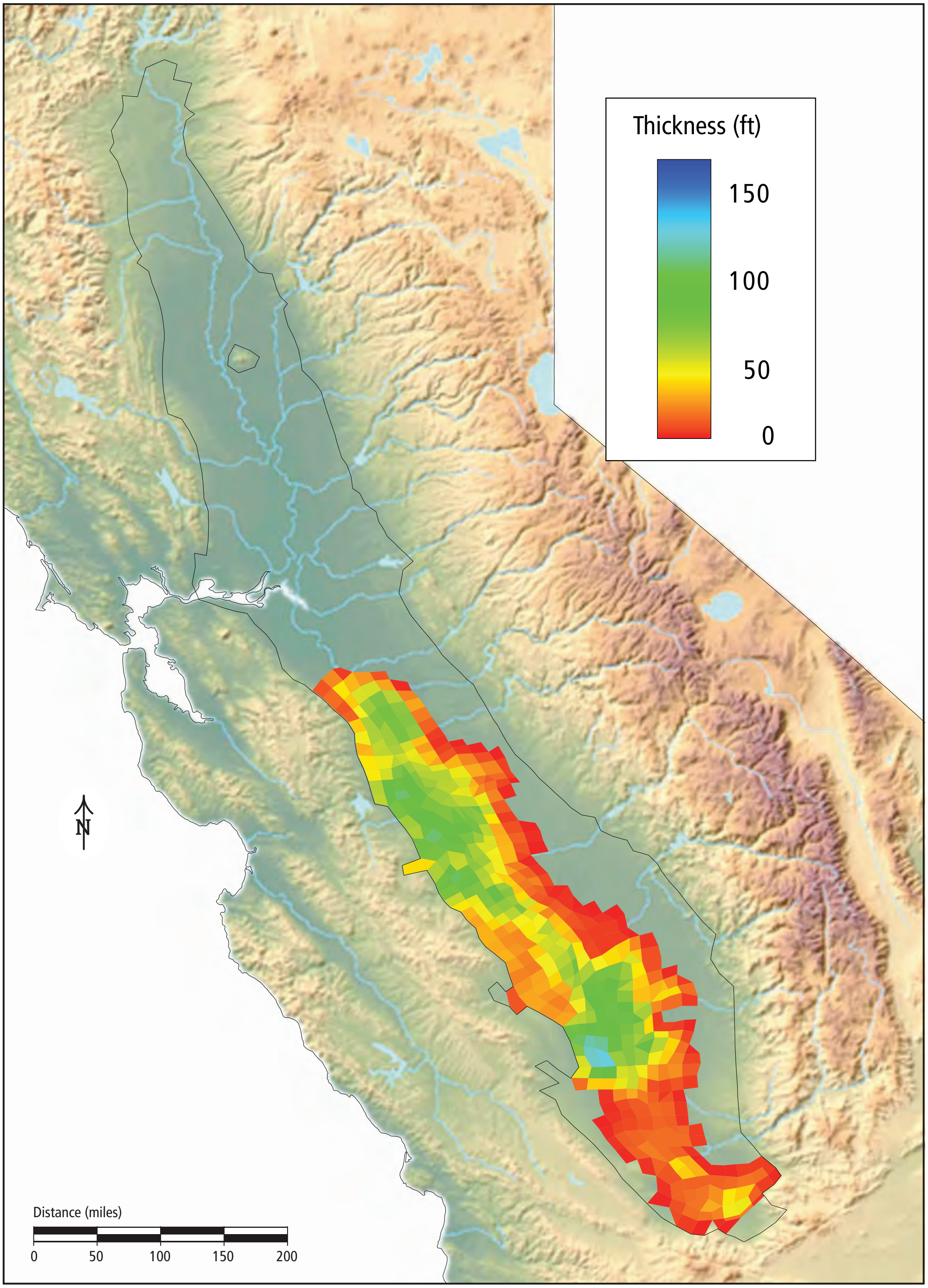


Figure 13C. Thickness of the middle model layer.

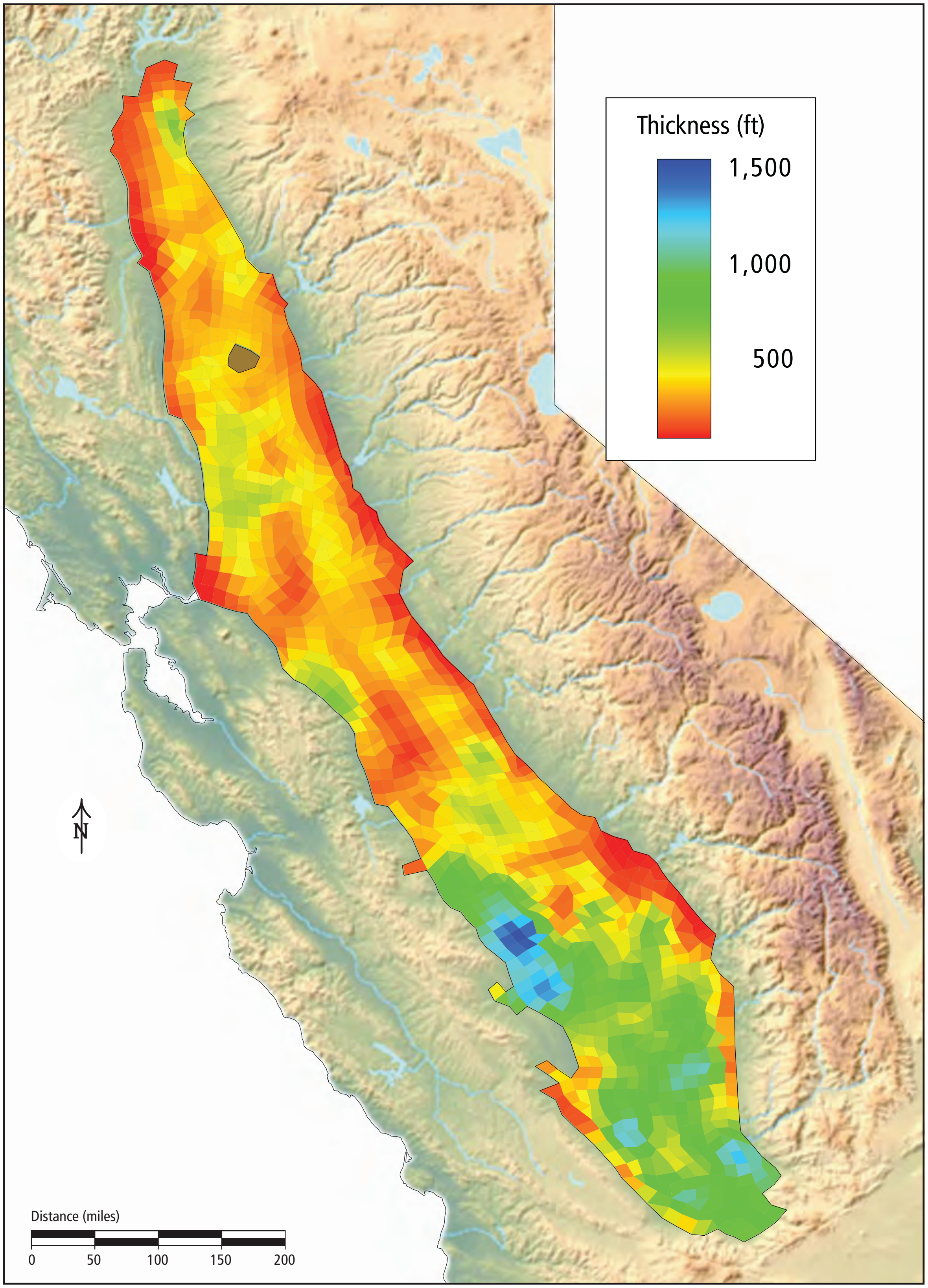


Figure 13D. Thickness of the bottom model layer.

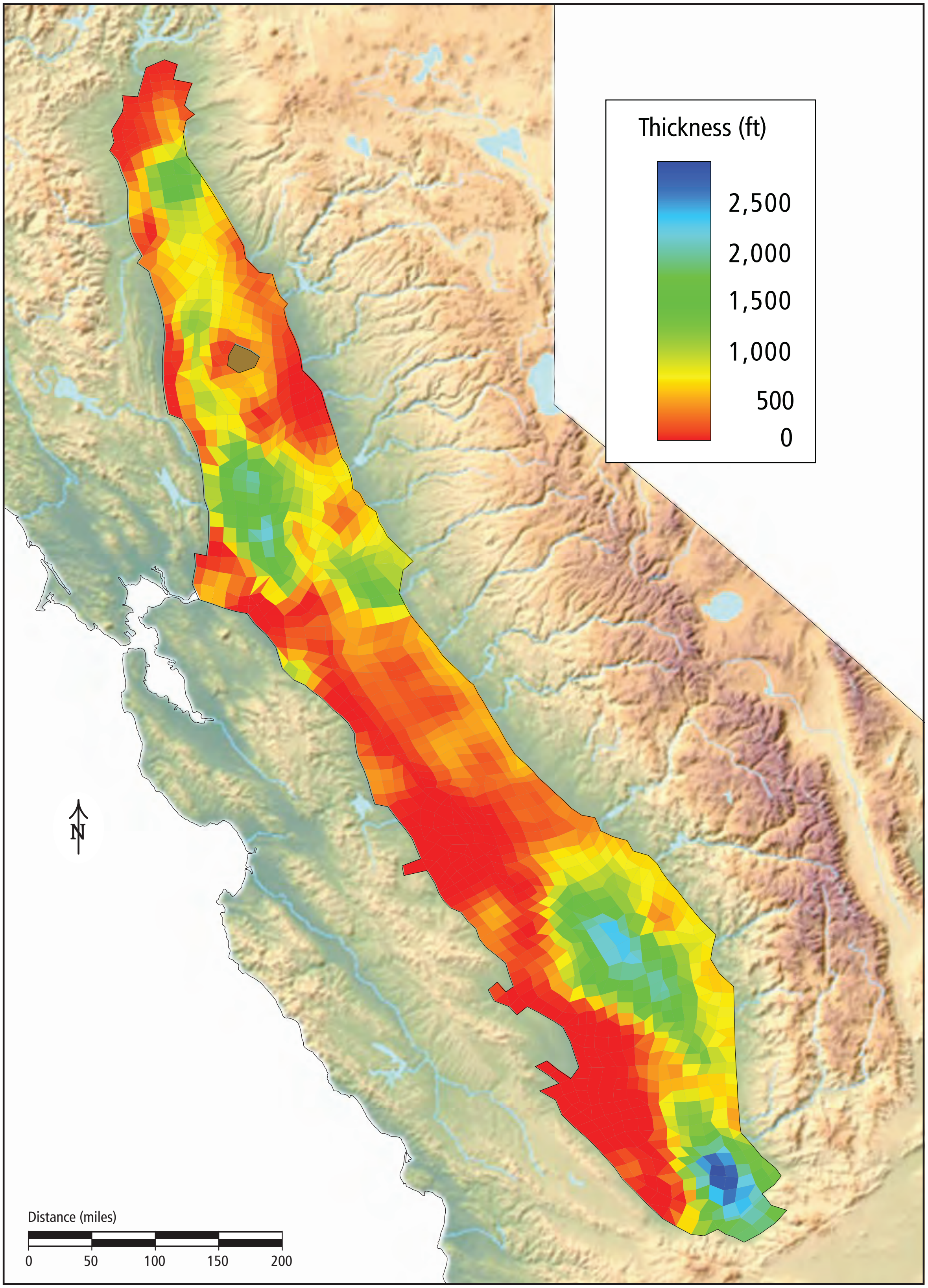


Figure 14. Simulated thickness of the Central Valley aquifer.

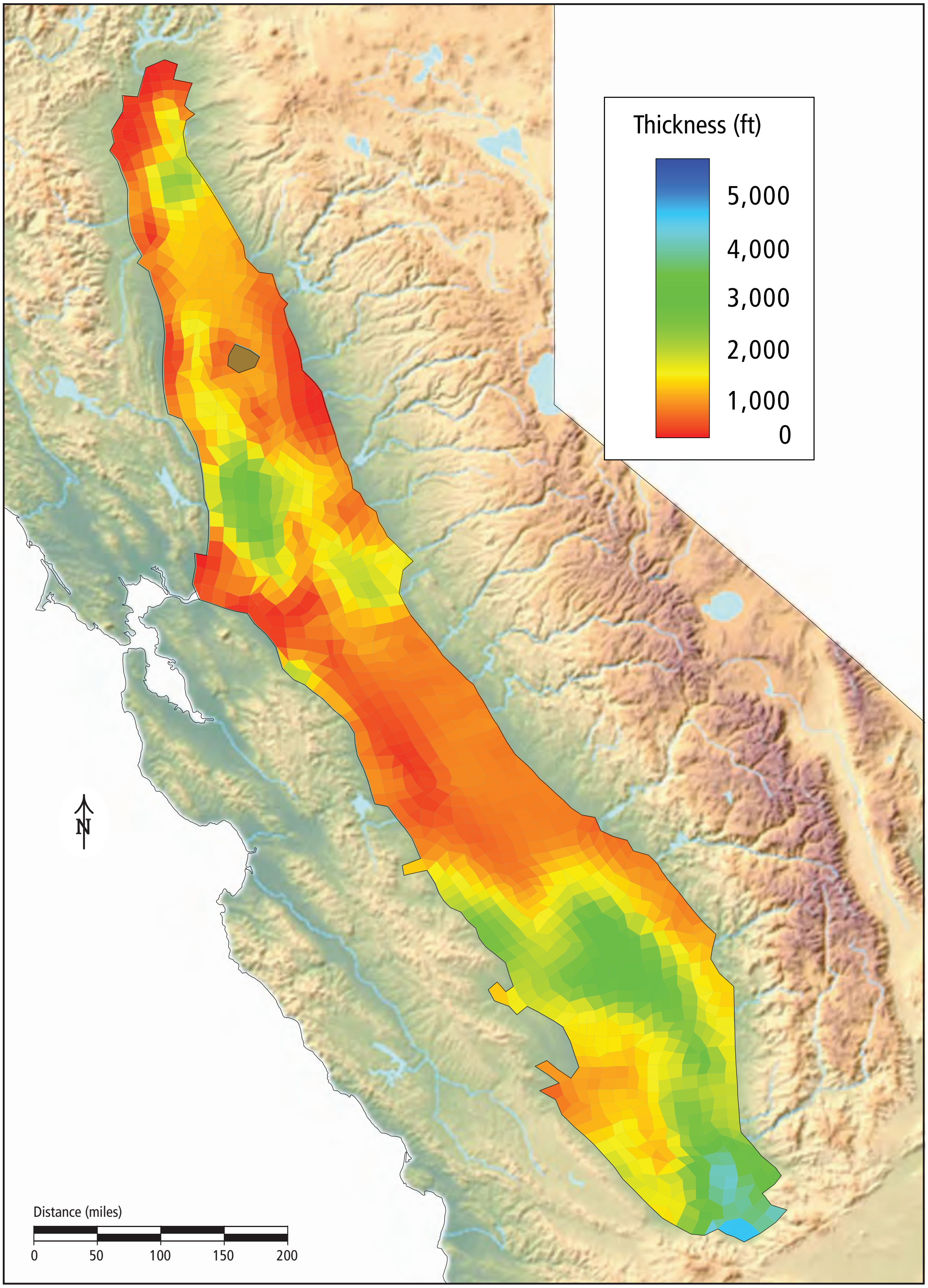


Figure 23. Hydrologic soil group for each C2VSim coarse-grid model element.

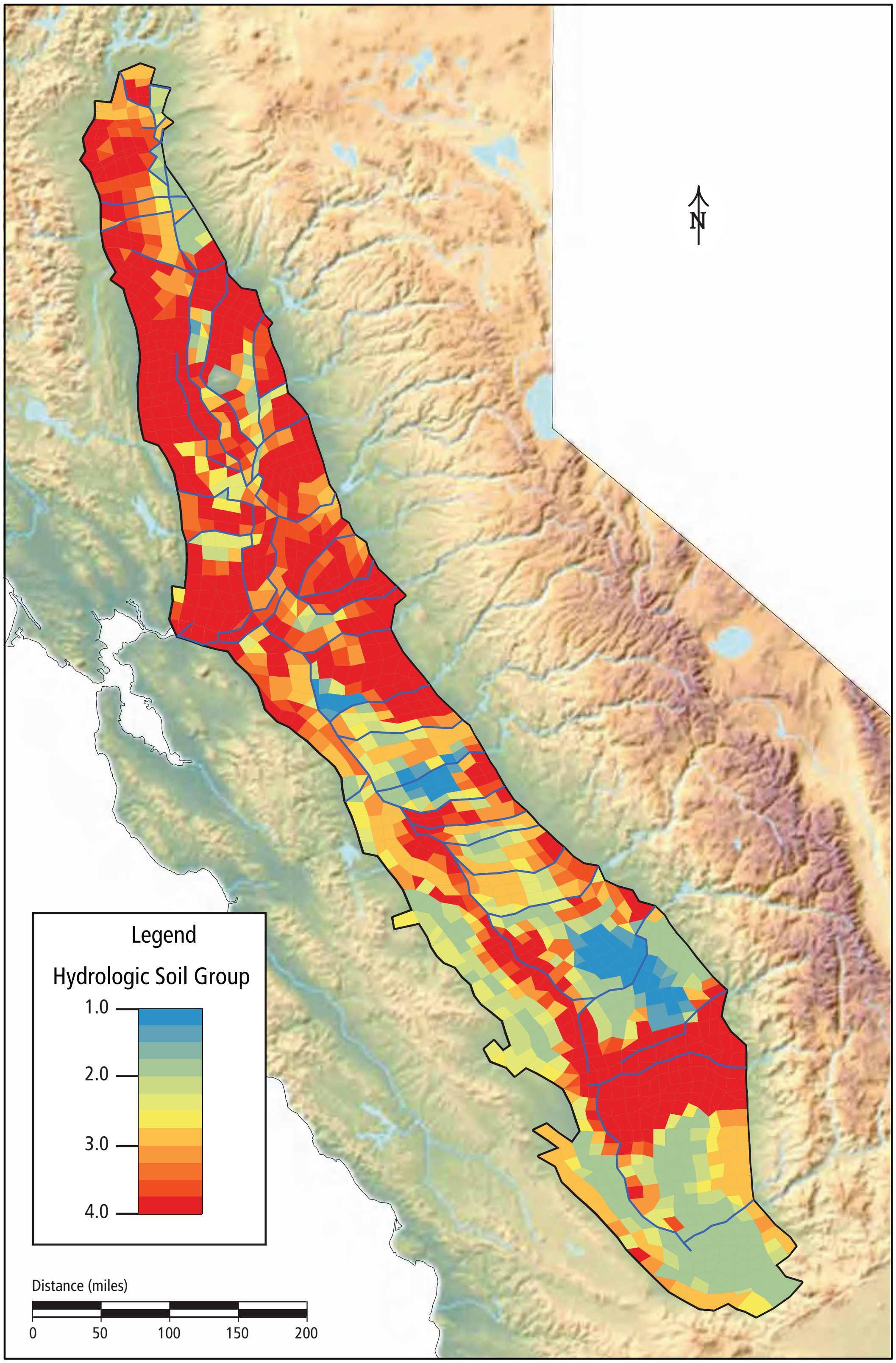


Figure 34A. C2Vsim horizontal hydraulic conductivity, model layer 1.

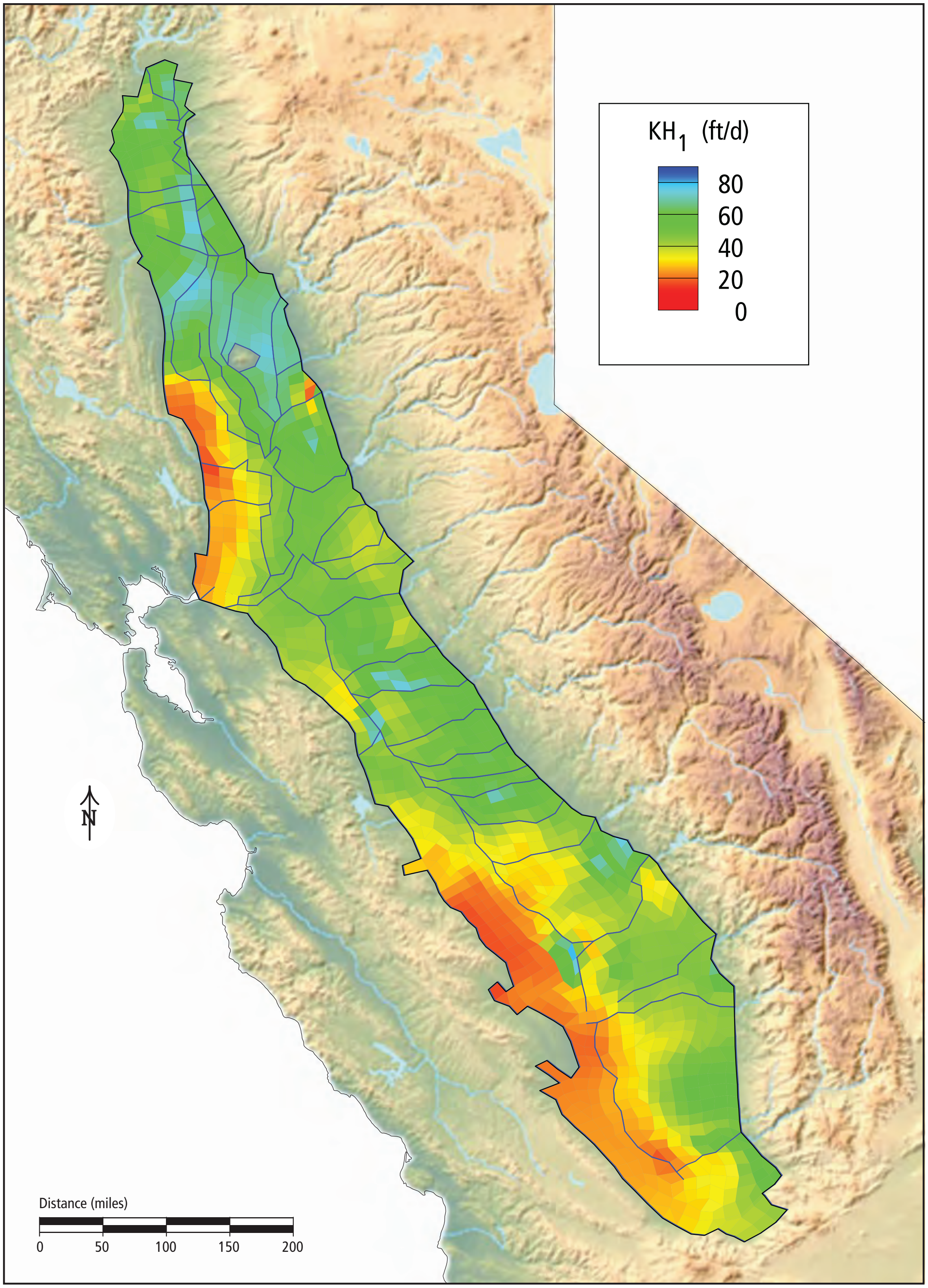


Figure 34B. C2VSim horizontal hydraulic conductivity, model layer 2.

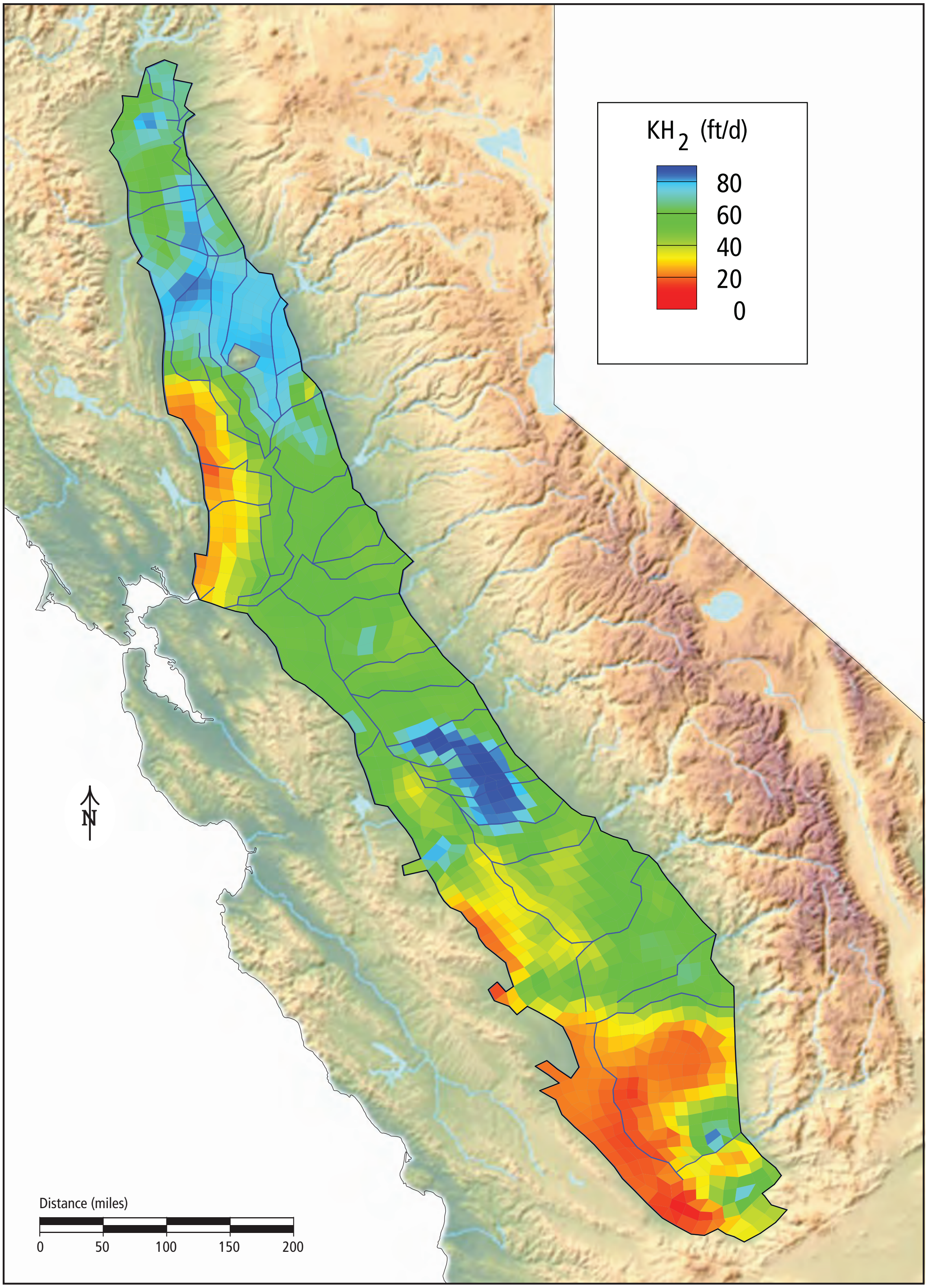


Figure 34C. C2VSim horizontal hydraulic conductivity, model layer 3.

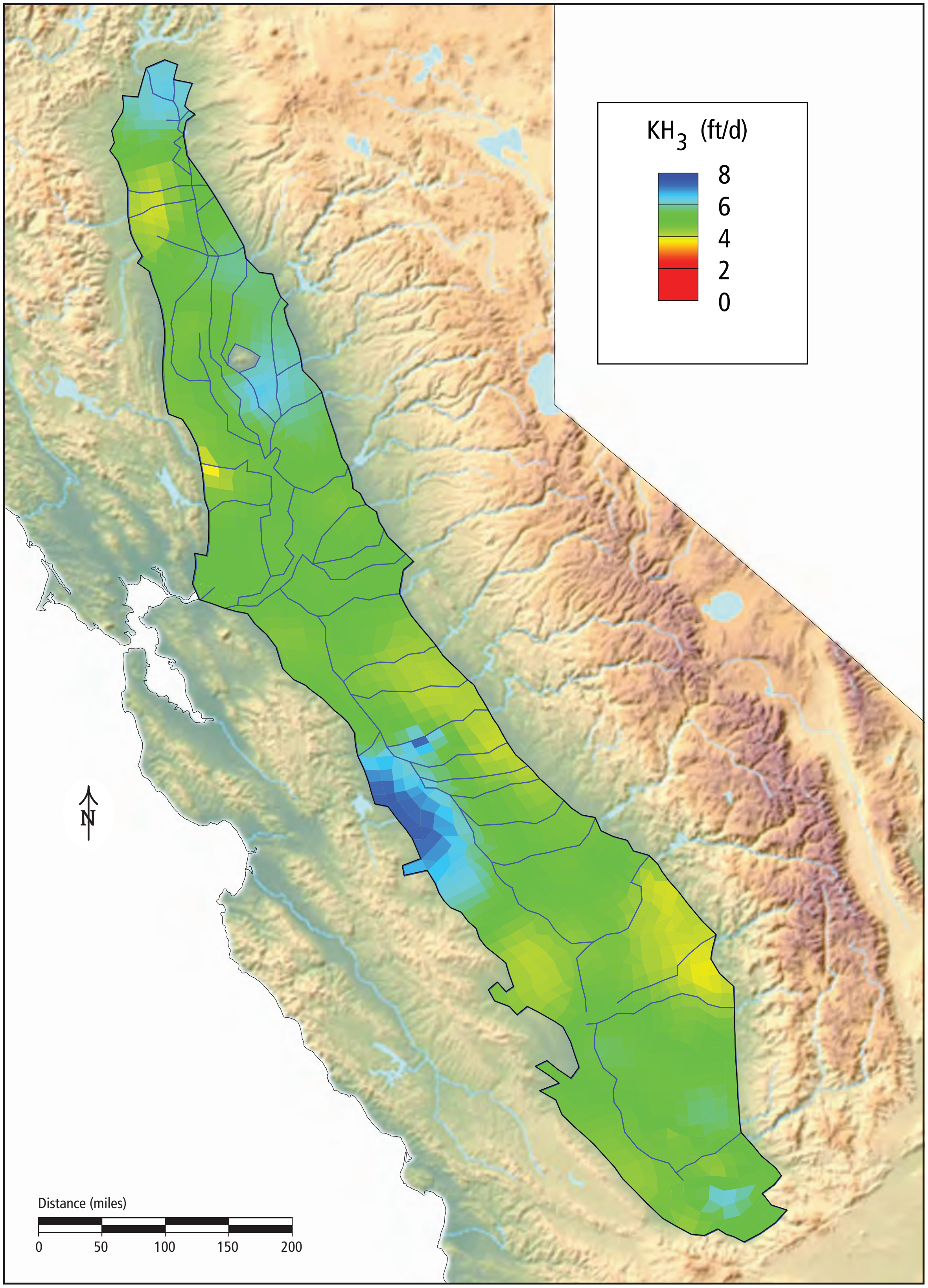


Figure 35A. C2VSim vertical hydraulic conductivity, model layer 1.

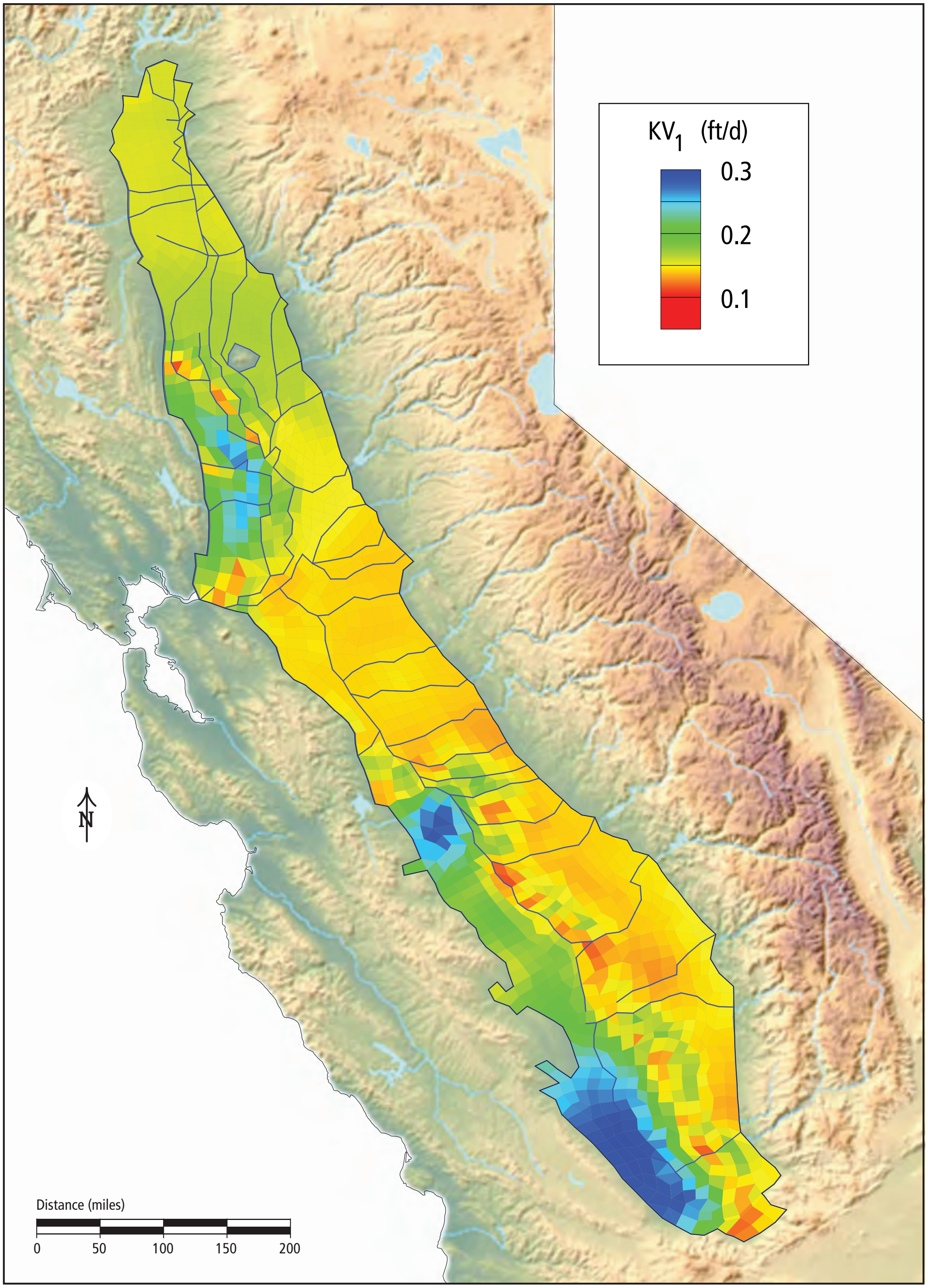


Figure 35B. C2VSim vertical hydraulic conductivity, model layer 2.

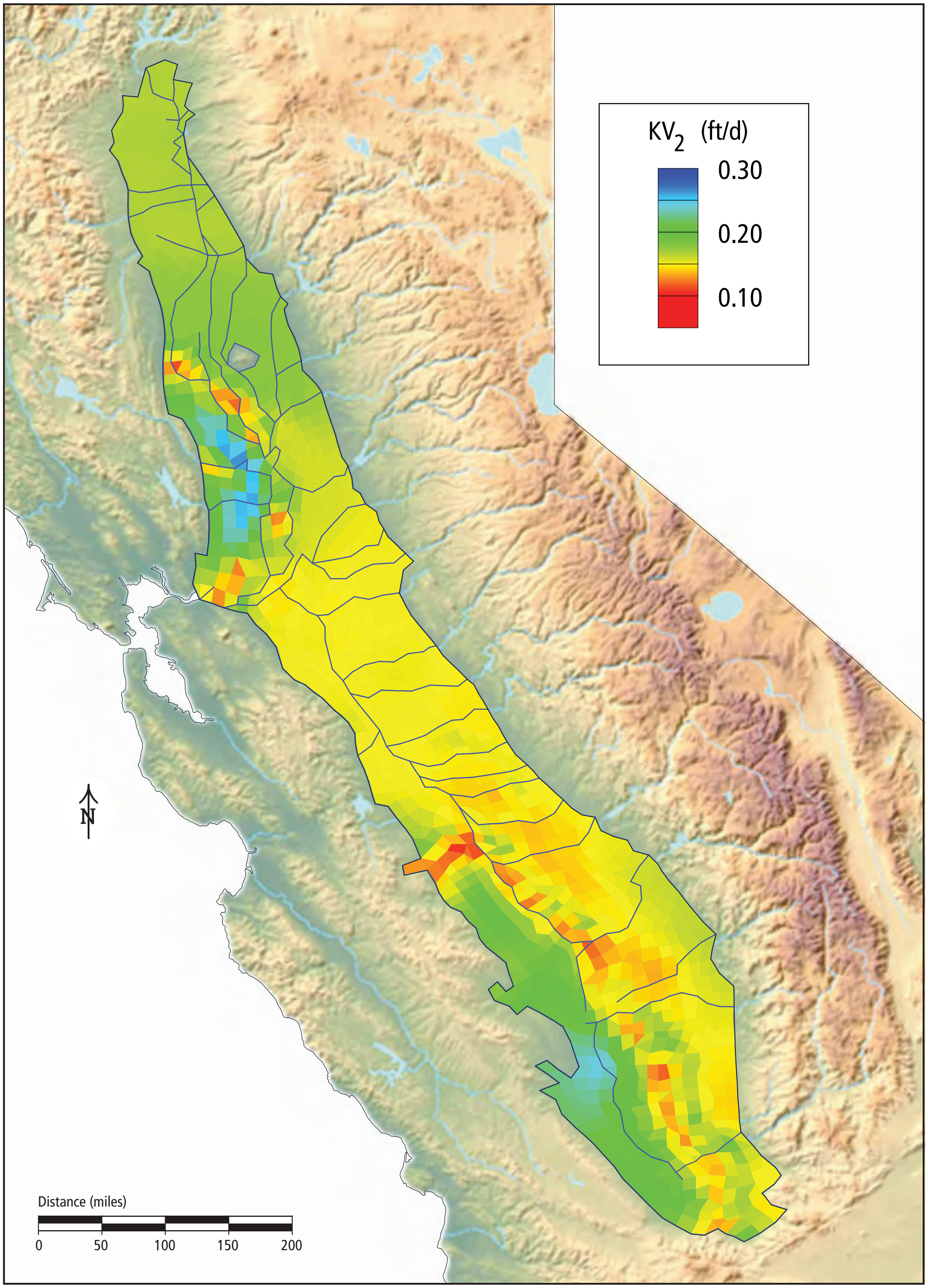


Figure 35C. C2VSim vertical hydraulic conductivity, model layer 3.

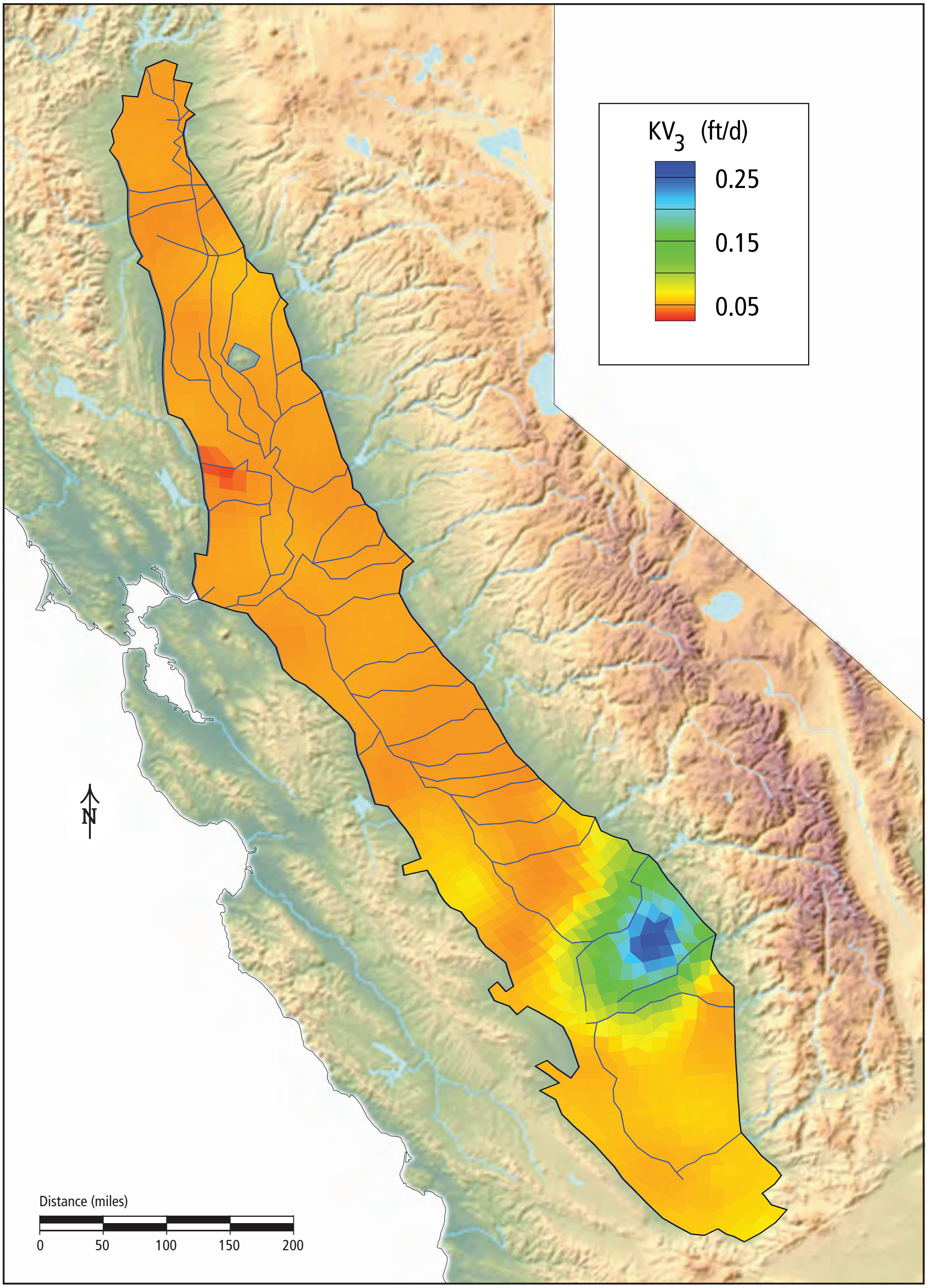


Figure 36. C2VSim vertical hydraulic conductivity, Corcoran Clay.

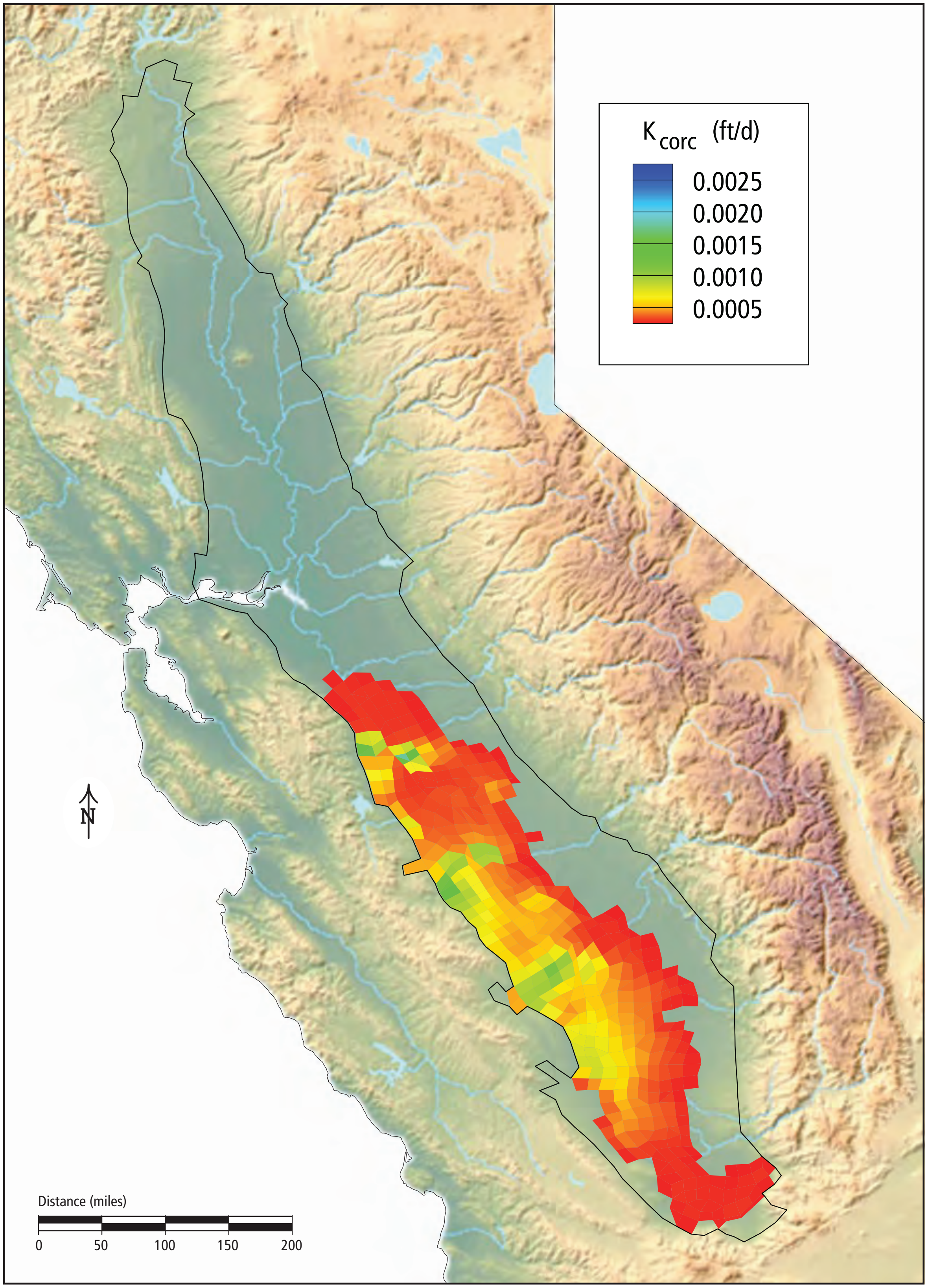


Figure 37A. C2VSim specific yield, model layer 1.

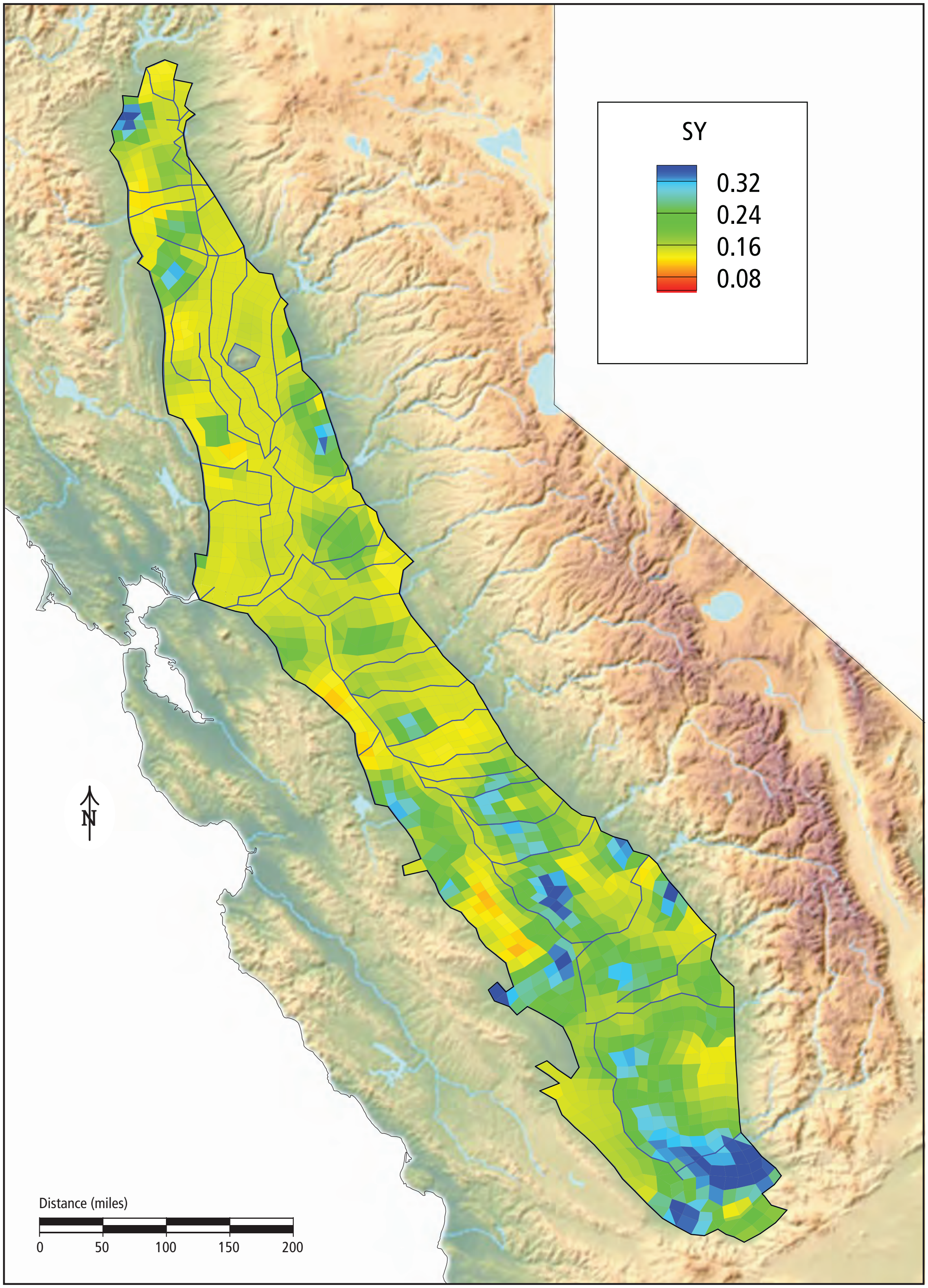


Figure 37B. C2VSim specific storage, model layer 2.

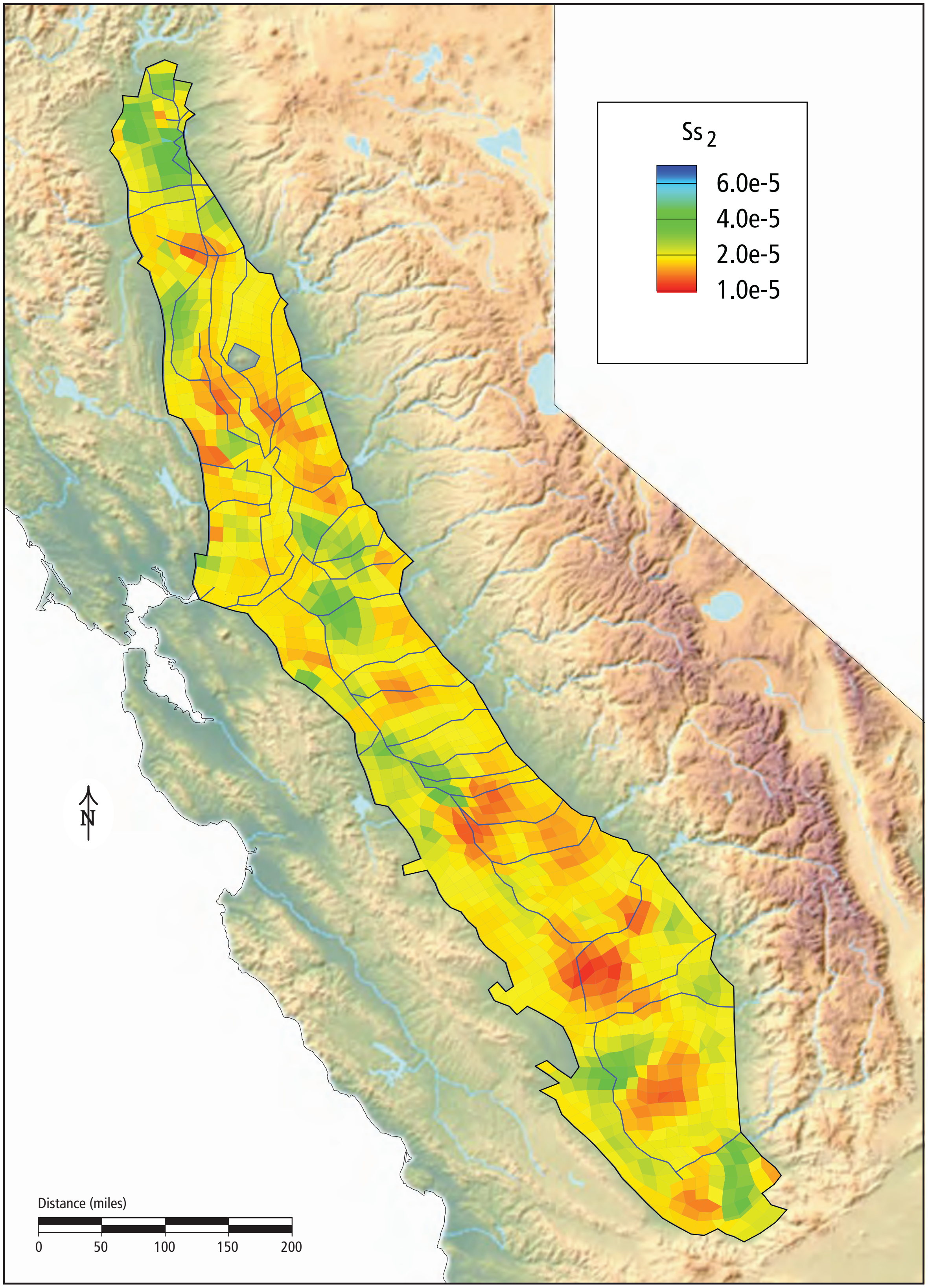
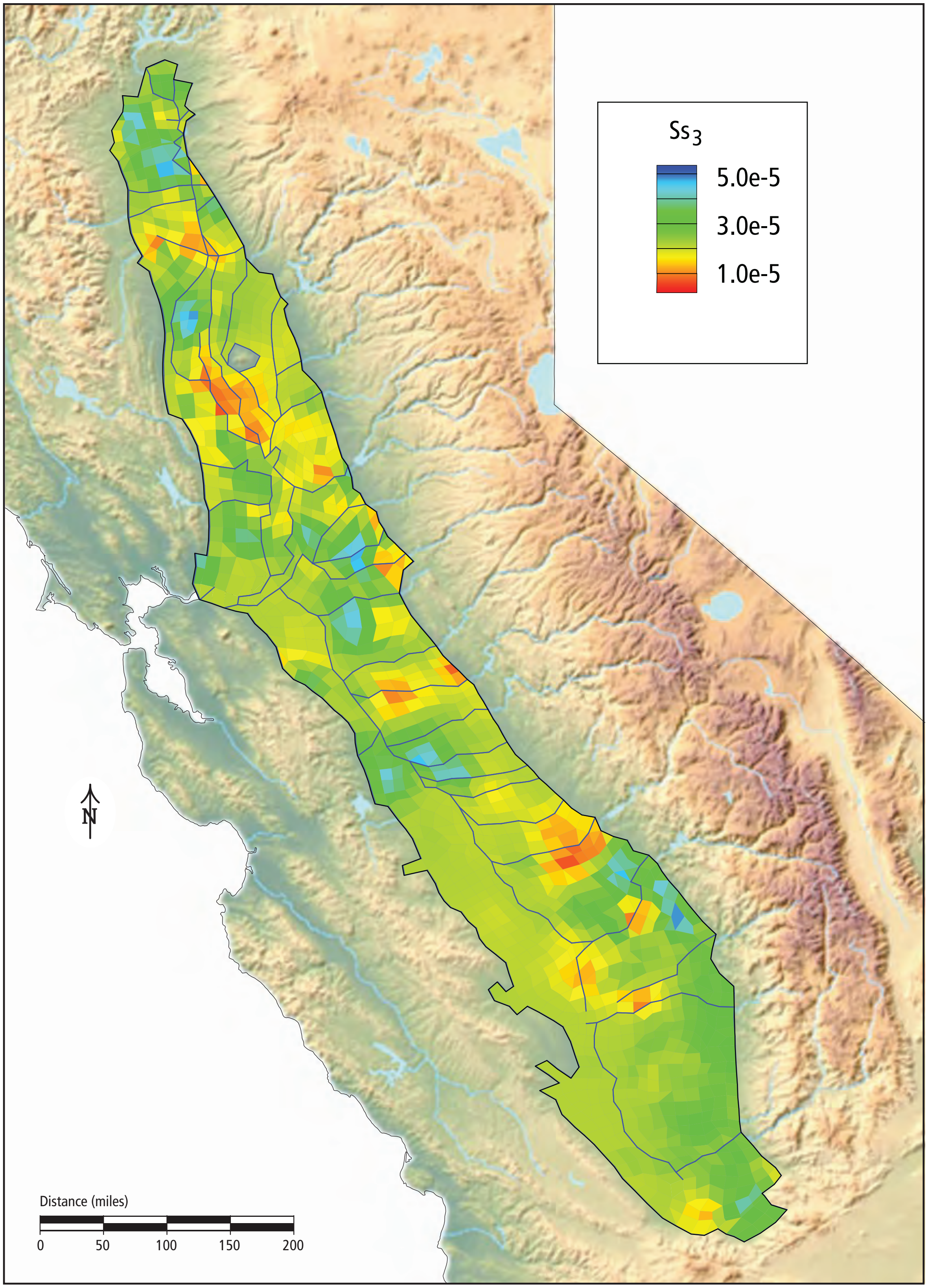


Figure 37C. C2VSim specific storage, model layer 3.



8 Protest Dismissal Agreement

Protest Dismissal Agreement

This Protest Dismissal Agreement (Agreement) is entered into of the last date next to the signatures below, by and between the Central Delta Water Agency (CDWA), County of San Joaquin (County[1]), East Bay Municipal Utility District (EBMUD), North San Joaquin Water Conservation District (NSJWCD), South Delta Water Agency (SDWA), and Stockton East Water District (SEWD), individually referred to as "Party" and collectively referred to hereafter as "Parties."

Recitals

A. County Recitals

- WHEREAS, on February 9, 1990, County applied to the State Water Resources Control Board (State Water Board) to appropriate water from the American River pursuant to Application No. 29657 (County Application 29657);

- WHEREAS, on October 4, 1990, County applied to the State Water Board to appropriate water from the Mokelumne River pursuant to Application No. 29835 (County Application 29835);

- WHEREAS, on November 26, 1996, EBMUD filed with the State Water Board a protest of County Application 29835;

- WHEREAS, EBMUD is a member-agency of the Freeport Regional Water Authority (FRWA) and on March 27, 2008, the FRWA filed with the State Water Board a protest of County Application 29657;

- WHEREAS, on June 27, 2014, County filed an amended appropriation application No 29657 and an amended appropriation application No. 29835 with the State Water Board and anticipates that additional amendments are likely to be made in the future; and

- WHEREAS, County timely protested EBMUD's time extension petition on its Permit 10478, timely protested EBMUD's clarifying petition on Permit 10478, timely protested EBMUD's change petition on Permit 10478, and timely submitted comments to the Draft EIR for the Permit 10478 Time Extension Project.

[1] The reference to "County" includes the County of San Joaquin, San Joaquin County Flood Control and Water Conservation District, and Mokelumne River Water and Power Authority.

B. EBMUD Recitals

- WHEREAS, on November 27, 2000, EBMUD filed with the State Water Board a petition for an extension of time on its Permit 10478 seeking an extension to the year 2040;

- WHEREAS, CDWA/SDWA, County, NSJWCD and SEWD each filed with the State Water Board a protest of EBMUD's time extension petition on its Permit 10478;

- WHEREAS, on March 5, 2012, EBMUD filed with the State Water Board a clarifying petition on its Permit 10478 seeking to add a term to the permit;

- WHEREAS, County, NSJWCD and SEWD each filed with the State Water Board a protest of EBMUD's clarifying petition on Permit 10478;

- WHEREAS, on December 27, 2012, EBMUD filed with the State Water Board change petitions on Permit 10478, Permit 10479, License 1388, License 6062, and License 11109;

- WHEREAS, County, NSJWCD and SEWD each filed with the State Water Board a protest of EBMUD's changes petitions on Permit 10478; and

- WHEREAS, in November 2008, EBMUD issued a Notice of Preparation under the California Environmental Quality Act ("CEQA") for the EBMUD Camanche Permit Extension Environmental Impact Report (EIR). On September 30, 2013, EBMUD published the Permit 10478 Time Extension Project Draft EIR for public review. County, NSJWCD and SEWD each submitted timely comments to the Draft EIR and CDWA/SDWA joined the comments of County. On September 12, 2014, EBMUD issued a Notice of Availability of the FEIR for the Permit 10478 Time Extension Project, and on September 23, 2014, EBMUD certified the Final EIR and approved the Permit 10478 Time Extension Project. On September 24, 2014, EBMUD filed a Notice of Determination pursuant to the Public Resources Code. On October 22, 2014, the Parties entered into a Tolling Agreement to toll all applicable statutes of limitations for the commencement of litigation based on the alleged failure to comply with CEQA.

C. NSJWCD Recitals

- WHEREAS, on June 1, 2007, NSJWCD filed with the State Water Board a petition for change for Permit 10477 to add new points of diversion, expand place of use, and add underground storage supplement;

- WHEREAS, on March 18, 2009, NSJWCD filed with the State Water Board a petition for an extension of time for Permit 10477 seeking an extension to the year 2025;

- WHEREAS, on June 19, 2009, EBMUD filed with the State Water Board protests of NSJWCD's time extension petition and change petition for Permit 10477;

- WHEREAS, on March 19, 2010, NSJWCD filed with the State Water Board a request to amend the petition for change to request that the proposed place of use be reduced to only NSJWCD's current boundaries;

- WHEREAS, on June 8, 2010, NSJWCD filed with the State Water Board a request to amend the petition for change to remove the proposed new point of diversion at Woodbridge Irrigation District dam;

- WHEREAS, on January 31, 2013, NSJWCD filed with the State Water Board a request to amend the petition for change to return the proposed new point of diversion at Woodbridge Irrigation District dam and add the Tracy Lakes Groundwater Recharge Project point of diversion;

- WHEREAS, on January 3, 2014, NSJWCD filed with the State Water Board a request to amend the petition for an extension of time for Permit 10477 to seek an extension to the year 2040;

- WHEREAS, on February 3, 2014, NSJWCD published pursuant to CEQA a Notice of Intent to Adopt Mitigated Negative Declaration for the Water Rights Change Petitions and Tracy Lake Groundwater Recharge Project (Tracy Lake Project). EBMUD submitted timely comments to the draft Mitigated Negative Declaration. On March 10, 2014, NSJWCD approved the Mitigated Negative Declaration and the Tracy Lake Project. On March 11, 2014, NSJWCD filed a Notice of Determination pursuant to the Public Resources Code; and

- WHEREAS, NSJWCD timely protested EBMUD's time extension petition on its Permit 10478, timely filed with the State Water Board a protest of EBMUD's clarifying petition on Permit 10478, and timely comments to the Draft EIR and timely comments on the FEIR for the Permit 10478 Time Extension Project.

D. <u>CDWA, SDWA and SEWD Recitals</u>

- WHEREAS, SEWD and CDWA/SDWA filed with the State Water Board a protest of EBMUD's time extension petition on its Permit 10478;

- WHEREAS, SEWD filed with the State Water Board a protest of EBMUD's clarifying petition and change petition on Permit 10478; and
- WHEREAS, SEWD submitted timely comments to the Draft EIR and timely comments on the FEIR for the Permit 10478 Time Extension Project, and CDWA and SDWA joined in the County's comments on the Draft EIR.

E. <u>Resolution of Issues</u>

WHEREAS, the Parties wish to resolve issues between them regarding the above-referenced petitions and applications and protests concerning the petitions and applications.

F. <u>Environmental Review</u>

WHEREAS, the obligations of the Parties under this Agreement are conditioned upon compliance with the California Environmental Quality Act (CEQA), Public Resources Code sections 21000, et seq. In no event shall any Party be required to undertake any activity under this Agreement that will result in a physical change to the environment before completion of the applicable level of CEQA review.

AGREEMENT

NOW, THEREFORE, the parties agree to dismiss their respective protests, as set forth below, on the terms and conditions set forth herein, which terms and conditions represent good and valuable consideration for this Agreement:

1. Dry Year Water for NSJWCD:

a. **Dry Year Water**: Beginning in 2015 and continuing for the term of Permit 10478, EBMUD shall release from Camanche Dam and Reservoir the following quantities of water (Dry Year Water) to NSJWCD in each year that the conditions in section 1(b) are satisfied:

i. Up to 6,000 acre feet (AF) when EBMUD's Projected End-of-September (EOS) Total System Storage (TSS) is greater than 550 TAF (after 6 TAF releases assumed for NSJWCD).

ii. Up to 3,000 AF when EBMUD's Projected End-of-September (EOS) Total System Storage (TSS) is greater than 525 TAF but less than 550 TAF (after 3 TAF releases assumed for NSJWCD).

b. Conditions for Dry Year Water:

i. Water is not otherwise available to NSJWCD under Permit 10477 and the October 11, 1963 Agreement between NSJWCD and EBMUD.

ii. Water quality conditions in Camanche Reservoir are stable (28 TAF hypolimnion through October).

iii. Release of the Dry Year Supply will not cause a "dry" or "critically dry" year pursuant to Attachment 1 of the 1998 Joint Settlement Agreement.

iv. NSJWCD has submitted a request to EBMUD for the Dry Year Water on or before May 1st.

v. NSJWCD must use the Dry Year Supply for purposes of direct or in-lieu recharge in the Eastern San Joaquin groundwater basin.

vi. EBMUD shall not be obligated to release more than 6,000 AF total Dry Year Water from Camanche Reservoir to NSJWCD in any one Drought Sequence. A Drought Sequence is defined as beginning whenever November 5th carry-over storage levels in Pardee and Camanche Reservoirs are projected to be less than maximum allowable levels under terms of the U.S. Army Corps of Engineers flood control manual, and ending when carry-over levels recover to maximum allowable storage levels. Any water that EBMUD releases for the City of Lodi between November 6th and March 30th, pursuant to Section 4 of this Agreement, which is not water available under the Permit 10477 direct diversion right, shall count against this 6,000 AF limitation.

vii. In return for releasing the Dry Year Water described in this section, EBMUD will receive a credit to extract banked groundwater, the credit to be at 50% of the quantity of Dry Year Water actually applied either through direct or in-lieu recharge in the NSJWCD service area, and subject to the terms of the San Joaquin County export permit. (E.g., For each 1,000 AF of Dry Year Water as provided for herein actually applied in the NSJWCD service area, EBMUD receives a 500 AF banked groundwater extraction credit enabling EBMUD to withdraw and export the credited water in the future, subject to the terms of the San Joaquin County export permit.)

viii. County has issued an export permit to facilitate EBMUD's withdrawal and export of the groundwater credit noted above. If a County export permit for this purpose has not issued on or before December 31, 2030, or the extraction and export by EBMUD of its banked credits is prevented by law, EBMUD's obligation to release the Dry Year Water under this section shall terminate. Groundwater credits obtained by EBMUD at the time of termination shall survive such termination, and EBMUD shall have the right to transfer, assign or otherwise use such groundwater credits consistent with applicable law and regulations. Absent a detailed banking agreement or an export permit specifying loss terms, surviving groundwater credits shall depreciate at a rate of five (5) percent loss per annum.

ix. NSJWCD will be responsible for potential carriage losses of Dry Year Water between its release from Camanche Dam and its diversion downstream at the NSJWCD diversion facilities. The Parties agree to quantify said carriage losses at 10% of the quantity of NSJWCD Dry Year water that EBMUD releases from Camanche Dam to the lower Mokelumne River.

As part of the coordinated operations agreement described in Section 4.a.iii of this Agreement, NSJWCD and EBMUD agree to develop provisions regarding the scheduling of Dry Year Water and Wet Year Water under this Agreement.

c. **State Water Board Petition**: EBMUD will file the necessary State Water Board petitions to implement the provisions of this section and will prepare any necessary CEQA documentation on the petitions. NSJWCD will cooperatively assist EBMUD in the preparation of the CEQA documentation, and the Parties will support the petitions and CEQA documentation.

2. **Wet Year Water:** EBMUD shall release from Camanche Dam and Reservoir up to 8,000 acre feet (AF) of Permit 10478 water (Wet Year Water) to NSJWCD provided the following conditions are met:

a. **Conditions:**

i. The SWRCB approves the necessary changes to Permit 10478.

ii. NSJWCD has 20,000 AF of water available under Permit 10477 and the October 11, 1963 Agreement between NSJWCD and EBMUD in the year that the Wet Year Water is requested from EBMUD.

iii. EBMUD determines that the water is surplus to the obligations and demands of Permit 10478 and Permit 10477.

iv. NSJWCD takes delivery of the Wet Year Water on or before November 5th of that year.

v. NSJWCD requests delivery of the water for purposes of direct or in-lieu recharge in the Eastern San Joaquin groundwater basin.

vi. In return for releasing the Wet Year Water described in this section, EBMUD will receive a credit to extract banked groundwater, the credit to be at 50% of the quantity of Wet Year Water actually applied either through direct or in-lieu recharge in the NSJWCD service area, and subject to the terms of the San Joaquin County export permit. (E.g., For each 1,000 AF of Wet Year Water as provided for herein actually applied in the NSJWCD service area, EBMUD receives a 500 AF banked groundwater extraction credit enabling EBMUD to withdraw and export the credited water in the future, subject to the terms of the San Joaquin County export permit.)

vii. County has issued an export permit to facilitate EBMUD's withdrawal and export of the groundwater credit noted above, and the withdrawal and export by EBMUD of its banked credits is not prevented by law.

b. **Relationship to Permit 10477**: The Wet Year Water provided to NSJWCD by EBMUD under this section is over and above NSJWCD's right to divert up to 20,000 AF pursuant to the terms of its Permit 10477.

c. **Term:** The length of EBMUD's obligation to release Wet Year Water under this section will correspond to the length of the permit term for Permit 10478.

d. **SEWD Use of Wet Year Water**: Wet Year Water available to NSJWCD under this section, but not requested by NSJWCD, may be requested by SEWD subject to the Section 2.a conditions set forth above including the same banking credit provisions applicable to NSJWCD.

e. **Transport of Wet Year Water to SEWD:** Wet Year Water to SEWD under Section 2.d above may be conveyed through the Mokelumne Aqueducts when unused capacity in the Aqueducts is available as determined by EBMUD, subject to execution of a wheeling agreement with EBMUD consistent with Water Code section 1810 et seq. which agreement will include the payment of fair compensation (fair compensation means the reasonable charges incurred by EBMUD, including capital, operation, maintenance, and replacement costs, and increased costs from any necessitated purchase of supplemental power) to EBMUD for the use of the unused capacity. Diversion facilities necessary for SEWD to use this water do not currently exist and will be the responsibility of SEWD to construct. EBMUD agrees to work cooperatively with SEWD in SEWD's planning and development of said diversion facilities.

f. **State Water Board Petition**: EBMUD will file the necessary State Water Board petitions to implement the provisions of this section and will prepare any necessary CEQA documentation on the petitions. NSJWCD and SEWD will cooperatively assist EBMUD in the preparation of the CEQA documentation, and the Parties will support the petitions and CEQA documentation.

3. Extraction of Banked Water by EBMUD

a. **Export Permit:** The provision of Wet Year and Dry Year water, discussed in Sections 1 and 2 of this Agreement, include establishment of credits for EBMUD to extract banked groundwater. EBMUD agrees that any extraction of banked groundwater by EBMUD pursuant to this Agreement, for export outside of the County, is subject to an export permit under County's groundwater export ordinance, San Joaquin County Ordinance Code, Section 5-8100 et seq.[2] The Parties will work cooperatively and in good faith to facilitate an export permit application to County by EBMUD and to support the issuance of the groundwater export permit to EBMUD, subject to all applicable laws including CEQA.

b. **Extraction Facilities**: Extraction facilities include wells and associated controls and power facilities to withdraw banked water from the Eastern San Joaquin groundwater basin.

   i. **Use of Existing Facilities:** To the extent feasible, existing extraction facilities owned by NSJWCD, SEWD or landowners within those agencies will be utilized for the extraction of banked water by EBMUD for export pursuant to this Agreement and subject to separate agreements with the owners of those facilities. Any agreement between EBMUD and an individual landowner for use of landowner facilities for extraction is subject to the approval of the applicable local agency – NSJWCD or SEWD. EBMUD may utilize unused capacity in NSJWCD or SEWD facilities to extract and convey banked water when such capacity is available as

[2] The fact that EBMUD has agreed to apply for an export permit for purposes of this Agreement shall not be deemed an admission by SEWD regarding the applicability of San Joaquin County Ordinance Code, Section 5-8100 et seq. to any other groundwater banking program not specifically discussed in this Agreement.

determined by the local agency owning those facilities, subject to a facilities use agreement which will include the payment of fair compensation (fair compensation means the reasonable charges incurred by the facilities owner, including capital, operation, maintenance, and replacement costs, and increased costs from any necessitated purchase of supplemental power) to the owner of those facilities for the use of the unused capacity.

ii. **New Facilities:** Unless otherwise provided for in an extraction facilities use agreement, EBMUD will be responsible for the cost of installing new groundwater extraction facilities that it believes are necessary to withdraw banked water, to which it has a credit, from the groundwater basin, and to convey the banked groundwater to places of use outside of San Joaquin County. Any new extraction facilities installed for this purpose will be owned and operated by County or the local agency (SEWD or NSJWCD) where the extraction facilities are located. County, EBMUD, and the local agency where the extraction facilities are located shall enter into an extraction facilities use agreement that provides EBMUD shall have the first right to use the extraction facilities. County and/or the local agency may utilize unused capacity in the extraction facilities when such capacity is available, as determined by EBMUD, subject to payment to EBMUD of a proportionate share of the reasonable costs incurred by EBMUD for installation of the facilities. Any party that utilizes the new extraction facilities shall pay the operating entity a proportional share of the costs incurred for operation, maintenance, and replacement costs, and increased costs from any necessitated purchase of supplemental power for the use of the facilities.

c. **Rules for Extraction:** Subject to the terms and operating conditions contained in the San Joaquin County export permit, EBMUD may withdraw the banked water at its discretion in the future and may deliver that water to other parties at its discretion. EBMUD may also allow others to extract its banked water at its discretion for use within San Joaquin County to facilitate water exchanges or other transactions.

d. **Water Code Section 1220:** The Parties agree to work cooperatively to take actions to comply with Water Code Section 1220.

4. EBMUD and NSJWCD Coordinated Operations

a. **NSJWCD Water Sale to City of Lodi** NSJWCD holds Permit 10477 under which NSJWCD may directly divert, and divert to storage, water from the Mokelumne River from December 1 of each year to July 1 of the succeeding year. NSJWCD and EBMUD have entered into agreements under which EBMUD stores Permit 10477 water in its Camanche Reservoir in those years when water is available to NSJWCD under Permit 10477, and subsequently releases that stored water for NSJWCD through November 5th of that same year. NSJWCD has entered into an agreement with the City of Lodi (City) to sell up to 1,000 AF of water available under Permit 10477 from NSJWCD to the City during the period from October 15 of one year to March 30 of the succeeding year. To the extent the City requests NSJWCD to deliver this water after November 5th, and the requested deliveries are not available pursuant NSJWCD's Permit 10477 direct diversion right, EBMUD agrees as follows:

i. In years when water is available to NSJWCD under its Permit 10477 and the terms of the written Agreement between EBMUD and NSJWCD dated October 11, 1963 and Supplementary Agreement dated May 27, 1969, which agreements specify when EBMUD stores and releases Permit 10477 water to NSJWCD, EBMUD agrees to carryover up to 1000 AF of that water after November 5th and to release that water after November 5th of that year and before March 30th of the succeeding year for use by NSJWCD to sell to the City pursuant to their agreement.

ii. EBMUD agrees to release up to 1,000 AF of said stored water in response to requests by NSJWCD. Any such releases shall reduce the amount of Dry Year Water described in Section 1 of this Agreement by a like amount.

iii. NSJWCD agrees to coordinate the release of water to the City under this Section with the Woodbridge Irrigation District and EBMUD and enter into a coordinated operations agreement for this purpose upon the request of EBMUD. The coordinated operations agreement will specify a reasonable rate and schedule for the November 5 – March 30 releases that are agreeable to the City, NSJWCD, EBMUD and WID.

b. **Tracy Lake Groundwater Recharge Project:** NSJWCD and EBMUD agree to execute the Coordinated Operations Agreement for the Tracy Lake Groundwater Recharge Project, attached hereto as Exhibit A.

5. Funding for Groundwater Banking Demonstration Project

a. **Demonstration Project:** County and EBMUD are investigating the feasibility of a Groundwater Banking Demonstration Project to demonstrate that EBMUD water can be conveyed from the Mokelumne River, into San Joaquin County for recharge, and then later extracted and exported out of the County.

b. **Location:** The Parties agree the Demonstration Project shall be located within NSJWCD and shall utilize portions of the NSJWCD South System.

c. **Export Permit:** EBMUD and County must obtain an export permit from San Joaquin County for the Demonstration Project.

d. **Funding:** Provided the County issues the export permit and the withdrawal and export by EBMUD of its banked credits is not prevented by law, EBMUD shall pay a total of $4.0 million to County for the costs associated with the Demonstration Project in accordance with the subsection e. schedule below. $1.75 million of this sum must be used to improve the NSJWCD South System.

e. **Timing**: If County does not issue the Demonstration Project export permit by June 30, 2016, then EBMUD shall not be obligated to pay County any of the $4.0 million for the Demonstration Project unless County, EBMUD and NSJWCD agree to a modification of this term. Absent an agreed upon modification on or before June 30, 2016 , EBMUD shall pay NSJWCD $1.75 million on or before July 15, 2016, which funds will be used by NSJWCD to improve the NSJWCD South System.

f. **Cost control:** County and EBMUD will endeavor to design the Demonstration Project in a manner to control its costs. As the Demonstration Project design and planning proceed, if Project costs appear that they may exceed the $4.0 million figure referred to above, County and EBMUD will meet and confer on means to control Project costs and otherwise seek alternative funding sources, such as grants, for the Project.

6. San Joaquin County Application 29835

a. **Temporary Storage**: County's appropriation Application 29835 seeks to appropriate water from the Mokelumne River. County acknowledges that the Mokelumne River is highly variable and that flows will be diminished from year to year as more water is diverted by EBMUD into its Aqueducts and by other senior diverters on the river. Based on this understanding, and upon issuance by the State Water Board of a water right permit under County Application 29835 and subject to an operating agreement to be jointly developed by EBMUD and County as provided below, County may request EBMUD to, and EBMUD shall, collect and temporarily store for County in Camanche Reservoir or Pardee Reservoir, or in both said reservoirs, Mokelumne River water not to exceed 48,000 AF annually which County would be entitled to divert and store under the aforementioned permit during each storage season from December 1st to the following June 30th. The amount of storage available for County in Pardee and Camanche Reservoirs shall be determined solely by EBMUD as surplus to its water needs and releases for senior water rights and required fishery flows, including those releases required by the 1998 Joint Settlement Agreement. When EBMUD determines that such surplus storage is available for the County, EBMUD will release that stored water for the County during the period of July 1st to October 31st of the same year for rediversion by County.

Stored water available for rediversion by County is limited to the stored water that is in excess of EBMUD needs and that has to be released by November 5th to meet U.S. Army Corps of Engineers flood control requirements. Nothing in this Agreement shall obligate EBMUD to store water for County beyond November 5th. County understands that the amount of the excess storage capacity varies from year to year and may not exist in Pardee and Camanche Reservoirs during July 1 through October 31 in some years and that, hence, in some years stored water will not be available for release by EBMUD and rediversion by County. This provision does not impact County's ability to directly divert Mokelumne River water in the period of December 1st to the following June 30th pursuant any permit issued under County Application 29385.

b. **County Use of Mokelumne Aqueducts**: Water appropriated under a water right permit issued pursuant to County Application 29835 may be conveyed through the Mokelumne Aqueducts when unused capacity in the Aqueducts is available as determined by EBMUD, subject to execution of a wheeling agreement with EBMUD consistent with Water Code section 1810 et seq. which agreement will include the payment of fair compensation (fair compensation means the reasonable charges incurred by EBMUD, including capital, operation, maintenance, and replacement costs, and increased costs from any necessitated purchase of supplemental power) to EBMUD for the use of the unused capacity. Facilities to divert water from the Mokelumne Aqueduct will need to be developed. EBMUD and County will enter into an agreement for developing said facilities and allocating the costs of their development proportionate to the respective benefit received by each party, if any.

c. **Operating Agreement for County Use of EBMUD Facilities**: County and EBMUD will develop an operating agreement for County's diversion, storage, and conveyance of County permit water at Pardee and Camanche Reservoirs and through the Mokelumne Aqueducts. The operating agreement will include terms protective of EBMUD's Mokelumne Project operations, including water rights, water supply, release requirements for the fishery, senior water rights, flood control and hydropower, to protect its customers' interests, and payment by County to compensate EBMUD for use of its reservoirs pursuant to Section 6.d. The term of the operating agreement will coincide with the length of Permit 10478 and the water right permit issued to County by the State Water Board under Application 29835.

d. **Compensation Paid to EBMUD for Use of Reservoirs**: County shall pay EBMUD two dollars ($2.00) for each AF of water released by EBMUD for County pursuant to the operating agreement. The first assessment of this charge shall occur in the first year that EBMUD releases water for the County pursuant to this Section. The $2.00 per AF charge will be adjusted annually thereafter based on the Consumer Price Index (CPI) for inflation.

e. **CEQA on County Application 29835**: County will need to prepare CEQA documentation on County Application 29835. County agrees to provide EBMUD with an administrative draft of that CEQA documentation prior to release of the draft CEQA document, and to provide EBMUD at least 60 days to review it. EBMUD agrees to provide County with written comments on the administrative draft CEQA documentation. County agrees to make good faith efforts to address the comments raised by EBMUD on the administrative draft CEQA documentation. Provided the above occurs, and so long as County includes in its CEQA document mitigation measures sufficient to reduce potentially significant environmental effects on EBMUD and the Mokelumne River fishery ecosystem to a level of insignificance, EBMUD agrees not to file a writ of mandate or other legal action to challenge County's CEQA documentation. In the event the parties disagree on resolution of CEQA issues, they agree to meet and confer.

f. **Seniority**: Any water rights permit or license issued under County Application 29835 shall be junior in priority to EBMUD's rights under Applications 4228, 13156, 4768, 5128, 15201, and 25056 and to NSJWCD's Application 12842.

g. **Permit Conditions**: County agrees to accept in any permit issued pursuant to Application 29835 a condition on fishery protections, including bypass flows, diversion rates, and fish screens for County's Lower Mokelumne River rediversions.

7. Dismissals

Within 7 business days of the last approval of this Agreement by the Parties, all Parties shall send notice to the State Water Board withdrawing and requesting the dismissal of their pending protests, listed in the Recitals to this Agreement. The Parties further agree to forego protesting applications and petitions listed in the Recitals, forego appearing in any SWRCB proceeding other than in support of the relevant application or petition, and forego filing CEQA writ petitions challenging the CEQA documentation for those petitions and applications listed in the Recitals.

Specifically:

CDWA/SDWA, County, NSJWCD and SEWD shall withdraw their protests against EBMUD's time extension petition, clarifying petition and change petition on Permit 10478 and will not bring a challenge against the CEQA documentation for said petitions. CDWA, County, NSJWCD, SDWA and SEWD also shall not protest any subsequent notice of EBMUD's time extension petition, clarifying petition or change petitions.

CDWA/SDWA, County, NSJWCD and SEWD agree not to file protests or otherwise challenge EBMUD's change petitions filed on December 27, 2012 on Permit 10479, License 1388, License 6062, and License 11109 or to challenge the CEQA documentation, if any, on said petitions.

EBMUD shall withdraw its protests against County Application 29835 and will not bring a challenge against the CEQA documentation for said application provided County meets its obligations under Section 6.d "CEQA on County Application 29835" above. EBMUD also shall not protest any subsequent notice of County's pending appropriation application 29835.

EBMUD, in its role as a member of FRWA, shall support the dismissal of FRWA's Protest against County Application 29657. EBMUD shall assist County by facilitating meetings between County and the Sacramento County Water Agency aimed at resolving issues between those agencies concerning the use of FRWA facilities.

EBMUD shall withdraw its protests against NSJWCD's time extension petition and change petitions on Permit 10477 and will not bring a challenge against the CEQA documentation for said petitions. EBMUD also shall not protest any subsequent notice of NSJWCD's pending time extension petition or change petitions.

8. Settlement

The purpose of this Agreement is to settle the active and on-going legal and factual disputes and water rights protests of the Parties. To the extent that this Agreement contemplates any action by a Party that is a Project within the meaning of the California Environmental Quality Act (CEQA), the Parties agree that that action is contingent on full compliance with CEQA and any other applicable law. Specifically, any project that may also comprise an element of this

Agreement shall not proceed unless and until the Party or Parties have completed the appropriate level of CEQA and public environmental review. Pending completion of any required CEQA process, individual projects remain subject to the exercise of discretion of the lead or responsible agency, including the discretion to approve or disapprove the project or alternatively to require the project to undertake mitigation measures or alternatives as may be set forth in the applicable environmental document. If CEQA compliance results in the identification of project changes, alternatives or mitigation measures that require material variation from the terms of this Agreement, the Parties agree to immediately meet and confer in good faith to facilitate any necessary amendments to this Agreement.

9. General Provisions

a. **Binding on Successors:** This Agreement, and all of the rights, duties and obligations contained in this Agreement, shall inure to the benefit of and be binding upon the Parties, and their successors and assigns.

b. **Amendment:** This Agreement, and any provisions herein, may not be changed, waived, discharged or terminated unless by a written instrument, signed as follows:

   i. Section 1: Amendments to Section 1 shall be signed by EBMUD and NSJWCD

   ii. Section 2: Amendments to Section 2 shall be signed by EBMUD, NSJWCD and SEWD.

   iii. Section 3: Amendments to Section 3 shall be signed by all the Parties to this Agreement.

   iv. Section 4: Amendments to Section 4 shall be signed by EBMUD and NSJWCD.

   v. Section 5: Amendments to Section 5 shall be signed by County, EBMUD, and NSJWCD.

   vi. Section 6: Amendments to Section 6 shall be signed by County and EBMUD.

   vii. Sections 7-9: Amendments to Sections 7-9 shall be signed by all the Parties to this Agreement.

c. **Effective Date:** The Effective Date shall be the date on which the last Party's Board of Directors has approved the Agreement.

d. **Authorizations:** The undersigned are authorized to execute this Agreement on behalf of their respective Parties and have read, understood and agreed to all of the terms and conditions of this Agreement.

e. **Counterparts:** The Agreement may be executed in one or more counterparts which, taken together, shall be deemed to constitute one and the same document.

f. **Law of California:** This Agreement shall be governed by the laws of the State of California.

g. **Entire Agreement:** This Agreement constitutes a full and final settlement of this matter. It is expressly understood and agreed that the Agreement has been freely and voluntarily entered into by the Parties with and upon advice of counsel.

h. **Waiver:** A Party's failure to exercise or delay in exercising any right, power, or privilege under this Agreement shall not operate as a waiver, nor shall it preclude or restrict any future exercise of that or any other right or remedy.

i. **Headings:** The section headings contained in this Agreement are for reference purposes only and shall not affect in any way the meaning or interpretation of this Agreement.

j. **Severability**: In the event that any of the provisions of this Agreement are held by a court to be unenforceable, the validity of the enforceable provisions shall not be adversely affected.

k. **Attorneys' Fees:** If any legal action or proceeding arising out of or related to this Agreement is brought by any party to this Agreement, the prevailing Party, in addition to any other relief that may be granted, shall be entitled to recover reasonable attorneys' fees, costs, and other expenses incurred in the action or proceeding by the prevailing Party.

l. **Notices**: All notices, requests, claims, demands and other communications between the parties shall be in writing, and shall be given by delivery in person or by first class, registered or certified mail, postage prepaid, to the address of the Party specified in this Agreement or such other address as either Party may specify in writing. The addresses of the parties are as follows:

COUNTY

COUNTY OF SAN JOAQUIN
Director of Public Works
Thomas M. Gau
1810 East Hazelton Avenue
Stockton, CA 95205
Phone: (209) 468-3000
Fax: (209) 468-2999
tgau@sjgov.org

With a copy to:

Neumiller & Beardslee
c/o Thomas J. Shephard, Sr., Esq.
P.O. Box 20
Stockton, CA 95201-3020
Phone: (209) 948-8200
Fax: (209) 948-4910
tshephard@neumiller.com

EBMUD

EAST BAY MUNICIPAL UTILITY DISTRICT
Alexander R. Coate, General Manager
375 11th Street
Oakland, CA 94607
Phone: (510) 287-0101
Fax: (510) 287-0188
acoate@ebmud.com

With a copy to:

Fred S. Etheridge, Esq.
East Bay Municipal Utility District
Office of General Counsel
375 11th Street
Oakland, CA 94607
Phone: (510) 287-0816
Fax: (510) 287-0162
fetherid@ebmud.com

NSJWCD

NORTH SAN JOAQUIN WATER CONSERVATION DISTRICT
President of the Board of Directors
Post Office Box E Victor, CA
95253

With a copy to:

Jennifer Spaletta, Esq.
Spaletta Law, PC
PO Box 2660
Lodi, California 95241
Phone: (209)224-5568
Fax: (209)224-5589
Jennifer@spalettalaw.com

SEWD

STOCKTON EAST WATER DISTRICT
Scot A. Moody, General Manger
P.O. Box 5157
Stockton, CA 95205-0157
Phone: (209) 948-0333
Fax: (209) 948-0423
smoody@sewd.net

With a copy to:
Karna E. Harrigfeld, Esq.
Herum\Crabtree\Suntag
5757 Pacific Avenue, Suite 222
Stockton, CA 95207
Phone: (209) 472-7700
Fax: (209) 472-7986
kharrigfeld@herumcrabtree.com

CDWA

CENTRAL DELTA WATER AGENCY
Dante J. Nomellini, Esq. 235 E
Weber Ave Stockton, CA
95202
Phone: (209)465-5883
Fax: (209) 465-3956
ngmplcs@pacbell.net

SDWA

SOUTH DELTA WATER AGENCY
John Herrick, Esq.
4255 Pacific Ave. Suite 2
Stockton, CA 95207
Phone: (209)956-0150
Fax: (209)956-0154
Jherrlaw@aol.com

m. **Arbitration:** All claims and disputes arising under or relating to this Agreement, other than claims for injunctive relief, are to be settled by binding arbitration pursuant to the commercial rules of the American Arbitration Association. An award of arbitration may be confirmed in a court of competent jurisdiction. Any claim for injunctive relief may be pursued in a court of law.

n. **Venue:** Venue for all claims and disputes arising under or relating to this Agreement shall be in Sacramento County. Any arbitration proceeding arising under this Agreement shall be in Sacramento County, and any civil action allowed under this Agreement shall be heard in the Sacramento Superior Court.

o. **Definitions and Acronyms**: Exhibit B hereto contains definitions and acronyms which are hereby incorporated into this Agreement.

CENTRAL DELTA WATER AGENCY

By: Rudy Mussi — Date: 11-25-14
Name: Rudy Mussi
Its: Trustee

Approved as to form:
By: ________ — Date: 11-25-14
Name: Dante John Nomellini

COUNTY OF SAN JOAQUIN

By: Robert V. Elliott (signature)
Name: Robert V. Elliott
Chairman of the Board of Supervisors

Date: 11/25/2014

ATTEST: Mimi Duzenski
Clerk of the Board of Supervisors of the County of San Joaquin, State of California

By: Mimi Duzenski (SEAL)
Deputy Clerk

SAN JOAQUIN COUNTY CALIFORNIA

Approved as to form:

By: (signature)
Name: David Wooten, County Counsel

Date: 11/25/14

Recommended for Approval:

Thomas M. Gau (signature)
Thomas M. Gau
Director of Public Works
San Joaquin County, a political subdivision of the State of California

EAST BAY MUNICIPAL UTILITY DISTRICT

By: ____________________
Name: ____________________
Its: ____________________

Date: ____________________

Approved as to form:

By: ____________________
Name: ____________________

Date: ____________________

COUNTY OF SAN JOAQUIN

By: ______________________________ Date: ______________________
Name: ____________________________
Chairman of the Board of Supervisors

ATTEST: ________________
Clerk of the Board of Supervisors of the County of San Joaquin, State of California

By: ____________________(SEAL)
Deputy Clerk

Approved as to form:

By: ______________________________ Date: ______________________
Name: David Wooten, County Counsel

Recommended for Approval:

____
Thomas M. Gau
Director of Public Works
San Joaquin County, a political subdivision of the State of California

EAST BAY MUNICIPAL UTILITY DISTRICT

By: [signature] Date: 11/25/14
Name: ALEXANDER R. COATE
Its: GENERAL MANAGER

Approved as to form:

By: [signature] Date: November 25, 2014
Name: Fred S. Etheridge

NORTH SAN JOAQUIN WATER CONSERVATION DISTRICT

By: [signature] Date: 11/24/14
Name: Joe Valente
Its: President

Approved as to form:

By: [signature] Date: 11/24/14
Name: Jennifer Spaletta

SOUTH DELTA WATER AGENCY

By: ______________________ Date: ______________
Name: ______________________
Its: ______________________

Approved as to form:

By: ______________________ Date: ______________
Name: ______________________

STOCKTON EAST WATER DISTRICT

By: ______________________ Date: ______________
Name: ______________________
Its: ______________________

Approved as to form:

By: ______________________ Date: ______________
Name: ______________________

NORTH SAN JOAQUIN WATER CONSERVATION DISTRICT

By: ______________________ Date: ______________________
Name: ______________________
Its: ______________________

Approved as to form:

By: ______________________ Date: ______________________
Name: ______________________

SOUTH DELTA WATER AGENCY

By: [signature] Date: 11/19/14
Name: John Herrick
Its: Counsel and Manager

Approved as to form:

By: [signature] Date: 11/19/2014
Name: John Herrick

STOCKTON EAST WATER DISTRICT

By: ______________________ Date: ______________________
Name: ______________________
Its: ______________________

Approved as to form:

By: ______________________ Date: ______________________
Name: ______________________

NORTH SAN JOAQUIN WATER CONSERVATION DISTRICT

By: ______________________ Date: ______________________
Name: ______________________
Its: ______________________

Approved as to form:

By: ______________________ Date: ______________________
Name: ______________________

SOUTH DELTA WATER AGENCY

By: ______________________ Date: ______________________
Name: ______________________
Its: ______________________

Approved as to form:

By: ______________________ Date: ______________________
Name: ______________________

STOCKTON EAST WATER DISTRICT

By: [signature] Date: 11/25/14
Name: ALVIN CERTOPASSI
Its: President of the Board of Directors

Approved as to form:

By: [signature] Date: 11/25/14
Name: Karna E. Harrigfeld

Exhibit A – Tracy Lake Coordinated Operations Agreement

Coordination Agreement for Operation of Tracy Lake Project

This Coordination Agreement is made this __ day of ____ between East Bay Municipal Utility District ("EBMUD"), Woodbridge Irrigation District ("WID") and North San Joaquin Water Conservation District ("NSJWCD").

RECITALS

a. EBMUD, WID and NSJWCD each hold water rights on the Mokelumne River ("River").

b. EBMUD operates the Pardee and Camanche dams and reservoirs on the River while WID operates and diverts its water at the WID dam on the River.

c. EBMUD and NSJWCD entered into an agreement on October 11, 1963, as amended by the Supplementary Agreement dated May 27, 1969, which agreements specify when EBMUD stores and releases Permit 10477 water to NSJWCD. NSJWCD also entered into a Stipulated Agreement dated June 30, 1992 with California Department of Fish and Game (now known as California Department of Fish and Wildlife), the California Sportsfishing Protection Alliance, and EBMUD. Provisions of the Stipulated Agreement were added as terms under Permit 10477 in 1992.

d. NSJWCD has three points of diversion under its water right downstream of Camanche and upstream of the WID dam. NSJWCD has requested approval of a fourth point of diversion for its water right downstream of the WID dam for its Tracy Lake Groundwater Recharge Project ("Tracy Lake").

e. In order for NSJWCD to receive water under its water right at the new Tracy Lake point of diversion, it needs the cooperation of EBMUD and WID to release or bypass this water from their respective facilities.

f. EBMUD makes various releases of water from Camanche Dam to satisfy prior right holders on the River, for fishery purposes pursuant to the Joint Settlement Agreement ("JSA"), and for other required purposes, and WID passes water downstream of WID dam.

g. The parties have met and conferred and agreed on how they will coordinate operations to enable NSJWCD's new diversion at the proposed Tracy Lake project and avoid injury or interference with the water rights of EBMUD, WID, or prior right holders, or the fishery release activities of WID and EBMUD pursuant to the JSA.

Accordingly, the parties agree as follows:

AGREEMENT

1. **Schedule of Releases.** In addition to the notification required under Provision 3.b. of the 1969 Supplementary Agreement between NSJWCD and EBMUD, NSJWCD will weekly, beginning prior to the start of the irrigation season and one week in advance of each week in which NSJWD is intending to divert water, notify WID and EBMUD of the quantity of water that it expects to divert in the ensuing week into Tracy Lake from the River, and the requested flow rate (in cfs) for such diversions.

2. **Change in Release Schedule.** NSJWCD will divert River water into the South Tracy Lake, which will act as a re-regulating reservoir. Landowners will pump water out of South Tracy Lake as needed to meet crop water demands. Consequently, the parties understand that the rate of irrigation use does not need to match the River diversion rate. NSJWCD shall endeavor to keep the rate of diversion from the River to Tracy Lake constant and shall not request changes to the release rate for water released from Camanche Dam, and passed through the WID dam, more frequently than weekly. Change requests must be submitted to EBMUD and WID at least a week prior to the effective time of the desired release change, except the parties may agree to changes with less notice depending upon the existing and projected river conditions.

3. **Determining When Releases are Available for Diversion.** Water released from Camanche Dam by EBMUD for NSJWCD flows down the River and is then bypassed by WID at the WID dam. There is a time lag and other diversions and losses between the time of the Camanche release and the availability of the water at the Tracy Lake diversion below the WID dam. To address this, the parties agree to the following protocol:

    a. EBMUD will notify NSJWCD of the quantity of water available for release from Camanche Dam for NSJWCD's Tracy Lake diversion and will notify both WID and NSJWCD, in a timely manner via telephone or in writing, when it has released water from Camanche Dam for NSJWCD's Tracy Lake diversion. Such release shall be made by EBMUD into the natural channel of the River at a point immediately downstream from Camanche Dam.

    b. WID will bypass the amount of water so released for the NSJWCD diversion that arrives at the WID Dam, i.e. such amount of water that arrives at WID dam that exceeds the JSA required fishery bypass flows plus WID's scheduled diversions of water at WID Dam and any other required releases.

c. EBMUD will inform WID of the gage height at the Golf Station gage to meet the JSA required fishery bypass flows below WID Dam and any other required releases, including the water available for NSJWCD diversion, downstream of WID Dam.

d. When water released for Tracy Lake is apparent at the Golf Station gage, WID will notify NSJWCD that the water is available for diversion. NSJWCD will then verify when the release is also evident at the new Tracy Lake monitoring station located downstream of the new Tracy Lake river diversion point. NSJWCD will then operate the Tracy Lake diversion pump station consistent with Section 5 of the 1963 Agreement, to take only that amount of water that has been released by EBMUD, bypassed by WID, and verified at the Golf Station gage and at the new Tracy Lake monitoring station by a positive change in surface elevation of the river. NSJWCD's diversions shall not in any event interfere with or reduce the amount of water bypassing WID Dam for fishery and other purposes under the Joint Settlement Agreement.

e. The parties agree to cooperate to the maximum extent practicable to coordinate the diversion at Tracy Lake to match water availability as measured at the new Tracy Lake monitoring station and the flow meter on the diversion pump station for Tracy Lake to avoid any waste of water or interference with flows bypassed at WID dam for other purposes.

4. **Measurement Gaging Stations.** NSJWCD shall install a new river monitoring station just downstream of the point of diversion to Tracy Lake. NSJWCD shall install a continuous monitoring and recording device to continuously monitor and record the River stage. This monitoring station shall be maintained and its accuracy verified monthly by NSJWCD during Tracy Lake diversions. The calibration data shall be provided to EBMUD monthly. In addition, NSJWCD shall install a meter on the pump discharge that records and transmits diversions to Tracy Lake. NSJWCD shall install a continuous monitoring data logging device on the Tracy Lake diversion pump station that will measure flow rate and the total amount diverted. These devices shall be equipped to allow this information to be remitted in real time to WID and EBMUD. The diversion pump station meter shall be calibrated annually by NSJWCD in each year that water is available to NSJWCD for use at Tracy Lake and the calibration data shall be provided to EBMUD.

5. **Data Recording and Sharing.** WID, EBMUD and NSJWCD shall each make its monthly preliminary data available on publicly accessible websites. NSJWCD shall

provide EBMUD and WID real time continuous monitoring data of river stage from the new River monitoring station and of flow rate and total diversions to Tracy Lake.

6. **WID and EBMUD Participation**. The addition of NSJWCD's diversion of water released by EBMUD from its Camanche Reservoir for rediversion at Tracy Lakes, which water must be passed through WID's Dam in addition to WID's bypassing of JSA flows and water for other downstream water diversions, adds a further complication and responsibility to EBMUD's and to WID's obligations while diverting their own water from the River for their own uses. Accordingly, their commitment to participate in this Cooperation Agreement is conditioned upon their participation not resulting in unforeseen impacts or restrictions on their own operations. In the event that their participation imposes any such impacts or restrictions on their operations, they shall be free to condition their further participation upon such terms as are reasonably needed to eliminate such impacts or restrictions on their operations.

7. **Real Time Coordination.** The parties recognize that there will be times when they need to work together to adjust operations to address planned or unforeseen circumstances, related to the protection of the anadromous fishery. The parties agree to work collaboratively to adjust operations to meet fishery requirements and unforeseen circumstances.

8. **Purpose of this Agreement**. The purpose of this agreement is to facilitate coordinated operations. Nothing in this agreement shall be construed to modify or contradict the rights and obligations of the parties under their respective water rights or other contractual agreements.

The parties have executed this Coordination Agreement, in triplicate, as of the day and year stated above, by their respective authorized officers.

EAST BAY MUNICIPAL UTILITY DISTRICT

By:__________________________ Date:_________
General Manager

By:__________________________
Secretary

WOODBRIDGE IRRIGATION DISTRICT

By:______________________________ Date:____________
President

By:______________________________
Secretary

NORTH SAN JOAQUIN WATER CONSERVATION DISTRICT

By:______________________________ Date:__________
President

By:______________________________
Secretary

Exhibit B – Definitions and Acronyms

1998 Joint Settlement Agreement: An agreement entered into by and between EBMUD, U.S. Fish and Wildlife Service, and California Department of Fish and Wildlife, regarding flow and non-flow measures appropriate for the lower Mokelumne River.

AF: Acre-feet.

Agreement: The Protest Dismissal Agreement.

Aqueducts: EBMUD's Mokelumne Aqueducts which carry water from Pardee Reservoir to the EBMUD service area and traverse San Joaquin County.

CDWA: Central Delta Water Agency.

CEQA: California Environmental Quality Act.

City: City of Lodi.

County: County of San Joaquin, San Joaquin County Flood Control and Water Conservation District, and Mokelumne River Water and Power Authority.

Demonstration Project: The Groundwater Banking Demonstration Project described in the September 24, 2013 Memorandum of Agreement between the San Joaquin County Flood Control and Water Conservation District and EBMUD.

EBMUD: East Bay Municipal Utility District.

EIR: Environmental Impact Report under CEQA.

EOS: End-of-September.

FRWA: Freeport Regional Water Authority.

Mokelumne Project: EBMUD's Pardee Dam and Reservoir and Powerhouse, Camanche Dam and Reservoir and Powerhouse, Mokelumne Aqueducts, and associated conveyance and pumping facilities, and Camanche Fish Hatchery.

NSJWCD: North San Joaquin Water Conservation District.

Parties: CDWA, County, EBMUD, SDWA, and SEWD collectively.

Party: CDWA, County, EBMUD, SDWA, or SEWD.

Protest: A formal written opposition or protest filed with the State Water Board challenging a permit application or petition before the State Water Board, including appearances or advocacy in opposition to such applications or petitions in any proceedings before the State Water Board.

SDWA: South Delta Water Agency.

SEWD: Stockton East Water District.

South System: NSJWCD's existing South Pump Station (near Tretheway Road) and distribution system, including portions of Pixley and Bear Creeks.

State Water Board: State Water Resources Control Board.

TAF: Thousand acre-feet.

TSS: Total System Storage in EBMUD's Pardee, Camanche and Terminal Reservoirs.

Tracy Lake Project: Tracy Lake Groundwater Recharge Project.

WID: Woodbridge Irrigation District.

Sixth Amendment to Protest Dismissal Agreement

This Sixth Amendment to Protest Dismissal Agreement (Sixth Amendment) is entered into as of the last date next to the signatures below, by and between East Bay Municipal Utility District (EBMUD), North San Joaquin Water Conservation District (NSJWCD), and County of San Joaquin (County[1]), individually referred to as "Party" and collectively referred to hereafter as "Parties."

Recitals

A. On September 24, 2013, EBMUD and the County entered into a Memorandum of Agreement Relative to a Groundwater Banking Demonstration Project in San Joaquin County.

B. In 2014, County and EBMUD entered into an Agreement to Share the Cost of Consultant Services Procured to assist in the development of the Groundwater Banking Demonstration Project (Demo Project).

C. EBMUD, NSJWCD, and County previously entered into a Protest Dismissal Agreement (PDA) on November 25, 2014.

D. Under the PDA, EBMUD, and County agreed to pursue the Demo Project. Further, in accordance with Section 5.b of the PDA, PDA signatories agreed that the Demo Project would be located within NSJWCD and shall utilize portions of the NSJWCD South System. Sections 5.d and 5.e of the PDA set forth conditions for EBMUD's funding of the Demo Project and improvements to the NSJWCD South System.

E. On May 26, 2016, EBMUD, NSJWCD, and County entered into an Amendment to the PDA that extended the due date for the County to issue the Demo Project export permit to August 10, 2016, and obligated EBMUD to pay NSJWCD $1.75 million on or before July 15, 2016.

F. The Parties agree that NSJWCD received the $1.75 Million from EBMUD prior to July 15, 2016, in satisfaction of Section 5.e.

G. Section 9.b.v of the PDA provides that Section 5 of the PDA may be amended by a written instrument signed by County, EBMUD, and NSJWCD.

---

[1] The reference to "County" includes the County of San Joaquin, San Joaquin County Flood Control and Water Conservation District, and Mokelumne River Water and Power Authority.

H. In accordance with Section 9.b.v of the PDA, on August 29, 2016, County, EBMUD, and NSJWCD entered into a Second Amendment to Protest Dismissal Agreement that extended the due date for the County to issue the Demo Project export permit to September 30, 2016.

I. On September 29, 2016, the Parties entered into the Third Amendment to the Protest Dismissal Agreement extending the due date for issuance of the Demo Project export permit to October 31, 2016.

J. The Parties then entered into the Fourth Amendment to the Protest Dismissal Agreement on October 31, 2016, which extended the due date until November 30, 2016.

K. On November 28, 2016, the Parties executed the Fifth Amendment to the Protest Dismissal Agreement (Fifth Amendment), which extended the Demo Project export permit issuance deadline until December 31, 2016.

L. The Parties now desire to modify Section 5 of the PDA to extend further the deadline for issuance of the Demo Project export permit to June 30, 2017.

AGREEMENT

NOW, THEREFORE, for valuable consideration which is hereby acknowledged by the Parties, the Parties agree as follows:

1. The recitals set forth above are incorporated.

2. Section 5.e of the PDA is hereby amended to read in full as follows:

   e. **Timing**:

      i. If County does not issue the Demonstration Project export permit by June 30, 2017, then EBMUD shall not be obligated to pay County $2.25 Million of the $4 Million for the Demonstration Project unless County, EBMUD, and NSJWCD agree to a modification of this term.

      ii. Pursuant to Section 5.e.ii of the Agreement, as it was amended in the May 26, 2016 Amendment to Protest Dismissal Agreement, EBMUD paid NSJWCD $1.75 Million of the $4 Million prior to July 15, 2016. Said $1.75 Million is to be used to improve the NSJWCD South System. NSJWCD shall place the funds in a separate, interest bearing account and shall only use the funds for improvements to its South System.

NSJWCD's acceptance of the $1.75 Million does not obligate or commit NSJWCD to undertake any groundwater banking project with EBMUD.

3. Except as set forth above, each and every provision of the PDA shall remain in full force and effect. This Amendment supersedes and replaces the Fifth Amendment to the PDA dated November 28, 2016.

EAST BAY MUNICIPAL UTILITY DISTRICT

By: Alexander R. Coate Date: 12.22.16

Name: ALEXANDER R. COATE FSE

NORTH SAN JOAQUIN WATER CONSERVATION DISTRICT

By: [signature] Date: 1-30-17

Name: Joe Valente, President

SAN JOAQUIN COUNTY

By: [signature] Date: 12.23.2016

Name: Kris Balaji
SJ Public Works Director

9 Dream Project Extraction Monitoring

9.1 Monitoring Protocols

Monitoring protocols for the DREAM Project consist of components that come directly from the San Joaquin County Groundwater Export Ordinance and other requirements necessary to ensure that there are measurable metrics available to determine if the success criteria can be met.

9.2 Monitoring Committee

The Groundwater Export Ordinance requires establishment of a five-member Monitoring Committee. For the DREAM Project, the Monitoring Committee would consist of:

- The San Joaquin County Director of Public Works or designee
- The San Joaquin County Director of Environmental Health or designee
- A representative of the Permittee
- A representative of the local agency that provides water service in the project area
- A representative of landowners within two miles of the Project area

It is recommended that the Board of Supervisors appoint the following members to the Monitoring Committee and set the following conditions of approval for an Export Permit:

- Kris Balaji, San Joaquin County Director of Public Works, and Fritz Buchman (Alternate), Deputy Director of Public Works;
- Linda Turkatte, San Joaquin County Director of Environmental Health and Rod Estrada (Alternate), Lead Senior REHS;
- The Eastern Water Alliance, as a co-applicant, shall designate a primary and alternate representative no less than 180 days from the beginning of the scheduled extraction of groundwater for export.
- The North San Joaquin Water Conservation District, as the agency providing water service in the Project area, shall designate a primary and alternate representative no less than 180 days from the beginning of the scheduled extraction of groundwater for export.
- The North San Joaquin Water Conservation District, as the agency providing water service in the Project area, shall solicit from landowners within the Project Area a primary and alternate representative no less than 180 days from the beginning of the scheduled extraction of groundwater for export.

- It is also recommended that the Board of Supervisors allow a representative from EBMUD to participate in the Monitoring Committee as an Ex-Officio Member only to advise and discuss, but not vote on matters concerning the Monitoring Committee.

It shall be the duty of the Monitoring Committee to review, at least annually, and upon receipt of a complaint regarding operation of the project, relevant facts and information and if necessary to recommend to the Board of Supervisors whether or not the project is operating within the terms and conditions of the permit issued for the project, whether or not the project is operating inconsistent with a required finding, and/or whether or not the project is operating to the injury of any party. The Monitoring Committee may engage the services of suitable professional groundwater specialist to provide assistance to the Monitoring Committee.

The Monitoring Committee will maintain official records of recharge and recovery activities, which records shall be open and available to the public. The Monitoring Committee will have the right to verify the accuracy of reported information by inspection, observation or access to user records (i.e., utility bills).

All actions and recommendations of the Monitoring Committee shall be by a supermajority (four fifths) vote of the members of the Monitoring Committee.

9.3 Monitoring Plan

A monitoring plan is required for the purpose of identifying, verifying, avoiding, preventing or mitigating significant adverse effects to surrounding landowners.

9.3.1 Monitoring Plan Elements

The Monitoring Plan includes the following:

1. The hydrographs of 13 representative wells with at least 20 years of historical data in the surrounding area extending two and a half miles from the extraction well. The location of the wells and the well hydrographs are shown in Exhibit A. These wells will be measured monthly to establish baseline conditions and to monitor the effects of the extraction operation.

2. One well without historical data is included in the monitoring plan for the reason that it is located within one mile of the extraction well to evaluate gradient and flow direction. The frequency of monitoring will be monthly.

3. The minimum operating levels for four of the project monitoring wells are shown in Table 2 and located in Exhibit A. These levels will be reviewed and adjusted by the Monitoring Committee prior to the start of any extraction period. Per the Groundwater Export Ordinance, if the water levels in any of these monitoring wells decline by more than five feet from the approved minimum operating level, the project extraction well shall be shut down for evaluation. The Monitoring Committee shall make a recommendation to the Board of Supervisors for continued operation of the extraction well based on the results of the evaluation and may set more

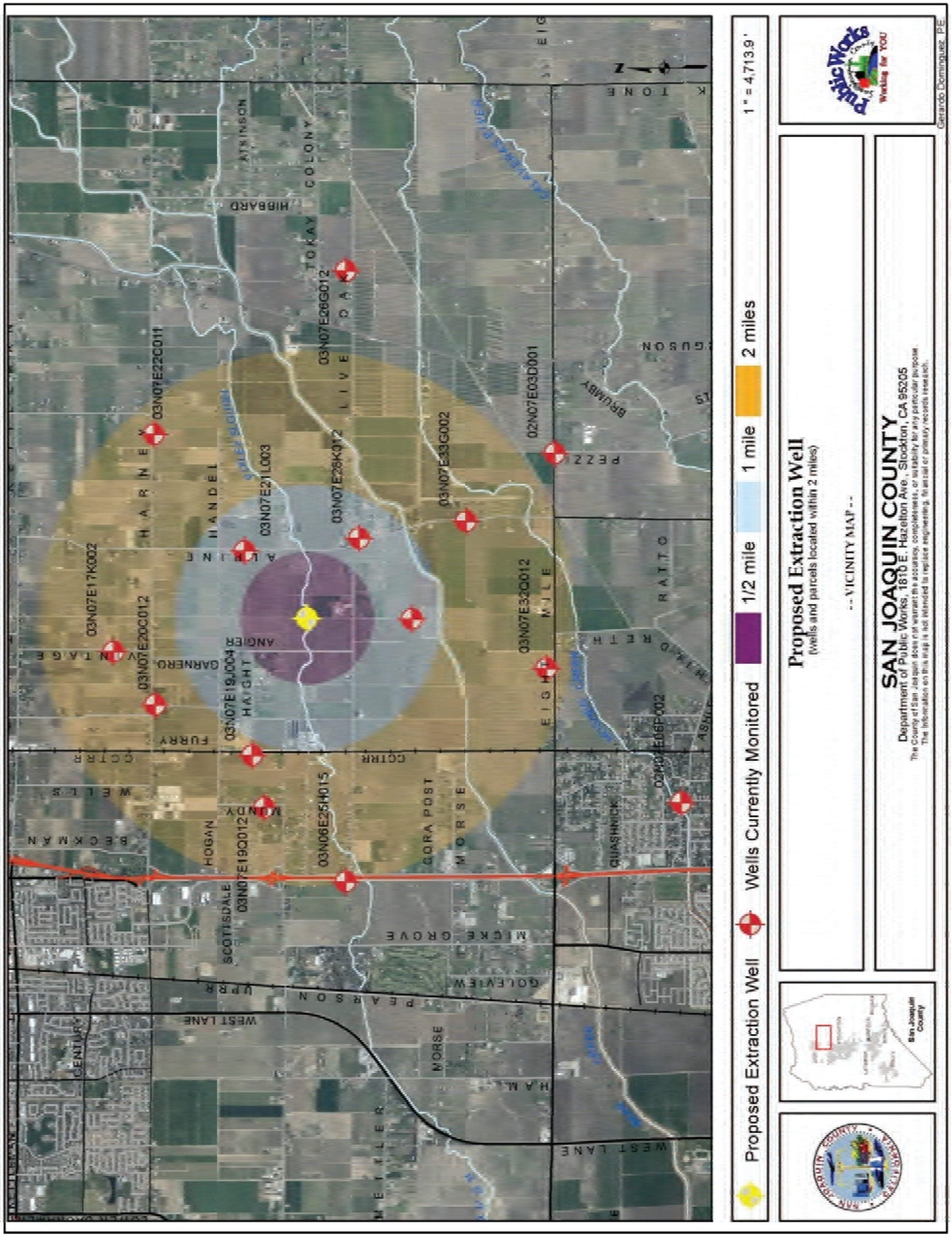
stringent shutdown levels or propose actions such as a temporary shutdown of extractions to achieve minimum operating levels.

4. All groundwater extractions will occur at the identified existing agricultural well depicted in Exhibit A during the non-irrigation season at rates not exceeding the well's existing capacity to prevent significant decreases in water levels. If the well monitoring identifies any adverse effects from the extraction, the extraction rate will be adjusted by limiting the daily hours for pumping or terminating the pumping.

Table 9-1 - Historical Groundwater Levels and Proposed Minimum Operating Levels (feet msl)

Well	Groundwater Level Range over last 25 Years		Groundwater Level Range over last 5 Years		Minimum Operating Level
	Low	High	Low	High	
03N07E17K002	-45.7	2.0	-45.7	-30.4	-45.7
03N07E19J004	-59.0	-22.5	-59.0	-38.0	-59.0
03N07E21L003	-51.5	-19.5	-51.5	-33.6	-51.5
03N07E33G002	-54.0	-29.6	-50.0	-42.2	-50.0

9.4 Exhibit A – Representative Historical Water Levels in Project Area

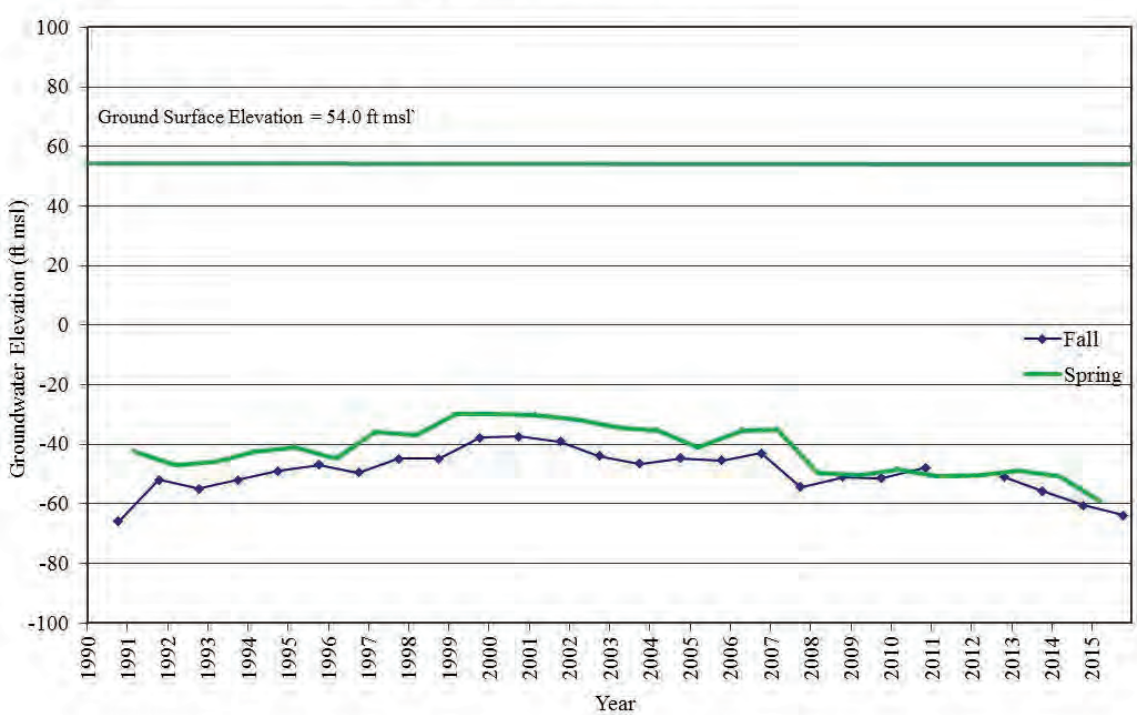


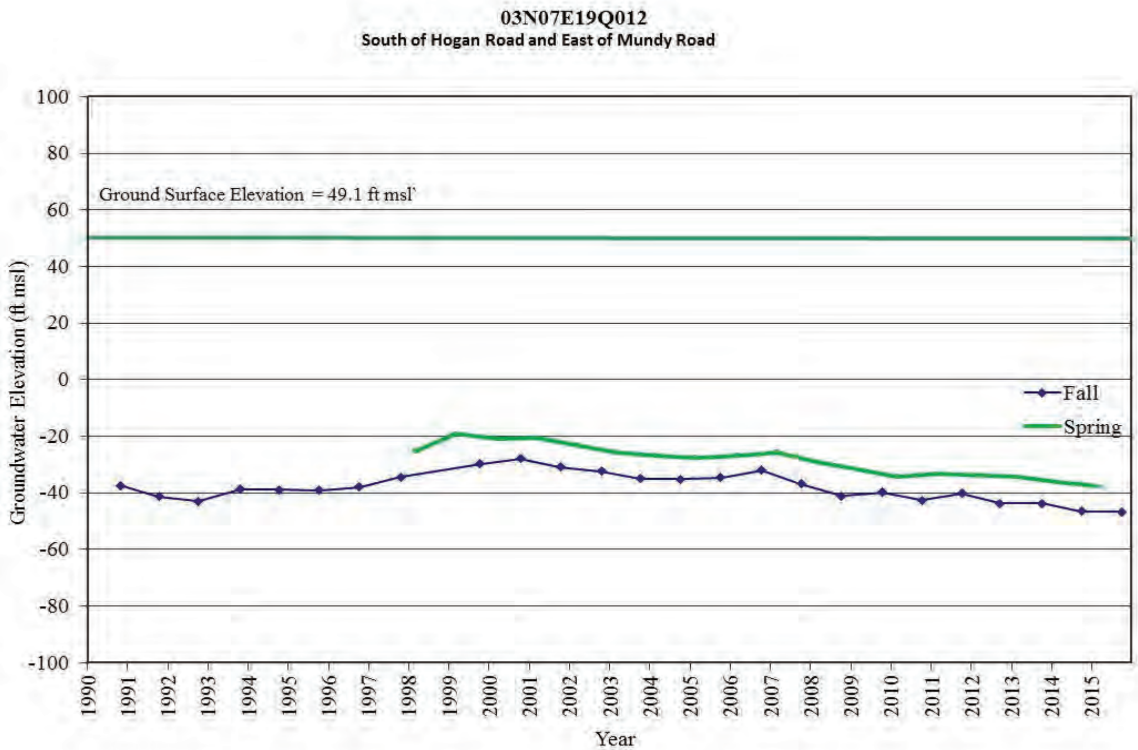
02N07E06P002

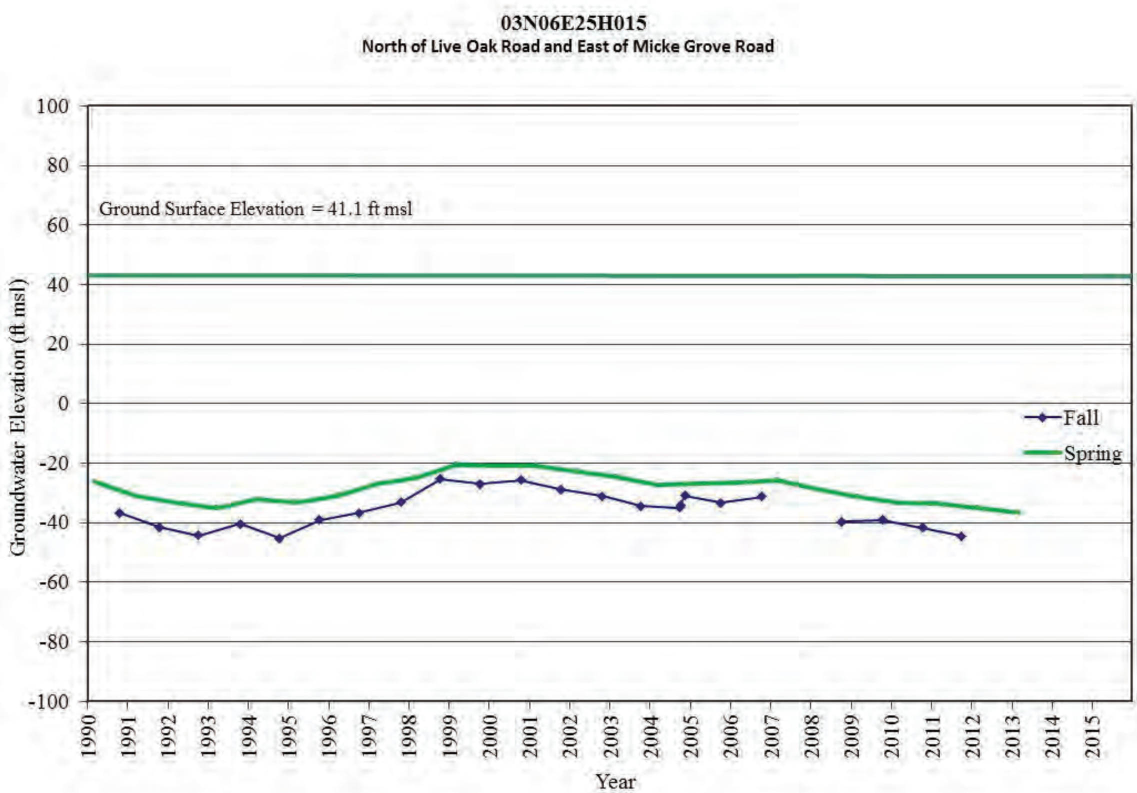
South of Mosher Drive and East of Freesia Avenue

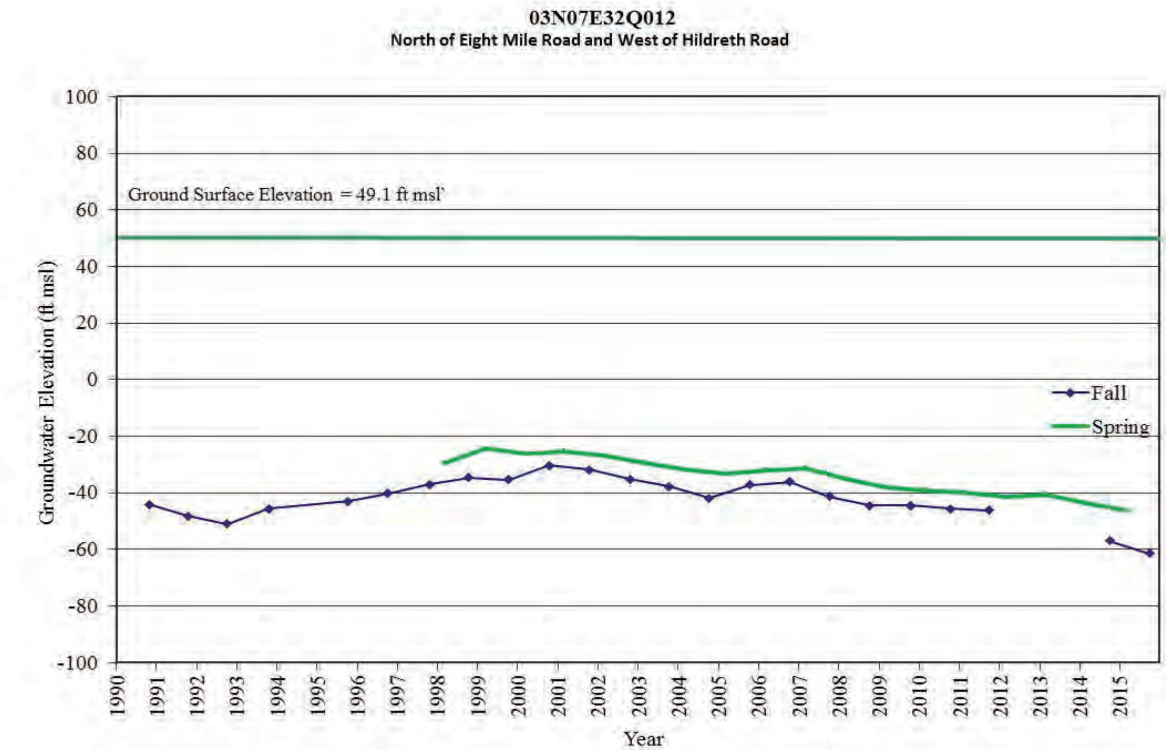
02N07E03D001

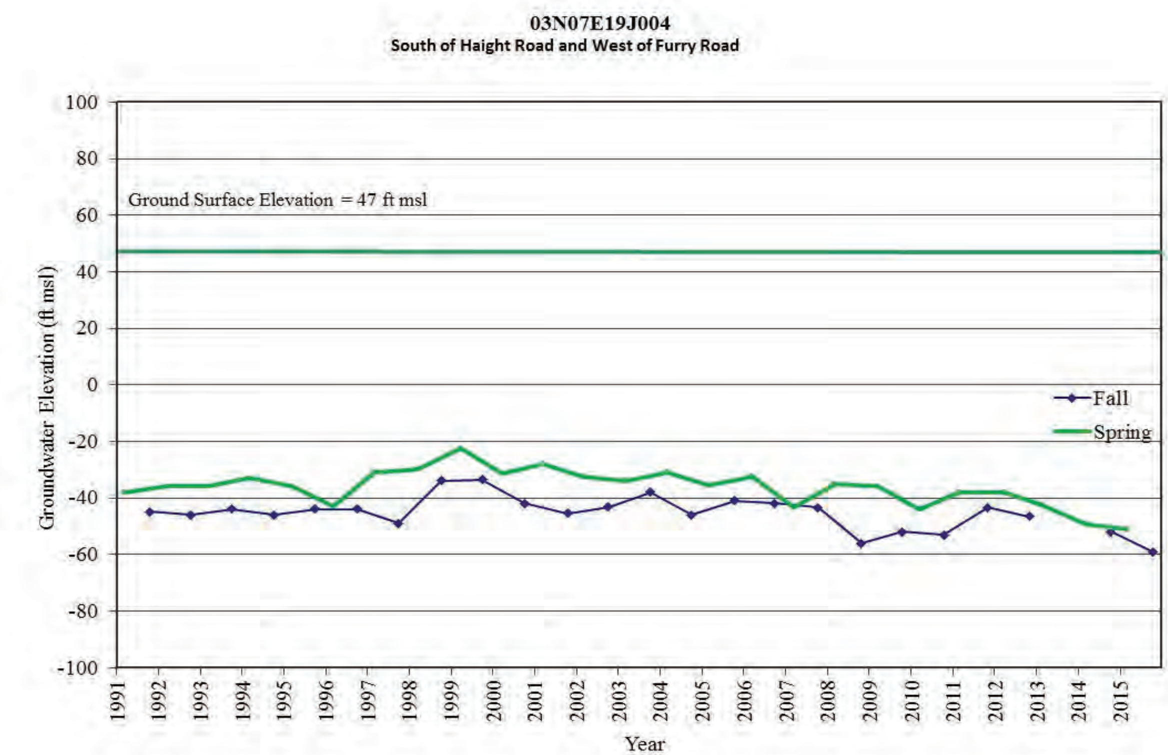
South of Eight Mile Road and West of Pezzi Road



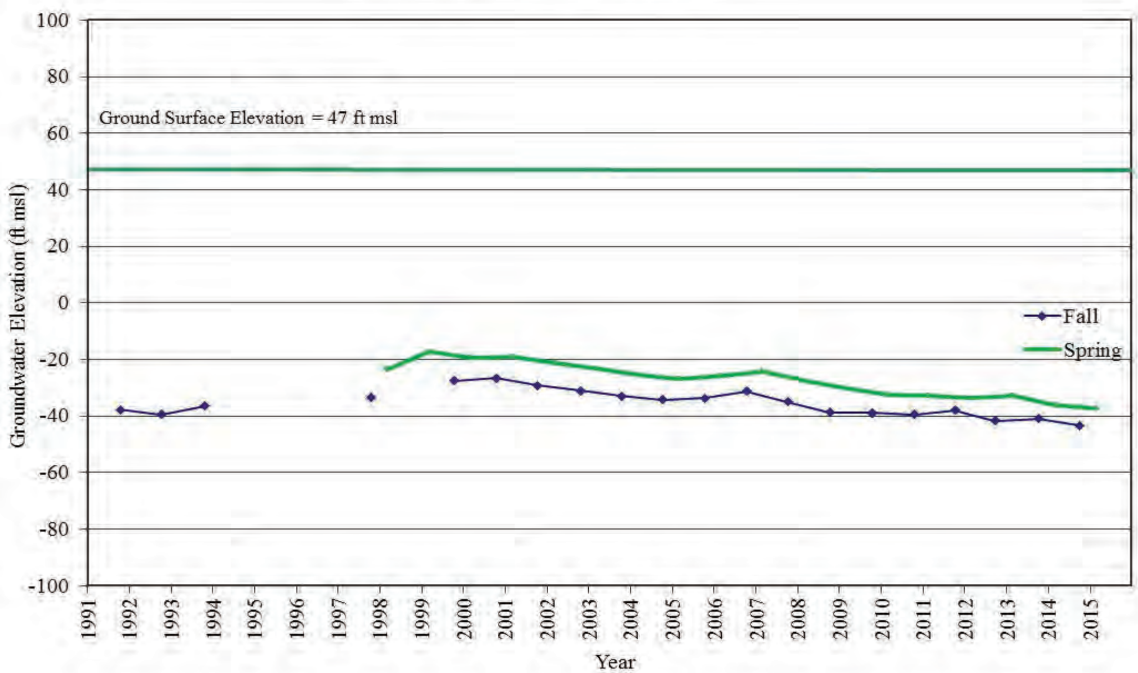

03N07E19Q012
South of Hogan Road and East of Mundy Road
Ground Surface Elevation = 49.1 ft msl`
Groundwater Elevation (ft msl)
Year
Fall
Spring
100
80
60
40
20
0
-20
-40
-60
-80
-100
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015


03N06E25H015
North of Live Oak Road and East of Micke Grove Road
Ground Surface Elevation = 41.1 ft msl
Groundwater Elevation (ft msl)
Year
Fall
Spring
100
80
60
40
20
0
-20
-40
-60
-80
-100
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015

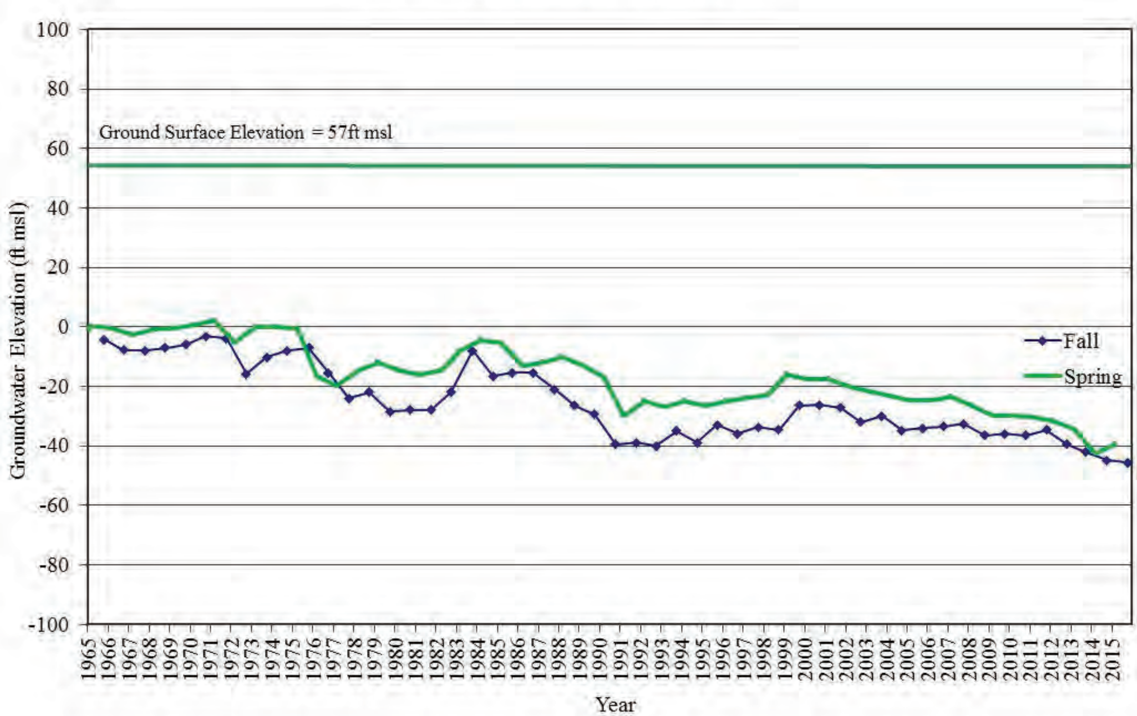

03N07E32Q012
North of Eight Mile Road and West of Hildreth Road
Ground Surface Elevation = 49.1 ft msl`
Groundwater Elevation (ft msl)
Year
Fall
Spring


03N07E19J004
South of Haight Road and West of Furry Road
Ground Surface Elevation = 47 ft msl
Groundwater Elevation (ft msl)
Year
Fall
Spring

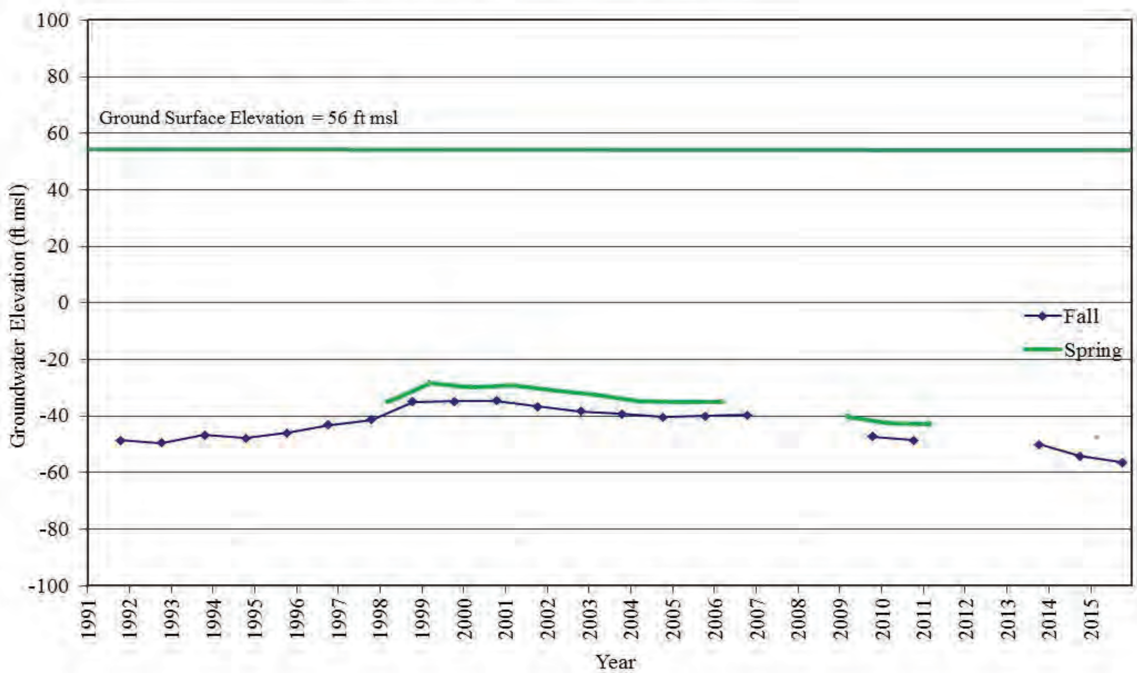
03N07E20C012
South of Harney Road and East of Furry Road



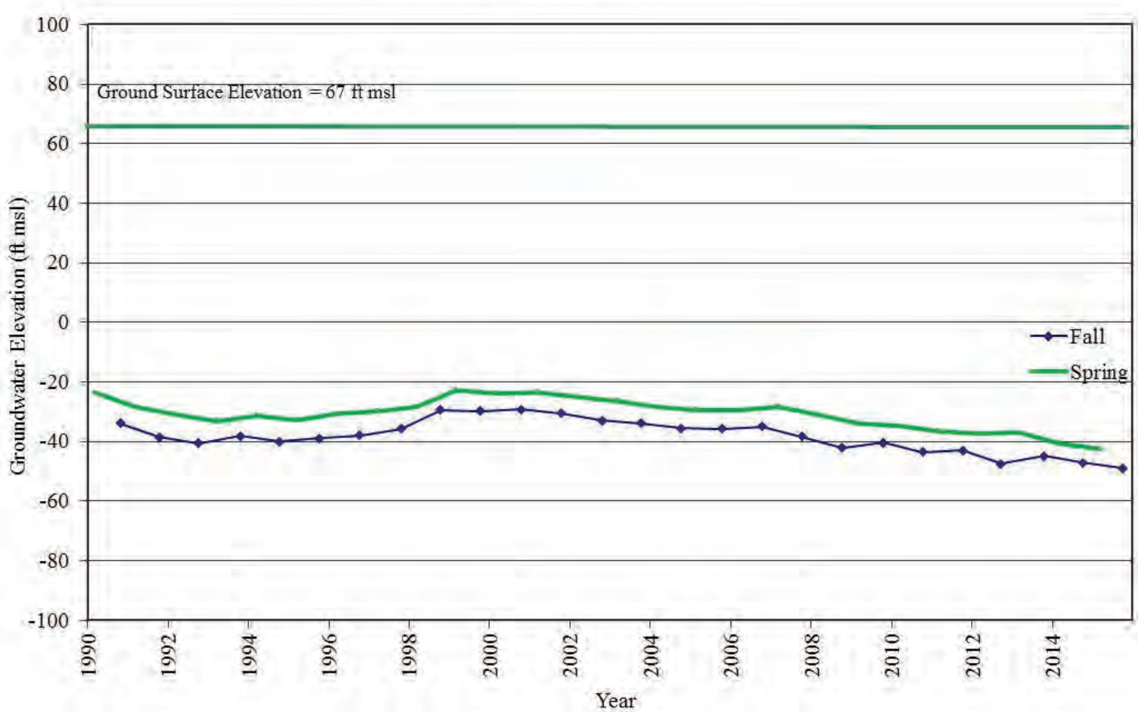
03N07E17K002
North of Harney Road Road and East of Vintage Road



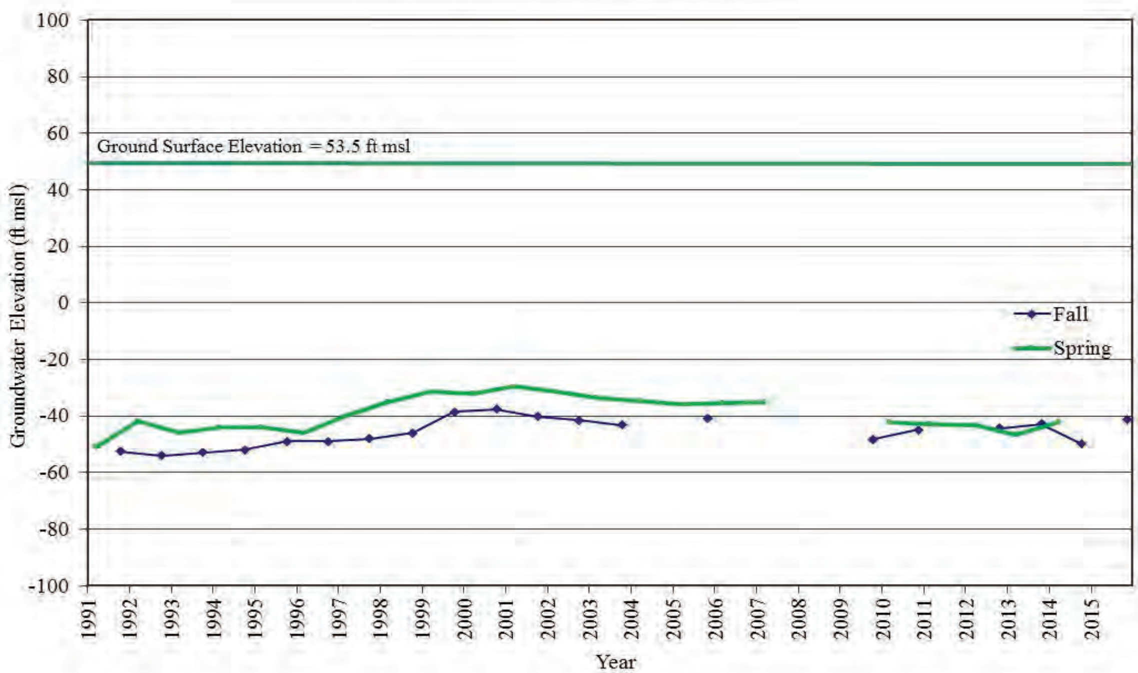
03N07E28K012
South of Live Oak Road and East of Alpine Road



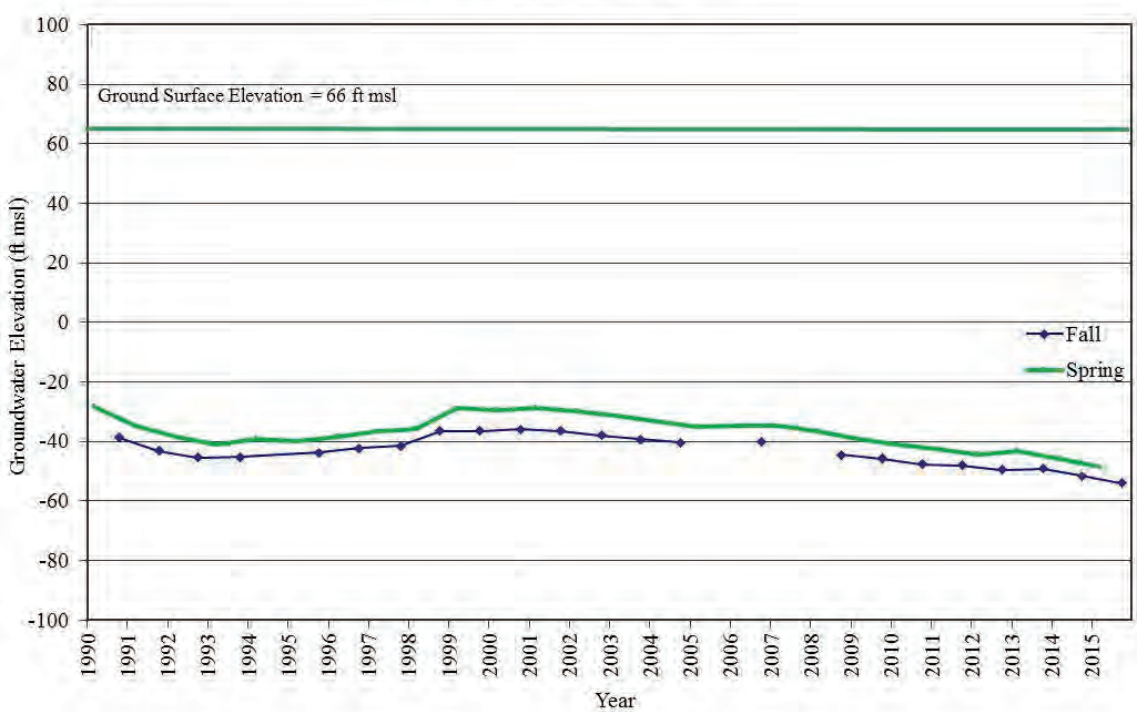
03N07E22C011
South of Harney Road West of Locust Tree Road

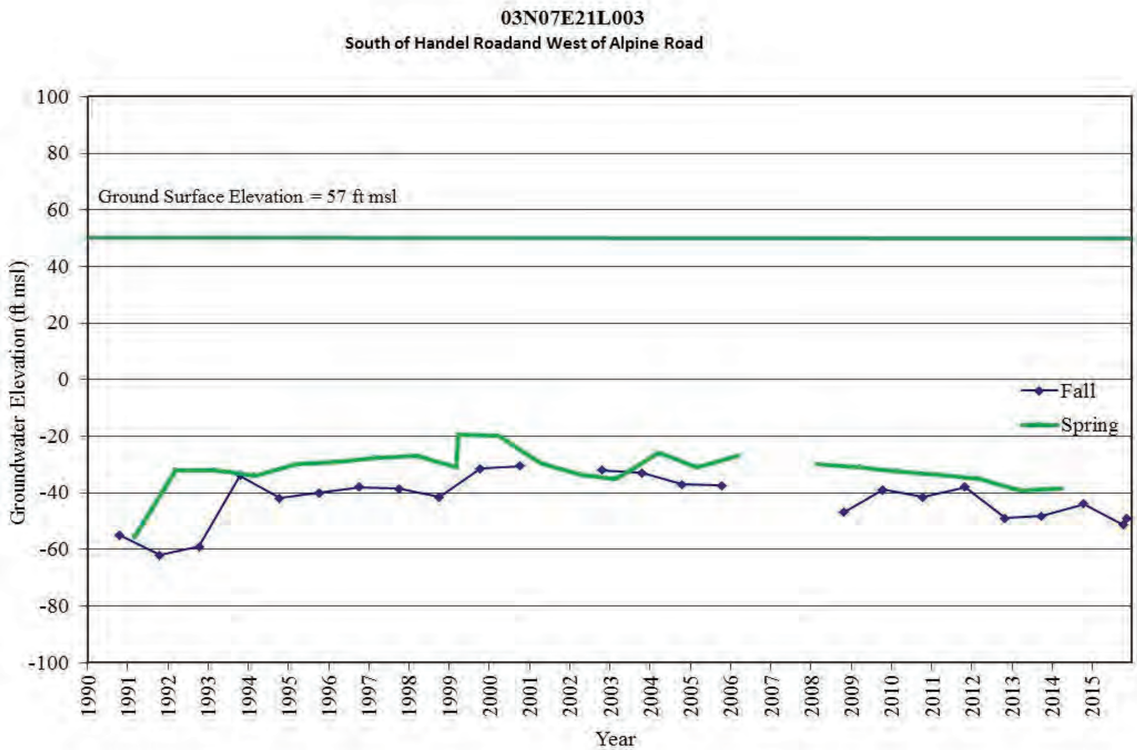


03N07E33G002
North of Eight Mile Road and West Alpine Road



03N07E26G012
North of Live Oak Road and West of Highway 88




03N07E21L003
South of Handel Roadand West of Alpine Road
Ground Surface Elevation = 57 ft msl
Groundwater Elevation (ft msl)
100
80
60
40
20
0
-20
-40
-60
-80
-100
Fall
Spring
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Year

10 Groundwater Quality

The replenishment water will be high-quality Mokelumne River surface water, with suspended solids less than 10 mg/l[64] and conductivity averaging less than 50 µmho/cm (about 40 ppm TDS). The recharge water is neutral in pH and meets all primary drinking water standards.[65] A complete suite of water quality analyses was conducted on the proposed extraction Well K-13 in January 2016. The groundwater is of high quality with 180 mg/L Total Dissolved Solids, and meets all primary drinking water standards. The well was tested for a variety of pesticides, chlorinated acids, dibromo-chloropropane (DBCP), and uranium, none of which were detected. A summary of water quality measurements is presented as Table 1-4.

Table 10-1 - Summary of Water Quality Measurements

		Well K-13	**Mokelumne Hatchery**
		Groundwater	Surface Water
Dates		1/26/2016	2010-14
Conductivity	µmhos/cm	230	49
TDS	mg/L	180	38*
Dissolved Oxygen	mg/L	--	11
Hardness as CaCO3	mg/L	77	18
Total Nitrogen	mg/L	0.54	--
Chromium VI	µg/L	2.4	--
Copper	µg/L	ND	0.6
Zinc	µg/L	ND	1.1
pH		7.64	6.9
Pesticides, Uranium, Chlorinated Acids, DBCP	--	ND	--

*computed from conductivity
ND = not detected

10.1 Mokelumne River Water Quality

Representative water quality data for the Lower Mokelumne River was provided by EBMUD for the period 2010 through 2014. Samples were taken at the Mokelumne River Fish Hatchery at the base of Camanche Dam and at Elliot Road. The collected data is presented in Table 10-2 and shows a source water of very high quality.

64 From Beckman Test Well report
65 Data from EBMUD, 2016

Table 10-2 Water Quality of Lower Mokelumne River 2010 thru 2014 at hatchery after aerator and at Elliott Rd

Locator	Parameter	Collect Date	Sample Type	Qualifier	Results	Units
HATCH CAFH01	CONDUCTIVITY	7/20/2011 11:40	GRAB		37	umhos/cm
HATCH CAFH01	CONDUCTIVITY	8/17/2011 11:10	GRAB		38	umhos/cm
HATCH CAFH01	CONDUCTIVITY	9/28/2011 10:15	GRAB		38	umhos/cm
HATCH CAFH01	CONDUCTIVITY	10/19/2011 11:00	GRAB		33	umhos/cm
HATCH CAFH01	CONDUCTIVITY	11/16/2011 11:20	GRAB		41	umhos/cm
HATCH CAFH01	CONDUCTIVITY	12/14/2011 10:15	GRAB		39	umhos/cm
HATCH CAFH01	CONDUCTIVITY	1/18/2012 8:10	GRAB		41	umhos/cm
HATCH CAFH01	CONDUCTIVITY	2/15/2012 10:50	GRAB		37	umhos/cm
HATCH CAFH01	CONDUCTIVITY	3/21/2012 13:30	GRAB		39	umhos/cm
HATCH CAFH01	CONDUCTIVITY	4/24/2012 11:20	GRAB		48	umhos/cm
HATCH CAFH01	CONDUCTIVITY	5/16/2012 10:20	GRAB		44	umhos/cm
HATCH CAFH01	CONDUCTIVITY	6/27/2012 10:45	GRAB		178	umhos/cm
HATCH CAFH01	CONDUCTIVITY	7/18/2012 10:30	GRAB		48	umhos/cm
HATCH CAFH01	CONDUCTIVITY	8/15/2012 10:15	GRAB		49	umhos/cm
HATCH CAFH01	CONDUCTIVITY	9/19/2012 11:15	GRAB		49	umhos/cm
HATCH CAFH01	CONDUCTIVITY	10/17/2012 10:50	GRAB		48	umhos/cm
HATCH CAFH01	CONDUCTIVITY	11/13/2012 11:50	GRAB		46	umhos/cm
HATCH CAFH01	CONDUCTIVITY	12/19/2012 11:50	GRAB		43	umhos/cm
HATCH CAFH01	CONDUCTIVITY	1/16/2013 11:35	GRAB		39	umhos/cm
HATCH CAFH01	CONDUCTIVITY	2/20/2013 11:30	GRAB		37	umhos/cm
HATCH CAFH01	CONDUCTIVITY	4/18/2013 9:15	GRAB		40	umhos/cm
HATCH CAFH01	CONDUCTIVITY	5/15/2013 11:50	GRAB		44	umhos/cm
HATCH CAFH01	CONDUCTIVITY	6/19/2013 11:50	GRAB		48	umhos/cm
HATCH CAFH01	CONDUCTIVITY	7/24/2013 11:30	GRAB		43	umhos/cm
HATCH CAFH01	CONDUCTIVITY	8/28/2013 11:20	GRAB		49	umhos/cm
HATCH CAFH01	CONDUCTIVITY	9/18/2013 11:40	GRAB		46	umhos/cm

Locator	Parameter	Collect Date	Sample Type	Qualifier	Results	Units
HATCH CAFH01	CONDUCTIVITY	10/16/2013 11:50	GRAB		49	umhos/cm
HATCH CAFH01	CONDUCTIVITY	11/20/2013 11:40	GRAB		48	umhos/cm
HATCH CAFH01	CONDUCTIVITY	12/18/2013 11:20	GRAB		51	umhos/cm
HATCH CAFH01	CONDUCTIVITY	1/22/2014 10:50	GRAB		47	umhos/cm
HATCH CAFH01	CONDUCTIVITY	2/26/2014 11:40	GRAB		46	umhos/cm
HATCH CAFH01	CONDUCTIVITY	3/19/2014 11:50	GRAB		49	umhos/cm
HATCH CAFH01	CONDUCTIVITY	4/16/2014 12:00	GRAB		46	umhos/cm
HATCH CAFH01	CONDUCTIVITY	5/28/2014 11:45	GRAB		48	umhos/cm
HATCH CAFH01	CONDUCTIVITY	6/18/2014 10:55	GRAB		50	umhos/cm
HATCH CAFH01	CONDUCTIVITY	7/16/2014 11:20	GRAB		52	umhos/cm
HATCH CAFH01	CONDUCTIVITY	8/20/2014 11:45	GRAB		50	umhos/cm
HATCH CAFH01	CONDUCTIVITY	9/29/2014 11:05	GRAB		51	umhos/cm
HATCH CAFH01	CONDUCTIVITY	10/20/2014 11:35	GRAB		51	umhos/cm
HATCH CAFH01	CONDUCTIVITY	11/18/2014 11:00	GRAB		55	umhos/cm
HATCH CAFH01	CONDUCTIVITY	12/18/2014 11:20	GRAB		53	umhos/cm
HATCH CAFH01	DISSOLVED OXYGEN	1/20/2010 10:30	GRAB		11.4	mg/L
HATCH CAFH01	DISSOLVED OXYGEN	2/24/2010 10:40	GRAB		11.9	mg/L
HATCH CAFH01	DISSOLVED OXYGEN	3/17/2010 11:05	GRAB		11.7	mg/L
HATCH CAFH01	DISSOLVED OXYGEN	4/21/2010 10:45	GRAB		11.2	mg/L
HATCH CAFH01	DISSOLVED OXYGEN	5/26/2010 8:15	GRAB		11.32	mg/L
HATCH CAFH01	DISSOLVED OXYGEN	6/23/2010 11:00	GRAB		10.9	mg/L
HATCH CAFH01	DISSOLVED OXYGEN	7/21/2010 11:00	GRAB		10.5	mg/L
HATCH CAFH01	DISSOLVED OXYGEN	8/25/2010 11:20	GRAB		10.2	mg/L
HATCH CAFH01	DISSOLVED OXYGEN	9/22/2010 12:55	GRAB		10.1	mg/L
HATCH CAFH01	DISSOLVED OXYGEN	10/20/2010 11:15	GRAB		10.1	mg/L
HATCH CAFH01	DISSOLVED OXYGEN	11/17/2010 11:10	GRAB		10.2	mg/L
HATCH CAFH01	DISSOLVED OXYGEN	12/16/2010 11:15	GRAB		10.7	mg/L

Locator	Parameter	Collect Date	Sample Type	Qualifier	Results	Units
HATCH CAFH01	DISSOLVED OXYGEN	1/19/2011 11:15	GRAB		12.1	mg/L
HATCH CAFH01	DISSOLVED OXYGEN	2/16/2011 10:55	GRAB		11.9	mg/L
HATCH CAFH01	DISSOLVED OXYGEN	3/16/2011 9:40	GRAB		12.1	mg/L
HATCH CAFH01	DISSOLVED OXYGEN	4/20/2011 10:50	GRAB		11.3	mg/L
HATCH CAFH01	DISSOLVED OXYGEN	5/18/2011 11:00	GRAB		10.9	mg/L
HATCH CAFH01	DISSOLVED OXYGEN	6/15/2011 10:40	GRAB		10.5	mg/L
HATCH CAFH01	DISSOLVED OXYGEN	7/20/2011 11:40	GRAB		10.6	mg/L
HATCH CAFH01	DISSOLVED OXYGEN	8/17/2011 11:10	GRAB		10.4	mg/L
HATCH CAFH01	DISSOLVED OXYGEN	9/28/2011 10:15	GRAB		10.21	mg/L
HATCH CAFH01	DISSOLVED OXYGEN	10/19/2011 11:00	GRAB		10.2	mg/L
HATCH CAFH01	DISSOLVED OXYGEN	11/16/2011 11:20	GRAB		10.1	mg/L
HATCH CAFH01	DISSOLVED OXYGEN	12/14/2011 10:15	GRAB		10.6	mg/L
HATCH CAFH01	DISSOLVED OXYGEN	1/18/2012 8:10	GRAB		11.98	mg/L
HATCH CAFH01	DISSOLVED OXYGEN	2/15/2012 10:50	GRAB		11.7	mg/L
HATCH CAFH01	DISSOLVED OXYGEN	3/21/2012 13:30	GRAB		11.5	mg/L
HATCH CAFH01	DISSOLVED OXYGEN	4/24/2012 11:20	GRAB		11.3	mg/L
HATCH CAFH01	DISSOLVED OXYGEN	5/16/2012 10:20	GRAB		10.1	mg/L
HATCH CAFH01	DISSOLVED OXYGEN	6/27/2012 10:45	GRAB		11	mg/L
HATCH CAFH01	DISSOLVED OXYGEN	7/18/2012 10:30	GRAB		10.9	mg/L
HATCH CAFH01	DISSOLVED OXYGEN	8/15/2012 10:15	GRAB		10.7	mg/L
HATCH CAFH01	DISSOLVED OXYGEN	9/19/2012 11:15	GRAB		10.6	mg/L
HATCH CAFH01	DISSOLVED OXYGEN	10/17/2012 10:50	GRAB		10.3	mg/L
HATCH CAFH01	DISSOLVED OXYGEN	11/13/2012 11:50	GRAB		10.3	mg/L
HATCH CAFH01	DISSOLVED OXYGEN	12/19/2012 11:50	GRAB		11	mg/L
HATCH CAFH01	DISSOLVED OXYGEN	1/16/2013 11:35	GRAB		11.3	mg/L
HATCH CAFH01	DISSOLVED OXYGEN	2/20/2013 11:30	GRAB		11.9	mg/L
HATCH CAFH01	DISSOLVED OXYGEN	4/18/2013 9:15	GRAB		11.12	mg/L

Locator	Parameter	Collect Date	Sample Type	Qualifier	Results	Units
HATCH CAFH01	DISSOLVED OXYGEN	5/15/2013 11:50	GRAB		11.3	mg/L
HATCH CAFH01	DISSOLVED OXYGEN	6/19/2013 11:50	GRAB		10.7	mg/L
HATCH CAFH01	DISSOLVED OXYGEN	7/24/2013 11:30	GRAB		10.7	mg/L
HATCH CAFH01	DISSOLVED OXYGEN	8/28/2013 11:20	GRAB		10.3	mg/L
HATCH CAFH01	DISSOLVED OXYGEN	9/18/2013 11:40	GRAB		10.6	mg/L
HATCH CAFH01	DISSOLVED OXYGEN	10/16/2013 11:50	GRAB		10.3	mg/L
HATCH CAFH01	DISSOLVED OXYGEN	11/20/2013 11:40	GRAB		10.7	mg/L
HATCH CAFH01	DISSOLVED OXYGEN	12/18/2013 11:20	GRAB		11.4	mg/L
HATCH CAFH01	DISSOLVED OXYGEN	1/22/2014 10:50	GRAB		11.9	mg/L
HATCH CAFH01	DISSOLVED OXYGEN	2/26/2014 11:40	GRAB		11	mg/L
HATCH CAFH01	DISSOLVED OXYGEN	3/19/2014 11:50	GRAB		11.3	mg/L
HATCH CAFH01	DISSOLVED OXYGEN	4/16/2014 12:00	GRAB		10.9	mg/L
HATCH CAFH01	DISSOLVED OXYGEN	5/28/2014 11:45	GRAB		10.5	mg/L
HATCH CAFH01	DISSOLVED OXYGEN	6/18/2014 10:55	GRAB		10.1	mg/L
HATCH CAFH01	DISSOLVED OXYGEN	7/16/2014 11:20	GRAB		10.1	mg/L
HATCH CAFH01	DISSOLVED OXYGEN	8/20/2014 11:45	GRAB		10	mg/L
HATCH CAFH01	DISSOLVED OXYGEN	9/29/2014 11:05	GRAB		10.2	mg/L
HATCH CAFH01	DISSOLVED OXYGEN	10/20/2014 11:35	GRAB		10.1	mg/L
HATCH CAFH01	DISSOLVED OXYGEN	11/18/2014 11:00	GRAB		8.6	mg/L
HATCH CAFH01	DISSOLVED OXYGEN	12/18/2014 11:20	GRAB		11	mg/L
HATCH CAFH01	OXIDATION/REDUCTION POTENTIAL	8/17/2011 11:10	GRAB		247	mV
HATCH CAFH01	OXIDATION/REDUCTION POTENTIAL	9/28/2011 10:15	GRAB		266	mV
HATCH CAFH01	OXIDATION/REDUCTION POTENTIAL	10/19/2011 11:00	GRAB		250	mV
HATCH CAFH01	OXIDATION/REDUCTION POTENTIAL	11/16/2011 11:20	GRAB		325	mV
HATCH CAFH01	OXIDATION/REDUCTION POTENTIAL	12/14/2011 10:15	GRAB		336	mV
HATCH CAFH01	OXIDATION/REDUCTION POTENTIAL	1/18/2012 8:10	GRAB		318	mV
HATCH CAFH01	OXIDATION/REDUCTION POTENTIAL	2/15/2012 10:50	GRAB		223	mV

Locator	Parameter	Collect Date	Sample Type	Qualifier	Results	Units
HATCH CAFH01	OXIDATION/REDUCTION POTENTIAL	3/21/2012 13:30	GRAB		222	mV
HATCH CAFH01	OXIDATION/REDUCTION POTENTIAL	4/24/2012 11:20	GRAB		420	mV
HATCH CAFH01	OXIDATION/REDUCTION POTENTIAL	5/16/2012 10:20	GRAB		322	mV
HATCH CAFH01	OXIDATION/REDUCTION POTENTIAL	6/27/2012 10:45	GRAB		285	mV
HATCH CAFH01	OXIDATION/REDUCTION POTENTIAL	7/18/2012 10:30	GRAB		281	mV
HATCH CAFH01	OXIDATION/REDUCTION POTENTIAL	8/15/2012 10:15	GRAB		120	mV
HATCH CAFH01	OXIDATION/REDUCTION POTENTIAL	9/19/2012 11:15	GRAB		128	mV
HATCH CAFH01	OXIDATION/REDUCTION POTENTIAL	10/17/2012 10:50	GRAB		162	mV
HATCH CAFH01	OXIDATION/REDUCTION POTENTIAL	11/13/2012 11:50	GRAB		130	mV
HATCH CAFH01	OXIDATION/REDUCTION POTENTIAL	12/19/2012 11:50	GRAB		185	mV
HATCH CAFH01	OXIDATION/REDUCTION POTENTIAL	1/16/2013 11:35	GRAB		205	mV
HATCH CAFH01	OXIDATION/REDUCTION POTENTIAL	2/20/2013 11:30	GRAB		200	mV
HATCH CAFH01	OXIDATION/REDUCTION POTENTIAL	4/18/2013 9:15	GRAB		214	mV
HATCH CAFH01	OXIDATION/REDUCTION POTENTIAL	5/15/2013 11:50	GRAB		225	mV
HATCH CAFH01	OXIDATION/REDUCTION POTENTIAL	6/19/2013 11:50	GRAB		685	mV
HATCH CAFH01	OXIDATION/REDUCTION POTENTIAL	7/24/2013 11:30	GRAB		235	mV
HATCH CAFH01	OXIDATION/REDUCTION POTENTIAL	8/28/2013 11:20	GRAB		180	mV
HATCH CAFH01	OXIDATION/REDUCTION POTENTIAL	9/18/2013 11:40	GRAB		220	mV
HATCH CAFH01	OXIDATION/REDUCTION POTENTIAL	10/16/2013 11:50	GRAB		217	mV
HATCH CAFH01	OXIDATION/REDUCTION POTENTIAL	11/20/2013 11:40	GRAB		256	mV
HATCH CAFH01	OXIDATION/REDUCTION POTENTIAL	12/18/2013 11:20	GRAB		220	mV
HATCH CAFH01	OXIDATION/REDUCTION POTENTIAL	1/22/2014 10:50	GRAB		307	mV
HATCH CAFH01	OXIDATION/REDUCTION POTENTIAL	2/26/2014 11:40	GRAB		265	mV
HATCH CAFH01	OXIDATION/REDUCTION POTENTIAL	3/19/2014 11:50	GRAB		233	mV
HATCH CAFH01	OXIDATION/REDUCTION POTENTIAL	4/16/2014 12:00	GRAB		235	mV
HATCH CAFH01	OXIDATION/REDUCTION POTENTIAL	5/28/2014 11:45	GRAB		274	mV
HATCH CAFH01	OXIDATION/REDUCTION POTENTIAL	6/18/2014 10:55	GRAB		215	mV

Locator	Parameter	Collect Date	Sample Type	Qualifier	Results	Units
HATCH CAFH01	OXIDATION/REDUCTION POTENTIAL	7/16/2014 11:20	GRAB		218	mV
HATCH CAFH01	OXIDATION/REDUCTION POTENTIAL	8/20/2014 11:45	GRAB		231	mV
HATCH CAFH01	OXIDATION/REDUCTION POTENTIAL	9/29/2014 11:05	GRAB		287	mV
HATCH CAFH01	OXIDATION/REDUCTION POTENTIAL	10/20/2014 11:35	GRAB		235	mV
HATCH CAFH01	OXIDATION/REDUCTION POTENTIAL	11/18/2014 11:00	GRAB		210	mV
HATCH CAFH01	OXIDATION/REDUCTION POTENTIAL	12/18/2014 11:20	GRAB		268	mV
HATCH CAFH01	PH	1/20/2010 10:30	GRAB		7.4	pH units
HATCH CAFH01	PH	2/24/2010 10:40	GRAB		7	pH units
HATCH CAFH01	PH	3/17/2010 11:05	GRAB		7	pH units
HATCH CAFH01	PH	4/21/2010 10:45	GRAB		6.7	pH units
HATCH CAFH01	PH	5/26/2010 8:15	GRAB		6.96	pH units
HATCH CAFH01	PH	6/23/2010 11:00	GRAB		6.9	pH units
HATCH CAFH01	PH	7/21/2010 11:00	GRAB		7.2	pH units
HATCH CAFH01	PH	8/25/2010 11:20	GRAB		6.8	pH units
HATCH CAFH01	PH	9/22/2010 12:55	GRAB		7.4	pH units
HATCH CAFH01	PH	10/20/2010 11:15	GRAB		7.7	pH units
HATCH CAFH01	PH	11/17/2010 11:10	GRAB		6.2	pH units
HATCH CAFH01	PH	12/16/2010 11:15	GRAB		7.21	pH units
HATCH CAFH01	PH	1/19/2011 11:15	GRAB		7.1	pH units
HATCH CAFH01	PH	2/16/2011 10:55	GRAB		6.9	pH units
HATCH CAFH01	PH	3/16/2011 9:40	GRAB		6.69	pH units
HATCH CAFH01	PH	4/20/2011 10:50	GRAB		6.8	pH units
HATCH CAFH01	PH	5/18/2011 11:00	GRAB		6.6	pH units
HATCH CAFH01	PH	6/15/2011 10:40	GRAB		6.5	pH units
HATCH CAFH01	PH	7/20/2011 11:40	GRAB		6.5	pH units
HATCH CAFH01	PH	8/17/2011 11:10	GRAB		6.8	pH units
HATCH CAFH01	PH	9/28/2011 10:15	GRAB		6.09	pH units

Locator	Parameter	Collect Date	Sample Type	Qualifier	Results	Units
HATCH CAFH01	PH	10/19/2011 11:00	GRAB		6.8	pH units
HATCH CAFH01	PH	11/16/2011 11:20	GRAB		6.8	pH units
HATCH CAFH01	PH	12/14/2011 10:15	GRAB		7.4	pH units
HATCH CAFH01	PH	1/18/2012 8:10	GRAB		6.66	pH units
HATCH CAFH01	PH	2/15/2012 10:50	GRAB		6.6	pH units
HATCH CAFH01	PH	3/21/2012 13:30	GRAB		7.2	pH units
HATCH CAFH01	PH	4/24/2012 11:20	GRAB		7.5	pH units
HATCH CAFH01	PH	5/16/2012 10:20	GRAB		6.7	pH units
HATCH CAFH01	PH	6/27/2012 10:45	GRAB		7	pH units
HATCH CAFH01	PH	7/18/2012 10:30	GRAB		6.8	pH units
HATCH CAFH01	PH	8/15/2012 10:15	GRAB		7	pH units
HATCH CAFH01	PH	9/19/2012 11:15	GRAB		6.3	pH units
HATCH CAFH01	PH	10/17/2012 10:50	GRAB		6.8	pH units
HATCH CAFH01	PH	11/13/2012 11:50	GRAB		6.1	pH units
HATCH CAFH01	PH	12/19/2012 11:50	GRAB		7.3	pH units
HATCH CAFH01	PH	1/16/2013 11:35	GRAB		6.6	pH units
HATCH CAFH01	PH	2/20/2013 11:30	GRAB		7	pH units
HATCH CAFH01	PH	4/18/2013 9:15	GRAB		6.94	pH units
HATCH CAFH01	PH	5/15/2013 11:50	GRAB		6.7	pH units
HATCH CAFH01	PH	6/19/2013 11:50	GRAB		6.9	pH units
HATCH CAFH01	PH	7/24/2013 11:30	GRAB		7	pH units
HATCH CAFH01	PH	8/28/2013 11:20	GRAB		6.1	pH units
HATCH CAFH01	PH	9/18/2013 11:40	GRAB		6.3	pH units
HATCH CAFH01	PH	10/16/2013 11:50	GRAB		6.5	pH units
HATCH CAFH01	PH	11/20/2013 11:40	GRAB		6.8	pH units
HATCH CAFH01	PH	12/18/2013 11:20	GRAB		7.2	pH units
HATCH CAFH01	PH	1/22/2014 10:50	GRAB		7.1	pH units

Locator	Parameter	Collect Date	Sample Type	Qualifier	Results	Units
HATCH CAFH01	PH	2/26/2014 11:40	GRAB		7	pH units
HATCH CAFH01	PH	3/19/2014 11:50	GRAB		7.1	pH units
HATCH CAFH01	PH	4/16/2014 12:00	GRAB		6.8	pH units
HATCH CAFH01	PH	5/28/2014 11:45	GRAB		6.8	pH units
HATCH CAFH01	PH	6/18/2014 10:55	GRAB		7	pH units
HATCH CAFH01	PH	7/16/2014 11:20	GRAB		7.2	pH units
HATCH CAFH01	PH	8/20/2014 11:45	GRAB		7.1	pH units
HATCH CAFH01	PH	9/29/2014 11:05	GRAB		6.8	pH units
HATCH CAFH01	PH	10/20/2014 11:35	GRAB		7.1	pH units
HATCH CAFH01	PH	11/18/2014 11:00	GRAB		6.5	pH units
HATCH CAFH01	PH	12/18/2014 11:20	GRAB		7.4	pH units
HATCH CAFH01	TEMPERATURE	1/20/2010 10:30	GRAB		10.6	deg C
HATCH CAFH01	TEMPERATURE	2/24/2010 10:40	GRAB		10.3	deg C
HATCH CAFH01	TEMPERATURE	3/17/2010 11:05	GRAB		10.6	deg C
HATCH CAFH01	TEMPERATURE	4/21/2010 10:45	GRAB		11.1	deg C
HATCH CAFH01	TEMPERATURE	5/26/2010 8:15	GRAB		11.95	deg C
HATCH CAFH01	TEMPERATURE	6/23/2010 11:00	GRAB		12.4	deg C
HATCH CAFH01	TEMPERATURE	7/21/2010 11:00	GRAB		12.9	deg C
HATCH CAFH01	TEMPERATURE	8/25/2010 11:20	GRAB		13.9	deg C
HATCH CAFH01	TEMPERATURE	9/22/2010 12:55	GRAB		14.3	deg C
HATCH CAFH01	TEMPERATURE	10/20/2010 11:15	GRAB		15.4	deg C
HATCH CAFH01	TEMPERATURE	11/17/2010 11:10	GRAB		15.6	deg C
HATCH CAFH01	TEMPERATURE	12/16/2010 11:15	GRAB		12.88	deg C
HATCH CAFH01	TEMPERATURE	1/19/2011 11:15	GRAB		8.9	deg C
HATCH CAFH01	TEMPERATURE	2/16/2011 10:55	GRAB		8.8	deg C
HATCH CAFH01	TEMPERATURE	3/16/2011 9:40	GRAB		8.76	deg C
HATCH CAFH01	TEMPERATURE	4/20/2011 10:50	GRAB		9.6	deg C

Locator	Parameter	Collect Date	Sample Type	Qualifier	Results	Units
HATCH CAFH01	TEMPERATURE	5/18/2011 11:00	GRAB		11.7	deg C
HATCH CAFH01	TEMPERATURE	6/15/2011 10:40	GRAB		12.5	deg C
HATCH CAFH01	TEMPERATURE	7/20/2011 11:40	GRAB		15.2	deg C
HATCH CAFH01	TEMPERATURE	8/17/2011 11:10	GRAB		14.6	deg C
HATCH CAFH01	TEMPERATURE	9/28/2011 10:15	GRAB		15.27	deg C
HATCH CAFH01	TEMPERATURE	10/19/2011 11:00	GRAB		15.5	deg C
HATCH CAFH01	TEMPERATURE	11/16/2011 11:20	GRAB		15.5	deg C
HATCH CAFH01	TEMPERATURE	12/14/2011 10:15	GRAB		12.3	deg C
HATCH CAFH01	TEMPERATURE	1/18/2012 8:10	GRAB		9.56	deg C
HATCH CAFH01	TEMPERATURE	2/15/2012 10:50	GRAB		9.5	deg C
HATCH CAFH01	TEMPERATURE	3/21/2012 13:30	GRAB		11.2	deg C
HATCH CAFH01	TEMPERATURE	4/24/2012 11:20	GRAB		11.3	deg C
HATCH CAFH01	TEMPERATURE	5/16/2012 10:20	GRAB		11.7	deg C
HATCH CAFH01	TEMPERATURE	6/27/2012 10:45	GRAB		11.6	deg C
HATCH CAFH01	TEMPERATURE	7/18/2012 10:30	GRAB		11.7	deg C
HATCH CAFH01	TEMPERATURE	8/15/2012 10:15	GRAB		11.9	deg C
HATCH CAFH01	TEMPERATURE	9/19/2012 11:15	GRAB		12.5	deg C
HATCH CAFH01	TEMPERATURE	10/17/2012 10:50	GRAB		13	deg C
HATCH CAFH01	TEMPERATURE	11/13/2012 11:50	GRAB		13.6	deg C
HATCH CAFH01	TEMPERATURE	12/19/2012 11:50	GRAB		12.4	deg C
HATCH CAFH01	TEMPERATURE	1/16/2013 11:35	GRAB		9.9	deg C
HATCH CAFH01	TEMPERATURE	2/20/2013 11:30	GRAB		9.3	deg C
HATCH CAFH01	TEMPERATURE	4/18/2013 9:15	GRAB		11.51	deg C
HATCH CAFH01	TEMPERATURE	5/15/2013 11:50	GRAB		10.6	deg C
HATCH CAFH01	TEMPERATURE	6/19/2013 11:50	GRAB		11.2	deg C
HATCH CAFH01	TEMPERATURE	7/24/2013 11:30	GRAB		11.7	deg C
HATCH CAFH01	TEMPERATURE	8/28/2013 11:20	GRAB		12.6	deg C

Locator	Parameter	Collect Date	Sample Type	Qualifier	Results	Units
HATCH CAFH01	TEMPERATURE	9/18/2013 11:40	GRAB		13	deg C
HATCH CAFH01	TEMPERATURE	10/16/2013 11:50	GRAB		13.7	deg C
HATCH CAFH01	TEMPERATURE	11/20/2013 11:40	GRAB		13.2	deg C
HATCH CAFH01	TEMPERATURE	12/18/2013 11:20	GRAB		11.5	deg C
HATCH CAFH01	TEMPERATURE	1/22/2014 10:50	GRAB		10.3	deg C
HATCH CAFH01	TEMPERATURE	2/26/2014 11:40	GRAB		10.7	deg C
HATCH CAFH01	TEMPERATURE	3/19/2014 11:50	GRAB		11.8	deg C
HATCH CAFH01	TEMPERATURE	4/16/2014 12:00	GRAB		12	deg C
HATCH CAFH01	TEMPERATURE	5/28/2014 11:45	GRAB		13.8	deg C
HATCH CAFH01	TEMPERATURE	6/18/2014 10:55	GRAB		14.9	deg C
HATCH CAFH01	TEMPERATURE	7/16/2014 11:20	GRAB		15.6	deg C
HATCH CAFH01	TEMPERATURE	8/20/2014 11:45	GRAB		16.2	deg C
HATCH CAFH01	TEMPERATURE	9/29/2014 11:05	GRAB		16.1	deg C
HATCH CAFH01	TEMPERATURE	10/20/2014 11:35	GRAB		15.8	deg C
HATCH CAFH01	TEMPERATURE	11/18/2014 11:00	GRAB		15.9	deg C
HATCH CAFH01	TEMPERATURE	12/18/2014 11:20	GRAB		13.5	deg C
MS ELLIOTT	CADMIUM	1/20/2010 11:30	GRAB	U	0.051	ug/L
MS ELLIOTT	CADMIUM	2/24/2010 12:00	GRAB	U	0.051	ug/L
MS ELLIOTT	CADMIUM	3/17/2010 13:30	GRAB	U	0.051	ug/L
MS ELLIOTT	CADMIUM	4/21/2010 12:50	GRAB	U	0.051	ug/L
MS ELLIOTT	CADMIUM	5/26/2010 9:30	GRAB	U	0.051	ug/L
MS ELLIOTT	CADMIUM	6/23/2010 13:25	GRAB	U	0.051	ug/L
MS ELLIOTT	CADMIUM	7/21/2010 13:00	GRAB	U	0.051	ug/L
MS ELLIOTT	CADMIUM	8/25/2010 13:00	GRAB	U	0.051	ug/L
MS ELLIOTT	CADMIUM	9/22/2010 11:30	GRAB	U	0.051	ug/L
MS ELLIOTT	CADMIUM	10/20/2010 13:10	GRAB	U	0.051	ug/L
MS ELLIOTT	CADMIUM	11/17/2010 13:20	GRAB	U	0.051	ug/L
MS ELLIOTT	CADMIUM	12/16/2010 13:15	GRAB	U	0.051	ug/L
MS ELLIOTT	CADMIUM	1/19/2011 12:55	GRAB	U	0.051	ug/L
MS ELLIOTT	CADMIUM	2/16/2011 12:10	GRAB	U	0.02	ug/L
MS ELLIOTT	CADMIUM	3/16/2011 13:30	GRAB	U	0.02	ug/L
MS ELLIOTT	CADMIUM	4/20/2011 12:50	GRAB	U	0.02	ug/L

Locator	Parameter	Collect Date	Sample Type	Qualifier	Results	Units
MS ELLIOTT	CADMIUM	5/18/2011 12:55	GRAB	U	0.02	ug/L
MS ELLIOTT	CADMIUM	6/15/2011 13:15	GRAB	U	0.02	ug/L
MS ELLIOTT	CADMIUM	7/20/2011 13:15	GRAB	U	0.02	ug/L
MS ELLIOTT	CADMIUM	8/17/2011 13:00	GRAB	U	0.02	ug/L
MS ELLIOTT	CADMIUM	9/28/2011 11:00	GRAB	U	0.02	ug/L
MS ELLIOTT	CADMIUM	10/19/2011 13:20	GRAB	U	0.02	ug/L
MS ELLIOTT	CADMIUM	11/16/2011 13:15	GRAB	U	0.02	ug/L
MS ELLIOTT	CADMIUM	12/14/2011 12:40	GRAB	U	0.02	ug/L
MS ELLIOTT	CADMIUM	1/18/2012 9:10	GRAB	U	0.02	ug/L
MS ELLIOTT	CADMIUM	2/15/2012 13:15	GRAB	U	0.02	ug/L
MS ELLIOTT	CADMIUM	3/21/2012 12:30	GRAB	U	0.02	ug/L
MS ELLIOTT	CADMIUM	4/24/2012 13:15	GRAB	U	0.02	ug/L
MS ELLIOTT	CADMIUM	5/16/2012 12:50	GRAB	U	0.02	ug/L
MS ELLIOTT	CADMIUM	6/27/2012 13:00	GRAB	U	0.02	ug/L
MS ELLIOTT	CADMIUM	7/18/2012 13:15	GRAB	U	0.02	ug/L
MS ELLIOTT	CADMIUM	8/15/2012 11:30	GRAB	U	0.02	ug/L
MS ELLIOTT	CADMIUM	9/19/2012 13:00	GRAB	U	0.02	ug/L
MS ELLIOTT	CADMIUM	10/17/2012 13:00	GRAB	U	0.02	ug/L
MS ELLIOTT	CADMIUM	11/13/2012 13:25	GRAB	U	0.02	ug/L
MS ELLIOTT	CADMIUM	12/19/2012 13:05	GRAB	U	0.02	ug/L
MS ELLIOTT	CADMIUM	1/16/2013 13:00	GRAB	U	0.02	ug/L
MS ELLIOTT	CADMIUM	2/20/2013 13:30	GRAB	U	0.02	ug/L
MS ELLIOTT	CADMIUM	3/20/2013 13:20	GRAB	U	0.02	ug/L
MS ELLIOTT	CADMIUM	4/18/2013 10:00	GRAB	U	0.02	ug/L
MS ELLIOTT	CADMIUM	5/15/2013 13:15	GRAB	U	0.02	ug/L
MS ELLIOTT	CADMIUM	6/19/2013 13:15	GRAB	U	0.02	ug/L
MS ELLIOTT	CADMIUM	7/24/2013 13:20	GRAB	U	0.02	ug/L
MS ELLIOTT	CADMIUM	8/28/2013 13:15	GRAB	U	0.02	ug/L
MS ELLIOTT	CADMIUM	9/18/2013 13:20	GRAB	U	0.02	ug/L
MS ELLIOTT	CADMIUM	10/16/2013 13:20	GRAB	U	0.02	ug/L
MS ELLIOTT	CADMIUM	11/20/2013 13:15	GRAB	U	0.02	ug/L
MS ELLIOTT	CADMIUM	12/18/2013 13:20	GRAB	U	0.02	ug/L
MS ELLIOTT	CADMIUM	1/22/2014 13:00	GRAB	U	0.02	ug/L
MS ELLIOTT	CADMIUM	2/26/2014 13:15	GRAB	U	0.02	ug/L
MS ELLIOTT	CADMIUM	3/19/2014 13:10	GRAB	U	0.02	ug/L
MS ELLIOTT	CADMIUM	4/16/2014 13:20	GRAB	U	0.03	ug/L
MS ELLIOTT	CADMIUM	5/28/2014 13:20	GRAB	U	0.02	ug/L
MS ELLIOTT	CADMIUM	6/18/2014 13:20	GRAB	U	0.02	ug/L
MS ELLIOTT	CADMIUM	7/16/2014 13:15	GRAB	U	0.02	ug/L
MS ELLIOTT	CADMIUM	8/20/2014 13:35	GRAB	U	0.02	ug/L

Locator	Parameter	Collect Date	Sample Type	Qualifier	Results	Units
MS ELLIOTT	CADMIUM	9/29/2014 13:20	GRAB	U	0.02	ug/L
MS ELLIOTT	CADMIUM	10/20/2014 13:15	GRAB	U	0.02	ug/L
MS ELLIOTT	CADMIUM	11/18/2014 13:00	GRAB	U	0.02	ug/L
MS ELLIOTT	CADMIUM	12/18/2014 13:15	GRAB	U	0.02	ug/L
MS ELLIOTT	COPPER	1/20/2010 11:30	GRAB		0.58	ug/L
MS ELLIOTT	COPPER	2/24/2010 12:00	GRAB		0.65	ug/L
MS ELLIOTT	COPPER	3/17/2010 13:30	GRAB		0.58	ug/L
MS ELLIOTT	COPPER	4/21/2010 12:50	GRAB		0.61	ug/L
MS ELLIOTT	COPPER	5/26/2010 9:30	GRAB		0.72	ug/L
MS ELLIOTT	COPPER	6/23/2010 13:25	GRAB		0.58	ug/L
MS ELLIOTT	COPPER	7/21/2010 13:00	GRAB		0.76	ug/L
MS ELLIOTT	COPPER	8/25/2010 13:00	GRAB		0.54	ug/L
MS ELLIOTT	COPPER	9/22/2010 11:30	GRAB		0.53	ug/L
MS ELLIOTT	COPPER	10/20/2010 13:10	GRAB		0.57	ug/L
MS ELLIOTT	COPPER	11/17/2010 13:20	GRAB		0.52	ug/L
MS ELLIOTT	COPPER	12/16/2010 13:15	GRAB		0.68	ug/L
MS ELLIOTT	COPPER	1/19/2011 12:55	GRAB		0.69	ug/L
MS ELLIOTT	COPPER	2/16/2011 12:10	GRAB		0.68	ug/L
MS ELLIOTT	COPPER	3/16/2011 13:30	GRAB		1.1	ug/L
MS ELLIOTT	COPPER	4/20/2011 12:50	GRAB		0.67	ug/L
MS ELLIOTT	COPPER	5/18/2011 12:55	GRAB		0.54	ug/L
MS ELLIOTT	COPPER	6/15/2011 13:15	GRAB		0.51	ug/L
MS ELLIOTT	COPPER	7/20/2011 13:15	GRAB		0.67	ug/L
MS ELLIOTT	COPPER	8/17/2011 13:00	GRAB		0.41	ug/L
MS ELLIOTT	COPPER	9/28/2011 11:00	GRAB		0.68	ug/L
MS ELLIOTT	COPPER	10/19/2011 13:20	GRAB		0.62	ug/L
MS ELLIOTT	COPPER	11/16/2011 13:15	GRAB		0.51	ug/L
MS ELLIOTT	COPPER	12/14/2011 12:40	GRAB		0.51	ug/L
MS ELLIOTT	COPPER	1/18/2012 9:10	GRAB		0.57	ug/L
MS ELLIOTT	COPPER	2/15/2012 13:15	GRAB		0.54	ug/L
MS ELLIOTT	COPPER	3/21/2012 12:30	GRAB		0.58	ug/L
MS ELLIOTT	COPPER	4/24/2012 13:15	GRAB		0.84	ug/L
MS ELLIOTT	COPPER	5/16/2012 12:50	GRAB		0.71	ug/L
MS ELLIOTT	COPPER	6/27/2012 13:00	GRAB		0.59	ug/L
MS ELLIOTT	COPPER	7/18/2012 13:15	GRAB		0.6	ug/L
MS ELLIOTT	COPPER	8/15/2012 11:30	GRAB		0.55	ug/L
MS ELLIOTT	COPPER	9/19/2012 13:00	GRAB		0.53	ug/L
MS ELLIOTT	COPPER	10/17/2012 13:00	GRAB		0.62	ug/L
MS ELLIOTT	COPPER	11/13/2012 13:25	GRAB		0.53	ug/L
MS ELLIOTT	COPPER	12/19/2012 13:05	GRAB	*	0.48	ug/L

Locator	Parameter	Collect Date	Sample Type	Qualifier	Results	Units
MS ELLIOTT	COPPER	1/16/2013 13:00	GRAB		0.36	ug/L
MS ELLIOTT	COPPER	2/20/2013 13:30	GRAB		0.61	ug/L
MS ELLIOTT	COPPER	3/20/2013 13:20	GRAB		0.57	ug/L
MS ELLIOTT	COPPER	4/18/2013 10:00	GRAB		0.68	ug/L
MS ELLIOTT	COPPER	5/15/2013 13:15	GRAB		0.63	ug/L
MS ELLIOTT	COPPER	6/19/2013 13:15	GRAB		0.69	ug/L
MS ELLIOTT	COPPER	7/24/2013 13:20	GRAB		0.66	ug/L
MS ELLIOTT	COPPER	8/28/2013 13:15	GRAB		0.57	ug/L
MS ELLIOTT	COPPER	9/18/2013 13:20	GRAB		0.62	ug/L
MS ELLIOTT	COPPER	10/16/2013 13:20	GRAB		0.56	ug/L
MS ELLIOTT	COPPER	11/20/2013 13:15	GRAB		0.63	ug/L
MS ELLIOTT	COPPER	12/18/2013 13:20	GRAB		0.59	ug/L
MS ELLIOTT	COPPER	1/22/2014 13:00	GRAB		0.57	ug/L
MS ELLIOTT	COPPER	2/26/2014 13:15	GRAB		0.38	ug/L
MS ELLIOTT	COPPER	3/19/2014 13:10	GRAB		0.44	ug/L
MS ELLIOTT	COPPER	4/16/2014 13:20	GRAB		0.57	ug/L
MS ELLIOTT	COPPER	5/28/2014 13:20	GRAB		0.59	ug/L
MS ELLIOTT	COPPER	6/18/2014 13:20	GRAB		0.66	ug/L
MS ELLIOTT	COPPER	7/16/2014 13:15	GRAB		0.64	ug/L
MS ELLIOTT	COPPER	8/20/2014 13:35	GRAB		0.58	ug/L
MS ELLIOTT	COPPER	9/29/2014 13:20	GRAB		0.61	ug/L
MS ELLIOTT	COPPER	10/20/2014 13:15	GRAB		0.58	ug/L
MS ELLIOTT	COPPER	11/18/2014 13:00	GRAB		0.59	ug/L
MS ELLIOTT	COPPER	12/18/2014 13:15	GRAB		1.3	ug/L
MS ELLIOTT	HARDNESS: TOTAL AS CACO3	1/20/2010 11:30	GRAB		17	mg/L
MS ELLIOTT	HARDNESS: TOTAL AS CACO3	2/24/2010 12:00	GRAB		17	mg/L
MS ELLIOTT	HARDNESS: TOTAL AS CACO3	3/17/2010 13:30	GRAB		16	mg/L
MS ELLIOTT	HARDNESS: TOTAL AS CACO3	4/21/2010 12:50	GRAB		16	mg/L
MS ELLIOTT	HARDNESS: TOTAL AS CACO3	5/26/2010 9:30	GRAB		15	mg/L
MS ELLIOTT	HARDNESS: TOTAL AS CACO3	6/23/2010 13:25	GRAB		15	mg/L
MS ELLIOTT	HARDNESS: TOTAL AS CACO3	7/21/2010 13:00	GRAB		16	mg/L
MS ELLIOTT	HARDNESS: TOTAL AS CACO3	8/25/2010 13:00	GRAB		17	mg/L
MS ELLIOTT	HARDNESS: TOTAL AS CACO3	9/22/2010 11:30	GRAB		19	mg/L
MS ELLIOTT	HARDNESS: TOTAL AS CACO3	10/20/2010 13:10	GRAB		18	mg/L
MS ELLIOTT	HARDNESS: TOTAL AS CACO3	11/17/2010 13:20	GRAB		14	mg/L
MS ELLIOTT	HARDNESS: TOTAL AS CACO3	12/16/2010 13:15	GRAB		15	mg/L
MS ELLIOTT	HARDNESS: TOTAL AS CACO3	1/19/2011 12:55	GRAB		16	mg/L
MS ELLIOTT	HARDNESS: TOTAL AS CACO3	2/16/2011 12:10	GRAB		14	mg/L
MS ELLIOTT	HARDNESS: TOTAL AS CACO3	3/16/2011 13:30	GRAB		18	mg/L
MS ELLIOTT	HARDNESS: TOTAL AS CACO3	4/20/2011 12:50	GRAB		18	mg/L

Locator	Parameter	Collect Date	Sample Type	Qualifier	Results	Units
MS ELLIOTT	HARDNESS: TOTAL AS CACO3	5/18/2011 12:55	GRAB		18	mg/L
MS ELLIOTT	HARDNESS: TOTAL AS CACO3	6/15/2011 13:15	GRAB		17	mg/L
MS ELLIOTT	HARDNESS: TOTAL AS CACO3	7/20/2011 13:15	GRAB		16	mg/L
MS ELLIOTT	HARDNESS: TOTAL AS CACO3	8/17/2011 13:00	GRAB		13	mg/L
MS ELLIOTT	HARDNESS: TOTAL AS CACO3	9/28/2011 11:00	GRAB		13	mg/L
MS ELLIOTT	HARDNESS: TOTAL AS CACO3	10/19/2011 13:20	GRAB		15	mg/L
MS ELLIOTT	HARDNESS: TOTAL AS CACO3	11/16/2011 13:15	GRAB		16	mg/L
MS ELLIOTT	HARDNESS: TOTAL AS CACO3	12/14/2011 12:40	GRAB		14	mg/L
MS ELLIOTT	HARDNESS: TOTAL AS CACO3	1/18/2012 9:10	GRAB		13	mg/L
MS ELLIOTT	HARDNESS: TOTAL AS CACO3	2/15/2012 13:15	GRAB		25	mg/L
MS ELLIOTT	HARDNESS: TOTAL AS CACO3	3/21/2012 12:30	GRAB		20	mg/L
MS ELLIOTT	HARDNESS: TOTAL AS CACO3	4/24/2012 13:15	GRAB		18	mg/L
MS ELLIOTT	HARDNESS: TOTAL AS CACO3	5/16/2012 12:50	GRAB		18	mg/L
MS ELLIOTT	HARDNESS: TOTAL AS CACO3	6/27/2012 13:00	GRAB		16	mg/L
MS ELLIOTT	HARDNESS: TOTAL AS CACO3	7/18/2012 13:15	GRAB		16	mg/L
MS ELLIOTT	HARDNESS: TOTAL AS CACO3	8/15/2012 11:30	GRAB		16	mg/L
MS ELLIOTT	HARDNESS: TOTAL AS CACO3	9/19/2012 13:00	GRAB		17	mg/L
MS ELLIOTT	HARDNESS: TOTAL AS CACO3	10/17/2012 13:00	GRAB		17	mg/L
MS ELLIOTT	HARDNESS: TOTAL AS CACO3	11/13/2012 13:25	GRAB		20	mg/L
MS ELLIOTT	HARDNESS: TOTAL AS CACO3	12/19/2012 13:05	GRAB		20	mg/L
MS ELLIOTT	HARDNESS: TOTAL AS CACO3	1/16/2013 13:00	GRAB		15	mg/L
MS ELLIOTT	HARDNESS: TOTAL AS CACO3	2/20/2013 13:30	GRAB		15	mg/L
MS ELLIOTT	HARDNESS: TOTAL AS CACO3	3/20/2013 13:20	GRAB		16	mg/L
MS ELLIOTT	HARDNESS: TOTAL AS CACO3	4/18/2013 10:00	GRAB		16	mg/L
MS ELLIOTT	HARDNESS: TOTAL AS CACO3	5/15/2013 13:15	GRAB		24	mg/L
MS ELLIOTT	HARDNESS: TOTAL AS CACO3	6/19/2013 13:15	GRAB		16	mg/L
MS ELLIOTT	HARDNESS: TOTAL AS CACO3	7/24/2013 13:20	GRAB		18	mg/L
MS ELLIOTT	HARDNESS: TOTAL AS CACO3	8/28/2013 13:15	GRAB		19	mg/L
MS ELLIOTT	HARDNESS: TOTAL AS CACO3	9/18/2013 13:20	GRAB		18	mg/L
MS ELLIOTT	HARDNESS: TOTAL AS CACO3	10/16/2013 13:20	GRAB		17	mg/L
MS ELLIOTT	HARDNESS: TOTAL AS CACO3	11/20/2013 13:15	GRAB		16	mg/L
MS ELLIOTT	HARDNESS: TOTAL AS CACO3	12/18/2013 13:20	GRAB		28	mg/L
MS ELLIOTT	HARDNESS: TOTAL AS CACO3	1/22/2014 13:00	GRAB		17	mg/L
MS ELLIOTT	HARDNESS: TOTAL AS CACO3	2/26/2014 13:15	GRAB		18	mg/L
MS ELLIOTT	HARDNESS: TOTAL AS CACO3	3/19/2014 13:10	GRAB		18	mg/L
MS ELLIOTT	HARDNESS: TOTAL AS CACO3	4/16/2014 13:20	GRAB		18	mg/L
MS ELLIOTT	HARDNESS: TOTAL AS CACO3	5/28/2014 13:20	GRAB		21	mg/L
MS ELLIOTT	HARDNESS: TOTAL AS CACO3	6/18/2014 13:20	GRAB		20	mg/L
MS ELLIOTT	HARDNESS: TOTAL AS CACO3	7/16/2014 13:15	GRAB		22	mg/L
MS ELLIOTT	HARDNESS: TOTAL AS CACO3	8/20/2014 13:35	GRAB		20	mg/L

Locator	Parameter	Collect Date	Sample Type	Qualifier	Results	Units
MS ELLIOTT	HARDNESS: TOTAL AS CACO3	9/29/2014 13:20	GRAB		20	mg/L
MS ELLIOTT	HARDNESS: TOTAL AS CACO3	10/20/2014 13:15	GRAB		19	mg/L
MS ELLIOTT	HARDNESS: TOTAL AS CACO3	11/18/2014 13:00	GRAB		20	mg/L
MS ELLIOTT	HARDNESS: TOTAL AS CACO3	12/18/2014 13:15	GRAB		22	mg/L
MS ELLIOTT	ZINC	1/20/2010 11:30	GRAB	U	1	ug/L
MS ELLIOTT	ZINC	2/24/2010 12:00	GRAB	U	1	ug/L
MS ELLIOTT	ZINC	3/17/2010 13:30	GRAB	U	1	ug/L
MS ELLIOTT	ZINC	4/21/2010 12:50	GRAB	U	1	ug/L
MS ELLIOTT	ZINC	5/26/2010 9:30	GRAB		1.2	ug/L
MS ELLIOTT	ZINC	6/23/2010 13:25	GRAB	U	1	ug/L
MS ELLIOTT	ZINC	7/21/2010 13:00	GRAB	U	1	ug/L
MS ELLIOTT	ZINC	8/25/2010 13:00	GRAB	U	1	ug/L
MS ELLIOTT	ZINC	9/22/2010 11:30	GRAB	U	1	ug/L
MS ELLIOTT	ZINC	10/20/2010 13:10	GRAB	U	1	ug/L
MS ELLIOTT	ZINC	11/17/2010 13:20	GRAB	U	1	ug/L
MS ELLIOTT	ZINC	12/16/2010 13:15	GRAB	U	1	ug/L
MS ELLIOTT	ZINC	1/19/2011 12:55	GRAB	U	1	ug/L
MS ELLIOTT	ZINC	2/16/2011 12:10	GRAB	U	1	ug/L
MS ELLIOTT	ZINC	3/16/2011 13:30	GRAB	U	1	ug/L
MS ELLIOTT	ZINC	4/20/2011 12:50	GRAB	U	1	ug/L
MS ELLIOTT	ZINC	5/18/2011 12:55	GRAB	U	1	ug/L
MS ELLIOTT	ZINC	6/15/2011 13:15	GRAB	U	1	ug/L
MS ELLIOTT	ZINC	7/20/2011 13:15	GRAB		1.1	ug/L
MS ELLIOTT	ZINC	8/17/2011 13:00	GRAB	U	1	ug/L
MS ELLIOTT	ZINC	9/28/2011 11:00	GRAB		1.8	ug/L
MS ELLIOTT	ZINC	10/19/2011 13:20	GRAB	U	1	ug/L
MS ELLIOTT	ZINC	11/16/2011 13:15	GRAB	U	1	ug/L
MS ELLIOTT	ZINC	12/14/2011 12:40	GRAB	U	1	ug/L
MS ELLIOTT	ZINC	1/18/2012 9:10	GRAB	U	1	ug/L
MS ELLIOTT	ZINC	2/15/2012 13:15	GRAB	U	1	ug/L
MS ELLIOTT	ZINC	3/21/2012 12:30	GRAB	U	1	ug/L
MS ELLIOTT	ZINC	4/24/2012 13:15	GRAB	U	1	ug/L
MS ELLIOTT	ZINC	5/16/2012 12:50	GRAB	U	1	ug/L
MS ELLIOTT	ZINC	6/27/2012 13:00	GRAB	U	1	ug/L
MS ELLIOTT	ZINC	7/18/2012 13:15	GRAB	U	1	ug/L
MS ELLIOTT	ZINC	8/15/2012 11:30	GRAB	U	1	ug/L
MS ELLIOTT	ZINC	9/19/2012 13:00	GRAB	U	1	ug/L
MS ELLIOTT	ZINC	10/17/2012 13:00	GRAB	U	1	ug/L
MS ELLIOTT	ZINC	11/13/2012 13:25	GRAB	U	1	ug/L
MS ELLIOTT	ZINC	12/19/2012 13:05	GRAB	U	1	ug/L

Locator	Parameter	Collect Date	Sample Type	Qualifier	Results	Units
MS ELLIOTT	ZINC	1/16/2013 13:00	GRAB	U	1	ug/L
MS ELLIOTT	ZINC	2/20/2013 13:30	GRAB	U	1	ug/L
MS ELLIOTT	ZINC	3/20/2013 13:20	GRAB		1	ug/L
MS ELLIOTT	ZINC	4/18/2013 10:00	GRAB		1.1	ug/L
MS ELLIOTT	ZINC	5/15/2013 13:15	GRAB	U	1	ug/L
MS ELLIOTT	ZINC	6/19/2013 13:15	GRAB	U	1	ug/L
MS ELLIOTT	ZINC	7/24/2013 13:20	GRAB		1.1	ug/L
MS ELLIOTT	ZINC	8/28/2013 13:15	GRAB	U	1	ug/L
MS ELLIOTT	ZINC	9/18/2013 13:20	GRAB	U	1	ug/L
MS ELLIOTT	ZINC	10/16/2013 13:20	GRAB	U	1	ug/L
MS ELLIOTT	ZINC	11/20/2013 13:15	GRAB	U	1	ug/L
MS ELLIOTT	ZINC	12/18/2013 13:20	GRAB	U	1	ug/L
MS ELLIOTT	ZINC	1/22/2014 13:00	GRAB	U	1	ug/L
MS ELLIOTT	ZINC	2/26/2014 13:15	GRAB	U	1	ug/L
MS ELLIOTT	ZINC	3/19/2014 13:10	GRAB	U	1	ug/L
MS ELLIOTT	ZINC	4/16/2014 13:20	GRAB	U	2	ug/L
MS ELLIOTT	ZINC	5/28/2014 13:20	GRAB	U	1	ug/L
MS ELLIOTT	ZINC	6/18/2014 13:20	GRAB	U	1	ug/L
MS ELLIOTT	ZINC	7/16/2014 13:15	GRAB	U	1	ug/L
MS ELLIOTT	ZINC	8/20/2014 13:35	GRAB	U	1	ug/L
MS ELLIOTT	ZINC	9/29/2014 13:20	GRAB		6.6	ug/L
MS ELLIOTT	ZINC	10/20/2014 13:15	GRAB	U	1	ug/L
MS ELLIOTT	ZINC	11/18/2014 13:00	GRAB	U	1	ug/L
MS ELLIOTT	ZINC	12/18/2014 13:15	GRAB		1.2	ug/L

Source: EBMUD Water Quality Section

10.2 Groundwater Quality

A complete suite of water quality analyses was conducted on the proposed extraction Well K-13 in January 2016. The groundwater is of high quality with 180 mg/L Total Dissolved Solids, and meets all primary drinking water standards. The well was tested for a variety of pesticides, chlorinated acids, dibromo-chloropropane (DBCP), and uranium, none of which were detected.